

# Opportunities and challenges of interprofessional collaboration and education

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**Published in**

Frontiers in Medicine  
Frontiers in Education



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ISSN 1664-8714  
ISBN 978-2-8325-4704-5  
DOI 10.3389/978-2-8325-4704-5

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# Opportunities and challenges of interprofessional collaboration and education

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## Citation

Thistlethwaite, J., Musaeus, P., Mueller-Schilling, M., Schlosser, S., eds. (2024).  
*Opportunities and challenges of interprofessional collaboration and education*.  
Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-4704-5

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## OPEN ACCESS

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RECEIVED 27 February 2024  
ACCEPTED 05 March 2024  
PUBLISHED 21 March 2024

CITATION  
Thistlethwaite JE, Musaeus P and Müller M  
(2024) Editorial: Opportunities and challenges  
of interprofessional collaboration and  
education. *Front. Med.* 11:1392690.  
doi: 10.3389/fmed.2024.1392690

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# Editorial: Opportunities and challenges of interprofessional collaboration and education

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## KEYWORDS

interprofessional collaboration, interprofessional education, interprofessional collaborative practice, interprofessional collaborative practice competencies, interprofessional learning

## Editorial on the Research Topic

### Opportunities and challenges of interprofessional collaboration and education

In the contemporary era, health and social care are delivered by different professionals who engage with patients, clients, families, and communities. These encounters require interprofessional collaborative practice (IPCP) defined as “the process of developing and maintaining effective interprofessional working relationships with learners, practitioners, patients/clients/families and communities to enable optimal health outcomes” (1). IPCP is thus quality care that does not happen automatically by involving different professionals but requires attention to many factors including location, context, methods of communication, level of understanding of team roles, team tasks, professional backgrounds, scopes of practice, and patient experiences. Due to the intricate web of social interactions required, IPCP can be extremely challenging.

Collaboration encompasses teamwork and in addition other models of interprofessional working that occur in contemporary health care systems. It is a complex process that is not confined to person to person social interaction such as, for example, between nurse and patient, but rather interactions amongst health and social care organizations, teams, and professionals working to ensure a patient's trajectory in the healthcare system is as efficient and humane as possible. Thus, IPCP is relevant not only in individual social interactions but also broadly within societies' health and social care systems. IPCP can be conceived in terms of regulated agents as: “a process in which autonomous or semi-autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions” (2). Six elements influencing interprofessional working have been identified: shared team identity; clear roles/goals; interdependence; integration; shared responsibility; and team tasks (3). These occur in various degrees from co-located teamwork with a few members to much wider networks with lesser levels of interdependence, integration and shared responsibility as the number of people involved increases.

Preparing professionals for collaboration requires specific training, including learning from self and others. As the title of a World Health Organization publication from 1988 succinctly states this involves “learning together to work together” (4). The Centre for

the Advancement of Interprofessional Education's (CAIPE) definition of interprofessional education (IPE) is “occasions when two or more professions learn with, from and about each other, to improve collaboration, and the quality of care” (5). The definition stresses the interactive nature of interprofessional learning (IPL) that may be formal, informal or serendipitous. IPL should involve more than simple observation of professionals at work, for example a medical student sitting in with a nurse practitioner, but rather participation, simulation and, if feasible, authentic real-life placements where learners become part of the team. There is a burgeoning literature on the contextual nature of IPC and factors leading to successful IPE.

The field of interprofessional education and collaborative practice (IPECP) research and evaluation is expanding. The global network, InterprofessionalResearch. Global (IPR.Global), has proposed three areas for IPECP research that include building the science and scholarship of IPECP, addressing the complexity of interprofessional endeavors through innovative approaches, and developing evidence of impact along the continuum from IPE to service delivery (6). These areas encompass health professional education, practice, and the connection between them.

In this *Frontiers in Medicine, Healthcare Professions Education, Research Topic on Opportunities and challenges of interprofessional collaboration and education*, the collection of 13 papers covers a range of topics related to IPECP but primarily focuses on IPE. Seven are of German authorship, reflecting in part the growth of IPE in Germany and indeed the other German-speaking countries of Austria and Switzerland. These three countries have formed a regional network, IP-Health (Society for Interprofessional Health and Social Care), which is a member of Interprofessional.Global ([www.interprofessional.global](http://www.interprofessional.global)).

At the forefront of authentic practice-based IPE for health professional students are the interprofessional training wards (IPTW), which are functioning inpatient wards staffed by students working collaboratively under supervision. The first documented IPTW was opened in Sweden in 1996 (7). The first German IPTWs were implemented in 2017 (8). Evaluation of such wards contributes to our knowledge of the impact of IPE on student learning and factors contributing to such learning, and three papers from Germany on IPTWs are included in this Research Topic. Mitzkat et al. report on the development of individual competencies and team performance of medical and nursing students on placement in the Heidelberg IPTW. Straub et al. studied an IPTW in pediatrics in Freiburg and its effectiveness in training nursing and medical students. A questionnaire was developed to evaluate students' learning experiences and program structure. In their study on patient perspectives within an IPTW in internal medicine in Regensburg, Schlosser-Hupf et al. found that the clinical impact of these educational structures was significant, with 96.7% of patients appreciating the ward rounds' atmosphere and conduct, and 98.3% satisfied with treatment discussions and information during their hospital stay.

In addition, Albrecht et al. discuss that health professionals such as physicians and nurses contribute significantly to the

transformation process toward a healthy, sustainable and climate-sensitive society. The results of their survey suggest that the current state of climate-specific health literacy differs between different groups of health professionals. They conclude that there is a need to improve health professionals' levels of climate-specific health literacy and that IPCP and IPTWs play an important role in increasing awareness and knowledge regarding planetary health.

Other IPL activities included in this Research Topic focus on learning through adaptation and simulation (De Wever et al.) and during student placements on international electives (Nawagi et al.). Specific areas for IPL covered in the collection include care of patients with dementia (Dressel et al.), and point-of-care ultrasound (POTUS) for post-licensure emergency department team-based health professionals (Witte et al.). These papers highlight the need for interactive learning and planning by an interprofessional team.

IPL should be focussed on helping students to meet defined interprofessional competencies or learning outcomes. There are several interprofessional competency frameworks that can assist in such definition, two of the most cited being those of the Canadian Interprofessional Health Collaborative of 2010 (1), currently being updated, and the Interprofessional Education Collaborative Expert Panel, updated in 2023 (9). However, in recognition of diverse populations and health systems globally, some jurisdictions devise their own lists to meet the needs of their local communities. Andersen et al. present their synthesis of national expert opinion on interprofessional competency indicators for health professional students in New Zealand particularly in public health promotion.

Another important factor in IPE is faculty development: training of academic staff for interprofessional facilitation. Schlicker et al. consider the challenges of introducing IPE in Germany when educators are insufficiently prepared and advocate for specific training that includes interprofessional learning for the educators themselves, with two or more professions learning together to develop IPE competencies.

Given that healthcare communication is complex, interprofessional communication is perhaps even more complicated. There is a danger of poor health communication (between health professionals or between health professional and patient). Therefore there is a need for research on what is good interprofessional communication and the mechanisms explaining why some modes of communication are more efficient than others. This is addressed in two scoping reviews. First, in a scoping review on distributed team processes in healthcare services, Eid et al. identify the need for improved communication and coordination, especially in geographically dispersed settings. Also, the study emphasizes the need for more (longitudinal as well as intervention-control) research, particularly from low- and middle-income countries. In the study by Abu-Rish Blakeney et al. it was found that poor communication in healthcare leads to inefficiencies, errors, and conflicts. In this study a model is proposed on how to involve multiple healthcare professions, patients, and families in collaborative care planning. Research and evaluation of IPE benefits from interdisciplinary as well as interprofessional input: exploring the utilization of concepts and

ways of working from disciplines not traditionally associated with health care. Ferreira et al. advocate for the application of systems engineering (SE) to help manage and sustain the complexity of IPE and its aim of improving patient care through interprofessional collaboration.

The World Health Organization in 2010 concluded that one of the most promising solutions in view of the megatrends in healthcare can be found in interprofessional collaboration (10). We extend our gratitude to all researchers across various disciplines who have contributed their work to our Research Topic of interprofessional collaboration and education. We hope our readers find valuable insights and benefits for their research, teaching, and clinical practices, further enriching this important field.

## Author contributions

JT: Writing—review & editing, Writing—original draft. PM: Writing—review & editing, Writing—original draft. MM: Writing—original draft, Writing—review & editing.

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## Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

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## OPEN ACCESS

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## SPECIALTY SECTION

This article was submitted to  
Healthcare Professions Education,  
a section of the journal  
Frontiers in Medicine

RECEIVED 14 January 2023

ACCEPTED 13 March 2023

PUBLISHED 24 March 2023

## CITATION

Andersen P, Broman P, Tokolahi E, Yap JR and  
Brownie S (2023) Determining a common  
understanding of interprofessional  
competencies for pre-registration health  
professionals in Aotearoa New Zealand:  
A Delphi study.  
*Front. Med.* 10:1119556.  
doi: 10.3389/fmed.2023.1119556

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# Determining a common understanding of interprofessional competencies for pre-registration health professionals in Aotearoa New Zealand: A Delphi study

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There is growing awareness that factors such as the growing incidence of co-morbidity and increasing complexity of patient health needs cannot be addressed by health professionals practicing in isolation. Given this, there is an increasing emphasis on preparing students in health-related programs for effective interprofessional practice. Less clear, however, are the specific skills and clinical or learning opportunities necessary for students to develop effectiveness in interprofessional practice. These factors drove a team associated with a tertiary health education provider in Hamilton, New Zealand to transform traditional clinical student experiences in the form of an interprofessional student-assisted clinic. The clinic was intended, in part, to provide students with opportunities to learn and experience interprofessionalism in practice but was hampered by limited information available regarding the specific skill requirements necessary for students in New Zealand to learn in this context. In this Delphi study, we synthesize national expert opinion on student competency indicators necessary for effective interprofessional practice. The resultant set of indicators is presented and opportunities for application and further research discussed. The paper offers guidance to others seeking to innovate health curricula, develop novel service-oriented learning experiences for students, and foster interprofessional practice competence in the future health workforce.

## KEYWORDS

interprofessional education, competencies, assessment, curriculum transformation, Delphi, health workforce education, New Zealand



## 1. Introduction

Similar to other developed nations, the growing burden of poor population health in Aotearoa New Zealand has been well publicized (1). The Ministry of Health (MoH) records that over the last 10 years, the estimated rate of diabetes among New Zealanders has increased from 35.7 per 1,000 population in 2012 to 41.5 in 2021. Adult and child obesity are also on the rise, with 1 in 3 adults (34.3%) and 1 in 8 children (12.7%) classified as obese in 2019/2020. MoH further reports that adults and children living in socioeconomically deprived areas were 1.6 times and 2.5 times as likely to be obese as those living in the least deprived areas. The challenge of these health issues, and health disparities requires both an understanding of the principles of non-communicable disease management and control and the role of environmental factors in health and disease (2). Moreover, the increasing complexity of patient care requirements and the incidence of co-morbidity requires health and social service practitioners to collaborate in the delivery of care (3). In other words, to be effective in addressing the needs of the population, health interventions increasingly require the collective efforts of professionals from a very wide array of fields (4).

Within the educational context, this calls for curricula and programs of study which place an emphasis on interprofessional practice, known as interprofessional education (IPE) (5, 6). In one definition, IPE is understood to occur when “students from two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes” [1 p. 13, (7)]. How IPE is conceptualized and practiced can vary depending on the country and the healthcare setting. Further to this, regulations on interprofessional competencies vary across countries (8, 9). Despite this variability, some commonly described themes and elements include effective communication, mutual respect, teamwork, reflexive practice, leadership and management, and ethical considerations (10–12). While general and didactic, such competencies help to grow healthcare professionals that can share information and ideas, to negotiate and resolve conflicts, and to work effectively as part of multidisciplinary healthcare teams in the management of complex patient care. This has been shown to result in improved healthcare experiences and outcomes and reduced healthcare costs (10, 13, 14).

In this background there is an urgent need for academic institutions to respond with opportunities for students to learn and demonstrate competency in an interprofessional context (5, 6) and develop competency assessment tools to accommodate assessment of students practicing in this context (15, 16). To do so, Loura et al. (11) suggest a competency-based approach, aligning interprofessional competency frameworks to learning-outcomes based curricula to ensure proper appropriation of knowledge and implementation of IPE in practice to enable learners to take more responsibility for their own learning and development (17). Grymonpre et al. (18) argue that successful implementation of IPE requires collaborative efforts at macro-, meso-, and micro- levels. For example, they suggest creating partnerships between higher education institutions, government and practice communities (macro-level), developing and revising a strategic IPE plan (meso-level), and adopting common frameworks and language (micro-level) when advancing IPE. Put together,

they highlight the importance of creating authentic, experiential IPE for health professionals in training as knowledge cannot be independent of the situations where it is learned and applied (19). However, understaffing and complex workplace issues fueling the lack of clinical placements make offering students opportunities to work with other professions across the sector difficult. These circumstances call for creative curriculum delivery and create an opportunity for a more “personalized learning” model with an emphasis on heutagogical (student-driven) models of education, underpinned by real-world application of knowledge and skills that involve problem and project-based learning (20).

One approach internationally to transforming health curricula and enhancing the development of interprofessional practice has been the introduction of student-assisted or student-led clinics (21–23). One such project, He Kaupapa Oranga Tahi, based in Hamilton, New Zealand, was initiated with the aim of promoting and integrating IPE. The project undertaken by our team is funded by Trust Waikato with these overarching objectives: establish an interprofessional center of clinical training excellence preparing health professionals with a high level of clinical capability, cultural competence, and community insight. In this clinic, Waikato Institute of Technology–Te Pūkenga students from different professions (nursing, physiotherapy, occupational therapy, social work, counseling, exercise physiology, and sports science), working under the supervision of health professionals, undertake community-based clinical experience providing primary health care as a team, strongly networked to community-based health and social service provider partners. The clinic focuses on diabetes, heart disease, and mobility and falls prevention as particular healthcare needs in the local community (1, 22). The intention is for the clinic to provide an opportunity for students to come to an understanding of their professional role and that of other professionals they work with, and how collectively as a team they contribute to health care outcomes (12, 21, 22). The development of this innovative clinical and placement experience prompted consideration of suitable curricula for involved students, particularly around the skills and competencies required to operate effectively in this interprofessional environment.

In a tertiary education context, it is essential that assessment of competency requirements is consistent with the learning outcomes defined in each discipline’s program of study and meet the requirements of each discipline’s regulatory body. Although there is an identified need for more studies investigating behavior-based or competency-based outcomes of interprofessional practice (15, 16, 22), there is no consensus about what these outcomes should include, particularly for pre-registration health professionals in New Zealand. Various tools and frameworks exist internationally (24–30), and the Otago Interprofessional Education Conceptual Model (31) outlines domains of competency relevant to the New Zealand context, consistent with international literature. However, no behavioral or performance indicators were found to complement this model and no known competency tools have been found that assess pre-registration (as opposed to graduate level) interprofessional competencies across health disciplines in New Zealand. To facilitate the development of a competency assessment tool suitable for assessing practice expectations of students working in an interprofessional student-assisted clinic, this enquiry sought to determine expert consensus, from academic

staff supporting the learning of students from a range of health disciplines, to the question “What knowledge, skills and behaviors do health discipline experts consider indicators of competent student interdisciplinary practice in New Zealand?”

Detailed examination of this topic in New Zealand is timely, given the health programme unification currently underway as part of the government’s wider Reform of Vocational Education (RoVE) programme. These reforms have included the merger of 16 existing local “Institutes of Technology and Polytechnics” (ITPs), and 9 industry training organizations (ITOs) into a large, unified non-university tertiary education provider—Te Pūkenga—The New Zealand Institute of Skills and Technology (32). Its predecessor organizations delivered or arranged over 2,000 programs to more than 200,000 learners across the country, including health programmes leading to registration in most fields outside of medicine and dentistry. Significant work is currently underway developing single, “unified” programs of study for the newly established entity to deliver across the country in each learning category (32). This unification of multiple programmes of study into single programmes gives further impetus for defining a collective national view of necessary competencies for effective interprofessional practice across disciplines. Understanding student practice expectations and embedding the interprofessional domains and indicators into one framework will set the foundation for genuinely responsive best practices to be cultivated, implemented, and assessed in these unified programmes.

## 2. Materials and methods

### 2.1. Study design

The study followed a Delphi methodology for determining consensus on a question of interest from experts in the field (33). This well-established technique is common in healthcare and nursing fields (34). With an underlying assumption that expert consensus is more valid than individual opinion, it involves two or more rounds of questionnaires amongst a panel of experts. Qualitative/open-ended questions aimed at identifying key factors from experts typically feature in early rounds, while later rounds are primarily quantitative, with experts indicating the extent to which they agree with various identified factors of interest (33, 35). Expert opinions are synthesized after each round and only those on which there is consensus are retained in future rounds, with the panel thus guided toward agreement. The number of rounds used is best determined by the level of consensus shown amongst expert participants.

A modified Delphi methodology was adopted as the aim was to achieve a collective consensus view of subject academics across a wide range of taught health fields/professions and institutions across Te Pūkenga—the New Zealand Institute of Skills and Technology. Unlike other group methods, a Delphi study does not require the researcher or participants to be located in proximity. In addition, it involves the blinding of participants, who work anonymously and independently from one another. This participant blinding reduces the risk of group dynamics influencing outcomes (33).

### 2.2. Participants

For this study, an expert was defined as a teaching staff member of a health or wellbeing-related Te Pūkenga program, with 5 + years of professional experience in their relevant field, and an interest in interprofessional education and practice. As teaching staff, each were both a health professional with an understanding of both their field and a health-related educator with experience teaching, supervising, and/or assessing healthcare students. We sought an expert sample in which each of the varied health-related fields of study currently taught within Te Pūkenga (nursing, medical imaging, paramedicine, counseling, social work, physiotherapy, osteopathy, massage, sport and exercise science, clinical exercise physiology, and occupational therapy) were represented, and with participants from a range of the 16 institutes of technology and polytechnics which at the time of data collection were undertaking a merger into Te Pūkenga—the New Zealand Institute of Skills and Technology. As a vocational (non-university) education provider, Te Pūkenga does not offer higher-level degrees in fields such as medicine or dentistry. In recognition of this fact, some IPE experts in university medical education programmes in New Zealand were also invited to participate.

The study was approved by the Wintec Human Ethics in Research Group (HERG), approval reference WTLR18170522 dated 20 May 2022, as a low-risk application. Potential participants were provided an information sheet and consent form prior to agreeing to participate, and informed consent was provided electronically *via* an initial survey section with agreement required prior to proceeding. Confidentiality in reporting was assured for participants and names were not collected, although some identifying information such as profession, teaching institution, and job title was asked for and is reported here by consent.

Subsequent to ethical approval, potential participant educators for the study were identified by (a) members of the research team; (b) purposive sampling of experienced staff from a list of all health programs offered by Te Pūkenga subsidiaries (identified *via* institutional websites); (c) snowball sampling whereby individuals asked to participate were also invited to provide details of appropriate experts. Sampling was deliberate inasmuch as at least one appropriate expert was sought from each health field taught in the Te Pūkenga network, and from a range of the 16 institutions undertaking the merger. In addition to teaching staff in Te Pūkenga-taught qualifications, several interprofessional education experts (in medicine) from the New Zealand university sector were also invited to participate, in recognition of their specific expertise in this field. The number of expert participants recruited ( $n = 17$ ) aligns to the Delphi panel size of between 15 and 30 participants recommended by De Villiers et al. (36).

### 2.3. Data tool, collection, and analysis

In the absence of consensus in the New Zealand context around interprofessional competencies necessary for students to develop, an initial survey tool was developed comprising of a list of 78 indicators of interprofessional competencies



that were collated from a range of sources (25, 26, 37–42). For the purposes of this inquiry, and guided by the literature, these were considered to group naturally into 6 key competency domains: *communication*; *leadership*; *interpersonal relationships and mutual support*; *monitoring and situational awareness*; *student knowledge*; and *student skills*. The initial (first round) survey also included an open-ended question for participants to indicate any competencies/indicators not included in the initial list.

Data collection was *via* three sequential survey rounds undertaken using SurveyMonkey® internet survey software (SurveyMonkey LLC, Portland, OR, USA), with invite links distributed by email. Partially completed surveys were excluded from analysis, on the assumption that partial completion reveals insight into participants' level of engagement. To maximize rigor, the order of lists within each key category was randomized for each participant in each round. Analysis of resulting data was undertaken using Excel® (Microsoft, Redmond, WA, USA). The study comprised two rating rounds (rounds 1 and 2) where participants rated the relevance of items (interprofessional competency indicators) on a 1–100 scale and a ranking round (round 3) where participants ranked the remaining items' importance against each other.

In (rating) round 1, consensus agreement was calculated using a combination of mean scores, indicating levels of importance, and quartile deviation, indicating the level of consensus (43). Items receiving a median score of 70 or greater and with an interquartile range of 20 or less were considered to have high consensus importance and proceeded to ranking round 3. In keeping with previous research (44), indicators in round 1 with median scores below 30 (indicating low importance) and with an interquartile range of 20 or less (indicating high consensus) were considered less important by high consensus and excluded from subsequent rounds. Items not meeting either criterion were considered uncertain and re-rated in round 2. In round 2 a median score of 70 or greater was required for items to proceed to round 3. In the final ranking round (round 3), mean rankings were calculated to indicate the collective expert view of the importance of each item (45).

### 2.3.1. Survey round 1

The first round was undertaken from 28 June to 10 August 2022. Initial invitations were emailed to 43 potential participants. Those of whom who did not complete were also sent a follow-up reminder email. A total of 17 experts completed the first round of the survey. For each indicator, participants were asked to show, on a 1–100 sliding scale, “the extent to which you agree the attribute, knowledge or skill is required for students to learn and demonstrate developing safe interprofessional practice.” The initial round also included a number of questions regarding participants' general characteristics, including professional role, number of years in profession and their teaching institution.

### 2.3.2. Survey round 2

The second round was undertaken from August 14 to 10 September 2022. A total of 15 of the 17 participants of the first survey round completed this round, which asked them to

reassess and indicate on a 1–100 scale the level of importance they attached to competency indicators retained from the initial list (consensus on high or low importance not having been achieved) and to do the same for additional indicators not included in the initial list but mentioned by one or more participants in the open-ended question of round 1. The similar scores achieved for retained indicators in this round compared to the first survey round suggested that further rating surveying would not result in significant further clarity and, therefore, results from the current and previous round were taken to provide a conclusive list of relevant competencies and indicators in New Zealand context.

### 2.3.3. Survey round 3

The final survey round was undertaken 10 October to 18 November 2022 and was completed by 12 of the 17 participants who had completed the earlier rounds. This round asked experts to rank, within each of the 6 key competency domains, the 73 important indicators agreed as relevant from earlier rounds, from most to least important. There is consensus within the literature that the number of items individuals can reasonably rank against each other is around 20 (46, 47). Here, the number of indicators retained to be ranked in the 6 key competency domains varied from 7 (in the knowledge competency domain) to 18 (in the leadership and interpersonal relationships and mutual support competency domains). This round was intended for experts to collectively determine the relative importance of each of the indicators, as an important corollary of identifying the indicators themselves.

## 3. Results

### 3.1. Participant characteristics

**Table 1** shows participants' general characteristics, as indicated in the first survey round. Of the 17 expert participants, fifteen represented six of the 16 predecessor Institute of Technology and Polytechnics (ITPs) of Te Pūkenga. They were from the New Zealand university sector and in roles explicitly related to interprofessional health education. Although no New Zealand-based educator in the field of paramedicine was successfully recruited (only one such program of study exists within Te Pūkenga), a New Zealand clinical educator of paramedicine currently associated with an Australian university was approached and agreed to participate.

Regarding participants' working experience, the shortest and longest time participants had been registered/practiced/taught in their professional field was 5 and 42 years, respectively. The average (mean) number of years of working experience was 25.2 years. Response rates are an important consideration for expert consultation, being an indication of the level of enthusiasm and engagement in the research amongst experts (34). Forty-three (43) experts were initially invited to participate, of whom 17 (40%) completed an initial survey. Subsequent recovery rates were relatively high, with 15 (88%) of the 17 initial participants completing the second round and 12 (71%) completing the third.

TABLE 1 Expert panel characteristics ( $n = 17$ ).

	N	%
<b>Gender</b>		
Male	6	35%
Female	11	65%
<b>Primary teaching programme/area of expertise</b>		
Nursing	3	23%
Medical imaging	2	12%
Paramedicine	1	6%
Counseling	1	6%
Social work	1	6%
Physiotherapy	1	6%
Osteopathy	1	6%
Massage	1	6%
Sport and exercise science	1	6%
Clinical exercise physiology	1	6%
Occupational therapy	1	6%
Midwifery	1	6%
Interprofessional education(Medicine)	2	12%
<b>Years of professional experience</b>		
Under 10 years	1	6%
10–19 years	4	24%
20–29 years	5	29%
30 + years	7	41%
<b>Rounds completed</b>		
Round 1 (1–100 scale rating and open-Ended question)	17	100%
Round 2 (1–100 scale rating)	15	88%
Round 3 (ranking)	12	71%

### 3.2. Rating rounds–interprofessional competency indicators

Consensus agreement was indicated in the first round by a median rating of 70 or greater and with a quartile deviation of 20 or less. Amongst the 17 experts who completed the first round, there was consensus agreement around the relevance or importance of 36 of the 78 interprofessional competency indicators included in the initial survey instrument. Three items in the initial survey were identified by consensus as unimportant (i.e., had a median score of less than 30 and an interquartile range of 20 or less). These were the leadership competency indicator *helps manage co-location*, and the skills competency indicators *education skills* and *counseling*.

There was uncertainty around 39 of the indicators in the primary survey (those having received a median score between 30 and 70 and/or a quartile deviation over 20). These indicators were re-rated in the second round. Also rated in the second round were 8 additional indicators mentioned by 6 participants in the open-ended question included in the first round. These were *avoiding bullying/antisocial behavior* (actively anti-bullying/speaking up) which was characterized in later rounds as an “interpersonal

relationships and mutual support” competency; *reflection*, *active listening skills*, *self-awareness*, *cultural safety/competency to work with difference* and *followership—the ability to take direction well* which were characterized as “student skill” competencies, and *understanding interprofessional values and ethics* and having *ability to work to strengths*, which were both characterized as indicators in the “student knowledge” competency domain. An overview of all competencies and indicators included in the study is provided in [Table 2](#).

In the second-round participants ( $n = 15$ ) were asked to rate again the importance of the 38 indicators where no consensus had been achieved and the additional 8 indicators identified by experts. In this round, a median rating of 70 (of 100) was required, a somewhat lesser requirement than the first round where the requirement for high consensus agreement (indicated by the interquartile range) was also included. Further rating rounds would increase the response burden on participants and were considered unlikely to offer significant further clarity. Of the 38 indicators retained from the earlier round, 31 met criteria for inclusion in the final list, although the relatively low consensus around these indicators compared to those that achieved consensus agreement (indicated by the low interquartile range) in the first round should be noted. Of the 8 additional indicators added by participants, all 8 achieved consensus agreement for inclusion in the final set of indicators, with median ratings of between 78 (for “reflection”) and 98 (for “understanding interprofessional values and ethics”).

Following rounds 1 and 2, consensus agreement was established around the importance of 73 core indicators or skills necessary for students preparing for interprofessional practice. This final set of indicators are grouped within the higher-level competencies, which could also be thought of as competency domains (24) or core competencies (48) of communication ( $n = 11$ ), leadership ( $n = 15$ ), interpersonal relationships and mutual support ( $n = 18$ ), monitoring and situational awareness ( $n = 11$ ), student knowledge ( $n = 7$ ), and student skills ( $n = 11$ ). Of the higher-level competencies, the highest levels of consensus agreement were shown for the indicators characterized in the “Interpersonal relationships and mutual support” domain. Of the 18 indicators included in this domain, 16 achieved consensus for inclusion in the first survey round. This compares with only 2 of 14 indicators in the monitoring and situational awareness domain that achieved consensus in the first round.

### 3.3. Ranking agreed interprofessional competencies

Following the two-round rating and indicator identification exercise of rounds 1 and 2, experts ( $n = 12$ ) ranked the final consensus set of 78 indicators within each of their 6 competency domains. The aim was for panel experts, given their experience and judgment, to determine the relevance and importance of indicators relative to each other, with obvious implications for the structure and focus of future healthcare training programs. The results of this exercise, with mean ranking scores (lower mean scores indicating higher rankings) are provided as [Table 3](#).

Asked to rank-order indicators to establish priorities amongst items, experts placed the greatest priority on *communicates*

*respectfully within all members of the healthcare team* within the “Communication” competency domain, *on understands the team structure* within the “Leadership” domain, *models effective teamwork* within the “Interpersonal relationships and mutual support” domain, *prioritizes actions* within the “Monitoring and situational awareness” domain, *understands interprofessional values and ethics* within the “Student knowledge” domain and *self-awareness* within the “Student skills” domain. The last two were both indicators identified by experts in the first round, not having been included in the original survey instrument.

## 4. Discussion

The aim of this study was to reach expert agreement on the IPE competencies necessary for students, and more specifically students in an New Zealand public health promotion and interdisciplinary context. A modified Delphi study sought the opinions of 17 expert academic staff teaching in health and social service programs in Te Pūkenga–New Zealand Institute of Skills and Technology, the primary national vocational education provider in New Zealand, and in medical training programmes in the local university sector. In two initial rating rounds, experts agreed with a high consensus on the importance of 73 interprofessional competency indicators. Indicators were initially derived from the literature on interprofessional practice/education, with additions nominated by experts. In the third-round, experts ranked the relative importance of indicators within each of the six domains.

At a high level, experts implicitly agreed, *via* their consensus view of the importance of 73 indicators as important for students to demonstrate in interprofessional practice, that competency in this area for New Zealand students cannot be distilled easily into one skillset, statement, or competency. This finding aligns with a consensus view in the literature that interprofessional practice is both complex and multifaceted (49–51). Expert opinion was generally supportive of the indicators obtained from the literature, which may not be surprising given that the experts were highly experienced teaching staff with an interest in the field. They were likely to be familiar with the literature on interprofessional competency and influenced by it. The alignment and agreement shown by local experts to indicators derived from existing literature do indicate the local relevance of global work in IPE, much of which originates in the United States and the United Kingdom (52, 53). As Green and Johnson (54) point out, all health (and education) systems within which future health care workers must be trained to work together exist in a local context.

One finding of note was that while the higher-level indicator *Promotes own disciplinary perspective within the team* was rated by experts as an important skill within the “communication” domain, more discipline-specific knowledges and skills (e.g., *Medication/pharmacology knowledge*, *Counseling*, and *Vital signs* etc.) were not recognized by the panel as important in an explicitly interprofessional context. While such discipline-specific knowledges are clearly important for relevant disciplines to be educated in and facilitate promoting one’s own disciplinary perspective within a team, it is assumed the panel did not consider competency in these indicators as vital to all members of healthcare teams aspiring to effective interprofessional practice.

This highlights how interprofessional learning outcomes are specific and focused and differ from core disciplinary skills. As O’Keefe et al. (27) suggest, “it can be argued that many interprofessional learning activities comprise core disciplinary competencies that are being taught in an interprofessional context rather than addressing specific interprofessional learning competencies *per se*” (p. 463). Educators should differentiate carefully between developing disciplinary skills or identity and developing interprofessional skills.

A number of higher-order competency indicators related to policy development and monitoring were not rated as important for students by the expert panel. For example, *Collaborates with the health team to generate new knowledge for the betterment of peoples’ lives, communities and wider society* and *Collaborates with the interprofessional team to develop policies and guidelines informed by best available evidence* and *Collaborates with the interprofessional team to monitor and update policies and guidelines informed by best available evidence* did not achieve consensus. This may be attributed to the practice-oriented nature of the survey and the fact panelists were asked to rate and rank necessary competencies for *students* of their disciplines. Such higher-order competency indicators as those may not be considered realistic to expect of health or social service students, or indeed novice practitioners, and may have been considered by the experts as important or relevant interprofessional competencies, though for advanced practitioners. There appears to be limited research exploring how interprofessional competencies develop over time, as practitioners progress from novice through to advanced clinicians. Interprofessional competency is not static and will dynamically evolve over a student’s, and later a clinician’s, time in practice. Panelists in the current study were invited to rank indicators as indicative of student level attainment. However, like practitioners’ progress from novice to more advanced levels of practice, there are graded levels of attainment for students too. For example, exposure, engagement, immersion and mastery of competency indicators might develop over a programme, as suggested in the Otago Interprofessional Education Conceptual Model (31). This level of distinction was not sought in the current study and could be beneficial to investigate in future research. For example, investigating which competencies are mastered earlier or later across a range of health programmes, or exploring if the competency indicators for first year nursing students are comparable with the competency indicators for first year occupational therapy students? The list of interprofessional competency indicators in the current study were found to represent a starting point, or baseline level of competency, from which further development in this area can proceed.

Panel experts identified the indicator *understands interprofessional values and ethics* as a clear oversight in the original survey instrument, perhaps not surprisingly given the ubiquity of reference to interprofessional values and ethics in the literature over time (24, 29), though more frequently framed as an overarching competency domain than indicator (24, 55, 56). When noting additional skills or competencies experts may not have differentiated between domain and indicator, and familiarity with the terms may have led to consensus more than questioning at what level interprofessional values and ethics are demonstrated. The degree of consensus agreement and high ranking of this indicator in subsequent rounds illustrates the extent to which

TABLE 2 Overview of interprofessional competencies and indicators.

Potential interprofessional competencies/Indicators	Round 1			Round 2		Final result
	Median	IQR	Result	Median	Result	
Communication						
Communication that facilitates a shared mental model	85	23	?	82	✓	✓
Effective communication with other professions	100	2	✓			✓
Understands and uses share terminology	100	29	?	98	✓	✓
Understands and uses shared documentation	78	23	?	72	✓	✓
Uses standardized clinical handover	80	49	?	68	–	–
Uses closed loop communication or “check back” to verify information	95	20	✓			✓
Engages in case conference/management	90	24	?	89	✓	✓
Engages in debrief	96	26	?	92	✓	✓
Applies conflict resolution techniques where required	100	20	✓			✓
Communicates respectfully with all members of the healthcare team	100	0	✓			✓
Uses only recognized terms and abbreviations when communicating	90	41	?	77	✓	✓
Promotes own disciplinary perspective within the team	87	31	?	90	✓	✓
Leadership						
Engages in collaborative leadership	98	30	?	92	✓	✓
Understands role responsibilities	100	2	✓			✓
Understands the team structure	91	17	✓			✓
Orientates the team	80	29	?	78	✓	✓
Articulates clear goals/plan	90	28	?	83	✓	✓
Includes patients and family whānau as part of the team	90	20	✓			✓
Understands responsibility for assigning tasks/Responsibilities to team members	80	27.75	?	82	✓	✓
Understands responsibility for managing/Allocating resources	80	40	?	76	✓	✓
Helps manage co-location	60	21	–	–	–	–
Engages in practice that maximizes activities of the team	90	14	✓			✓
Recognizes need to balance workloads in the team	90	25	?	83	✓	✓
Facilitates information sharing	100	10	✓			✓
Provides timely feedback to healthcare team	80	29	?	79	✓	✓
Monitors quality/efficiency – Reduction in clinical errors	90	31	?	87	✓	✓
Facilitates conflict resolution	90	40	?	92	✓	✓
Focuses on behaviors not personal attributes	92	10	✓			✓
Interpersonal relationships and mutual support						
Models effective teamwork	95	10	✓			✓
Develops role awareness	91	15	✓			✓
Facilitates collaboration	99	15	✓			✓
Understands roles of other health professionals	100	0	✓			✓
Respects knowledge and practice of others	100	7	✓			✓
Provides patient-centered care	100	8	✓			✓
Respects other’s culture/beliefs and values	100	2	✓			✓
Facilitates community and foster a climate where it is expected that assistance will be sought/offered	90	19	✓			✓
Protects others from high workload situations	59	30.75	?	63	–	–
Fosters mutual trust	100	7	✓			✓

(Continued)

TABLE 2 (Continued)

Potential interprofessional competencies/Indicators	Round 1			Round 2		Final result
	Median	IQR	Result	Median	Result	
Employs strategies to support team functioning	100	14	✓			✓
Anticipates support required	80	15	✓			✓
Anticipates other team members' needs	78	29.25	?	77	✓	✓
Advocates for the patient	99	18	✓			✓
Works in partnership with other healthcare professionals to define/Articulate common goals	100	15	✓			✓
Works collaboratively to improve health outcomes for individuals	99	15	✓			✓
Works collaboratively to improve health outcomes for populations	98	10	✓			✓
Collaborates to facilitate smooth transmission between services	100	14	✓			✓
Avoiding bullying/antisocial behavior (actively anti- bullying/speaking up)	Identified by experts			87	✓	✓
Monitoring and situational awareness						
Monitors environmental safety	99	25	?	94	✓	✓
Monitors context/triage acuity	82	28.75	?	77	✓	✓
Prioritizes actions	90	21	?	93	✓	✓
Uses strategies to monitor team performance	70	33	?	85	✓	✓
“Watches each other's backs”	83	27	?	80	✓	✓
Ensures mistakes/oversights are addressed quickly	99	21	?	95	✓	✓
Complies with policy and procedures	99	15	✓			✓
Monitors fatigue including psychological issues/stress	86	40	?	72	✓	✓
Monitors progress toward achievement of goals	99	20	✓			✓
Monitors status of team’s patient	99	19	✓			✓
Critically evaluates services delivered	90	38	?	77	✓	✓
Collaborates with the interprofessional team to develop policies and guidelines informed by best available evidence	86	24	?	62	–	–
Collaborates with the interprofessional team to monitor and update policies and guidelines informed by best available evidence	81	33.5	?	69	–	–
Collaborates with the health team to generate new knowledge for the betterment of peoples’ lives, communities and wider society	91	25	?	63	–	–
Student knowledge						
Develops an accurate/sound knowledge base	99	14	✓			✓
Understands group dynamics	86	21	?	83	✓	✓
Understands environmental culture	85	20	✓			✓
Develops discipline specific knowledge	98	24	?	98	✓	✓
Engages in shared decision-making	95	20	✓			✓
Medication/pharmacology knowledge	80	26	?	67	–	–
Understanding interprofessional values and ethics	Identified by experts			98	✓	✓
Having ability to work to strengths	Identified by experts			88	✓	✓
Student skills						
Health assessment	90	20	✓			✓
Group facilitation	72	47.75	?	60	–	–
Education skills	69	20	–	–	–	–
Counseling	60	17.75	–	–	–	–
Negotiation	70	17	✓			✓

(Continued)



TABLE 2 (Continued)

Potential interprofessional competencies/Indicators	Round 1			Round 2		Final result
	Median	IQR	Result	Median	Result	
Adaptability	90	20	✓			✓
Patient history	99	16	✓			✓
Vital signs	95	35	?	90	✓	✓
Medication administration	60	34.5	?	58	–	–
Communication	90	15	✓			✓
Reflection	Identified by experts			73	✓	✓
Active listening skills	Identified by experts			85	✓	✓
Self-awareness	Identified by experts			74	✓	✓
Cultural safety/Competency to work with difference	Identified by experts			93	✓	✓
Followership – the ability to take direction well	Identified by experts			89	✓	✓

experts agree that the explicit teaching of this content was essential. Effective interprofessional practice requires an understanding of differences in values and beliefs between disciplines (57). Exposure to IPE can promote proficiency for students in balancing views and understanding ethical dilemmas from different standpoints (58).

Of note is that the skill of followership arose as a significant indicator. Not originally included in the survey, followership was identified by experts in the first round and its importance reinforced in subsequent rounds. Followership can be defined as “the willingness to cooperate in a coordinated way to accomplish shared goals while engaging in collaborative teamwork” (59) (p. 82). McKimm and Vogan (60) argue that in developing teamworking and leadership skills, “learning how to be an authentic leader as well as a “proactive” follower can lead to more effective interprofessional teamworking and ultimately an improvement in health outcomes” (p. 41). While leadership-oriented research is historically more prominent, this is an increasing focus in healthcare scholarship that addresses followership, including acknowledging the need for health care clinicians to be “flexible in switching between leader and follower roles as appropriate to advance patient care” (61) (p. 3308). The relationship between followers and leaders is interdependent, followership can potentially reduce burnout, and followers can play a significant role in impacting successful outcomes in the work environment (62). Followership is therefore an important skill for students to develop when planning for an agile workforce and executing public health directives (62).

An additional indicator identified by experts in the first round, and reinforced in later rounds, was that of *cultural safety/competency to work with difference*. Cultural safety is a term that originated from nursing practice in New Zealand (63). As this nation becomes increasingly multicultural, and given its significant ethnic disparities in health, cultural competence must be reflected in healthcare practice. Broadly, this requires practitioners to recognize diverse contexts within and between cultural groups, and the impact of their own culture on their professional practice and interaction with clients (64) and how they work with other health professionals. Practitioners should therefore be able to function respectfully and effectively with people from different backgrounds and contribute positively to quality healthcare and achieving health equity. This is a moral and ethical obligation

that is also grounded in New Zealand legislation and manifests in regulatory body requirements reinforcing the role of health practitioners in reducing ongoing inequalities in health status and outcomes, particularly for Māori.

Increasing awareness of this dynamic in the local healthcare context likely played a role in the experts in this panel to identify this as necessary for effective interprofessional practice, though it is anticipated this would have arisen as essential for any interprofessional activity in New Zealand, regardless of the domain of focus. New Zealand is far from the only nation to experience health inequities and with recent social movements (such as Black Lives Matter) fore-fronting greater awareness of inequities, notions of cultural safety and responsiveness have attained international traction (65–67). While there is limited recognition of these concepts in explicitly IPE literature, it is possible that this field is just “catching up.” Taken as a whole, findings from this study seem to illustrate an expert belief that public health initiatives need to be interprofessional and culturally responsive by design; it is at this intersection that positive health outcomes can be achieved and sustained (68, 69).

## 4.1. Limitations

Limitations of this study must be noted. As a modified Delphi method, the study relied primarily on a preliminary list of competencies and indicators drawn from the literature. While this approach minimizes response burden and simplifies the approach, and opportunity was provided for participants to add any items not included to the list for subsequent rounds, this approach does raise the prospect that providing a predetermined list may introduce some level of conformity bias (70, 71). In addition, and although the study included multidisciplinary perspectives from health disciplines taught across in a national context, it only included staff from Te Pūkenga—the New Zealand Institute of Skills and Technology and interprofessional education staff from the New Zealand university sector. It cannot claim to be representative: participants were self-selected, and the sample size relatively low. Some fields (such as social work and sport science) were not represented in the latter rounds of the study. It should also be noted

TABLE 3 Indicators of interprofessional competency ( $n = 73$ ), ranked within competency domains.

Communication	$\bar{x}$	Leadership	$\bar{x}$	Interpersonal relationships and mutual support	$\bar{x}$	Monitoring and situational awareness	$\bar{x}$	Student knowledge	$\bar{x}$	Student skills	$\bar{x}$
Communicates respectfully with all members of the healthcare team	3.0	Understands the team structure	5.5	Models effective teamwork	4.9	Prioritizes actions	3.7	Understands interprofessional values and ethics	1.9	Self-awareness	4.0
Effective communication with other professions	4.0	Includes patients and family whānau as part of the team	6.7	Works in partnership with other healthcare professionals to define/articulate common goals	6.4	Monitors status of team's patient	4.4	Develops an accurate/+ sound knowledge base	2.3	Cultural safety/Competency to work with difference	4.4
Engages in debrief	5.7	Engages in collaborative leadership	6.8	Works collaboratively to improve health outcomes for individuals	6.9	Monitors progress toward achievement of goals	5.0	Understands group dynamics	2.9	Communication	4.6
Uses closed loop communication or "check back" to verify information	6.3	Understands role responsibilities	7.6	Understands roles of other health professionals	6.9	Complies with policy and procedures	5.1	Understands environmental culture	3.2	Reflection	4.8
Understands and uses shared documentation (=)	6.6	Engages in practice that maximizes activities of the team	8.6	Fosters mutual trust	7.1	Monitors context/Triage acuity	5.3	Ability to work to strengths	5.1	Active listening skills	5.4
Understands and uses shared terminology (=)	6.6	Articulates clear goals/Plan	8.6	Respects knowledge and practice of others	7.3	Uses strategies to monitor team performance	5.8	Engages in shared decision-making	5.3	Adaptability	6.7
Communication that facilitates a shared mental model	7.2	Facilitates information sharing	9.3	Advocates for the patient (=)	7.7	Monitors environmental safety	6.2	Develops discipline specific knowledge	5.4	Health assessment	6.8
Engages in case conference/management	7.3	Recognizes need to balance workloads in the team	9.8	Respects other's culture/beliefs and values (=)	7.7	Monitors fatigue including psychological issues/Stress	6.3			Followership –ability to take direction well	7.7
Applies conflict resolution techniques where required	7.8	Orientates the team (=)	10.3	Facilitates collaboration (=)	7.7	Ensures mistakes/Oversights are addressed quickly	7.1			Patient history	8.0
Promotes own disciplinary perspective within the team	8.5	Understands responsibility for assigning tasks/Responsibilities to team members (=)	10.3	Provides patient-centered care	8.0	Critically evaluates services delivered	8.1			Group facilitation	8.2
Uses only recognized terms and abbreviations when communicating	8.6	Provides timely feedback to healthcare team	10.9	Works collaboratively to improve health outcomes for populations	8.9	"Watches each other's backs"	9.2			Negotiation	9.4
		Monitors quality/Efficiency – Reduction in clinical errors	11.6	Avoiding bullying/antisocial behavior (actively anti-bullying/Speaking up)	10.5						
		Focuses on behaviors not personal attributes	11.9	Employs strategies to support team functioning	10.6						
		Understands responsibility for managing/Allocating resources	12.5	Develops role awareness	11.0						
		Facilitates conflict resolution	12.8	Anticipates other team members needs	12.4						
				Anticipates support required	12.6						
				Facilitates community and foster a climate where it is expected that assistance will be sought/Offered	12.6						
				Collaborates to facilitate smooth transmission between services	13.3						

 $\bar{x}$  = mean rank (round 3).



that participants and therefore expert perspectives presented here are exclusively those of academic teaching staff from the various health fields, not those currently engaged in health care practice. Whether these perspectives differ, and the implications for IPE and public health, are matters for further research.

## 5. Conclusion

Given interprofessional collaboration is increasingly required for effective public health services and initiatives, there is a clear need to train and assess health and social practice students in these domains. This modified Delphi study identifies a key set of 73 important interprofessional competency indicators for students in New Zealand, as rated and ranked by experts from a range of health and social service programs. Followership was an unexpected competency indicator that was identified by experts in the first round of this study, aligns with emerging literature and is worthy of further investigation. While identification of cultural competence in the New Zealand context was not unexpected there is a need to determine indicators in this area as they relate to interprofessional practice. This will provide direction for educators and ensure learners can be supported in their development as competent, culturally safe follower-leaders.

The high level of engagement from experts in this study confirms there was a need to clarify expectations of students' performance in interprofessional practice. Further work is indicated, including the development of a structured student assessment tool based on findings and completing necessary validation to ensure its rigor across a range of students and disciplines, learning providers, and placement settings (72). Nevertheless, the agreed domain and indicator framework presented here provides a local starting point for best practice "interprofessionalism" to be cultivated, implemented, and assessed.

## Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving human participants were reviewed and approved by the Wintec Human Ethics in Research Group

Approval Ref: WTLR18170522. The patients/participants provided their written informed consent to participate in this study.

## Author contributions

All authors contribution to study conception and design, data collection, analysis and interpretation of results, and manuscript preparation and reviewed the results and approved the final version of the manuscript.

## Funding

This research was supported by a Trust Waikato Community Impact Grant.

## Acknowledgments

The authors acknowledge Dr. Marrin Haggie, Dr. Angela Beaton, Lauren Bennett, Dr. Oliver W. A. Wilson, and Greg Smith for their helpful contributions to this work, and express deep gratitude to expert panel participants for their time and input.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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RECEIVED 24 March 2023

ACCEPTED 07 August 2023

PUBLISHED 22 August 2023

## CITATION

Witte M, Ott M, Schilling T, Müller M,  
Schmid S and Krohn A (2023) Implementing an  
interprofessional point-of-care ultrasound  
protocol for dyspneic patients in an emergency  
department as a blended learning concept—  
Feasibility of Employing Thoracic Ultrasound in  
Shortness of Breath.

*Front. Med.* 10:1193243.

doi: 10.3389/fmed.2023.1193243

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# Implementing an interprofessional point-of-care ultrasound protocol for dyspneic patients in an emergency department as a blended learning concept—Feasibility of Employing Thoracic Ultrasound in Shortness of Breath

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**Objective:** Dyspnea is a common symptom in the Emergency Department, with a wide variety of differential diagnoses. Previous research has demonstrated the diagnostic accuracy of Point-of-Care Ultrasound (POCUS) in this field of interest. Our goal was to better establish sonography in our emergency department with a practicable and time effective method. Therefore, we implemented a sonography protocol in an interprofessional emergency team using blended learning as a modern didactic approach and evaluated the learning and teaching success. We named the study FETUS, which stands for “Feasibility of Employing Thoracic Ultrasound in Shortness of Breath.”

**Methods:** A demonstration of the POCUS protocol was given, followed by individual supervision during clinical routine. A written manual, a pocket card, and further materials for personal training supplemented the training. A post-training questionnaire measured several parameters regarding the training, e.g., subjective skill-acquisition or media use.

**Results:** 32 medical and nursing staff participated in this study, 14 of whom completed the questionnaire. All training modalities offered were well received. A pre-post comparison of subjective sonographic competence shows a significant increase in both medical and nursing staff.

The other items surveyed also indicate the success of the intervention undertaken.

**Conclusion:** The use of different media as a blended learning approach can support the implementation of new measures in the ongoing working routine within an interprofessional team.

## KEYWORDS

dyspnea, point-of-care ultrasound, RADiUS protocol, interprofessional, emergency medicine, sonography



# 1. Introduction

Sonographic examination of the lung has been studied for several decades (1–6). Traditionally, it was thought to be of little use due to the sound-reflecting nature of subpleural air, which limits the sonographic visibility to only a few centimeters in depth. Other imaging modalities with greater penetration, such as chest radiography, have long been the gold standard (7–11). Although the physical nature of lung ultrasound is undisputed, the significance of the pleural processes visible on ultrasound for the entire lung has been well established by numerous studies, since most.

pneumological pathologies relevant to emergency department also involve peripheral lung segments (12–18). Pulmonary ultrasound has been shown to be highly effective in a wide variety of lung diseases, in most cases superior to chest radiography. This includes diagnoses such as pulmonary edema, pneumonia, acute respiratory distress syndrome, consolidations, or pneumothorax (19–24). Certainly, the global pandemic of SARS-CoV-2 with a high rate of respiratory manifestations and a temporary lack of adequate diagnostic equipment was a catalyst for the development of lung ultrasound as a rapid and powerful examination modality (25–29).

According to various studies, dyspnea is one of the three most common chief complaints in the emergency department (30). The variety of possible pathologies that can cause respiratory distress poses a challenge to rapid medical evaluation. Since not only pulmonary but also cardiovascular or hematological disorders can cause dyspnea, a multitude of differential diagnoses must be considered (31). Clinical differentiation between cardiac and pulmonary etiologies of acute to chronic deterioration of respiratory symptoms is often challenging even for experts. Recent technological advances in making ultrasound smaller and more portable have had a tremendous impact on establishing a bedside application (32), both for physicians and nurses. Systematically performing this Point-of-Care-Ultrasound (POCUS) examination as an adjunct to the medical history and physical examination can significantly improve the medical decision-making process by allowing the examiner to differentiate an unclear etiology early and to understand pathophysiological mechanisms, leading to appropriate treatment (33, 34).

Due to the complexity of the organ systems involved in adequate oxygenation of the organism, the sonographic protocols used must take these conditions into account. A detailed examination of the lungs alone would not be sufficient for this purpose, nor would be focused echocardiography. Following established emergency medicine schemes such as the FAST (*Focused Assessment with Sonography for Trauma*) or RUSH (*Rapid Ultrasound in Shock and Hypotension*), the “Rapid Assessment of Dyspnea with Ultrasound” (RADiUS) by Manson and Hafez includes not only the pleural and echocardiologic examination, but also the inspection of the inferior vena cava (IVC) and the pleural cavity (35). This approach of examining these four components as a compromise made between an extensive screening of dyspneic patients and the time-efficient approach for emergency medicine routines. Lamsam et al. modified the RADiUS protocol by adding the short-axis view to the echocardiography and the eight Volpicelli lung zones to the pleural examination (36, 37). This increases the number of detectable differential diagnoses is increased due to a more precise and focal inspection of the pleural processes, making the modified RADiUS protocol a profound scheme for the sonographic work-up of dyspnea.

Based on the above considerations, our goal was to scientifically investigate the systematic implementation of this protocol and its impact on clinical practice. We have established a teaching program and implemented it under the acronym FETUS, which stands for “Feasibility of Employing Thoracic Ultrasound in Shortness of Breath.” Because nurses are the first point of contact with emergency patients and play an important role in interpreting symptoms and initiating diagnostics, we implemented the protocol interprofessionally in both professional groups, nurses, and physicians. Given the already documented efficacy of thoracic ultrasound, a relative large number of ED staff had to be trained to perform an adequate number of sonographic exams. To achieve a high response rate, the training concept had to be adapted to the challenging working conditions of clinical emergency medicine such as the high workload, shift work, heterogeneous level of prior knowledge of nurses and physicians, and hygiene regulations due to the COVID-19 pandemic. As part of this process, a multimodal teaching concept was developed that incorporated different didactic approaches to address the interprofessional challenges mentioned above. Blended learning was originally described as an educational method that combines face-to-face lessons with asynchronous teaching units (38). Staker and Horn provide a more nuanced definition of blended learning as “a formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path and/or pace; and at least in part at a supervised brick-and-mortar location away from home” (39). In addition to meeting students’ needs for greater flexibility in learning new content and a partial detachment from local presence, this approach also allows for more specific personalization of teaching methods (40, 41).

The purpose of this paper is to outline our approach to teaching staff in a practical and effective way while working in daily clinical routine. We focus our efforts not only on physicians, but also interprofessional on nurses. Already today, nurses are being delegated a wide range of specific tasks, even involving ultrasound devices such as ultrasound-guided placement of peripheral venous catheters.

Overall, we hope that the methods used can help other institutions with specific training, even if not related to emergency medicine or Point-of-Care-Ultrasound.

# 2. Methods

## 2.1. Participants and study design

This study was conducted at a maximum care hospital in Stuttgart, Germany. Before the start of the study, all aspects of the research project were approved by the ethics committee of the University of Heidelberg. Thirty-two employees participated voluntarily and gave both verbal and in written consent to attend the study, representing 49.2% of the full-time positions of the ward. The ultrasound knowledge of the participants was recorded by self-assessment in the questionnaire. For the study, both medical and nursing staff were presented with two videos, each approximately 6 min in length. The videos served as an introduction to the project and provided an initial overview of the topic (42, 43). Access to the videos with QR codes distributed in the emergency department. For about a month,

interested staff were invited to attend face-to-face training sessions several times a week on the premises of the emergency department.

Due to lower patient volumes in the early shift, the teaching sessions were offered after the morning briefing. The session lasted up to 45 min and included an average of three to six participants. All ultrasound training sessions were led by a single POCUS instructor, who demonstrated the POCUS exam on one of the participants. The initial training was followed by the individual instruction in the clinical routine for the specific examination, which required multiple trainers (qualified instructors, attending physicians) and a cumulative time commitment of 30 to 120 min per participant. In some cases, individual instruction extended beyond this time. This in-depth support was provided to one or two participants at a time, depending on their prior experience and level of knowledge. While only detailed questions were discussed with experienced personnel, the repetition of sonographic basics was an important aspect for inexperienced people. The latter was especially relevant for nurses, who naturally needed closer supervision due to the expansion of their original scope of practice.

This procedure allowed for the consolidation of newly acquired knowledge and the clarification of questions. The learning phase, or as we call it intervention phase, lasted 6 months. The instructor had a weekly expense of about 4 to 5 h. The instructor himself completed several DGIIN (German Society of Medical Intensive Care and Emergency Medicine) certified POCUS courses, furthermore the instructors were trained by two senior physicians with DEGUM course instructor experience and completed DEGUM (German Society for Ultrasound in Medicine) emergency sonography course. The entire teaching process was closely supervised by the senior physicians.

Training and ultrasound examinations were performed on two GE Logiq-e (GE Healthcare, Wauwatosa, WI, United States) and one Philips CX50 (Philips Healthcare, Andover, MA) ultrasound machines.

Following this training period, participants were asked to complete a post-training questionnaire, using Likert-Scale. Only one survey was conducted, which included pre- and post-training questions. As with general study participation, completion of the questionnaire was based on voluntary participation. The survey was divided into five parts according to the underlying topic: in addition to assessing subjective competence in performing a general or thoracic ultrasound before and after the training intervention, questions were asked about the general learning process, the use of different media formats, the learning environment and future independent application of the learned content. The Grazer Evaluation Model of Competence Acquisition (*Grazer Evaluationsmodell des Kompetenzerwerbs, GEKO*) was applied, developed and validated by Paechter et al. (44, 45) was used to determine the personal knowledge gain and the quality of the media-based training. The survey assessed each participant's subjective learning success using a six-point Likert scale (1 = strongly disagree to 6 = strongly agree) to avoid a neutral position and a five-point scale (1 = strongly disagree to 5 = strongly agree) to Evaluating Media-based [according to Paechter et al. (44, 45)]. Participants also had the opportunity to formulate deficits or praise in free text. The questionnaire was administered online; a complete list of the items surveyed is presented in Table 1. In addition to the questionnaire, participants' progress was tracked through personal supervision. No other measures were used to assess the progress of the participating medical staff.

**TABLE 1** Items of the post-training questionnaire, sorted according to category.

Skill acquisition (45)	1. I now have a broader knowledge of the subject.
	2. I can give a good overview of the contents of the course.
	3. I have learned to make connections between subjects.
	4. I have learned to recognize complex connections within the subject area.
	5. My level of knowledge is now much higher than at the beginning of the semester.
Media use (44)	1. I believe that the media resources used enable a better division of the learning material.
	2. I think that the media-based course encourages interdisciplinary thinking.
	3. I think the media-based preparation supports individual learning processes.
	4. I think the online resources promote independent learning.
	5. I find that the media-supported course enables me to check my own learning progress.
	6. I find that independent learning from home is supported by the resources provided.
	7. I find that the additional online resources promote the practical relevance.
	8. The media-supported courses give me a good overview of the subject.
	9. I find that the online offerings encourage a critical examination of the content.
	10. I think the online materials promote networked thinking.
	11. I think the self-tests reflect my personal learning progress well.
Environment	1. I felt well guided.
	2. There were enough opportunities to participate in the training.
	3. There were sufficient opportunities for questions.
	4. The training was compatible with my work schedule.
	5. I think the amount of time was appropriate.
	6. I felt overwhelmed with the RADiUS training.
	7. I felt underchallenged by the RADiUS training.
	8. I was motivated to learn by the RADiUS training.
	9. I was able to bring in my previous experience.
	10. The intellectual level was appropriate.
Independent use	1. I will continue to use the skills I have learned in RADiUS examination after the study.
	2. I have the confidence to independently evaluate RADiUS findings of patients with dyspnea.

## 2.2. Further practical guides

Supplemental information was provided to allow for ongoing and asynchronous training and reference. Written explanations with illustrated examples of the RADiUS protocol were implemented into

an existing IT database of departmental Standard Operating Procedures (SOPs). In addition to access on the department's IT system, remote options from mobile and private devices were established.

Serval studies have demonstrated a solid consistency in the visual assessment of cardiac function (46, 47). To support the acquisition of the necessary experience, an online learn-quiz was developed to train for echocardiographic orientation and an assessment of pump function in a variety of image and video examples. A score was used to provide feedback on personal performance. Incorrectly answered questions were explained with detailed comments. In addition, a customized pocket card was developed that can be carried at all times. It contains a brief summary of the examination procedure and possible pathologies (see Figure 1). In addition, a QR code provides access to the more detailed written explanations.

## 2.3. Statistical analysis

The questionnaire was collected anonymously, and each participant was randomly assigned an identification number, making traceability impossible. Data were analyzed and evaluated using SPSS version 28.0.1.1 (SPSS Inc., Chicago, United States; RRID:SCR\_002865). A Wilcoxon matched-pairs signed rank test was applied to evaluate the difference between the pre- and post-training survey questions. A Mann–Whitney test was used to compare the professions as independent samples. Further, survey results are presented descriptively (mean, standard deviation). Survey questions on specific topics were grouped for analysis (skill acquisition, use of media formats, learning environment and independent use of learned content). *p*-values of <0.05 were considered significant.

## 3. Results

### 3.1. Overall performance

The RADiUS protocol was performed and documented in 550 patients with dyspnea over a 6 months period. A total of 52 individuals attended the training sessions offered, including seven medical students who were not enrolled in the study. Of the remaining 45 participants, 32 (61.5%) decided to continue participation in the study. The video footage was viewed a total of 178 times, the written manual a total of 196 times. Over 300 copies of the pocket cards were distributed.

### 3.2. Participant survey data

The subsequent survey was completed by 14 of the 32 participants (43.8%). Table 2 shows the age distribution, profession and professional experience in emergency medicine of the survey participants. Regarding prior experience, 26% (general ultrasound) and 13% (thoracic ultrasound) of participants reported an elevated competency measure ( $\geq 4$  on the Likert scale) before the intervention was performed.

Subjective competence in general and thoracic ultrasound increased significantly with teaching ( $p < 0.007$  and  $p < 0.002$  respectively, Wilcoxon matched-pair rank test). Means, including

standard deviation, are shown in Figure 2. Pearson's correlation coefficient *r* was used to calculate the effect size of the change in subjective competence gain. For the use of general ultrasound, Pearson's *r* is 0.49, describing a moderate effect of change, and for thoracic ultrasound, it is 0.55, describing a strong effect.

Survey questions on specific topics were grouped for analysis. Participants were asked about subjective changes in sonographic competence, use of different media formats, learning environment, and independent use of learned content (see Figure 3). All participants reported subjective learning progress as a result of the training (Figure 3; Skill acquisition). The combined mean value is 4.15 with a standard deviation of 1.28. The questions of the validated GEKo assessment address issues of broadened subject knowledge and the formation of contexts (Table 1). The use of different media formats was also rated very positively by the participants, especially considering the five-point scale (mean = 4.05, SD = 0.53). There was widespread agreement that the media-supported preparation promoted individual learning processes and improved the assessment of personal learning progress. The practical relevance and the organization of the course content have also been improved (Figure 3; Media use). The third group of questionnaire items focused on the learning environment. Here, we recorded how the participants perceived the temporal and intellectual scope of the training and how they rated the personal supervision. Subjective under- or overload and compatibility with shift work were also addressed (mean = 4.35, SD = 0.59; see Figure 3; Environment). Finally, we asked about future independent use of the learned skills and abilities to independently assess sonographic findings of performed examinations (mean = 4.26, SD = 1.62; see Figure 3; Independent use). Participants were given the opportunity of additional comments to their responses in free text. Comments from participants who felt confident in their ability to independently apply what they had learned in the future included very positive feedback for the (personal) training and the clear examination procedure. The main reasons given for low confidence were a lack of time in the daily work routine and lack of individual supervision.

## 4. Discussion

### 4.1. General conclusions

In this study, we present a comprehensive approach to teaching new skills during ongoing ward routines. In doing so, we had to consider aggravating initial conditions such as shift work or high staff workload to introduce a new medical intervention into existing work routines. This led to a multimodal structure that addressed these circumstances through increased flexibility and asynchronous access to the educational content. In addition, we used modern media formats such as YouTube videos, quizzes, or pocket cards to increase acceptance. Through this study, we were able to fully train 32 members of our staff, who in turn applied the learned sonography scheme to 550 patients.

Despite repeated invitations, the response rate to the questionnaire remained low, which limits the significance of the results in terms of content. Nevertheless, the data presented confirms the learning success of the training. Participants felt more confident using and implementing the RADiUS protocol as a result of the interventions. Comparison of competency assessments showed significant gains in both general and thoracic



A

**FETUS**

**RADIUS**

The "Rapid Assessment of Dyspnea in Ultrasound" is an emergency medical sonography scheme for the assessment of dyspnea. In a few minutes, the condition of the pleura, lungs, heart & vena cava can be assessed.

**5 tips for a good image**

- 1 use enough ultrasound gel
- 2 apply enough pressure
- 3 probe choice: echo → phased array; lung, pleura & IVC → convex
- 4 left side positioning during echo
- 5 specific breathing commands

**Lung**

**Where?** Transducer perpendicular to thorax, marking cranially: 8 quadrants, outlined by nipples & anterior axillary line; additionally dorsal, if necessary

**How?** Center lung field, identify hyperechoic pleural line (PL), adjust penetration depth; use preset if possible; decide individually for each location

**What?**

1. Pleural line lung sliding? Exclude PTX with M-Mode? PL smooth?
2. Artefacts A-lines? >2 B-lines/ICS? Location?
3. Consolidations Size? Bronchograms?

**Pleural effusion**

**Where?** Probe perp., marking cranially, dorsal flank region

**How?** Liver/spleen longitudinally, showing the diaphragm cranially

**What?** Curtain-, Spine- & Mirror-Sign

**Inferior vena cava**

**Where?** Probe perp., marking cranially, subxiphoid right paramedial

**How?** Set vessel in longitudinal section & max. diameter, caveat: confusion with aorta, display RA

**What?** Diameter, resp. modulation

**Echo**

- 1 Parasternal long axis (PLAX) ~4. ICS, strictly parasternal, probe perp., marking to right shoulder
- 2 Parasternal short axis (PSAX) Rotate PLAX 90° clockwise, probe perp., marking to left shoulder
- 3 Apical 4-Chamber-View (A4C) ~5. ICS (below nipple), probe points flat to right shoulder, marking at 3 o'clock
- 4 Subxiphoid 4-Chamber-View (SX4C) below xiphoid, align probe flat, marking to left side

B

**FETUS**

**RADIUS**

Das "Rapid Assessment of Dyspnea in Ultrasound" ist ein notfallmedizinisches Sonographie-Schema zur Abklärung von Dyspnoe. In wenigen Minuten lassen sich so der Zustand von Pleura, Lunge, Herz & Vena cava beurteilen.

**5 Tipps für ein gutes Bild**

- 1 genug Ultraschallgel nutzen
- 2 ausreichend Druck anwenden
- 3 SK-Wahl: Echo → Sektor-SK; Lunge, Pleura & VCI → Konvex-SK
- 4 Linksseitenlagerung beim Echo
- 5 gezielte Atemkommandos

**Lunge**

**Wo?** Schallkopf (SK) senkrecht zum Thorax, Marker nach kranial; 8 Quadranten, begrenzt durch Mamillen & anteriore Axillarielinie (AAL); ggf. zusätzlich dorsal Lungenfeld mittig einstellen, echoreiche Pleuralinie (PL) identifizieren, Eindringtiefe justieren; möglichst Preset verwenden, für jede Anlotstelle individuell entscheiden

**Wie?**

1. Pleuralinie Lungengleiten? Ausschluss Pneu via M-Mode? PL glatt?
2. Artefakte A-Linien? >2 B-Linien/ICR? Lokalisation?
3. Konsolidierungen Größe? Bronchogramme?

**Pleuraergüsse**

**Wo?** SK senkrecht, Marker nach kranial, dorsale Flankenregion

**Wie?** Leber/Milz im Längsschnitt, kranial davon das Diaphragma einstellen

**Was?** Curtain-, Spine- & Mirror-Sign

**Vena cava inferior**

**Wo?** SK senkrecht, Marker nach kranial, subxiphoid rechts paramedial

**Wie?** Gefäß im Längsschnitt & max. Durchmesser einstellen, caveat Verwechslung mit Aorta → RA-Einmündung darstellen

**Was?** Durchmesser, Atemmodulation

**Echo**

- 1 Parasternale lange Achse (PLAX) ~4. ICR, streng parasternal, SK senkrecht, Marker zeigt zur re. Schulter
- 2 Parasternale kurze Achse (PSAX) PLAX 90° im UZS drehen, SK senkrecht, Marker zeigt zur li. Schulter
- 3 Apikaler Vierkammerblick (A4C) ~5. ICR (unter Mamille), SK zeigt flach auf re. Schulter, Marker auf 3 Uhr
- 4 Subxiphoidaler Vierkammerblick (SX4C) unterhalb d. Xiphoid, SK flach ausrichten, Marker nach links

**1 Pleural line**

Lung sliding? B-Linien? Lung puls? 3x no 3x yes

**2 Artefakte**

A-Linien horizontal lines at regular intervals, indicating air below the PL, also in PTX present

B-Linien vertical laser rays originating from pleura line when fluid increases subpleurally; only when both pleural sheets are adjacent to each other

**3 Consolidations**

"Hepatisation" = lung parenchyma visible when fluid is increased

dynamic/static bronchograms (air-filled bronchi/bronchiole)

**Assessing pleural effusions**

**Curtain-Sign** "Curtain" slides into view when pleural layers are adjacent = no PLE peripherally

**Mirror-Sign** Hyperchoic mirror artifact cranial to diaphragm = no PLE

**Spine-Sign** Spine visible cranial to diaphragm = PLE present in supine position

**Assessing vena cava**

Determination of diameter ~5 cm caudal to RA perp. to vessel wall; standard ± 2 cm; caveat incorrect measurement in case of tangential gate

Resp. modulation: at least 30% variance of IVC width during inspiration vs. expiration

IVC versus Aorta

- right paramedian
- left paramedian
- venous double pulse
- arterial pulse
- slender vessel wall
- thick vessel wall

**1 Pericardial effusion**

Onset usually on right side, in the process may spread to the left

Hemodynamic relevance with diastolic collapse likely

Hyperchoic portions suggest tamponade

**2 LV function**

Estimation possible by

- HR rhythmic, normofrequent?
- Wall movement abnormalities? Contraction strong & coordinated?
- Large opening width of anterior mitral leaflet?

**3 RV strain**

Estimation possible by

- RV > LV? Hypokinesia?
- Paradoxical septal movements (D-Sign in PSAX)?
- Proof of thrombus in right heart
- VCI bulging

Differential diagnoses	Lung	Heart
Normal findings	A-Linien, ≤ 2 B-Linien/ICS, Ø PLE	Normal LV-function, Ø RV-strain, Ø pericardial effusion
aeCOPD, Asthma	(increased) A-Linien	aeCOPD: chronic RV dilatation
Pneumothorax	Ø lung sliding, A-Linien	Tachycardia, RV & IVC dilatation possible
Pneumonia	Focal Ø lung sliding, focal > 2 B-Linien/ICS, PLE, Consolidations, dynamic bronchograms	Reduced LV function & IVC > 2 cm possible
Pulmonary edema	> 2 B-Linien in ≥ 2 ICS	RV dilatation (D-Sign), IVC ≥ 2 cm, Ø respiratory modulation
Pulmonary embolism	Wedge-shaped infarctions approx. 0.5 - 3 cm, focus often dorsobasal	Reduced LV function, IVC ≥ 2 cm, Ø respiratory modulation
Decomp. heart failure	PLE, > 2 B-Linien in ≥ ICS possible	Hypoechoic pericardial space
Pericardial effusion		

Abbreviations: A4C: Apical 4-chamber view, Ao: Aorta, AV: Aortic valve, E: effusion, ICS: intercostal space, Co: consolidation, LA: left atrium, Li: liver, Lu: lung, LV: left ventricle, MV: mitral valve, perp: perpendicular, PL: pleural line, PLAX: parasternal long axis, PLE: pleural effusions, PSAX: parasternal short axis, RA: right atrium, RV: right ventricle, S: spine, SX4C: subxiphoid four-chamber view, TV: tricuspid valve, VCI: inferior vena cava

All findings must be compared with the clinical context and questioned with regard to their situational validity.

Graphics courtesy of Sono4Students Freiburg, Version 1.6, 07/2023

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FIGURE 1

(A) Pocket card English (translation). (B) Pocket card German (original).

sonography for both physicians and nurses. In addition, participants rated the use of multiple media formats as beneficial, both for personal learning and for compatibility with working conditions. Here, the survey results for media use are more clearly positive than for skill acquisition (see Figure 3), especially since the Likert scale for media use was only five instead of six levels. The complementary use of asynchronous teaching materials not only improved the learning process, but also provided a low-threshold and constant availability of relevant information. In addition to the high demand for the pocket cards, the digital content provided (videos, manual) was viewed almost 200 times. This indicates a repeated use and a possible expansion of the user group of the provided resources. In addition, the complexity of the content taught, and the training capacity provided were rated positively by most participants (see Figure 3; Environment). However, some individuals mentioned a lack of opportunities for individual training.

Heavy workloads and limitations due to shift work were among the most frequently cited reasons. This opinion was also reflected in the form of free text (“Too little practice, no time to do this regularly,” “I would like more time and specialized

personnel to be able to apply my acquired knowledge more consistently in everyday life”), mostly expressed by nurses. These experiences during our study illustrate the considerable need for training of non-educated personnel in terms of sonography. In addition to the numerous educational references offered, live and individual interprofessional teaching remains the essential component for sufficient knowledge transfer. These results are underlined by the heterogeneous indications regarding the independent continuation of thoracic sonography (see Figure 3; Independent use). A large proportion of respondents indicated that they continued to apply what they had learned. However, some individuals disagreed. This is even more the case when asked about the interpretation of sonographic findings. While the differences between physicians and nurses were not significantly different for the other items, here the deviation within the small sample is significant. Overall, physicians were willing to apply the newly learned knowledge independently, whereas most nurses disagreed. This indicates that nurses require delegation and time to perform sonography.

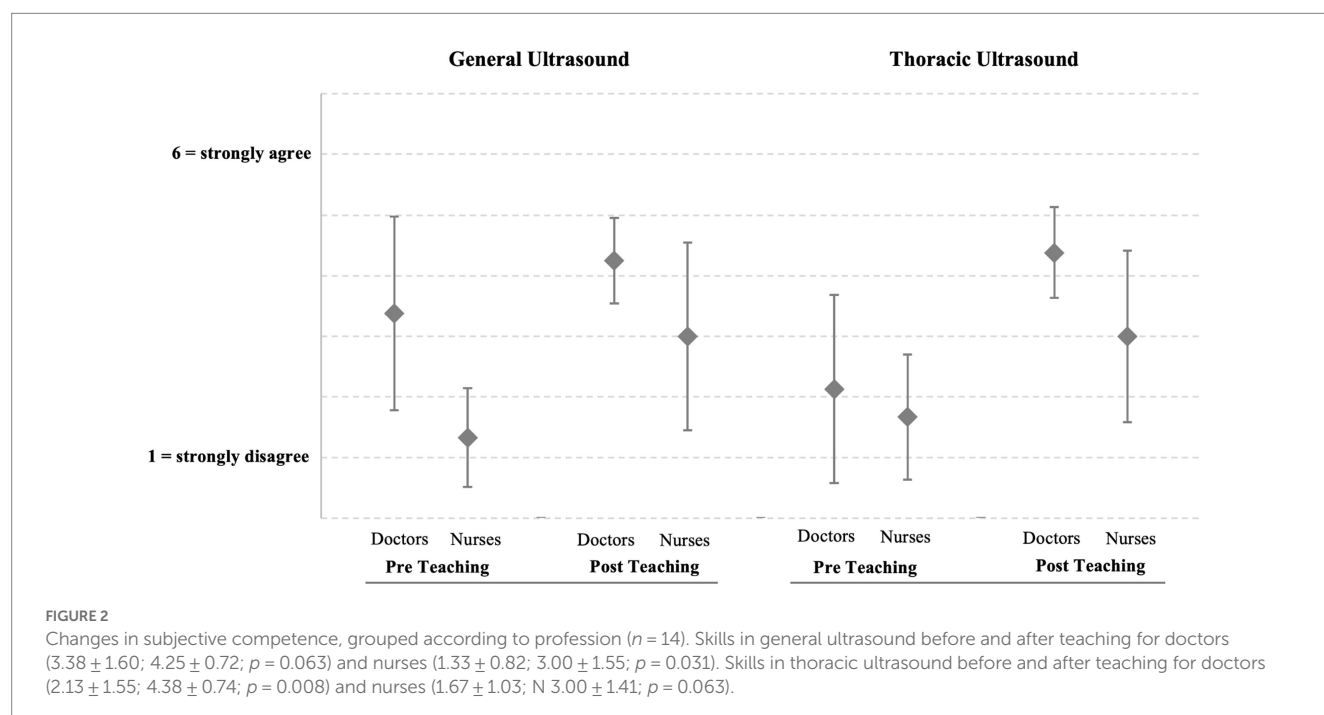
Overall, however, we were able to show that a multimodal teaching process including digital media is successful in improving the skills of both nurses and physicians in thoracic ultrasound. An effective teaching program, with a short personal teaching effort of 30–120 min, can be established in emergency departments. We plan to continue this concept and extend it to other areas of emergency ultrasound diagnostics.

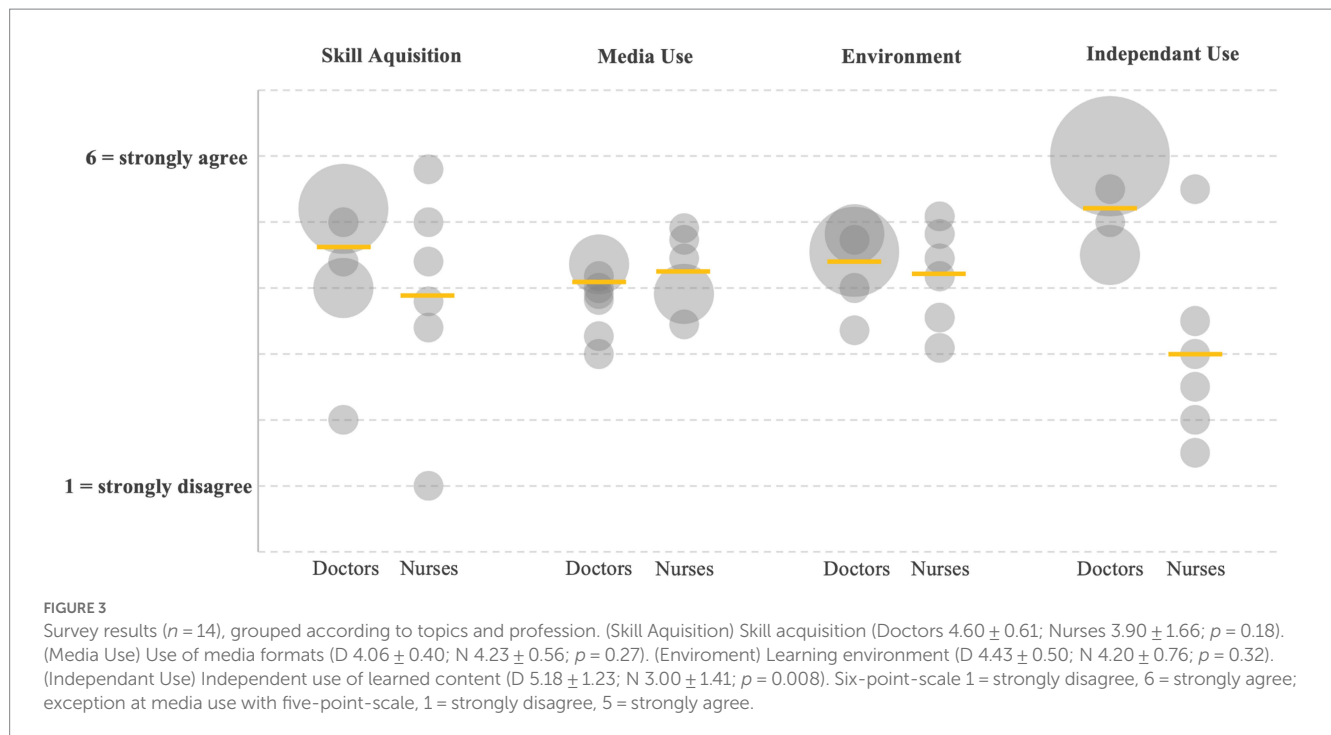
TABLE 2 Age distribution, profession and professional experience of survey participants ( $n = 14$ ).

Profession	%	Age distribution	%	Experience in EM	%
Medical Doctor	21.4	20–30 years	42.9	<1 year	35.7
Resident	35.7	30–40 years	42.9	1–2 years	7.1
Nurse	42.9	40–50 years	7.1	3–5 years	21.4
		>50 years	7.1	5–10 years	21.4
				>10 years	14.3

## 4.2. Study limitations

The statistical power of the survey is limited by the fact that it was conducted only after the intervention. An evaluation based on two questionnaires, one before and one after the training, would have been





required to accurately determine the level of training of the medical personnel involved. Another limitation is the low response rate to the survey, since participation was voluntary. This limits the significance of the results, mandatory participation would have strengthened the statistical validity. In addition, a selection bias is likely. As the participation of the ward staff in the training was voluntary, it can be assumed that the motivation of the participants was higher and therefore interested participants were more likely to experience the intervention positively. The results may also be influenced by young participants with rather limited experience in emergency medicine.

### 4.3. Overall conclusion

Despite some limitations in our initial study on the development of a learning model for POCUS, we conclude that our established learning model is time- and resource-efficient for emergency departments. It can effectively enhance the implementation of Point-of-Care Sonography in these settings.

### Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

### Ethics statement

The studies involving human participants were reviewed and approved by the ethics committee of the University of Heidelberg. The patients/participants provided their written informed consent to participate in this study.

### Author contributions

TS, AK, MM, and MW contributed to the conception and design of the study. AK, MO, and SS assisted in the collection of data. MW and TS performed the statistical analysis. MW, TS, AK, and MO wrote the manuscript. All authors contributed to the article and approved the submitted version.

### Acknowledgments

The authors thank all the staff of the Department of Interdisciplinary Acute, Emergency and Intensive Care Medicine (DIANI) of Klinikum Stuttgart. They also thank Christian Menzel, Harald Knof and Navid Azad for their active support in the execution of this project. Special thanks for the support and kindly providing the graphics for the Pocket Card goes to Christopher Starz.

### Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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RECEIVED 15 June 2023

ACCEPTED 25 August 2023

PUBLISHED 22 September 2023

## CITATION

Ferreira S, Phelps E, Abolmaali S, Reed G and Greilich P (2023) Opportunities to apply systems engineering to healthcare interprofessional education.  
*Front. Med.* 10:1241041.  
doi: 10.3389/fmed.2023.1241041

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# Opportunities to apply systems engineering to healthcare interprofessional education

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In medical settings, interprofessional education (IPE) plays an important role by bringing students from multiple disciplines together to learn how to collaborate effectively and coordinate safe patient care. Yet developing effective IPE is complex, considering that stakeholders from different schools and programs are involved, each with varying curriculum requirements and interests. Given its critical importance and inherent complexity, innovative approaches to address these challenges are needed to effectively develop and sustain effective IPE programs. Systems engineering (SE) combines a lifecycle perspective with established interdisciplinary processes to develop and sustain large complex systems. The need for SE approaches to manage healthcare complexity has been recognized, but the application of SE to IPE programs has been limited. We believe that there is a significant opportunity for IPE programs to benefit from the application of SE. The common themes running through SE and IPE led us to ask if SE can be used to address IPE complexity and achieve desired IPE outcomes. We believe that SE could facilitate further development and sustainability of a recently developed healthcare curriculum. We also propose to use SE to accelerate and manage future IPE curriculum development, while better understanding the states of vital IPE-related components. We discuss a framework that considers transitions of key IPE elements. We believe that use of interdisciplinary SE processes and holistic perspectives and methods such as system thinking will improve the management of system challenges while addressing IPE's inherent complexity and leading to better patient outcomes and more effective interprofessional collaboration.

## KEYWORDS

Interprofessional education, systems engineering, healthcare, state model, framework

## 1. Introduction

Interprofessional education (IPE) brings learners from multiple health professions together to learn how to collaborate and meet objectives such as safety, effectiveness, timeliness, patient-centeredness, efficiency, and equity as presented in the Institute of Medicine's *Crossing the Quality Chasm* (1). IPE includes occasions when "two or more professions learn with, from, and about each other to improve collaboration and the quality of care and services (2)." Achieving high-reliability in health services and patient-centered care also requires new educational approaches that support clinical transformation toward team-based care. Despite its challenges,

developing new IPE curricula that span boundaries among various professions and leverage each profession's unique expertise to achieve integrated healthcare is a state-of-the-art approach to these transformational objectives.

The Interprofessional Education Collaborative (IPEC) standards established four core competencies for interprofessional collaboration: (1) values/ethics for interprofessional practice; (2) roles and responsibilities; (3) interprofessional communication; and (4) teams and teamwork, and related sub-competencies (3). Unfortunately, a considerable gap in meeting these competencies remains. The barriers to building effective IPE are formidable and overcoming them will require substantial changes in existing attitudes, structure, and processes within academic medical centers (academic medical centers typically integrate patient care with health provider education and research) (4, 5). Successfully addressing these challenges is central to achieving objectives such as the Quintuple Aim (6), which adds health equity to the Quadruple Aim (7) that seeks well-being of the care team as a pre-requisite to the Triple Aim's (8) objectives of better patient experience, better population health, and lower costs.

Traditionally, systems engineering (SE) considers a full lifecycle, from beginning to end, to define, develop, implement, and sustain complex systems (9). SE is interdisciplinary, involving two or more disciplines (e.g., bodies of knowledge that typically expand over time such as medicine and engineering) (10), and relies on collaboration between stakeholders from different backgrounds working together toward a common set of defined objectives. SE can help manage the inherent complexity of IPE by applying well-established SE processes and concepts such as system thinking to achieve desired IPE outcomes. The need for SE approaches to manage healthcare complexity is already recognized (11–16), as is the need to teach important concepts such as systems thinking to health sciences learners (17). However, application of SE concepts and processes to develop and sustain IPE programs and curricula is currently limited, offering a significant opportunity for these programs to benefit from SE.

We discuss our application of SE concepts and processes, which consider the inherent complexity of IPE, as we developed an IPE program designed to advance teamwork and communication in an academic medical center. We propose the use of SE, specifically a state-based framework, explained in section 4, to accelerate and manage the development and implementation of an IPE curriculum. Using the University of Texas Southwestern Medical Center (UTSW) IPE program as a case study, we discuss the theoretical implications of a tailored SE approach while migrating to a desired future state of a health sciences curriculum.

## 2. Application of systems engineering to interprofessional education

IPE is complex when considering that multiple stakeholders from different schools and programs are involved, each with varying perspectives, curriculum requirements, interests, constraints, and with different learner timelines (e.g., medical students, health professions students, and nursing students). Indeed, an IPE program is a complex system, or even a system of systems (18), requiring different components, relationships between these components, and

interactions to successfully create joint curricula, staging activities, and events involving learners and instructors from different professions. Key UTSW IPE requirements included achieving and assessing student learning outcomes, building a cadre of IPE faculty and education scholars, and implementing sustainable organizational changes that will allow the IPE program to evolve as needs and constraints change. SE provides a holistic, methodical, and structured approach to address many IPE challenges.

Many organizations have developed clearly defined processes that they use to specify and develop systems (19–22). Those who create or modify educational curricula can borrow from SE to establish processes and guide their efforts to ensure efficient process development while considering multiple options that will satisfy stakeholder requirements and evolving needs. An interdisciplinary SE approach to IPE enables successful outcomes (9) by using system thinking and integrated processes to solve complex problems while keeping the whole system in perspective over its lifecycle. This lifecycle begins at project conception and continues through defining stakeholder needs and requirements, design, and implementation to delivery of a corresponding solution and sustaining the system (in this case, IPE) through retirement. In addition to basic and clinical sciences, health systems science is an emerging third science specific to healthcare education that was recently adopted and promoted by the American Medical Association (23) and uses systems thinking, which is also core to SE.

The recognized international standard for applying SE to a broad range of systems and products, ISO/IEC/IEEE 15288 (20), provides process descriptions and requirements and identifies four process groups: technical processes, technical management processes, agreement processes, and organizational project-enabling processes. Table 1 identifies the processes associated with each of these groups and presents examples of how some of them could be used to benefit IPE.

## 3. Case study: developing an interprofessional healthcare education program at an academic medical center

The University of Texas Southwestern Medical Center (UTSW) has made advancing IPE an institutional priority since 2009 (24). In 2019 UTSW extended this plan based on its alignment with the institution's 6 year strategic plan and a focus on building further depth in teamwork and communication. These included addressing mandates from the Association of American Medical Colleges (AAMC) for Entrustable Professional Activity (EPA) related to Give or Receive a Patient Handover (EPA #8), Collaborate as a Member of an Interprofessional Team (EPA #9) (25), and the IPE Collaborative's (IPEC) pillars of teamwork and communication (3). The result was a longitudinal, interprofessional program, Team FIRST, designed to teach core competencies in teamwork to health science students including medical, nursing, and other health profession students (e.g., occupational therapy, physical therapy, pharmacology, physician assistant). Healthcare clinicians must possess teamwork competencies to be effective members of high-reliability teams. The Team FIRST framework identified student learning outcomes linked to ten

TABLE 1 ISO/IEC/IEEE 15288 processes and IPE examples for process use.

Process group	Processes	Examples of process use
Technical	<ul style="list-style-type: none"> <li>• Business or mission analysis</li> <li>• Stakeholder needs and requirements definition</li> <li>• System requirements definition</li> <li>• Architecture definition</li> <li>• Design definition</li> <li>• System analysis</li> <li>• Implementation</li> <li>• Integration</li> <li>• Verification</li> <li>• Transition</li> <li>• Validation</li> <li>• Operation</li> <li>• Maintenance</li> <li>• Disposal</li> </ul>	Perform stakeholder analysis to determine how to effectively manage stakeholder groups (e.g., learners, facilitators, assessors) associated with IPE; elicit and identify requirements related to educational activities and deliverables including learning outcomes; design IPE curricula to address learning outcomes; perform learner and facilitator assessment. Validate that curriculum meets stakeholder needs through the curriculum lifecycle. Verify that requirements have been met in implemented deliverables. Develop transition plans and use them to transition education deliverables to appropriate stakeholders.
Technical management	<ul style="list-style-type: none"> <li>• Project planning</li> <li>• Project assessment and control</li> <li>• Decision management</li> <li>• Risk management</li> <li>• Configuration management</li> <li>• Information management</li> <li>• Measurement</li> <li>• Quality assurance</li> </ul>	Use planning, assessment, and control to manage IPE projects. Risk management can be used through the entire curriculum and related activity lifecycles to identify and manage risks, including mitigating high priority risks that could lead to adverse consequences. Perform configuration management to ensure the correct version of education deliverables is used or modified. Assess education related processes, deliverables, and stakeholders to ensure that products meet quality expectations and learner outcomes are achieved.
Agreement	<ul style="list-style-type: none"> <li>• Acquisition</li> <li>• Supply</li> </ul>	Agreement processes support creation of agreements between organizations to deliver and support products or services. Associated activities can help manage expectations of various stakeholders and internal and external organizations that contribute and participate in developing curricula and learning activities.
Organizational project-enabling	<ul style="list-style-type: none"> <li>• Infrastructure management</li> <li>• Portfolio management</li> <li>• Human resource management</li> <li>• Quality management</li> <li>• Knowledge management</li> <li>• Life cycle model management</li> </ul>	Organizational project-enabling processes apply at an enterprise level and focus on capability, infrastructure, and resources required across many projects. For example, infrastructure management can facilitate resource planning needed across IPE projects (e.g., classrooms, simulation labs, task mannequins and trainers, video equipment) and help manage conflicts and resource shortfalls at the organizational level. Another example is portfolio management that can help assess an IPE project's contribution to the organization's strategic plan and a project's return on investment relative to other projects available for investment.

teamwork competencies that are organized into three domains: communication skills, coordination skills, and handling teamwork challenges. The framework also evaluates the impact of five learning activities by assessing knowledge, skills, and attitudes (KSAs) (26).

This progressive series of five interactive activities includes: introduction to IP teamwork competencies (convergence), introduction to communication competencies, teamwork in the clinical learning environment, just-in-time teamwork clinical series, and using teamwork competencies after graduation. Student training involves four major phases (socialization, application, immersion, and remediation) in simulation- and clinical-based learning environments during their undergraduate education which, for medical students in the US, is the 4 years of medical school after earning their bachelor's degree. For nurses and health professions students in the US, undergraduate education can include up to a 4 years bachelor's program after high school depending on the specific profession. Using a triad of students (education), scholars, and (team) scientists, the Team FIRST leadership team built and supports a series of project

teams to achieve its learning outcomes that consider important implementation outcomes (e.g., acceptability, appropriateness, and feasibility) (27, 28) prior to executing Team FIRST activities with a high degree of fidelity.

IPE programs have many inherent challenges and barriers (4, 5). Some of the challenges that we faced at UTSW are grouped into four major categories based on perspectives of Team FIRST managers, mentors, and consultants who are authors of this paper (see Table 2). SE processes represented in the ISO/IEC/IEEE 15288 standard and concepts such as systems thinking that could be useful to address these challenges are shown in the third column of the table. SE processes can also be combined with methods from management, human factors, implementation science, and other sciences. Processes such as risk management, configuration management, and other technical management processes apply across the IPE curriculum life cycle. While not a complete list, examples shown in Table 2 highlight complexity as a common pressing challenge that overlays these concerns, and SE can be used to manage complexity.



TABLE 2 UTSW interprofessional education challenge examples &amp; applicable SE processes and approaches.

Challenge category	Challenge	Applicable SE processes or approaches
Curriculum	Achieve consensus on learning outcomes and curriculum requirements from many stakeholders with different interests, opinions, expertise, and experience who come from different organizations.	Stakeholder analysis, business and mission analysis, stakeholder needs and requirements definition, system requirements definition, validation, verification, decision management (e.g., alternative analysis/trade-off analysis), systems thinking.
	Effectively balance priorities related to requirements and constraints to develop an acceptable and feasible curriculum design, implementation, and sustainment strategies.	Decision management, architecture definition, design definition, system analysis, validation, risk management.
Multi-organization scheduling	Manage curriculum schedules for various professions and schedule IPE courses and activities with multiple UTSW and non-UTSW organizations, schools, and department administrators.	Planning, assessment, and control, infrastructure management.
	Manage pre-work and post-activity learner assessments; effective logistics and coordination of pre-work, activity/courses, and post-activity/course assessment of learners and required supporting faculty, staff, evaluators, and other roles.	Measurement, information management, quality assurance, planning, assessment, and control, verification.
Resources	Balance program requirements with constraints such as geographic co-location; fixed facilities, rooms, equipment, and support personnel that limit the number of learners, facilitators and staff that can be scheduled at point in time.	Infrastructure management, planning, assessment, and control.
	Obtain a sufficient quantity of trained and experience facilitators, evaluators, and staff.	Human resource management, knowledge management, portfolio management.
Organization	Organization may not be structurally set up to facilitate development of an evolving IPE program. Many schools were created before recognizing the need for IPE. Organization structures that previously allowed program success may now act as siloes, creating barriers to achieving evolving IPE objectives that require enhanced coordination. For the IPE program at UTSW, AAMC EPA 8 and 9 and IPE competencies must be aligned with the organization's strategic plan.	Portfolio management, quality management, systems thinking.
	Organizations may have political, relationship or reward barriers that reduce the ability to establish a satisfactory IPE program.	Human resource management, decision management, systems thinking.
	Coordinate complementary curriculum in each School to balance primary educational activities with development of longitudinal teamwork curriculum.	Decision management, planning.
	Alignment and shared control of selected modules within an individual School may need to be modified and enhanced to become interprofessional and achieve desired learning outcomes. Module ownership and contributor shifts may cause disruptions when additional stakeholders seek to broaden the applicability of existing modules.	

## 4. State-based framework for applying system engineering to IPE

Based on our experience with Team FIRST and concepts presented in Smartt and Ferreira (29), we propose a general approach to applying SE to IPE based on states of IPE associated entities (or things) as well as processes that are part of the ISO/IEC/IEEE 15288 standard. A framework is a basic conceptual structure (as of ideas) (30). An approach based on an entity's state considers the state of an entity at a given timepoint, such as a light bulb having two states, "off" or "on." By turning a switch, we can change the light bulb's state. Moving from one state to another is based on a decision(s) to initiate an event(s) that triggers an entity to transition from one state to another. The states and transitions are part of a model. See Figure 1A, for a simplified example of transitions within a general state-based

model. Note that an entity may also transition back to a previous state. Figure 1B, shows a series of states and transitions with movement between states resulting from a chain of events.

In the Smartt and Ferreira (29) framework, states are defined using four characteristics: organization, environment, process, and product, each of which contribute to IPE development. Each of these categories has multiple attributes. Here, we present an updated framework that considers the four characteristics (organization, environment, process, and product) as distinct entities, each having associated states. Each characteristic group can be subdivided. For example, an organization can be segmented into sub-entities such as projects or teams, each with their own states. An organization may have many teams and many projects, each in a different state at any timepoint, which would allow these entities to also relate to each other in meaningful ways.

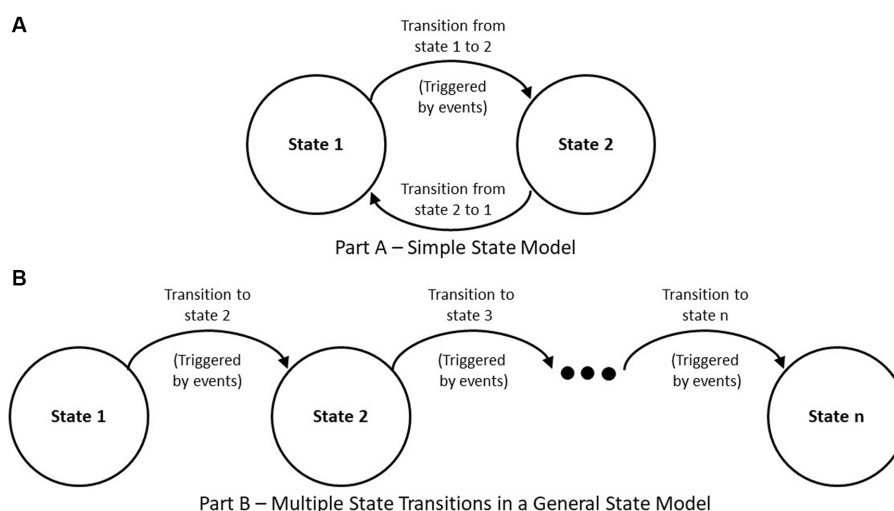


FIGURE 1  
General state-based model. (A) Simple state model. (B) Multiple state transitions in a general state model.

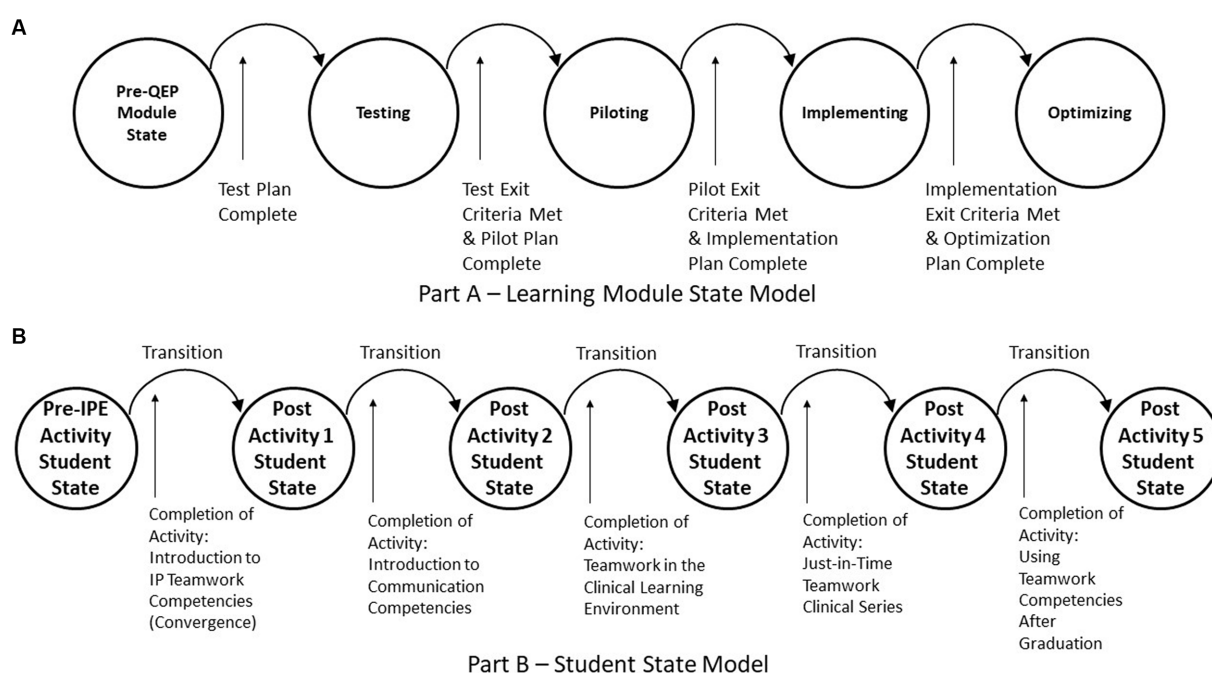


FIGURE 2  
IPE product examples—state models. (A) Learning module state model. (B) Student state model.

To illustrate use of the state-based framework using the product category as an example, IPE can have different types of products. For example, the UTSW Team FIRST core education products include module curriculum and activities, as well as learner, facilitator, and evaluator assessments. Team FIRST learning modules change their state when exit criteria associated to events are completed. Exit criteria indicate that students, faculty, operational staff, and executive sponsors achieved a sufficient level of acceptability, appropriateness, feasibility, and fidelity to transition

to the next state. Figure 2A illustrates the learning module states (testing, piloting, implementing, optimizing that must be passed based on completing the test plan, test exit criteria, pilot plan, and other products).

An educated student is another example of a product of the institution. Changes in a student's education state(s) occur following exposure to educational materials (e.g., documents, videos, lectures) and by participating in interactive educational activities that lead to specific learning outcomes. Figure 2B illustrates these state changes

using the five UTSW IPE and Team FIRST learning modules and associated activities. This figure assumes that modules are taken sequentially, thus completion of each activity would transition the student to the next post activity student state.

## 5. Discussion

The primary goal of Team FIRST was to create and implement learning activities with associated measurement systems and analysis processes that would be able to evaluate Team FIRST learning outcomes. To address this goal, we used the DMADV (define, measure, analyze, design, verify) method, which enables innovative improvements and development of new processes or products (31).

A significant task of the Team FIRST project team was to develop a portfolio of learning activities with behavioral and cognitive performance analysis built on a foundation of continuous quality improvement (QI). These QI principles guided the team to identify low performing sub-activities that could be dropped from the portfolio to improve the performance of other activities. Learner competencies are assessed before and after major activities and survey results are factored into determining low performing sub-activities. Overall, the goal was to identify activities that, when implemented, delivered additional cognitive and behavioral improvements while also improving the satisfaction of learners, instructors, and other stakeholders.

The UTSW Team FIRST project initially applied DMADV components of the ISO/IEC/IEEE 15288 standard processes, which certainly benefited the program however, SE offers a more comprehensive suite of processes than DMADV. While DMADV focuses on improving individual system components, effective IPE requires more comprehensive changes to coordinate and improve multiple components across multiple projects, multiple schools, and the overall organizational environment. For these reasons, the lifecycle perspective and broad array of processes make SE a better approach to address the inherent complexity of IPE. Thus, we are now considering how to best apply SE processes to ongoing IPE efforts, allowing us to achieve desired states for each of the entities involved, e.g., organization(s), team(s), project(s), activity(ies), and learning module(s).

Many organizations already use some features of SE though they may not refer to it by this name. However, to expand the use of SE processes in an organization requires a careful strategy to selectively choose which processes to incorporate and to what level. Doing too much, too quickly, is risky because organizations and individuals need time to understand and respond to emergent concerns when using new processes and methods.

Few studies have been published that describe how to implement SE processes in academic medical centers, health professions institutions, and other healthcare education organizations. Organizations must consider an incremental staged approach that apply selected SE processes so that their utility can be demonstrated and expanded over time. For example, a process might be piloted and evaluated on a single project module and associated activities before broader implementation. As beneficial SE processes are identified, organizations should consider assessing and improving process maturity using models such as Capability Maturity Model Integration (CMMI) (32) to guide further improvements.

While SE can help create, implement, and sustain IPE programs, it will not address all concerns and barriers. SE should be used as an

enabler, together with other disciplines and approaches including project management, human factors, team science, and other engineering disciplines along with stakeholders intimately familiar with the needs and concerns of a program and/or organization.

Resources, including dedicated and interested personnel, tools, and equipment, are also needed to introduce the use of SE in an organization. Consultants with SE expertise can help to jumpstart and facilitate progress, but senior leadership and management must also champion these efforts since without them, it will be difficult to obtain the resources, including time and effort, needed to make SE a success.

Standardizing the use of SE within an organization can build consistent practice and scalability however, developing SE capability with its corresponding process improvement will likely require significant time (33). Prior to broad application, new processes need to be carefully planned and introduced to ensure their success, while also considering stakeholder needs, feedback, and lessons learned. Natural resistance to change must also be addressed and managed because the daily business of operating medical and health professions schools places high demand on stakeholders, who are in constant motion with a default mode biased toward past performance.

### 5.1. Challenges and limitations

Several challenges can hinder the successful application of SE to IPE. First, there are insufficient examples and case studies focused on applying SE to health science education. While some health-related cases exist, most SE examples and cases focus on other complex systems such as defense, transportation, communication, and other domains and industries that employ a significant number of systems engineers. The limited availability of systems engineers in health science education is also a significant challenge to applying SE in this setting.

Second, in the absence of examples and exposure to the healthcare domain and concerns, there is a paucity of systems engineers who are sufficiently familiar with the healthcare domain. This is not due to a lack of interest. Indeed, there is interest and growth in healthcare systems courses and programs among systems engineers. The complexity of healthcare, other issues related to social well-being, as well as the need to balance economic and other considerations contribute to challenges that need to be addressed to ensure sustainable outcomes and availability of SE in healthcare domains.

Lastly, the significance of SE and how to deploy systems engineers to address IPE needs to be better recognized within healthcare. As awareness of how to effectively use SE to address problems and create successful healthcare systems grows, more studies will be published about the benefits of SE and increased interest in applying systems engineering will occur.

### 5.2. Conclusion

SE processes can benefit health science IPE. Here we have described the ongoing development of a UTSW IPE program with efforts to apply SE processes to overcome IPE challenges. We discussed a nascent state-based framework with IPE-related examples. This framework will be used to better understand the states of vital IPE-related components during further development and after implementation.

SE can benefit IPE at the level of individual projects all the way to organization levels. In particular, interdisciplinary SE processes will help academic medical centers develop more effective structures and manage requirements and resources, while also helping to address inherent IPE complexity. These impacts can help achieve the Quintuple Aim by allowing teams to more readily address healthcare changes while balancing increasing limitations of financial and other resources at local, regional, and national levels.

The application of systems, industrial, and other engineering principles to healthcare delivery in the United States is long overdue as judged by the absence of sufficient progress in many quality measures over time (34, 35). Appropriate application of SE principles, as illustrated in the program we described, has the potential to reinforce the systems nature of many patient safety issues that plague medicine today. When medical education leaders recognize these issues and begin to apply a team-based, systems focus, our ability to develop a safer care delivery system will greatly improve.

The SE framework presented in this paper provides ideas that can be applied to IPE. Additional research is needed to further evaluate and determine how SE can benefit IPE and other healthcare related concerns, how to perform this evaluation, as well as how SE can be expanded with new approaches to better address healthcare challenges. Our intention is to continue evaluating Team FIRST as a case study and in the application of SE in healthcare education.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

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## Author contributions

SF conceptualized and led the manuscript development. PG assisted in the conceptualization and draft development. EP and GR developed manuscript sections. SA assisted with draft development. PG and GR provided senior project guidance. All authors contributed to the article and approved the submitted version.

## Funding

The research associated with this paper was funded internally by Team FIRST and the University of Texas Southwestern Medical Center.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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RECEIVED 06 June 2023

ACCEPTED 22 August 2023

PUBLISHED 22 September 2023

## CITATION

Dressel K, Ablinger I, Lauer AA, Grimm HS,  
Hartmann T, Hermanns C, Schwarz M,  
Taddey T and Grimm MOW (2023)  
Interprofessional education: a necessity in  
Alzheimer's dementia care—a pilot study.  
*Front. Med.* 10:1235642.  
doi: 10.3389/fmed.2023.1235642

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# Interprofessional education: a necessity in Alzheimer's dementia care—a pilot study

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**Introduction:** Interprofessional collaboration is seen as an indispensable prerequisite for high-quality health services and patient care, especially for complex diseases such as dementia. Thus, the current project aimed to extend interprofessional and competency-based education in the field of dementia care to the previously understudied therapy professions of nutrition, speech-language pathology, and physiotherapy.

**Methods:** A three-day workshop was designed to provide specific learning objectives related to patient-centered dementia care, as well as competences for interprofessional collaboration. Teaching and learning approaches included case-based learning in simulated interprofessional case-conferences and peer-teaching. A total of 42 students ( $n = 20$  nutrition therapy and counseling,  $n = 8$  speech-language pathology,  $n = 14$  physiotherapy), ranging from first to seventh semester, finished the whole workshop and were considered in data analysis. Changes in self-perceived attitudes toward interprofessional collaboration and education were measured by the German version of the UAE-IP. An in-house questionnaire was developed to evaluate knowledge and skills in the field of dementia, dementia management and interprofessional collaboration.

**Results:** Participation in the workshop led to significant improvements in the total scores of the UAE-IP-D and the in-house questionnaire, as well as their respective subscales. Moderate to large effect sizes were achieved. All professions improved significantly in both questionnaires with large effect sizes. Significant differences between professions were found in the UAE-IP-D total score between students of speech-language pathology and physiotherapy in the posttest. Students of nutrition therapy and counseling revealed a significant lower level of self-perceived knowledge and skills in the in-house questionnaire pre- and post-testing.

**Discussion:** The pilot-study confirms the effectiveness of interprofessional education to promote generic and interprofessional dementia care competencies and to develop positive attitudes toward interprofessional learning and collaboration in the therapy professions, thus increasing professional diversity in interprofessional education research. Differences between professions were confounded by heterogenous semester numbers and participation conditions. To achieve a curricular implementation, interprofessional education should be expanded to include a larger group of participants belonging to different professions, start early in the study program, and be evaluated over the long term.

## KEYWORDS

interprofessional education, therapy professions, dementia care, competency-based education, learning methods, interprofessional relations

## 1. Introduction

### 1.1. Interprofessional collaboration and education

Given the current challenges in health care, interprofessional collaboration, which involves regular interactions and negotiations between different health professions (1, 2), is seen as an indispensable prerequisite for high-quality health services and patient care by global leaders and in research (2–8). There is evidence that interprofessional collaboration has positive effects on clinical processes and outcomes as well as on patient reported outcomes, although clear conclusions are difficult to draw due to methodological limitations (2, 9, 10). To date, however, health care providers have typically operated under a single disciplinary approach. Interprofessional education (IPE), where “members or students of two or more professions learn with, from and about each other to improve collaboration and the quality of care and services” (11) is seen as a promising way to develop competencies associated with effective collaborative teamwork (3, 6–8). It is expected that early exposure to IPE will in turn lead to behavioral changes in future professional practice, optimizing health system performance toward the quadruple aim of enhanced patient’s health care experience, improved population health, reduced costs and improved work life of health care providers (1, 12). Comparable to professional practice, undergraduate education is predominantly organized unprofessionally, with learners of different health professions being trained in isolation, resulting in limited knowledge and skills in interprofessional collaboration (1, 13).

### 1.2. Interprofessional collaboration and education in Germany

In Germany, too, the need for interprofessional collaboration and education has been recognized and is mentioned in some regulations governing education (6, 14–16). In particular, the IPE initiative “Operation Team” (17), funded by the non-profit Robert Bosch Stiftung, has strengthened the development and anchoring of IPE in Germany in various funding phases. There are now some interprofessional training centers and interprofessional curricula (6) [e.g., Medical Faculty of Heidelberg (18); University Medicine Berlin Charité (19); Interprofessional Healthcare of the Baden-Wuerttemberg Cooperative State University (DHBW) Heidenheim (20)], but overall training is mainly organized unprofessionally. The situation remains difficult, especially for non-medical professions, whose primary education is predominantly at vocational schools and thus limited to lower education levels [European Qualifications Framework EQF, Level 4 (21)], with the exception of some study programs (22, 23) (see Box 1).

### 1.3. Competencies for interprofessional collaboration

In contrast to profession specific and generic competencies for all health professions, which can also be acquired unprofessionally, interprofessional collaborative competencies can only be achieved through IPE (4). In international frameworks these competencies include role clarification, team functioning, and interprofessional communication, but also values and ethics, conflict resolution, reflection and patient-centered care (4). These collaborative competencies are acquired in three stages: in the first phase (exposure) students gain a deeper understanding of their own discipline and a first insight into the roles of other health care providers, challenging misconceptions about professional roles; in the second phase (immersion), interprofessional role learning takes place through collaborative interactions; in the final phase (mastery) dual professional identity is mastered (13, 27, 28). To develop interprofessional competencies, IPE should start early and be continued throughout the course of studies (7, 8, 13), although the optimal timing is still under debate (29). If IPE is introduced before one’s professional identity has developed, students may not be ready for collaborative learning. A late start may reinforce stereotypes toward other professions (29).

The competencies acquired in the three stages of IPE can be classified on six levels according to Barr’s et al. modified Kirkpatrick model (30). Level 1 captures the learner’s reaction to the IPE experience, level 2a comprises the modification of attitudes between participating professions and toward the value of interprofessional collaboration for patient-centered care, and level 2b covers the acquisition of knowledge and skills associated to IPE. Levels 3, 4a and 4b are related to the individual transfer of IPE into practice, changes in organizational practice and to improvements in clinical outcomes.

### 1.4. Evidence for interprofessional education

Although the evidence base of IPE is still challenging (6), reviews demonstrate positive effects of IPE, especially among undergraduate learners in the IPE learning stages 1 und 2 (13) and in outcomes associated with level 1, 2a, 2b (31). IPE leads to changes in students’ perception and attitudes toward collaborative learning and practice (8, 31–34). Most reviews also found improved knowledge and skills (e.g., understanding the roles of other disciplines, communicating with other professions) following IPE intervention (31, 32), with Spaulding et al. (8) reporting ambiguous results. There is a growing body of evidence on the successful translation of IPE to collaborative professional practice and patient outcomes, but studies are less common, and results should be interpreted with caution (7, 8, 31).

IPE studies generally comprise six to 10 professions, but also a broader and smaller professional mix (13, 31). Lairamore et al. (35)

### BOX 1 Training of non-medical health professions in Germany

Traditionally, initial education in non-medical health professions has been provided in three-year training programs at vocational schools with a state qualification at the end. To meet the increasing demands for high-quality health care, there is an ongoing debate, whether and to what extent the education of non-medical health professions should be academized, raising non-medical education programs from upper secondary level EQR level 4 (21) to the bachelor's degree level EQR level 6 (21, 23). In 2020, the discussion ended in the full academization of midwifery training (24), and a partial academization for nursing studies (16), with most trainees completing vocational schools and some graduating from university for better career opportunities and professional practice on scientific basis. For the therapy professions, a model was introduced in 2009 that allows primary education at university level (25). As a result, a variety of training programs have evolved, ranging from pure vocational schools, to studies combined with vocational schools, to pure higher education at university. The final decision about education in the therapy professions is expected in 2024, with the revision of profession-specific legislation and regulations, of which interprofessionality is an essential component (5, 23, 26).

compared a case-based IPE event with five and 10 different professions, with the smaller group having an advantage due to the more focused case construction. Nursing, medicine (13, 31) and, within the therapy professions, physiotherapy (13) are the most frequently included professions in IPE studies. Other professions, as nutrition therapy and counseling and speech-language pathology are still underrepresented, which leads to the demand of more diversity in IPE and the establishment of IPE beyond medical faculties (6).

Most IPE studies assess the success of their intervention with self-report surveys (8, 29). While there exist numerous instruments internationally, there are only a few translated into German (36), among them the University of the West of England Interprofessional Questionnaire UWE-IP (37–39). It measures self-perceived attitudes toward interprofessional learning, interaction and relationships and communication and teamwork. The UWE-IP shows good psychometric properties. The underlying factor structure is considered good. However, a relatively high correlation between some scales is shown, challenging the assumption of different dimensions (37). The UWE is recommended for the evaluation of IPE programs and allows the comparison across studies (6, 36). Nevertheless, the exploration of an IPE intervention normally requires more than one assessment tool and the combination of different evaluation methods (6).

## 1.5. Interprofessional dementia education

Due to the multi-layered components of dementia, person-centered, interprofessional approaches can increase the preventive or therapeutic potential in people with dementia (40–43). This is coupled with the need for collaborative coordination in dementia care to ensure optimal support for those affected (44–48). However, interprofessional collaborative practice in dementia care is still rare (49, 50). In this context, IPE can pave the way to prepare the future dementia work force for the delivery of integrated care (44, 46).

The format of IPE in dementia care varies from (extra-)curricular under- and postgraduate programs of different length (45, 48, 51–54), including online and technology-based education formats that allow for synchronous and asynchronous elaboration of teaching contents (45, 52, 53). In general, interprofessional dementia education resulted in increased knowledge about dementia and improved attitudes and empathy toward persons with dementia and their carers (44, 48, 51, 53–55). Regarding interprofessional collaborative competencies, the majority of the studies focused on the modification of attitudes, knowledge and skills (Barr et al. level 2a, 2b) (44, 45, 53–57), mostly with positive findings. Some studies even achieved medium to large effect sizes (45, 48), but the overall quality of the methodology is considered low (44).

## 1.6. Objectives

So far, the therapy professions are still underrepresented in IPE research. Their inclusion is urgently needed, in Germany especially in the context of the efforts to academize non-medical education programs, and globally in the context of complex diseases as dementia. Therefore, the current pilot study aimed to extend IPE to the hitherto less considered study courses of nutrition therapy and counseling, speech-language pathology and physiotherapy in the field of dementia care at a German university of applied health sciences, that offers education beyond the primary professional qualification. More specifically, the pilot study was conducted to improve generic competencies related to dementia and person-centered dementia management as well as to changes in attitudes, knowledge and skills related to interprofessional collaboration (Barr et al. level 2a, 2b) in general and in dementia care. We hypothesized that the participation would lead to positive changes in self-perceived attitudes toward interprofessional collaboration and education, measured with the UWE-IP-D (37), and would result in improvements associated with knowledge and skills in the field of dementia, dementia management and interprofessional collaboration, measured with an in-house questionnaire. We did not expect any differences in gains between the individual health professions.

## 2. Methods

### 2.1. Participants

Our intervention was designed as an interprofessional workshop for students of the bachelor's degree programs in physiotherapy, nutrition therapy and counseling and speech-language pathology at the SRH University of Applied Health Sciences. The students studied at different SRH locations in Nordrhein-Westfalen (North Rhine-Westphalia, NRW) and met in November, shortly after the start of the winter semester, for a joint workshop at the SRH Campus Rheinland. We started the workshop with 53 students ( $n = 28$  nutrition therapy and counseling,  $n = 8$  speech-language pathology and  $n = 17$  physiotherapy). A total of 42 students finished the whole workshop and were considered in data analysis (Table 1, participants). Reasons for exclusions were participation in not all three workshop days, missing information on the questionnaires, so that an allocation pre/post was not

possible and missing submission of the questionnaire. All participating students received credits points for their study program, no other incentives were given. The workshop was facilitated by some of the authors, who taught in the individual study programs: three experienced nutrition therapy and counseling professors and senior assistants, two speech-language pathology professors (one of whom participated online for health reasons), and one assistant for physiotherapy. Among the teaching staff, one had previous experience in interprofessional education. All participants gave their consent to the further use of the collected data in anonymized form. The study was reviewed and approved by the SRH University of Applied Health Sciences for ethical standards.

## 2.2. Interprofessional education workshop

We used a pre-post design to evaluate the IPE intervention. Data were collected immediately before and after a three-day workshop. Our design did not take a control group or randomization into account, as the workshop was part of ongoing courses in each degree program. The workshop consisted of a total of 30 lessons of 45 min each, with a one-day break between the second and third workshop day.

The workshop was conceived as a pilot project with the aim of implementing IPE in the curriculum of bachelor health degree programs in the future. Due to the high relevance for all professions, the topic of person-centered dementia care in an interprofessional setting was chosen for the workshop at the SRH Campus Rheinland. Interprofessional learning was aligned to the learning stages one (exposure) and two (immersion) with first insights into the roles of other health care providers and interprofessional role learning (13, 27). Learning objectives related to generic competencies in knowledge and skills about dementia and dementia management as well as to the framework of Barr's et al. modified Kirkpatrick model, primarily Level 2a, 2b (changes in attitudes, knowledge and skills related to interprofessional collaboration) (30), providing competences for interprofessional collaboration in relation to one's own and other professionals' roles and responsibilities, teamwork and communication. Some of these collaborative competences were formulated specific for dementia, and some described interprofessional

collaboration and education in general. Examples of learning objectives can be found in Table 2.

Derived from the focused competences, teaching and learning approaches included case-based learning (13, 58) in simulated interprofessional case-conferences (13, 59–61) and peer-assisted learning for knowledge transfer among different health professions and across different semester levels (62–64). These are commonly used pedagogical approaches in IPE and health education, relying on teamwork and allowing the combination of collaboration, simulation of real-life scenarios, concrete experiences and reflection (13, 65). According to the IPE idea students should learn with, about and from each other. Small group and active learning methods (e.g., poster walks) are other key components of IPE to foster active involvement and socialization in a safe and non-hierarchical atmosphere (66). Short input sequences from teaching staff were only used to introduce new topics (e.g., information about interprofessional collaboration and education; the use of scaffolds for case-conferences). The main task of the lecturers was to observe the learners in a structured way and to identify and support teachable moments and to moderate plenum discussions. Additionally, sufficient breaks and social events were provided for the personal and professional exchange of the participants.

The program focused on three main topics, each of which was addressed on one of the three workshop days. (1) Understanding of roles. (2) Collaborative dementia management. (3) Simulated interprofessional case-conference with role-play and development of a multicomponent treatment approach. All other materials (e.g., PowerPoint slides of the input sequences, scaffolds, results of group work) were accessible to all students during or after the workshop by email. The workshop was held as planned. Table 3 summarizes the content of the interprofessional dementia workshop.

## 2.3. Outcomes and measures

We used the German version of the UWE-IP (UWE-IP-D) (37–39) to measure self-perceived interprofessional attitudes immediately before and after our workshop in the domains of communication and teamwork (*Communication and Teamwork*

TABLE 1 Participants.

Study program	<i>n</i>	Semester ( <i>n</i> )	Prior knowledge	Mode of delivery
Nutrition therapy and counseling	20	1 (14)	No dementia specific knowledge; IPE: no prior experience	Obligatory
		3 (4)	Basic subject specific knowledge in dementia; IPE: no prior experience	
		5 (2)	Basic subject specific knowledge in dementia; IPE no prior experience	
Speech and language pathology	8	7	Basic subject specific knowledge in dementia	Voluntary as part of an elective module, in which students could choose between different thematic offers
			IPE: No prior experience	
Physiotherapy	14	7	Basic subject specific knowledge in dementia	Obligatory
			IPE: No prior experience	



TABLE 2 Examples of main learning objectives.

Area	Examples of learning objectives
Knowledge and skills in dementia and dementia management	Explaining the molecular mechanisms of Alzheimer's Disease
	Planning intervention according to the ICF for persons with dementia
	Describing language and communication disorders and disorders of food intake in people with dementia
	Explaining the importance of physical activity for people with dementia
Interprofessional learning and collaboration in general	Recognizing the value of interprofessional learning in relation to interprofessional team functioning, communication, and role clarification
	Valuing the expertise of other health professions
	Describing the scope of practice of other health professions
	Passing specialist information in an understandable way in the interprofessional team
Interprofessional learning and collaboration in dementia care	Recognizing the value of interprofessional collaboration in dementia management
	Identifying interfaces of different health professions in dementia management
	Setting treatment goals with other health professions relevant for a specific person with dementia
	Clarifying responsibilities in dementia management

Scale, 9 items), interprofessional learning (*IP Learning Scale*, 9 items), interprofessional interaction (*IP Interaction Scale*, 9 items) and interprofessional relationships (*IP Relationship Scale*, 8 items). The UWE-IP-D is a reliable psychometrically validated instrument (37). The 35 Items were rated on a 4-point (*Communication and Teamwork Scale*) or 5-point Likert scale with scores representing “strongly agree” to “strongly disagree.” Depending on the number of points achieved attitudes can be classified as positive, neutral or negative attitudes (37). In all subscales a lower score relates to a more positive response.

An in-house questionnaire ( $n = 33$  items) was developed to assess self-reported acquisition of knowledge and skills related to interprofessional teamwork in dementia management (*Domain IP Teamwork in Dementia Management*, 10 items), generic knowledge and skills on dementia and patient centered dementia care (*Domain Knowledge and Skills on Dementia Care* 8 items) and to interprofessional communication skills (*IP Communication*, 12 items) pre- and post-training. Items were measured on an 8-point Likert scale with 1–2 = “is completely true,” 3–4 = “is true,” 5–6 = “is partly true,” 7–8 = “is not true.” Three questions were addressed exclusively in the post-evaluation. Here, the quality of the workshop and the influence of the workshop on the future cooperation between the professional groups had to be scored on a 5-point scale, with one being the best rating. The last item offered the possibility of an open evaluation of the workshop. The students were able to comment on what they particularly liked about the workshop and what they had to criticize.

## 2.4. Analyses

For data analysis, the IBM SPSS Statistics 28 software was used. Missing data were compensated by mean value substitutions (<1%). According to Mahler et al. (37) we recoded some UWE-IP-D questions in reversed order. For further analysis, we relied on the sum scores, with a minimum of 9 points and a maximum of 36 points for the *Communication and Teamwork Scale*, a minimum of 9 and a maximum of 45 points for the *IP Learning Scale* and *IP Interaction Scale* and a minimum of 8 points and a maximum of 40 points for the *IP Relationship Scale*. According to the points achieved, attitudes were classified as positive, neutral or negative. This corresponded to scores of 9 to 20, 21 to 25 and 26 to 36 in the *Communication and Teamwork Scale*, scores of 9 to 22, 23 to 31 and 32 to 45 in the *IP Learning Scale* and *IP Interaction Scale* and scores of 8 to 20, 21 to 28 and 29 to 40 in the *IP Relationship Scale* (37–39). Analyses on the in-house questionnaire were also evaluated based on the sum scores. 30 items were included in the quantitative analyses, resulting in a total possible score of 30 to 240 points, a score of 10 to 80 for the *Domain IP Teamwork in Dementia Management*, a score of 8 to 64 for the *Domain Knowledge and Skills on Dementia Care*, and a score of 12 to 96 for the *Domain IP Communication*. Lower values indicate high self-perceived knowledge and skills, and higher values poorer self-assessment.

Pre-post analyses on mean sum scores of the UWE-IP-D and the in-house questionnaire were calculated for the whole group



TABLE 3 Content of the interprofessional dementia workshop.

	Main topic	Group composition, content and used methods
Day 1	Understanding of roles Generic competencies IP Competencies: Barr 2a, b Learning stage 1, 2	<ul style="list-style-type: none"> <li>• Evaluation</li> <li>• Warming up: speed dating for first contact</li> <li>• KL: interprofessional education; quality criteria in literature research</li> <li>• IP-groups: responsibilities and boundaries of individual professions in general</li> <li>• PL-discussion: understanding of professional roles and ethics</li> <li>• Peer teaching in IP-groups to specific themes: ICF in general and in dementia (tutors physiotherapy, speech-language pathology; tutees nutrition therapy and counseling); molecular mechanisms in dementia (tutors nutrition therapy and counseling; tutees physiotherapy, speech-language pathology); posters were prepared unprofessionally before the workshop</li> <li>• PL-discussion: debriefing</li> </ul>
Day 2	Collaborative dementia management Generic competencies IP competencies: Barr 2a, b IP learning stage 1, 2	<ul style="list-style-type: none"> <li>• UP-groups: professions in dementia management, responsibilities and therapy; review of the literature and poster preparation</li> <li>• IP-groups: poster walk—discussion of dementia-management results; overlaps in therapy professions</li> <li>• Preparation of Day 3: KL, scaffolds for case conferences (ISBAR, ICF-oriented guideline for case-conference) and for observation protocols; introduction to case study</li> <li>• PL-discussion: debriefing</li> <li>• Social event to connect</li> </ul>
Day 3	Simulated interprofessional case-conference with role-play IP competencies: Barr 2a, b IP learning stage: 2	<ul style="list-style-type: none"> <li>• KL: feedback rules and feedback methods</li> <li>• UP-groups: uniprofessional preparation of the case study</li> <li>• IP-groups: ICF-oriented case-conference with role play; feedback and reflection (process, professional exchange, communication etc.) a case presentation: general clinical history for all study programs; additional discipline-specific information, only accessible to the respective health profession (e.g., information about language and communication abilities only for speech-language pathology students)</li> <li>• PL-discussion: debriefing</li> <li>• IP-groups: drafts of a multicomponent therapy for dementia</li> <li>• PL-discussion: presentation of results</li> <li>• PL-discussion: debriefing, closure</li> <li>• Evaluation</li> </ul>

KL, Key lectures in the plenum; IP, Interprofessional; IP-groups, Interprofessional group compositions à 8 students; PL-discussion, Plenum discussion; UP-groups, Uniprofessional group compositions à 8 students.

using the paired-samples *t* test. Repeated measures analyses of variance (ANOVA) were performed with time as the within-factor and profession as the between-factor. *Post hoc* pairwise comparisons between professions were examined with paired-samples *t* tests. Tukey's correction was applied to control for potential alpha inflation due to repeated measurements. Except for the profession comparisons, all statistical tests were calculated on the bootstrap procedure, with each 1,000 simulated sample draws, to compensate for deviations from the requirements for a normal distribution of the analyses. Two-tailed *p*-values and alpha levels of 0.05 were used for all statistical tests. Furthermore, effect size measures were computed according to *Hedges'g*, with  $g > 0.8$  considered as a large effect,  $g > 0.5$  as a moderate effect, and  $g > 0.2$  as a small effect (67, 68). Cronbach's alpha was used to assess the internal item consistency of the three dimensions in the in-house questionnaire. Three items from the in-house questionnaire were used for the qualitative analysis. The evaluation of these open-ended responses followed the principles of qualitative analysis (69). Responses were transcribed by one of the authors and subsequently content was grouped and coded by two raters.

## 3. Results

### 3.1. UWE-IP-D

A total of 42 students completed the pre-post comparison with the UWE-IP-D (37). An analysis across all students showed that participation in the interprofessional dementia care workshop led to significant overall improvements in the total UWE-IP-D score (Mean score difference 13.86, 95% CI 10.93, 16.95,  $p < 0.001$ ) and in all four subscales (*Communication and Teamwork Scale*: Mean score difference 3.21, 95% CI 2.33, 4.19,  $p < 0.001$ ; *IP Learning Scale*: Mean score difference 2.71, 95% CI 1.48, 4.12,  $p = 0.002$ ; *IP Interaction Scale*: Mean score difference 3.05, 95% CI 1.67, 4.38,  $p < 0.001$  and *IP Relationship Scale*: Mean score difference 4.88, 95% CI 3.62, 6.14,  $p < 0.001$ ) with moderate to large effect sizes from *Hedges'g* 0.59 to 1.19. Table 4 summarizes the results in the UWE-IP-D questionnaire. In Figure 1 the median with classified attitudes of the whole group is shown for all subscales.

ANOVA revealed a significant main effect in the overall mean sum score values for time [ $F(1, 39) = 84.43$ ,  $p < 0.001$ , partial  $\eta^2 = 0.68$ ], but not for profession [ $F(2, 39) = 1.78$ ,  $p = 0.181$ ]. There was a statistically significant interaction between time and profession [ $F(2, 39) = 4.92$ ,

$p=0.012$ , partial  $\eta^2=0.202$ ]. The overall mean sum scores did not differ significantly according to professional groups before the intervention [ $F(2, 39) = 0.29$ ,  $p=0.750$ ,  $\eta^2=0.015$ ], but after the intervention [ $F(2, 39) = 4.792$ ,  $p=0.014$ ;  $\eta^2=0.197$ ]. *Post hoc* analysis revealed a significant difference in the mean UWE-IP-D total score after intervention only between students of speech-language pathology and physiotherapy (Mean difference 13.09, SE 4.38,  $p=0.013$ ). Regardless of this, all professions improved significantly in the UWE-IP-D total score after intervention [nutrition therapy and counseling (Mean score difference 16.23, 95% CI 12.12, 20.24,  $p<0.001$ ), speech-language pathology (Mean score difference 18.88, 95% CI 11.13, 27.50,  $p=0.005$ ) physiotherapy (Mean score difference 7.59, 95% CI 4.31, 10.67,  $p=0.002$ )], each with large effect sizes ranging from *Hedges'g* 1.18 to 1.65.

### 3.2. In-house questionnaire

Self-reported acquisition of interprofessional teamwork in dementia management, and generic dementia specific knowledge and skills and interprofessional communication were assessed with our in-house questionnaire. Data from 41 students were included in the quantitative in-house questionnaire evaluation. All three domains of the in-house questionnaire revealed reasonable internal consistency with Cronbach's alpha at both testing points, ranging from 0.91–0.95 (*Domain IP Teamwork in Dementia Management*) to 0.72–0.90 (*Domain Knowledge and Skills on Dementia Care*), and 0.91–0.96 (*Domain IP Communication*), respectively.

Overall significant results were achieved in the total in-house questionnaire score (Mean score difference 62.89, 95% CI 50.92, 74.86,  $p<0.001$ ) and in all three domains [*Domain IP Teamwork in Dementia Management* (Mean score difference 25.49, 95% CI 20.30, 30.68,  $p<0.001$ ), *Domain Knowledge and Skills on Dementia Care* (Mean score difference 21.84, 95% CI 18.25, 25.44,  $p<0.001$ ), *Domain IP Communication* (Mean score difference 15.56, 95% CI 11.22, 19.90,  $p<0.001$ )], with large effect sizes from *Hedges'g* 1.12 to 1.90. Table 5 provides an overview of the results of the in-house questionnaire.

The median in the *Domains IP Teamwork in Dementia Management* and *Knowledge and Skills on Dementia Care* changed from moderate ratings before the intervention to positive ratings after the intervention. Self-perceived attitudes in the *Domain IP Communication* were at the border between moderate-positive ratings in the pre-test and positive in the post-test (see Figure 2).

ANOVA revealed significant main effects in the overall mean sum score values for time [ $F(1, 38) = 103.473$ ,  $p<0.001$ , partial  $\eta^2=0.731$ ] and for profession [ $F(2, 38) = 9.702$ ,  $p<0.001$ , partial  $\eta^2=0.338$ ]. There was no statistically significant interaction between time and profession [ $F(2, 38) = 1.154$ ,  $p=0.326$ , partial  $\eta^2=0.057$ ]. Overall results on the in-house questionnaire differed significantly according to professional groups before the intervention [ $F(2, 38) = 5.907$ ,  $p=0.006$ ,  $\eta^2=0.237$ ] and after the intervention [ $F(2, 38) = 5.812$ ,  $p=0.006$ ,  $\eta^2=0.234$ ]. *Post-hoc* analyses revealed that students of nutrition therapy and counseling had marginally but non-significant higher mean sum scores than students of speech-language pathology (Mean score difference 30.20,  $p=0.057$ ) and significantly higher scores than students of physiotherapy (Mean score difference 33.46,  $p=0.008$ ) in pre-testing, and compared to students of speech-language pathology (Mean score difference 36.77,  $p=0.005$ ) in post-testing. This indicates a lower level of self-perceived knowledge and skills.

All professions improved significantly in the total score of the in-house questionnaire [nutrition therapy and counseling (Mean score difference 67.16, 95% CI 44.38, 86.25,  $p<0.001$ ), speech-language pathology (Mean score difference 73.72, 95% CI 61.85, 84.92,  $p<0.001$ ) physiotherapy (Mean score difference 50.91, 95% CI 36.65, 65.50,  $p<0.001$ )], each with large effect sizes ranging from *Hedges'g* 1.37 to 3.72.

### 3.3. Workshop feedback

Of the students who participated, 98% felt that the IPE workshop helped to improve collaboration between disciplines, 84% thereof unrestricted. On a 5-point evaluation scale of the workshop, with 1 being the best rating, the average rating for the entire sample was 1.7. Students of speech-language pathology evaluated the workshop with a mean of

TABLE 4 Results of the UWE-IP-D subscales pre- and post-intervention for the whole sample ( $n = 42$ ).

		Mean sum score	SE	Differences	95% confidence interval		Value of $p$	Hedges' g
				Mean sum scores	Lower value	Upper value		
Total	T1	77.75	1.48	13.86	74.72	80.89	<0.001	1.34
	T2	63.89	1.65		60.76	67.18		
Communication and Teamwork Scale	T1	18.20	0.49	3.21	17.21	19.15	<0.001	0.91
	T2	14.99	0.49		14.01	15.97		
Interprofessional Learning Scale	T1	15.57	0.62	2.71	14.38	16.76	0.002	0.59
	T2	12.86	0.59		11.71	14.05		
Interprofessional Interaction Scale	T1	27.19	0.64	3.05	25.90	28.48	<0.001	0.64
	T2	24.14	0.84		22.43	25.76		
Interprofessional Relationships Scale	T1	16.79	0.64	4.88	15.57	18.05	<0.001	1.19
	T2	11.90	0.53		10.90	13.02		

SE, Standard error of the mean value; Maximal total score value = 166. Maximal score value in *Communication and Teamwork Scale* = 36, in *Interprofessional Learning Scale* = 45, in *Interprofessional Interaction Scale* = 45, in *Interprofessional Relationships Scale* = 40.

1.2, students of nutrition therapy and counseling rated it 1.4 and students of physiotherapy rated it 2.4. In open questions, students indicated that they particularly appreciated the open exchange and teamwork between the professions. Some of them separately mentioned the case study positively. The students benefited above all from the collegial exchange between the professional groups, the dementia-specific increase in knowledge, but also from the fact that they received general information about and from other professional groups and about professional interfaces. In addition, there was a desire to expand the workshop to include other diseases and professions. However, some few students also wanted more student input, homogeneous groups in terms of study duration and more involvement of physiotherapy students.

## 4. Discussion

The therapy professions have received little attention to date in IPE research in general and in dementia care programs (6, 44, 48, 51,

53). Therefore, an IPE pilot workshop was designed for the three therapy professions of nutrition therapy and counseling, speech-language pathology, and physiotherapy. The three-day workshop was integrated into ongoing university courses. Like most studies (8, 13, 31, 44), our IPE program was situated in the IPE learning phases 1 and 2 [first insights into the roles of other health professions, interprofessional role learning through collaborative interactions (27, 28)] with outcomes related to Barr et al. levels 2a, 2b (30).

### 4.1. Summary and interpretation of the UWE-IP-D and in-house questionnaire results

We observed significant positive changes in attitudes toward other professions and toward the value of IPE, which is in accordance with the IPE literature in general (8, 31, 34) and in the field of dementia education (44, 45, 53, 54, 57). Attitudes measured with the UWE-IP-D

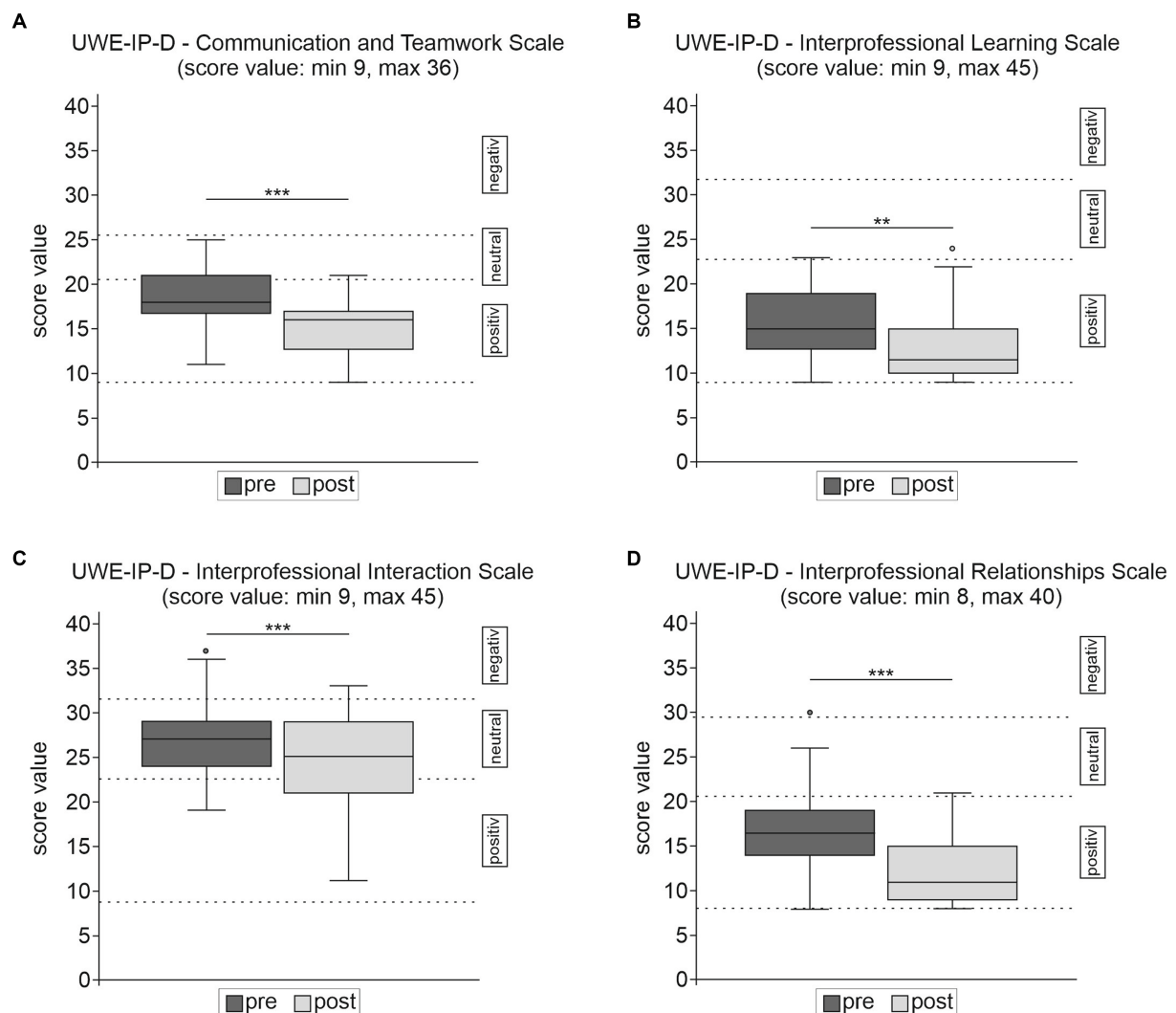


FIGURE 1

Results of the UWE-IP-D sub-scales (A–D) for the whole sample ( $n = 42$ ) pre- and post-intervention. Cumulative Scores for the UWE-IP-D were attributed to positive, neutral, negative areas according to Pollard et al. (38, 39). \*\*\* $p \leq 0.001$  and \*\* $p \leq 0.01$ . In all subscales a lower score relates to a more positive response.

TABLE 5 Results of the in-house questionnaire domains pre- and post-intervention for the whole sample ( $n = 41$ ).

		Mean sum score	SE	Differences	95% confidence interval		Value of $p$	Hedges' $g$
				Mean sum scores	Lower value	Upper value		
Total	T1	131.48	5.25	62.89	121.64	142.35	<0.001	1.64
	T2	68.59	4.49		60.01	77.42		
IP Teamwork in Dementia Management Scale	T1	48.02	2.12	25.49	44.06	52.30	<0.001	1.54
	T2	22.54	1.57		19.63	25.71		
Knowledge and Skills on Dementia Care Scale	T1	42.05	1.62	21.84	38.78	45.46	<0.001	1.90
	T2	20.20	1.39		17.68	23.15		
IP Communication Scale	T1	41.41	2.16	15.56	37.49	45.91	<0.001	1.12
	T2	25.85	1.82		22.34	29.41		

SE, Standard error of the mean value; Maximal total score value = 240. Maximal score value in Domain IP Teamwork in Dementia Management = 80, in Domain Knowledge and Skills on Dementia Care = 64, in Domain IP Communication = 96.

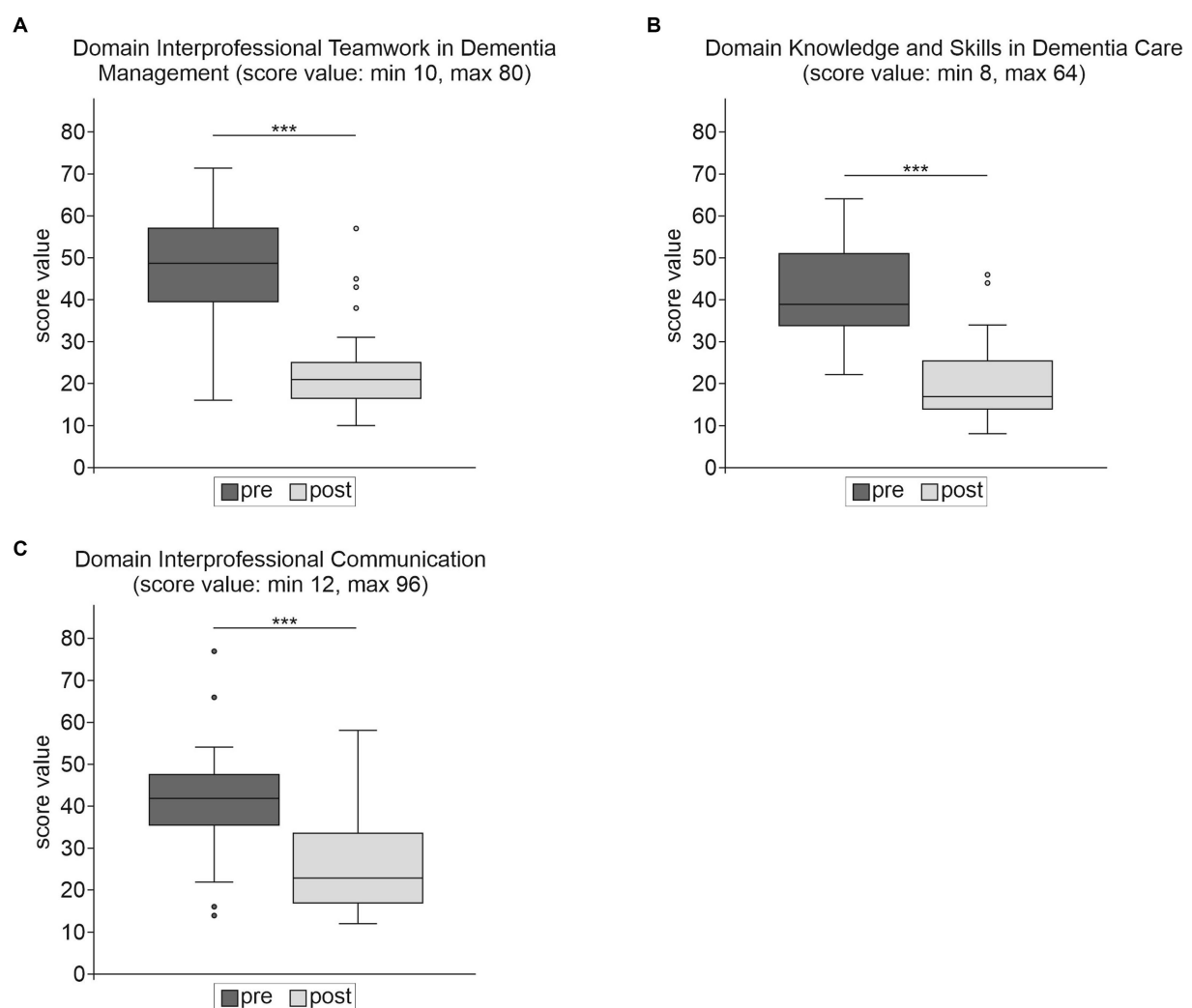


FIGURE 2

Results of the in-house questionnaire domains (A–C) for the whole sample ( $n = 41$ ) pre- and post-intervention. \*\*\* $p \leq 0.001$  and \*\* $p \leq 0.01$ . In all domains a lower score relates to a more positive response.

Scales *Communication and Teamwork*, *IP Learning*, and *IP Relationship* (37) were already positive before training and improved significantly with moderate to large effect sizes after the workshop, indicating high willingness and motivation to collaborate and learn together. Gains on these three UWE-IP Scales were also demonstrated in other studies (70–74). The most negative ratings pre- and post-training were on the *IP Interaction Scale*, related to status, stereotypes and inequality among professions, although there was a significant reduction of negative perceptions after the workshop. The worse rating in the *IP Interaction Scale* is consistent with other studies using the UWE-IP (39, 71, 72, 74–76), but only some of these observed improvements after an IPE program as we did (71, 72). The students' views regarding interprofessional interaction may be influenced by notions of imbalances in the hierarchy of the health care system (31), which in turn supports the claim of introducing IPE early in health education before negative stereotyping is reinforced (7, 8, 13, 29).

There is a general discussion in the literature about the need to test the effectiveness of the IPE intervention at different levels (6, 77). While standardized testing procedures, such as the UWE-IP (37, 39), allow for international comparisons of individual projects, the used evaluation instruments should also be adapted to the respective IPE settings and contents, so that as many aspects of the intervention as possible can be covered (6, 31). Therefore, we designed an in-house questionnaire to assess self-perceived abilities of interprofessional teamwork in dementia management, generic dementia specific knowledge and skills, and interprofessional communication in more detail. Significant gains with large effect sizes were seen in competencies that can only be acquired through IPE (4) (e.g., *Domains IP Teamwork in Dementia Management*; *IP Communication*), as well as in generic competencies related to dementia specific knowledge and skills, which are usually taught unprofessionally (*Domain Knowledge and Skills on Dementia Care*). As far as the *IP Communication* is concerned, overall rating was already moderate to positive before the intervention. Regarding self-reported generic knowledge and skills related to dementia (*Domain Knowledge and Skills on Dementia Care*) and interprofessional teamwork in dementia management (*Domain IP Teamwork in Dementia Management*), significant changes in each domain were observed, with medium ratings pre-intervention and positive ratings post-intervention. The gains are in line with other studies investigating dementia knowledge and skills before and after training (48, 53, 78, 79), except for the study of McCaffrey et al. (55), who could only find a numerical, non-significant knowledge increase. However, it should be noted that self-report instruments can reflect acquired knowledge and skills only to a limited extent (6). We are aware of only some studies in dementia care that have objectively examined the effects of IPE on knowledge gains by already published tools (48, 79) or specifically developed ones (55). Therefore, it seems promising to develop a program that teaches interprofessional collaboration in general and in dementia care while enabling the acquisition of generic dementia knowledge and including objective and self-assessment testing procedures.

## 4.2. Influencing factors on IPE

Several presage factors may have contributed to the significant effects on attitudes toward interprofessional collaboration and education as well as on dementia related knowledge and skills. Among the student characteristics, the high willingness and motivation for collaborative learning, that we had observed prior to the training, was probably

conducive (31). The high proportion of female students may also have influenced the results. While Reeves et al. (31) reported mixed effects of gender in their review, Wang et al. (34) observed more positive responses in female participants compared to males. Due to the small number of male students, we did not link gender to the data of our questionnaire to ensure anonymity. Therefore, a gender-specific analysis was not possible. In addition, a climate of safety, as we provided in small learning islands, facilitator input and debriefing, and informal networking opportunities may have fostered positive IPE experiences (31). The inclusion of only three professions allowed us to construct a focused case story. Lairamore et al. (35) observed a stronger impact of a case-based IPE event in groups of five professions compared to 10 with broadened case scenarios and less involvement of the individual professions. Nevertheless, the inclusion of more professions is desirable in the future to increase the complexity of the learning situations and to stimulate transfer to real practice (80). In the qualitative feedback students wished IPE to be strengthened by the inclusion of other diseases and additional professions. Knowledge of other health providers in general and their role in dementia management, exchange within the jointed groups, and collegial interaction were seen as key personal outcomes of the workshop.

Approaches to learning and teaching are important process factors that affect IPE (6, 31), and learning activities, desired outcomes and their assessment should be adequately aligned (4, 13). In accordance with international methods, the incorporation of peer-assisted learning with tutors and tutees from different professions (64) was designed to compare and contrast professional roles and responsibilities, to gain knowledge about dementia and dementia management. Competencies related to teamwork, communication and patient-centered dementia care were additionally maximized through experiential learning (13, 65, 80, 81), with the elements of a uniprofessionally prepared case study to be negotiated in a simulated interprofessional case-conference, followed by discussion and reflection.

## 4.3. Profession specific results

Contrary to our expectations, we observed some profession specific differences. In the pretest, attitudes measured with the UWE-IP-D (37) were comparable in all three groups, but nutrition therapy and counseling had a significantly lower baseline mean score in the in-house questionnaire. These differences can possibly be attributed to the lower semester numbers of nutrition therapy and counseling students (nutrition therapy and counseling: first to fifth semester; physiotherapy and speech-language pathology: seventh semester). Regarding the UWE-IP-D, a significant interaction between time and profession was observed, as physiotherapy students had lower pre-post gains compared to the other two professions. The skeptical attitude of some physiotherapy students toward the event is also reflected in the student feedback: physiotherapy students evaluated the workshop with 2.4, while the mean rating of speech-language pathology students and nutrition therapy and counseling students was 1.2 and 1.4, respectively. All three professions found that the workshop improved interprofessional collaboration in dementia management, but some participants wished physiotherapy students to be more included. The differential number of semesters can only partially explain the observed imbalances, since students of physiotherapy and speech-language pathology were both in the seventh semester. Another reason may lie in the fact that the workshop was led by several experienced nutrition therapy and counseling and speech-language pathology professors and senior assistants, whereas only one



assistant was available for physiotherapy for organizational reasons, leading to unbalanced professional representatives in the mixed small groups. According to Reeves et al. (31), facilitator's experience and support is a key factor in the delivery of IPE. Another difference in the implementation was that the workshop was voluntary for speech-language pathology students, but obligatory for students of nutrition therapy and counseling and physiotherapy students, possibly resulting in greater engagement in learning activities and larger gains for the voluntarily participating speech-language pathology students (8, 31). Nevertheless, physiotherapy students also benefited significantly on both the UWE-IP-D and the in-house questionnaire.

## 4.4. Strength and limitations, future research

The current pilot study expanded IPE in the under-researched area of dementia care and included the previously neglected therapy professions of speech-language pathology, nutrition therapy and counseling, and physiotherapy, which is necessary to account for more professional diversity (6), and in the German context of academization efforts in non-medical education programs (5, 26, 82). However, the inclusion of other key dementia care professions would be desirable. Since the curricular implementation of IPE in dementia care and in general is usually a time-consuming process with many challenges and adjustments in program development and evaluation (6, 45, 51), projects and pilot studies are needed to fine-tune and improve the content, group compositions and logistics in educational programs. Nevertheless, the aim should be to move away from the project level toward the curricular implementation of IPE, that starts early and is evaluated over the long term (1, 6). Furthermore, since there is a lack of evidence to what extent IPE transfers into clinical practice, future research should examine changes in behavioral, organizational and patient outcomes (1, 6, 31).

To address the complexity of assessing interprofessional collaboration competencies, we used several assessment methods aligned with our educational goals and content, including the UWE-IP-D (37), to allow for comparison across studies. Self-assessments can provide insight into internal states (e.g., attitudes), but there are concerns, such as the veracity of self-reports, and their weaknesses in measuring knowledge and skills (31, 77). For further evaluation, objective assessment of knowledge and skills should be included, although some interprofessional competencies are difficult to assess in a standardized way (6). The applied learning methods (e.g., case-based learning, simulated case-conference, peer-assisted learning) were suitable for achieving the desired learning goals. In addition, the use of hybrid methods should be explored, as this offers flexible teaching and learning opportunities to extend the workshop in terms of content and time to gradually develop collaborative competencies (6, 45).

There are some methodological limitations to consider: we had a relatively high number of missing data, so we cannot exclude a non-respondent bias. Our sample was small for comparison between professional groups, thus challenging findings of significance. Moreover, our group was heterogenous in terms of semester numbers, number of students and facilitators from different disciplines, and voluntary/obligatory participation, which may have influenced the results. Number of semesters was confounded with the professional affiliation. Therefore, these effects cannot be separated clearly. Because our intervention is complex, the outcome can be influenced by many variables (83, 84). Therefore, we detailed the main components of our intervention in

accordance with the checklist of Meinema (83) to enable a replicable design. A control group was not implemented for organizational reasons. However, a more rigorous design would be desirable to compare a uniprofessional intervention to an interprofessional one (84). The research design could further be strengthened by including a follow-up some weeks after the workshop to assess stability of learning gains.

All these aspects should be considered in future research, to raise the level of evidence and to draw conclusions about interprofessional learning and socialization processes, optimal alignment of workshop objectives, contents, methods, and competency-based assessment formats as well as differences in outcome between the professions.

## 4.5. Conclusion

In conclusion, this pilot-study confirms the effectiveness of IPE to promote interprofessional dementia care competencies and to develop positive attitudes toward interprofessional learning and collaboration in the therapy professions, thus increasing professional diversity in IPE research. In the future, the delivery of our dementia-care workshop should be expanded to a larger group of participants belonging to different professions, include additional, objective competency-based assessment methods, and be placed in the context of a longitudinal, curriculum-based IPE framework to prepare graduates for high quality patient care.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Author contributions

KD, IA, AL, HG, TH, TT, and MG contributed to the conception and design of the study, evaluated the data, and wrote the manuscript. MS supported the statistical analysis. CH prepared the data and organized the database. All authors contributed to the article and approved the submitted version.

## Funding

This research was funded by the MG Rhineland-Palatinate (Germany), grant NeurodegX. Furthermore, funding was provided by the European Commission under the framework programme of the European Union (grant agreement No. 211696) LipiDiDiet; the EU Joint ProgrammeNeurodegenerative Disease Research (JPND) and BMBF grants Multi-MeMo (01ED2306) and EURO-FINGERS (01ED2003), and the BMBF grants Health.AI 03WIR5602B und 03WI5604B.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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RECEIVED 16 June 2023

ACCEPTED 07 August 2023

PUBLISHED 27 September 2023

## CITATION

Mitzkat A, Mink J, Arnold C, Mahler C, Mihaljevic AL, Möltner A, Trierweiler-Hauke B, Ullrich C, Wensing M and Kieseewetter J (2023) Development of individual competencies and team performance in interprofessional ward rounds: results of a study with multimodal observations at the Heidelberg Interprofessional Training Ward. *Front. Med.* 10:1241557. doi: 10.3389/fmed.2023.1241557

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# Development of individual competencies and team performance in interprofessional ward rounds: results of a study with multimodal observations at the Heidelberg Interprofessional Training Ward

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**Introduction:** Interprofessional training wards (IPTW) aim to improve undergraduates' interprofessional collaborative practice of care. Little is known about the effects of the different team tasks on IPTW as measured by external assessment. In Heidelberg, Germany, four nursing and four medical undergraduates (= one cohort) care for up to six patients undergoing general surgery during a four-week placement. They learn both professionally and interprofessionally, working largely on their own responsibility under the supervision of the medical and nursing learning facilitators. Interprofessional ward rounds are a central component of developing individual competencies and team performance. The aim of this study was to evaluate individual competencies and team performance shown in ward rounds.

**Methods:** Observations took place in four cohorts of four nursing and four medical undergraduates each. Undergraduates in one cohort were divided into two teams, which rotated in morning and afternoon shifts. Team 1 was on morning shift during the first (t0) and third (t1) weeks of the IPTW placement, and Team 2 was on morning shift during the second (t0) and fourth (t1) weeks. Within each team, a tandem of one nursing and one medical undergraduate cared for a patient room with three patients. Ward round observations took place with each team and tandem at t0 and t1 using the IP-VITA instrument for individual competencies (16 items) and team performance (11 items). Four hypotheses were formulated for statistical testing with linear mixed models and correlations.

**Results:** A total of 16 nursing and medical undergraduates each were included. There were significant changes in mean values between t0 and t1 in individual competencies (Hypothesis 1). They were statistically significant for all three sum scores: "Roles and Responsibilities", "Patient-Centeredness",

and "Leadership". In terms of team performance (Hypothesis 2), there was a statistically significant change in mean values in the sum score "Roles and Responsibilities" and positive trends in the sum scores "Patient-Centeredness" and "Decision-Making/Collaborative Clinical Reasoning". Analysis of differences in the development of individual competencies in the groups of nursing and medical undergraduates (Hypothesis 3) showed more significant differences in the mean values of the two groups in t0 than in t1. There were significant correlations between individual competencies and team performance at both t0 and t1 (Hypothesis 4).

**Discussion:** The study has limitations due to the small sample and some sources of bias related to the external assessment by means of observation. Nevertheless, this study offers insights into interprofessional tasks on the IPTW from an external assessment. Results from quantitative and qualitative analysis of learners self-assessment are confirmed in terms of roles and responsibilities and patient-centeredness. It has been observed that medical undergraduates acquired and applied skills in collaborative clinic reasoning and decision-making, whereas nursing undergraduates acquired leadership skills. Within the study sample, only a small group of tandems remained constant over time. In team performance, the group of constant tandems tended to perform better than the group of random tandems. The aim of IPTW should be to prepare healthcare team members for the challenge of changing teams. Therefore, implications for IPTW implementation could be to develop learning support approaches that allow medical and nursing undergraduates to bring interprofessional competencies to team performance, independent of the tandem partner or team.

#### KEYWORDS

interprofessional education, interprofessional collaborative practice, interprofessional training ward, interprofessional ward rounds, evaluation, observation

## 1. Introduction

Improving interprofessional collaborative practice (IPCP) has been formulated as a policy goal in healthcare worldwide (1), acknowledging the associations that have been found between IPCP, quality of care, and patient safety (2–5). Accordingly, in recent years, the topic of interprofessional care has also gained relevance in the educational policy of health professions (medicine, nursing, and other allied health professions) and is demanded as a curricular concept for these vocational training and study programs (1, 6–13). In Germany, interprofessional education (IPE) and interprofessional learning (IPL) have been implemented in the curricula at many sites (14, 15). In medicine, interprofessional competencies should be taught longitudinally, according to the new National Competency-Based Learning Objective Catalog of Undergraduate Medical Education (16). Interprofessional competencies are also explicitly described for nursing in the new vocational training regulations (17). Competencies should be acquired at the level of independent and situation-appropriate performance by the end of training or study. Interprofessional training wards (IPTW) are of particular importance for this level of competence, as they exhibit a high degree of complexity in direct patient care that enables learners to interact self-determinedly and self-responsibly to the greatest possible extent (18–20). IPTWs have been implemented at many hospitals

worldwide (18, 21–36). IPTW addresses both profession-specific and interprofessional learning objectives, namely by having undergraduates from different healthcare professions (2–12 undergraduates, depending on the concept) take over the care of a certain number of patients as independently as possible under supervision by learning facilitators. Competency frameworks (37–40) are often used to formulate interprofessional learning objectives. The didactic concept builds on adult learning theories (41, 42), such as cognitive constructivism (43) and socio-constructivism (44). Interprofessional learning is also promoted through real-life placement (45, 46). Positive short-term effects of IPTW are described, especially with regard to a better understanding of professional roles, as well as the long-term effects of interprofessional competencies. Most studies on IPTW document learning outcomes based on students' self-reported evaluations (20). IPTW is also increasingly being implemented in Germany (47–49).

Together with the implementation of IPE/IPL in the curricula of health professions, there is an increasing need to evaluate it, especially with regard to its impact on the competencies for IPCP (50, 51). Questionnaires are often used for this purpose, which collect a structured self-assessment of the participant in IPE/IPL (52–54) and are mostly oriented toward competency frameworks (1, 39, 55). In Kirkpatrick's classification (56) of learning-related outcomes, as modified by Barr et al. (57), these studies primarily



map knowledge and attitude-related changes (levels 1 and 2a/b). Studies that assess behavioral change (level 3) or impact on quality of care (level 4a/b) through third-party assessment are rare.

## 1.1. The Heidelberg interprofessional training ward

In 2017, an interprofessional training ward (Heidelberger Interprofessionelle Ausbildungsstation, HIPSTA) was implemented in an abdominal surgery ward at the university hospital in Heidelberg, Germany (46). Together with the IPTW in Mannheim and Freiburg, which started shortly thereafter, it was the first IPTW in Germany. At that time, the “ward within a ward” included two three-bed patient rooms and a dedicated ward office. Utilities were shared with the surrounding ward. Four students of human medicine (medical undergraduates, MU) in their practical year (the last year of a total of 6 years of study) and four nursing trainees (nursing undergraduates, NU) in their third year of training (the last year of a total of 3 years of vocational training) spent a 3- to 5-week placement on the HIPSTA, during which they were responsible for the patient as far as possible independently and on their own responsibility. The undergraduates work in two shifts on weekdays, with a 2-h overlap at noon. On weekends and at night, patients are cared for by the ward’s regular nursing staff. The cohorts (4 NU + 4 MU) were assigned to early and late shifts in the weekly rotation. The respective teams of one shift (2 NU + 2 MU) were divided into two interprofessional tandems, which took over the care of the patients in one room each. One team of four participants was planned to start with the early shift for the whole first week; the other four were to start with the late shift. In the second week, the groups switch, and the participants who worked early shift in the first week work late shift in the second week, and vice versa. In weeks 3 and 4, they changed again, enabling each group to work in one shift for 5 days in a row and a weekly alternation of early and late shifts, resulting in 2 weeks of early and 2 weeks of late shifts for each participant in total.

As shown by a retrospective analysis of patient data (58), the patients to be cared for did not significantly differ from patients on the surrounding ward with regard to age, comorbidities, reason for admission, or data concerning surgery. The undergraduates were supervised by nursing and physician learning facilitators. A nursing facilitator was present throughout the morning shift. The physician facilitator was present for the morning ward rounds, midday handovers, and afternoon short rounds and was on call by phone the rest of the time. During the afternoon shift, an experienced nurse from the surrounding ward who had been well introduced to the HIPSTA concept was the contact person for the undergraduates. The learning facilitators interfered with patient care only when there was a concern that patient safety would otherwise be compromised. Otherwise, they remained in the background and only became active when requested by the undergraduates, answering questions or, in case participants asked for it, guided certain actions on the patient or in administration. They also provided feedback and fostered reflection and problem-solving processes. The daily routine at HIPSTA was structured by different practical learning phases in which the undergraduates learned both

professionally and interprofessionally. On the morning shift, the interprofessional ward round took place. It started at approximately 8 a.m. A tandem of one NU and one MU conducted the round in the room they were caring for. The facilitators took part in the rounds but remained in the background. In addition, the nursing shift leader of the surrounding ward, a pharmacist, and other medical staff may also have been involved. The other tandem of the team also passively participated in the ward round. The round in the patient’s room was usually preceded by a brief exchange outside the room on the current situation or on aspects that could not be discussed in front of the patient for certain reasons. After all patients in both rooms had been visited, a joint comprehensive debriefing of the information gained took place in the HIPSTA ward office. The further treatment, therapy, and care plan were developed jointly in tandem and coordinated with the nursing and physician facilitators.

For the overall evaluation of HIPSTA, a mixed-methods approach was chosen (59), which included quantitative and qualitative analyses. The results of the quantitative analyses of self-assessment questionnaires (60), the reconstructive analyses based on group interviews (61), and qualitative content analysis of personal interviews (62) show an acquisition of competence experienced by the learners with regard to collaboration, roles, responsibilities, and communication, more positive attitudes toward IPL and teamwork, and partial development of an (inter-)professional identity and socialization.

In addition to the self-reported assessment of the HIPSTA evaluation, behavioral change was captured via third-party observation. The interprofessional ward rounds were chosen as the observational setting because it was anticipated that observable interaction between the undergraduates and with the patients would show up particularly often. For this purpose, an instrument was developed (63), which is multimodal in design and assesses both individual competencies and team performance. By observing the ward rounds, it was intended to record whether and how individual competencies and team performance change over time by means of external assessment.

## 1.2. Aims and research questions

The aim of this article is to present and discuss the results of the structured ward round observation. Research questions were: How do nursing and medical undergraduates develop individual competences and team performance during their 4-week HIPSTA placement measured by external assessment in ward rounding? To what extent does the development of nursing and medical undergraduates differ? To what extent are individual competencies and team performance interdependent?

## 2. Methods

### 2.1. Design and data collection

Data were collected from January to May 2018 in four cohorts of HIPSTA in a pre- (beginning) post- (end) design. For this

purpose, participants' rounds were observed in their first (t0) and last week (t1) of their morning shift, when ward rounds took place. Observation was conducted by two researchers each using the IP-VITA<sup>pre</sup> [Individual competencies and team performance assessment tool (63)]. The instrument was developed empirically by first testing three instruments (64–66) available for the evaluation of interprofessional learning interventions with patient contact in a pre-study. The “Individual Teamwork Assessment Scale” (iTOFT) (64), the “Teamwork Assessment Scale” (TAS) (66), and the “McMaster-Ottawa Scale” (McMOS) (67) were used in at least one cohort ( $n = 4$  observations). Afterwards, their use in the HIPSTA evaluation was discussed. It was decided that data should be collected at both the individual and team levels and that a separate instrument would be needed for this purpose. Therefore, an instrument, the IP-VITA, was developed from the experience made with the former instruments. As shown in Figure 1, the data presented were collected using the preliminary version of the instrument (IP-VITA<sup>pre</sup>). In this version, observable individual behavior was assessed by 16 items. Nine items were further developed from the instrument testing and adapted to the specific context of ward rounding. These items were evaluated on a 6-point Likert scale. Seven items compressed the CanMEDS model (68). Observable interaction within the tandems was assessed by 11 items on a 4-point Likert scale. Definitions (strongly agree/don't agree at all, to a very high degree/to a very low degree) were given only for the maximum expressions. Gradations were scored at intervals in relation to these two poles. Figure 1 gives an overview of the study design and data collection.

Each researcher observed one person in the tandem regarding individual competencies. Both took notes on the interaction and completed the team performance scale jointly after the observation in terms of intersubjective interpretation for each tandem.

## 2.2. Statistical analysis

All data analysis was performed in the IBM SPSS Statistics 22 software, except for the mixed model calculated for the team performance scale, which was performed in R. The dataset was cleaned by identifying outliers and extreme values and checking the dataset for plausibility. Missing values occurred when a skill or behavior was not observable. They were excluded on an item-by-item basis, as no systematic correlation between the missing values could be identified.

For statistical analysis, interval scaling was assumed for the Likert-scale data. Therefore, the mean and standard deviation are presented to describe the dataset.

Descriptive statistics for the sample were compiled. Welch *t*-test was calculated for the age difference in groups by profession (NU, MU).

The IP-VITA<sup>pre</sup> was checked with regard to its internal consistency. Cronbach's alpha was calculated. Based on an exploratory factor analysis and theoretical considerations, three scores were formed for the individual competency scale and the team performance scale. For this purpose and for better comparability of graphical representation,

six-point scaled items were converted to a four-point scale. Subscales were checked for internal consistency using Cronbach's alpha.

The following hypotheses were formulated for testing:

1. H1: values of individual competencies (item and score) differ in t0 and t1.
2. H1: values of team performance (item and score) differ in t0 and t1.
3. H1: there are differences in the mean values of the NU and MU groups at t0 and t1, and there are differences in the mean change over time.
4. H1: the values of individual competencies and team performance are correlated.

To describe the change in individual competencies and team performance over time and within the professional groups, a linear mixed model with restricted maximum likelihood (REML) and Satterthwaite's method with an F-test were calculated. For individual differences, the model included group (Hypothesis 3), time (Hypothesis 1), and their interaction as fixed, and participants as a random factor (Hypothesis 3). For team performance, the model included time as fixed and the NU/MU group as random factors (Hypothesis 2). Effects with  $p < 0.05$  were considered significant. Trends that appeared to be particularly interesting were plotted graphically or described, even if they did not show a significant value.

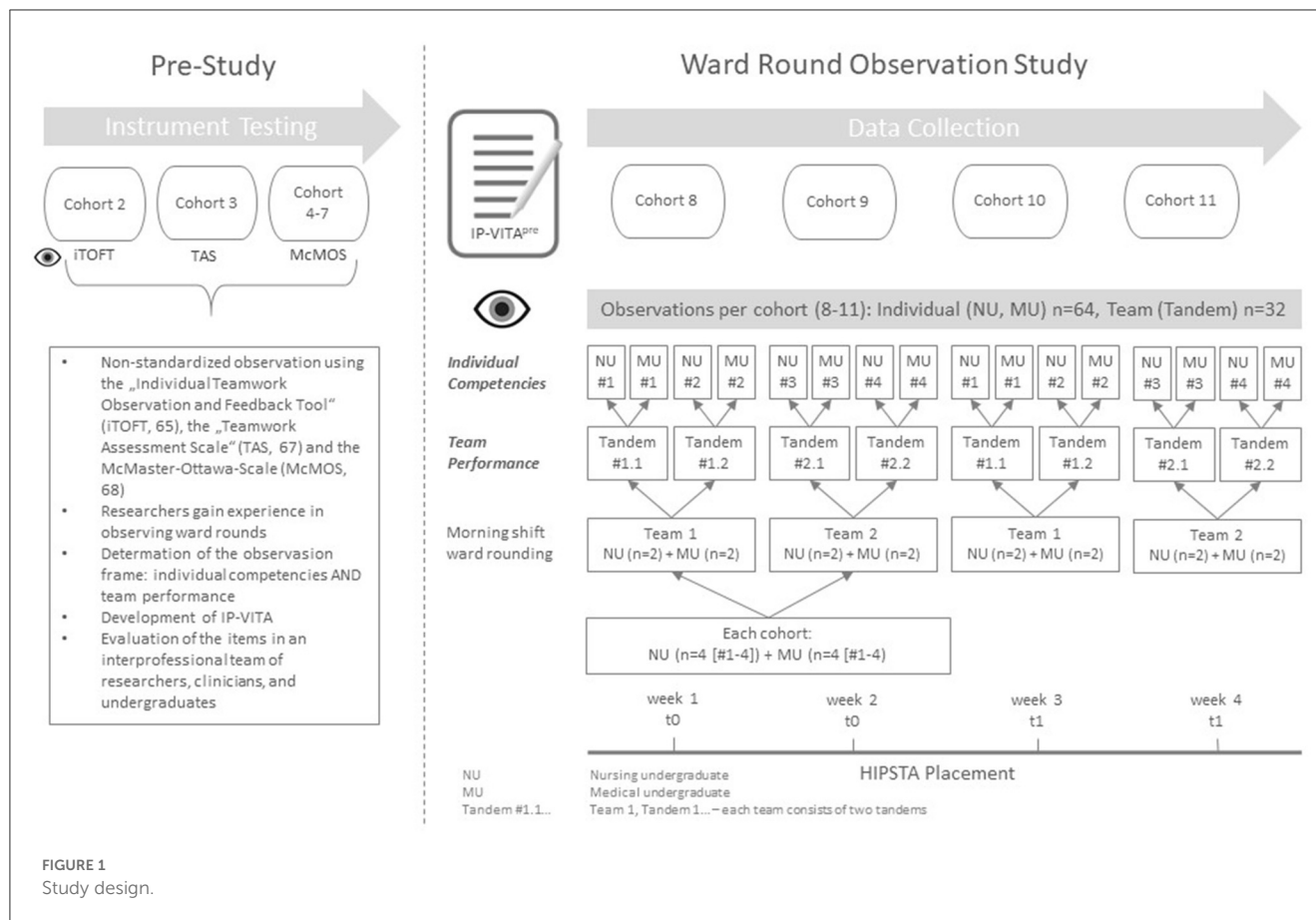
Pearson correlations were performed to determine relationships between individual competencies and team performance (Hypothesis 4).

## 3. Results

### 3.1. Participant characteristics

Observations with the IP-VITA<sup>pre</sup> took place in HIPSTA cohorts 8–11. A total of 16 nursing undergraduates (10 women and 6 men) and 16 medical undergraduates (3 women and 13 men) were included. No observation could be conducted with one medical undergraduate in cohort 10, and only one observation took place with one nursing undergraduate due to illness/shift change. In these cohorts, therefore, two other medical and one nursing undergraduate were observed at three instead of two data collection points. For individual competencies, the third observation was not included in the data analysis. At the team level, the observation was considered to be regular t0 or t1, as most of the other tandems also changed partners. Only four tandems remained constant across measurement time points t0 and t1, and the other 12 tandems worked with different partners at t1 than at t0.

Table 1 and Figure 2 provide an overview of the included participants. The mean age was  $21.8 \pm 1$  in the nursing group and  $27.7 \pm 3.4$  in the medical group overall. This difference is significant ( $p < 0.001$ ). There were significantly more women among nursing than among medical undergraduates (Fisher's test,  $p = 0.029$ ). Based on this, the mean age difference is significantly different between male and female participants ( $p = 0.002$ ).



The number of patients in the two rooms varied according to surgery or overlapping times of discharge/admission. During 15 ward rounds at t0 and t1, each of the three patients had to be discussed. In 14 rounds at t1 and 13 rounds at t0, there had been two patients. In two rounds (t0 and t1), the rooms were occupied only by one patient. The patients' clinical appearance was heterogeneous and covered the whole spectrum of a general abdominal surgery ward. The nursing and physician learning facilitators were present in all except for two rounds, where once the physician and once the nurse were not present. The nursing ward manager was present in some rounds, a pharmacist in two, and an intern in two ward rounds.

### 3.2. Analysis of the IP-VITA<sup>pre</sup>

Exploratory factor analysis yielded a three-component solution for the individual scale and a four-component solution for the team performance scale. This was checked for plausibility in terms of content. Cronbach's alpha was calculated for all subscales. For the individual competencies, 14 of the 16 items could be combined in the three subscales "Roles and Responsibilities" (6 items,  $\alpha = 0.891$ ), "Patient-Centeredness" (3 items,  $\alpha = 0.850$ ), and "Leadership" (5 items,  $\alpha = 0.845$ ). The items "Active participation" and "CanMEDS Collaborator" were not included. The three subscales explain almost 70% of the variance in the data.

For the team performance scale, the subscales "Roles and Responsibilities" (2 items,  $\alpha = 0.808$ ), "Patient-Centeredness" (4 items,  $\alpha = 0.844$ ), and "Decision-Making/Collaborative Clinical Reasoning (CCR)" (3 items,  $\alpha = 0.739$ ) excelled. The fourth component was discarded due to a lack of content plausibility and low inner consistency. The items "Exchange between NU and MU present" and "Swift effective round" were not included. The team scores explained 70% of the total variance of the team performance scale.

### 3.3. Development of individual competencies

We hypothesized (Hypothesis 1) that there is a mean value change from t0 to t1. In the linear mixed model calculated for the influence of time (t0, t1), significant differences between moments in time showed up in all subscale scores, as can be seen in Table 2. The mean value of all except one item of the subscale "Roles and Responsibilities" increased from t0 to t1. The increase was highly significant in the item "defines clear goals for further treatment" (mean change 0.80,  $p = 0.001$ ). This means, according to the descriptors of the item, that in the ward rounds observed at the end of the assignment on HIPSTA, the undergraduates more often explicitly addressed

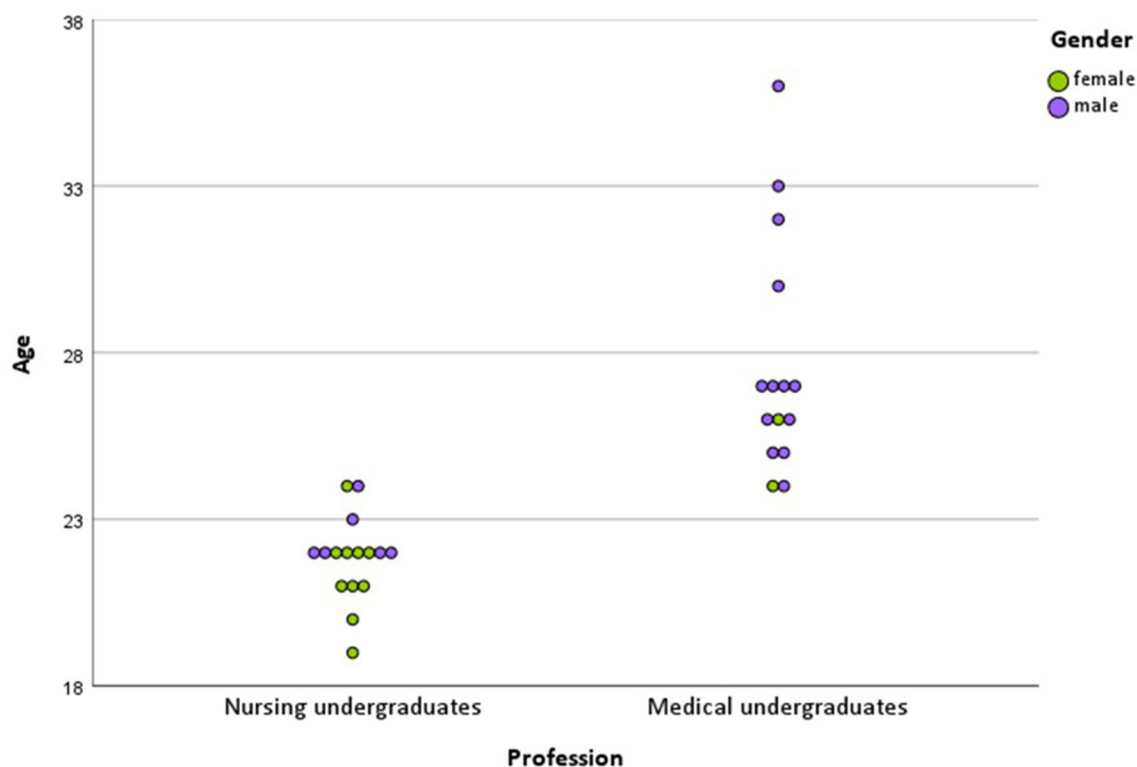


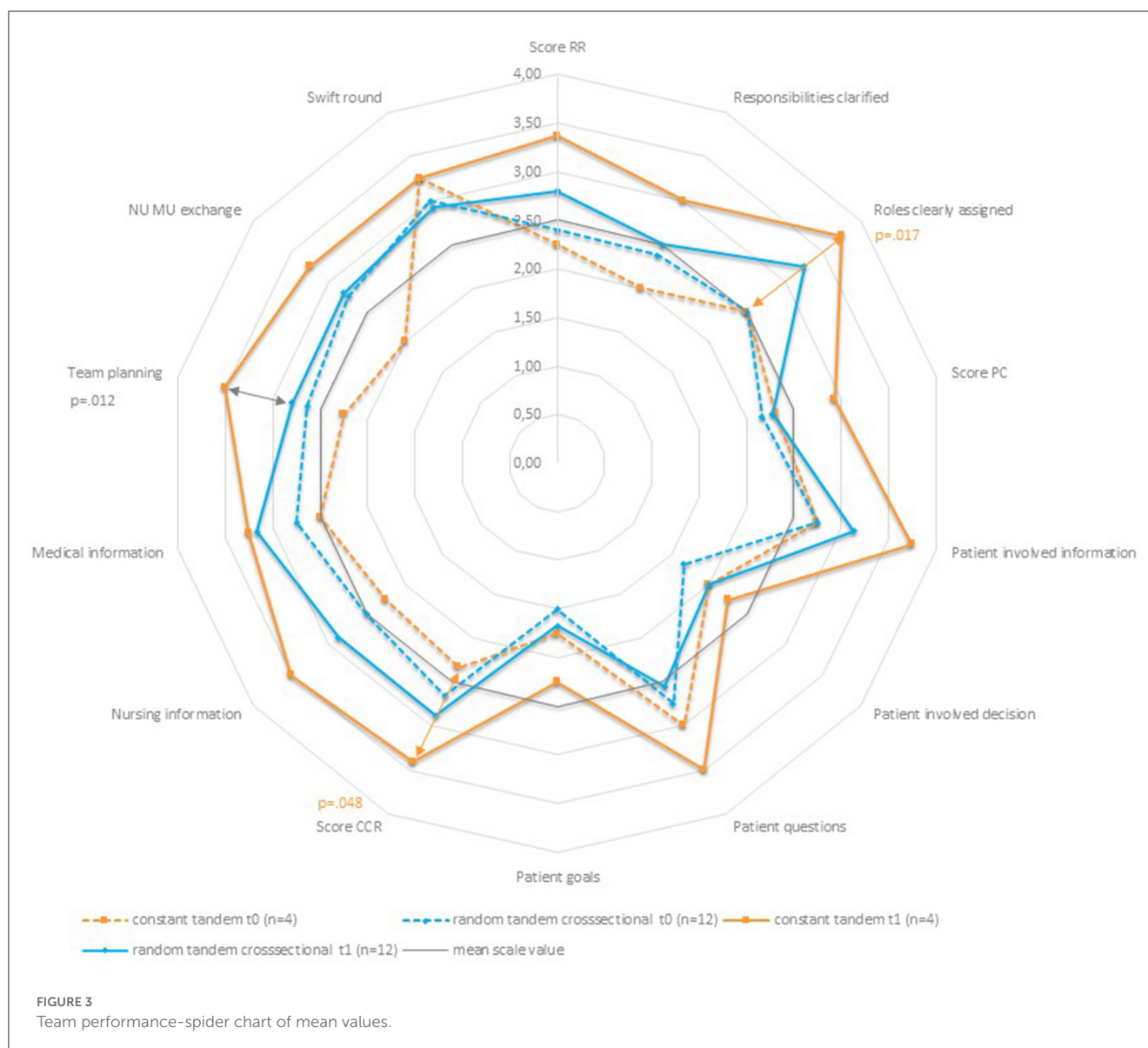
FIGURE 2  
Dot plot of the study sample.

further treatment, prioritized actions, and named feasible goals, including their realization in time. The difference in time was also highly significant for the item “CanMEDS Manager” (mean change 0.74,  $p = 0.001$ ). This means that the undergraduates were better organized and more effective with available resources in the second observed ward round. Overall, the increase in the subscale “Roles and Responsibilities” was significant (mean change 0.44,  $p = 0.016$ ). The mean value of all items in the subscale “Patient-Centeredness” increased from t0 to t1. The increase was significant for the item “Discusses current patient information with patient involvement” (mean change 0.55,  $p = 0.019$ ). This means that in the second observation, the undergraduates shared more information with each other and actively and clearly approached the patient to obtain or verify information. The increase in the item “CanMEDS Health Advocate” remained slightly below the significance threshold. No significant change could be observed regarding the handling of the patient’s questions. The change in the subscale “Patient-Centeredness” over time is at the significance threshold (mean change 0.40,  $p = 0.049$ ). The differences in means over time are significant in the subscale “Leadership” (mean change 0.39,  $p = 0.015$ ). At the item level, the mean change of “Self-confident/sovereign appearance” (mean change 0.052,  $p = 0.032$ ) and “CanMEDS Professional” (mean change 0.32,  $p = 0.030$ ) was significant. This means that the undergraduates were more confident, including in terms of verbal expression, and gave the impression of being confident about the process of ward rounding. The mean change over time in the item “CanMEDS Expertise” was

highly significant (mean change 0.52,  $p = 0.001$ ). This means that a higher level of diagnostic and therapeutic skills could be observed in t1. For the items that were not listed in a subscale, a significant difference in the mean value for the item “Active participation” could be shown (mean change 0.55,  $p = 0.002$ ). This means that the undergraduates showed up more proactive and less reactive. The change over time in the item “CanMEDS Collaborator” was not significant.

### 3.4. Development of team performance

We hypothesized (Hypothesis 2) that the mean values of the team performance scale (item and score) differ in t0 and t1. A linear mixed model was calculated that considered that most of the tandems were not constant from t0 to t1 of the observation of team performance, which means that different nursing and medical undergraduates performed the ward round, respectively. As can be seen in Table 3, there was a non-significant negative trend in the difference of mean scores from t0 to t1 in the items “Patient questions are answered” and “Swift effective rounds”. For all other items, there was a positive trend, but it was also mostly non-significant. The significant change in the mean sum scores of “Roles and Responsibilities” (mean change 0.67,  $p = 0.008$ ) is accounted for by the highly significant difference t0 to t1 in the item “Roles are clearly assigned” (mean change 0.75,  $p = 0.002$ ). This means

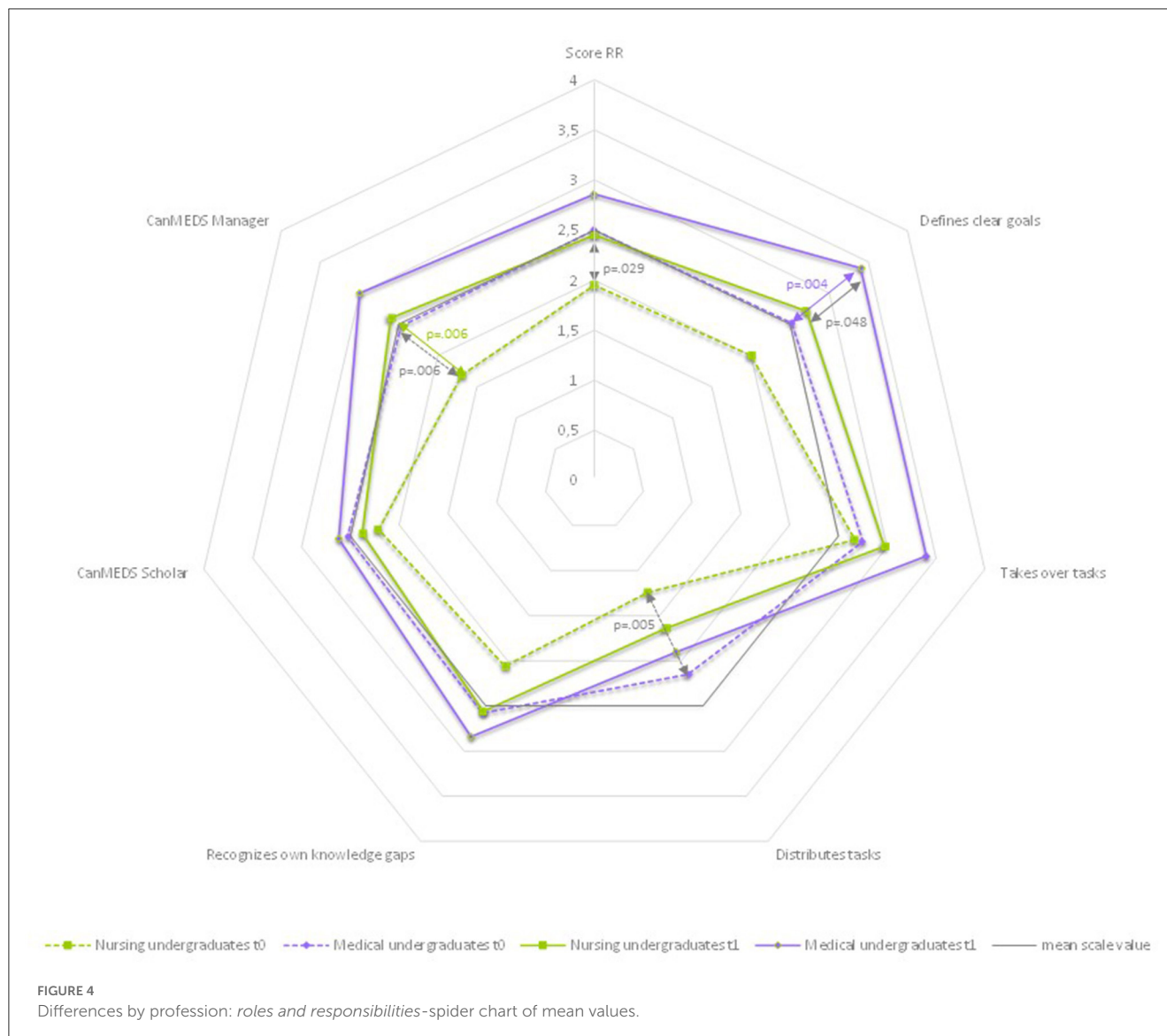


that the undergraduates showed a higher level of role awareness in the second observed ward round, behaved more according to their own professional roles, and seemed to acknowledge the role of the other profession.

It is important to emphasize that most of the tandems ( $n = 12$ ) at t1 were not composed identically to the observation at t0. The analysis of the development in the overall sample describes that two random individuals interacted at the beginning and end of their assignment in a ward round. Thus, the tandem is more of a theoretical construct than an empirical one, since individuals (NU and MU) in the tandems did not remain constant as would have been intended in the study design (Figure 1). In the following, therefore, the mean change over time is presented only for the small group of tandems ( $n = 4$ ) that were identical at t0 and t1. No p-values are given for the change in means over time for the group of random tandems. Rather, these data can be viewed as a cross-sectional investigation with random tandems

at t0 and t1, respectively, with which the group of constant tandems (seen as cross-sectional) is compared in Figure 3 and Table 4. Within the group of constant tandems, all items and scores except for the item “Swift effective round”, which remained the same from t0 to t1 (mean change 0.00,  $p = 1$ ), showed a clear positive tendency. However, this trend is significant only for the item “Roles are clearly assigned” (mean change 1.00,  $p = 0.017$ ) and the score “Decision-making/CCR” (mean change 1.00,  $p = 0.48$ ). Compared with all other tandems in t1, the team performance of the constant tandems (CT) was better across all items and scores than in the group of random tandems (RT). An exception is the item “swift effective round” (CT mean  $3.00 \pm 0.916$ , RT mean  $3.00 \pm 0.603$ ,  $P = 1$ ), which was identical. However, the differences between constant and random tandems are significant only for the item “Further procedure is planned by the team” (CT mean  $3.67 \pm 0.577$ , RT mean  $2.82 \pm 0.405$ ,  $p = 0.012$ ).





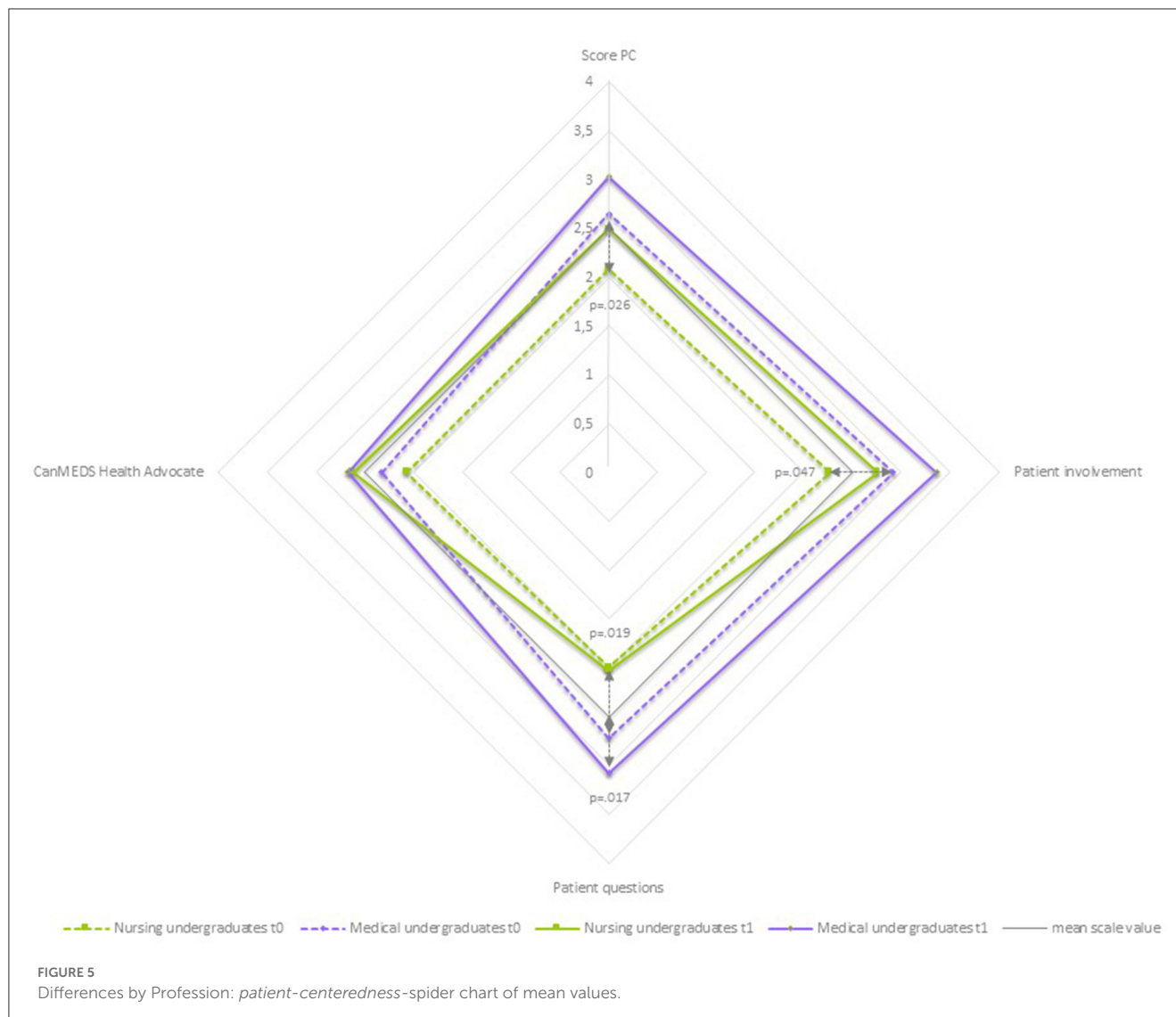
### 3.5. Differences between groups by profession

We hypothesized (Hypothesis 3) that there are group differences in the mean values of NU and MU in t0 and t1 and in the mean change over time. The linear mixed model was calculated to check for the subscales in each case: whether the groups of nursing undergraduates (NU group) and medical undergraduates (MU group) differed at time points t0 and t1, whether there was a change from t0 to t1 in each group itself, and whether these changes differed between groups. With regard to the two items not listed in the subscales, the item “Active participation” showed a highly significant group difference at t0 (NU mean  $2.5 \pm 0.903$ , MU mean  $3.6 \pm 0.529$ ,  $p < 0.001$ ), which leveled off somewhat at t1 but remained significant (NU mean  $3.3 \pm 0.844$ , MU mean  $3.84 \pm 0.356$ ,  $p = 0.036$ ). The difference over time t0 to t1 was highly significant for the NU group (mean change 0.8,  $p = 0.008$ ) but not for the MU group (mean change 0.24,  $p = 0.162$ ). However, the difference in trend was not significant (0.078) which means, that both groups

developed to a similar extent, albeit at a different level. There was no significant group difference for the item “CanMEDS Collaborator” in either t0 (NU mean  $2.56 \pm 0.814$ , MU mean  $2.80 \pm 0.561$ ,  $p = 0.355$ ) or t1 (NU mean  $2.73 \pm 0.961$ , MU mean  $2.80 \pm 0.862$ ,  $p = 0.843$ ). None of the groups had a significant change over time (NU mean change 0.17,  $p = 0.597$ , MU mean change 0.00,  $p = 1$ ). There was also no difference in the range of development over time ( $p = 0.676$ ).

#### 3.5.1. Roles and responsibilities

As shown in Table 5 and Figure 4, at t0, the MU group has higher mean values on all items than the NU group. This is highly significant for the items “Distributes tasks” (NU mean  $1.24 \pm 0.419$ , MU mean  $2.15 \pm 0.827$ ,  $p = 0.005$ ) and “CanMEDS Manager” (NU mean  $1.69 \pm 0.793$ , MU mean  $2.47 \pm 0.649$ ,  $p = 0.006$ ). This means that medical undergraduates asked nursing undergraduates more often to complete specific tasks later in the day and also exchanged about the timing of completion than the other way around. And

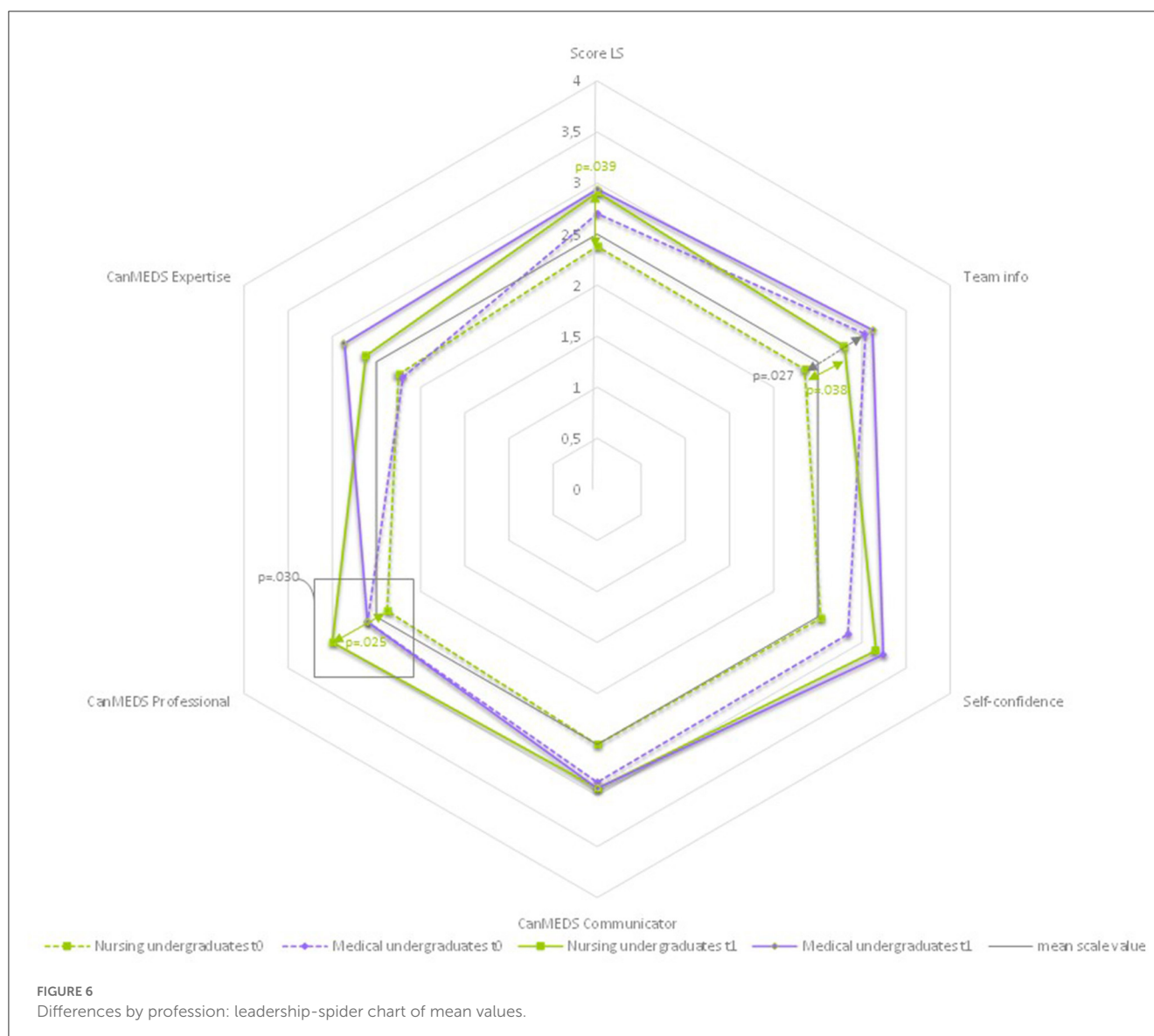


for the “CanMEDS Manager”, which was also significant in the total sample, they showed more behaviors that served the effective organization of the ward routine. Accordingly, the mean value of the sum score “Roles and Responsibilities” is significantly higher than in the NU group. Interestingly, none of these differences are still significant in t1. Instead, the difference in means between the groups NU and MU in the item “Defines clear goals” is significant in t1 (NU mean  $2.71 \pm 1.125$ , MU mean  $3.40 \pm 0.600$ ,  $p = 0.46$ ). This means that the medical undergraduates more often showed behaviors that served to prioritize the further course of treatment and more often named explicit feasible goals, including their implementation in terms of time. Looking at the development from t0 to t1 in the respective groups, we find that the difference in terms of time is highly significant in the MU group (mean change 0.004,  $p = 0.004$ ) but not in the NU group. But as seen in the data, the NU group also developed to a relatively high degree with respect to goal setting, although not at the 0.05 significance level. However, the differences in group development overall are not significant. Both groups developed similarly in all items and scores, albeit with different initial mean values. While the MU group

evolved primarily in terms of treatment goal setting, the change over time in the NU group in the “CanMEDS Manager” item was highly significant (mean change 0.91,  $p = 0.006$ ). We observed that the nursing undergraduates in t1 took more responsibility for the effective organization of ward procedures. Another finding is that while in t0 the differences in the mean values of the MU group compared to those of the NU group in the item “Distributes tasks” were highly significant, they are no longer so in t1. Instead, there is a significant change over time in the MU group in the item “Takes over tasks”. This means that the medical undergraduates observably expressed more frequently which tasks they would complete in the further course of the day.

### 3.5.2. Patient-centeredness

As shown in Table 6 and Figure 5, there were also differences in the mean values of the NU group compared to the MU group in the scale “Patient-Centeredness” at t0. Interestingly, all the mean values of the MU group are higher than those of the NU group. The difference is significant for the items “Discusses



current patient information with patient involvement” (NU mean  $2.27 \pm 0.951$ , MU mean  $2.92 \pm 0.758$ ,  $p = 0.47$ ), “Ensures that the patients’ questions are asked and answered” (NU mean  $2.00 \pm 0.740$ , MU mean  $2.72 \pm 0.844$ ,  $p = 0.019$ ), and the sum score (NU mean  $2.08 \pm 0.683$ , MU mean  $2.65 \pm 0.672$ ,  $p = 0.026$ ). This means that for the medical undergraduates, it was observed more frequently that they actively approached the patient to obtain and verify information, responded to the patient’s questions, and included the patient in the goal-setting process for further treatment. In t1, the difference in mean values between the groups is still significant with regard to the item “Patients question” (NU mean  $2.03 \pm 0.1007$ , MU mean  $3.08 \pm 0.035$ ,  $p = 0.017$ ). In both groups, there is a positive trend in the mean values of t0 compared with t1. However, this was not significant for any of the groups. The two groups of NU and MU develop similarly in all items and the score, with different initial mean values.

### 3.5.3. Leadership

For the subscale “Leadership”, as shown in Table 7 and Figure 6, no significant difference was found in the sum score between the two groups at either measurement time point. In t0, there was a significant difference in the mean values of both groups in the item “Ensures that all team members receive all information (team info)” (NU mean 2.35, MU mean 3.04,  $p = 0.027$ ). At both t0 and t1, the mean values of the MU group showed a slightly higher value than the NU group in almost all items. However, all these differences are not significant. An exception is the item “CanMEDS Expertise”, where in t0 the mean value of the NU group was very slightly higher (NU mean 2.25, MU mean 2.20) than that of the MU group. This is exactly the other way around at t1 (NU mean 2.62, MU mean 2.86). Looking at both groups separately over time, the positive trend in the mean differences from t0 to t1 is highly significant for the MU group for this item (mean change 0.66,  $p = 0.003$ ). This means that the medical undergraduates were more likely to

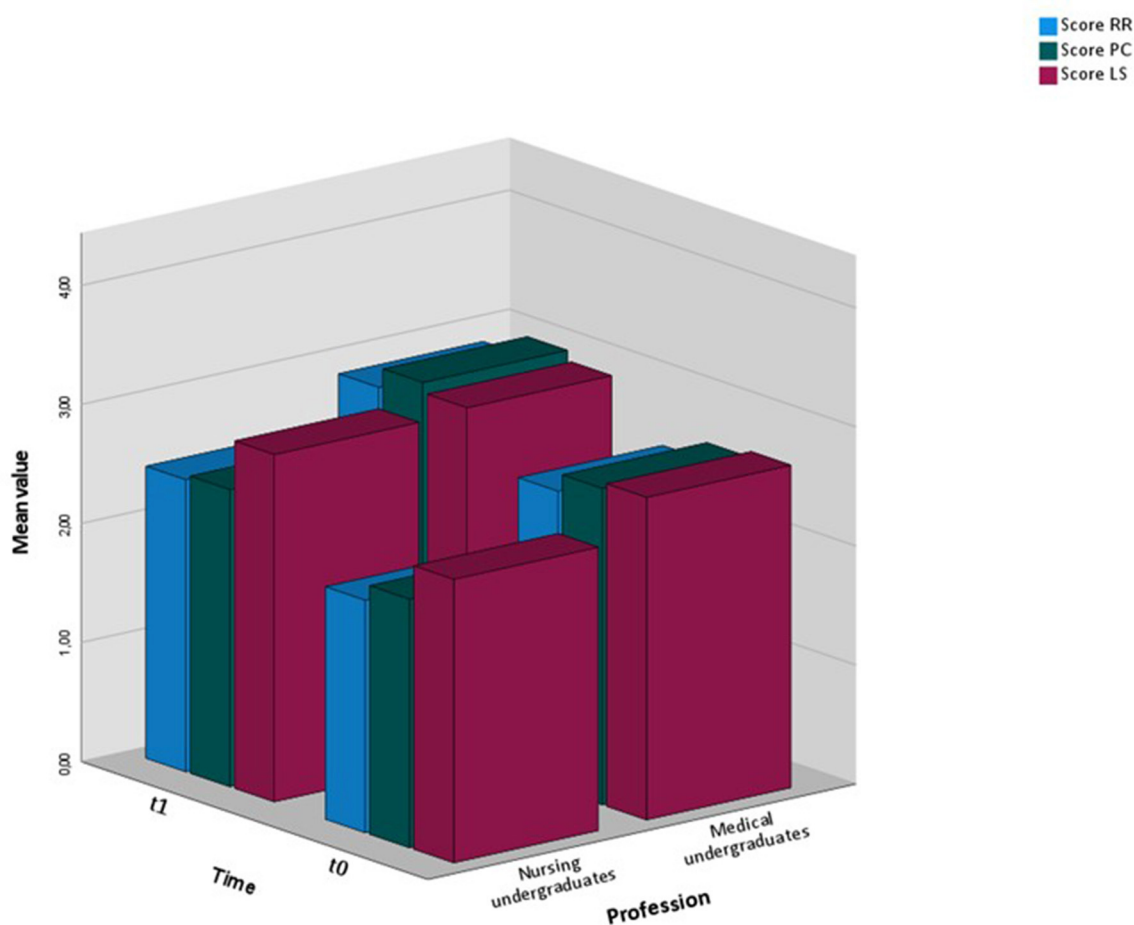


FIGURE 7  
Bar chart of sum scores by group and time.

be observed accessing and applying information to clinical practice and demonstrating diagnostic and therapeutic skills in t1 than in t0. In all other items, there was a positive trend in the MU group except for the item “CanMEDS Professional”, in which the mean value remained the same. On the other hand, the difference in the mean value for this item in the NU group is significant over time (mean change 0.62,  $p = 0.025$ ). This means that the nursing undergraduates in t1 showed more often than in t0 behavior, which aimed to deliver high-quality care, and it was observed that they were involved in the ward round with professionalism and integrity. For the NU group, the differences of mean values t0 to t1 for the sum score (mean change 0.53,  $p = 0.039$ ) and the item “Team info” (mean change 0.45,  $p = 0.038$ ) are also significant. The latter means that at t1, it was observed more frequently how the nursing undergraduates made sure, e.g., through eye contact or active inquiry, that the tandem partner took note of and understood the information that he or she had provided.

As can be seen in Figure 7, the maximum positive value (4.00) was not reached in any of the two groups at any time. The highest value in t1 (MU, Patient-Centeredness, mean 3.03) corresponds to 75.75% of the maximum value. The lowest value in t1 (NU, Roles and Responsibilities, mean 61.25) corresponds to 61.25% of the maximum value.

### 3.6. Relationship between individual competencies and team performance

We hypothesized (Hypothesis 4) that individual competencies and team performance are related. Pearson correlations were calculated to investigate whether there is a relation between individual competencies and team performance for all subscale sum scores.

As shown in Table 8, overall, within these four cohorts, at t0, there was only one significant moderate correlation for the individual and team score on “Roles and Responsibilities” ( $r = 0.416$ ,  $p < 0.05$ ). At t1, these scores showed a strong and highly significant correlation ( $r = 0.501$ ,  $p < 0.005$ ). The correlation between the individual and team scores on “Patient-Centeredness” was moderate and significant at t1 ( $r = 0.422$ ,  $p < 0.05$ ). Also at t1, there was a strong and highly significant correlation between both the individual scores on “Roles and Responsibilities” and “Patient-Centeredness” and the team score on “Decision-Making/CCR” (RR:  $p = 0.597$ ,  $p < 0.001$ , PC:  $r = 0.516$ ,  $p < 0.01$ ). The non-significant negative correlation of the individual score on “Roles and Responsibilities” with the team score on “Patient-Centeredness” became a positive, although not significant, correlation at t1.

TABLE 1 Study sample: profession, gender, and age.

Profession	Gender	<i>n</i>	Age	
			<i>x</i>	SD
Nursing	Female	10	21.40	1.35
	Male	6	22.50	0.83
Medical	Female	3	25.00	1.41
	Male	13	28.08	3.51
Total	Female	13	22.00	1.90
	Male	19	26.32	3.98



TABLE 2 Development of individual competencies.

	t0		t1		<i>p</i> <sup>*</sup>
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	
<b>Roles and responsibilities (Score RR)</b>	31	<b>2.22</b> (0.720)	30	<b>2.66</b> (0.704)	<b>0.016</b>
Defines clear goals for further treatment (Defines goals)	30	<b>2.26</b> (0.882)	29	<b>3.06</b> (0.943)	<b>0.001</b>
Takes over tasks	27	2.71 (0.966)	27	3.17 (0.928)	0.074
Distributes tasks	22	1.70 (0.820)	27	1.80 (0.815)	0.606
Recognizes own knowledge gaps and asks questions (Recognizes knowledge gaps)	27	2.33 (1.043)	28	2.71 (0.989)	0.270
CanMEDS Scholar	29	2.38 (0.820)	26	2.50 (0.707)	0.547
CanMEDS Manager	31	<b>2.06</b> (0.814)	30	<b>2.80</b> (0.925)	<b>0.001</b>
<b>Patient-Centeredness (Score PC)</b>	31	<b>2.36</b> (0.727)	30	<b>2.76</b> (0.907)	<b>0.049</b>
Discusses current patient information with patient involvement (Patient involvement)	31	<b>2.51</b> (0.910)	30	<b>3.06</b> (1.017)	<b>0.019</b>
Ensures that the patients' questions are asked and answered (Patient questions)	30	2.36 (0.862)	26	2.63 (1.132)	0.426
CanMEDS health Advocate	30	2.20 (0.664)	28	2.64 (0.989)	0.052
<b>Leadership (Score LS)</b>	31	<b>2.54</b> (0.584)	30	<b>2.93</b> (0.654)	<b>0.015</b>
Ensures that all team members receive all information (Team info)	31	2.68 (0.882)	29	3.06 (0.826)	0.063
Self-confident/sovereign appearance	31	<b>2.68</b> (0.882)	30	<b>3.20</b> (0.896)	<b>0.032</b>
CanMEDS Communicator	31	2.68 (0.653)	30	2.93 (0.828)	0.163
CanMEDS Professional	31	<b>2.48</b> (0.626)	30	<b>2.80</b> (0.664)	<b>0.030</b>
CanMEDS Expertise	27	<b>2.22</b> (0.506)	27	<b>2.74</b> (0.526)	<b>0.001</b>
<b>Not included in subscales</b>					
Active participation	31	<b>3.03</b> (0.925)	30	<b>3.58</b> (0.689)	<b>0.002</b>
CanMEDS Collaborator	31	2.68 (0.702)	30	2.77 (0.898)	0.676

\*p-value for F-test. The bold values indicate significant at  $p < 0.05$ .

TABLE 3 Development of team performance.

	t0		t1		<i>p</i> *
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	
<b>Roles and responsibilities (Core RR)</b>	16	2.37 (0.562)	16	3.00 (0.948)	<b>0.008</b>
Responsibilities are clarified	11	2.27 (0.786)	11	2.36 (1.027)	0.232
Roles are clearly assigned	16	2.5 (0.516)	16	3.25 (1.000)	<b>0.002</b>
<b>Patient-centeredness (Score PC)</b>	16	2.20 (0.647)	16	2.44 (0.807)	0.417
Patient is involved in information collection (Patient info)	16	2.75 (0.856)	16	3.13 (0.957)	0.159
Patient is involved in the decision-making process (Patient CCR)	15	1.73 (0.799)	15	2.07 (0.884)	0.251
Patient questions are answered (Patient questions)	14	2.93 (0.616)	14	2.79 (1.122)	0.650
Goals are defined with the patient (Patient goals)	16	1.56 (0.727)	16	1.81 (0.911)	0.641
<b>Decision-making/CCR (Score CCR)</b>	16	2.58 (0.430)	16	3.02 (0.811)	0.059
Relevant nursing information is present (Nursing info)	16	2.5 (0.516)	16	2.88 (1.204)	0.118
Relevant medical information is present (Medical info)	16	2.69 (0.479)	16	3.19 (0.911)	0.092
Further procedure is planned by the team (Team planning)	13	2.46 (0.776)	13	3.00 (0.577)	0.212
<b>Not included in subscales</b>					
Exchange between NU and MU is present (NU MU exchange)	16	2.75 (1.125)	16	2.81 (0.911)	0.761
Swift effective round (Swift round)	16	3.06 (0.680)	16	3.00 (0.632)	0.724

\**p*-value for F-test.

TABLE 4 Development of team performance in constant tandems.

	Constant tandems					t1 compared with random tandem cross-sectional		
	t0		t1		t0 > t1	Random tandem t1		
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>p</i> *	<i>n</i>	Mean (SD)	<i>p</i> *
<b>Roles and responsibilities</b>	4	2.25 (0.645)	4	3.12 (0.629)	0.063	12	2.95 (1.054)	0.772
Responsibilities are clarified	4	2.00 (0.816)	4	2.67 (0.577)	0.207	12	2.64 (1.120)	0.968
Roles are clearly assigned	4	<b>2.50</b> (0.577)	4	<b>3.50</b> (0.577)	<b>0.017</b>	12	3.17 (1.115)	0.582
<b>Patient-Centeredness</b>	4	2.31 (0.661)	4	2.68 (1.179)	0.248	12	2.36 (0.693)	0.593
Patient is involved in information collection	4	2.75 (0.947)	4	3.25 (1.500)	0.114	12	3.08 (0.793)	0.774
Patient is involved in the decision-making process	4	2.00 (1.000)	4	2.25 (0.957)	0.751	12	2.00 (0.853)	0.629
Patient questions are answered	4	3.00 (0.000)	4	3.00 (1.414)	0.203	12	2.73 (1.009)	0.682
Goals are defined with the patient	4	1.75 (0.500)	4	2.25 (0.957)	0.390	12	1.67 (0.888)	0.282
<b>Decision-making/CCR</b>	4	<b>2.33</b> (0.471)	4	<b>3.33</b> (0.902)	<b>0.048</b>		2.91 (0.792)	0.392
Relevant nursing information is present	4	2.25 (0.500)	4	3.50 (1.000)	0.067	12	2.67 (1.231)	0.243
Relevant medical information is present	4	2.50 (0.577)	4	3.25 (0.957)	0.228	12	3.17 (937)	0.880
Further procedures are planned by the team	4	2.25 (0.957)	4	<b>3.67</b> (0.577)	0.067	11	<b>2.82</b> (0.405)	<b>0.012</b>
<b>Not included in subscales</b>								
Exchange between NU and MU is present	4	2.00 (0.816)	4	3.25 (0.957)	0.094	12	2.67 (0.888)	0.282
Swift effective round	4	3.25 (0.500)	4	3.00 (0.916)	1.000	12	3.00 (0.603)	1.000

\*p-value for Satterthwaite's F-test. The bold values indicate significant at  $p < 0.05$ .

TABLE 5 Differences by profession – score “Roles and responsibility.”

	t0					t1					Development		
	NU		MU			NU		MU			NU t0 > t1	MU t0 > t1	group diff*
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>p</i> **	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>p</i> **	<i>p</i> **	<i>p</i> **	<i>p</i> **
<b>Score RR</b>	16	<b>1.95</b> (0.685)	15	<b>2.50</b> (0.662)	<b>0.029</b>	15	2.45 (0.826)	15	2.86 (0.503)	0.107	0.076	0.104	0.690
Defines clear goals	15	2.00 (0.807)	15	2.52 (0.903)	0.108	14	<b>2.71</b> (1.125)	15	<b>3.40</b> (0.600)	<b>0.048</b>	0.059	<b>0.004</b>	0.718
Takes over tasks	14	2.67 (1.057)	13	2.75 (0.898)	0.830	14	2.97 (1.139)	13	3.40 (0.600)	0.238	0.477	<b>0.041</b>	0.508
Distributes tasks	10	<b>1.24</b> (0.419)	12	<b>2.15</b> (0.827)	<b>0.005</b>	13	1.64 (0.792)	14	1.90 (0.872)	0.355	0.158	0.646	0.179
Recognizes own knowledge gaps	13	2.06 (0.921)	14	2.58 (1.119)	0.198	13	2.56 (1.162)	15	2.84 (0.832)	0.481	0.229	0.491	0.646
CanMEDS Scholar	14	2.21 (0.802)	15	2.53 (0.834)	0.304	13	2.38 (0.768)	13	2.62 (0.650)	0.417	0.579	0.776	0.833
CanMEDS Manager	16	<b>1.69</b> (0.793)	15	<b>2.47</b> (0.640)	<b>0.006</b>	15	2.60 (0.910)	15	3.00 (0.926)	0.243	<b>0.006</b>	0.077	0.373

\*Difference in development from t0 to t1 between groups. \*\*p-value for Satterthwaite's F-test. The bold values indicate significant at  $p < 0.05$ .

TABLE 6 Differences by profession – score “Patient-centeredness.”

	t0					t1					Development		
	NU		MU			NU		MU			NU t0 > t1	MU t0 > t1	group diff*
	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>p</i> **	<i>n</i>	Mean (SD)	<i>n</i>	Mean (SD)	<i>p</i> **	<i>p</i> **	<i>p</i> **	<i>p</i> **
<b>Score PC</b>	16	<b>2.08</b> (0.683)	15	<b>2.65</b> (0.672)	<b>0.026</b>	15	2.49 (0.939)	15	3.03 (0.816)	0.104	0.175	0.177	0.929
Patient involvement	16	<b>2.27</b> (0.951)	15	<b>2.92</b> (0.758)	<b>0.047</b>	15	2.76 (1.074)	15	3.36 (0.891)	0.107	0.193	0.157	0.879
Patient questions	15	<b>2.00</b> (0.740)	15	<b>2.72</b> (0.844)	<b>0.019</b>	11	<b>2.03</b> (1.007)	15	<b>3.08</b> (1.035)	<b>0.017</b>	0.916	0.306	0.489
CanMEDS health advocate	15	2.07 (0.594)	15	2.33 (0.724)	0.279	13	2.62 (1.044)	15	2.67 (0.976)	0.894	0.094	0.297	0.627

\*Difference in development from t0 to t1 between groups. \*\*p-value for Satterthwaite's F-test. The bold values indicate significant at  $p < 0.05$ .

TABLE 7 Differences by profession – score “Leadership.”

	t0					t1					Development		
	NU		MU			NU		MU			NU t0 > t1	MU t0 > t1	group diff*
	n	Mean (SD)	n	Mean (SD)	p**	n	Mean (SD)	n	Mean (SD)	p**	p**	p**	p**
Score LS	16	2.38 (0.658)	15	2.7 (0.456)	0.120	15	2.91 (0.720)	15	2.94 (0.606)	0.896	<b>0.039</b>	0.231	0.336
Team info	16	<b>2.35</b> (0.805)	15	<b>3.04</b> (0.842)	<b>0.027</b>	14	2.80 (0.868)	15	3.12 (0.815)	0.738	<b>0.038</b>	0.739	0.141
Self-confidence	16	2.53 (0.979)	15	2.84 (0.767)	0.349	15	3.16 (0.901)	15	3.24 (0.920)	0.812	0.076	0.207	0.628
CanMEDS Communicator	16	2.50 (0.730)	15	2.87 (0.516)	0.120	15	2.93 (0.884)	15	2.93 (0.799)	1.00	0.146	0.974	0.301
CanMEDS Professional	16	<b>2.38</b> (0.719)	15	2.60 (0.507)	0.325	15	<b>3.00</b> (0.756)	15	2.60 (0.507)	0.100	<b>0.025</b>	1.00	<b>0.030</b>
CanMEDS expertise	12	2.25 (0.452)	15	<b>2.20</b> (0.561)	0.804	13	2.62 (0.506)	14	<b>2.86</b> (0.535)	0.240	0.071	<b>0.003</b>	0.308

\*Difference in development from t0 to t1 between groups. \*\*p-value for Satterthwaite's F-test. The bold values indicate significant at  $p < 0.05$ .

TABLE 8 Correlations of individual and team scores t0/t1.

	t0 (n = 32)			t1 (n = 32)		
	Ind. RR	Ind. PC	Ind. LS	Ind. RR	Ind. PC	Ind. LS
Team RR	<b>0.416*</b>	0.041	0.306	<b>0.501**</b>	0.225	0.002
Team PC	−0.096	0.254	0.033	0.238	<b>0.422*</b>	0.251
Team CCR	0.153	−0.198	0.129	<b>0.597**</b>	<b>0.516**</b>	0.158*

RR, roles and responsibilities; PC, patient-centeredness; CCR, decision-making/CCR; LS, Leadership, \* $p < 0.05$ , \*\* $p < 0.01$ . The bold values indicate significant at  $p < 0.05$ .



TABLE 9 Correlations of individual and team scores t0/t1.

	t0						t1					
	NU (n = 16)			MU (n = 15)			NU (n = 16)			MU (n = 15)		
	Ind. RR	Ind. PC	Ind. LS	Ind. RR	Ind. PC	Ind. LS	Ind. RR	Ind. PC	Ind. LS	Ind. RR	Ind. PC	Ind. LS
Team RR	0.432	0.169	0.375	<b>0.567*</b>	−0.004	0.319	0.416	0.094	−0.080	<b>0.715**</b>	0.406	0.423
Team PC	−0.407	−0.130	−0.329	0.062	<b>0.562*</b>	0.456	0.248	0.330	0.180	0.345	<b>0.617*</b>	0.259
Team CCR	0.326	−0.189	0.105	−0.013	−0.239	0.192	<b>0.767**</b>	<b>0.611*</b>	<b>0.633*</b>	0.446	0.472	0.502

RR, roles and responsibilities; PC, patient-centeredness; CCR, decision-making/CCR; LS, leadership. \* $p < 0.5$ , \*\* $p < 0.01$ . The bold values indicate significant at  $p < 0.05$ .

Looking at group differences at t0 and t1 (Table 9), two significant ( $p < 0.05$ ) strong correlations were found between the individual competencies of the MU group and team performance in t0, respectively, in the same categories “Roles and Responsibilities (RR)” ( $r = 0.567$ ) and “Patient-Centeredness (PC)” ( $r = 0.562$ ). Both correlations become even stronger at t1 (RR  $r = 0.715$ , PC  $r = 0.617$ ) and highly significant ( $p < 0.01$ ) in the former. For the NU group, the relation between individual and team scores for “Roles and Responsibilities” is also apparent but not significant. Also, not significant but noteworthy is the negative correlation in the NU group between all individual sum scores and the team score “Patient-Centeredness”. In t1, however, the correlations are positive, although not significant. Looking at the team scores for “Decision-Making/Clinical Reasoning” (CCR), it is noticeable that there are no significant correlations with the individual scores at t0, but that there are moderately to strong positive correlations with all individual scores in both groups at t1, which are significant or highly significant for the NU group (RR  $r = 0.767$ ,  $p < 0.01$ , PC  $r = 0.611$ ,  $p < 0.05$ , LS  $r = 0.633$ ,  $p < 0.05$ ).

## 4. Discussion

### 4.1. Discussion of content

#### 4.1.1. Summary of key findings

For the evaluation of HIPSTA, structured ward round observation was conducted during the first and last weeks of the undergraduates’ placement. In this subtask, conducting an interprofessional ward round, the NU and MU demonstrated significant competence acquisition in all three competence domains: “Roles and Responsibilities”, “Patient-Centeredness”, and “Leadership”. However, the two groups developed differently; while the NU mainly acquired competence in leadership and management, the MU developed professional expertise and was better able to define treatment goals and take over tasks at the end of their placement. Team performance also showed that roles and responsibilities were much more observable. It was striking that the mean values of the group of constant tandems at t1 were higher than those of the random tandems in all items except the “Swift effective rounds”. These differences were not significant. The development of individual competencies and team performance are related. It has been shown that this correlation increases over time.

#### 4.1.2. Integration into the body of research with external assessment on IPTW

Studies with a similar methodological approach are scarce, making it difficult to contextualize these results within the body of research. Brätz et al. (48) examined whether IPTW placement at the University Medical Center Hamburg-Eppendorf, Germany, had an impact on medical students’ entrustable professional activities (EPA). After a 4-week placement in an IPTW (intervention group) or regular training (control group), 12 EPAs were recorded using a competency-based telemedicine assessment in a simulation of the first day of residency. The overall mean entrustment level was

significantly higher ( $p < 0.001$ ) in the IPTW group compared to the control group. Reeves et al. (32) and Freeth et al. (23) also conducted observations in the pilot of the Royal London Hospital's rheumatological and orthopaedic IPTW, UK. However, these were analyzed qualitatively and triangulated with data from individual and group interviews, so a systematic comparison of the results is not possible. Lidskog et al. (69) conducted unstructured observation when evaluating an IPTW within care for older people in Örebro, Sweden. In these studies, results were also triangulated with other qualitative data sources, so no comparison of the results of observation is possible. Same with the ethnographic observation conducted on an orthopedic ward at Karolinska Institutet, Stockholm, Sweden, by Ivarson et al. (70) that focused on a special learning intervention. The first result of the evaluation of the Mannheimer IPTW, Germany (37), identified ward round skills as a self-reported topic in which students gained competence.

#### 4.1.3. Discussion of findings concerning individual competencies and team performance

About the overall scale of individual competencies, it is interesting to note that the group-specific differences that existed at the beginning of the IPTW placement were only significant in two items at the end of the placement, which will be discussed in more detail. The groups did not develop differently, which may indicate that the educational concept of HIPSTA adequately supports both professional groups.

There was a statistically significant mean change in all subcategories of the individual competency scale, showing that participants seem to have improved their competencies, especially in terms of defining treatment goals, involving patients, and acting self-confidently. This confirms the results of the quantitative and qualitative (60) analysis of learners self-assessment of competency development and interprofessional socialization (61, 62) from an external, observational perspective. With regard to the development of the individual competencies subscale “*Roles and Responsibilities*”, the results described from questionnaire and interview studies (33, 49, 60, 62, 71–75) are substantiated and supplemented. The gain in understanding roles was also evident in the ward round observation. The participants behaved according to their professional roles and acknowledged the others' roles to a greater extent at the second team performance observation than at the first. Within the individual competency observation, an increase in self-confident/sovereign demeanor could also indicate a risen understanding of and identification with the professional identity. Higher confidence was also described in the interviews with participants 1–1.5 years after their placement on the HIPSTA (62).

##### 4.1.3.1. Patient-centeredness

With regard to the development of subscale “*Patient-Centeredness*”, no IPTW study so far has explicitly reported any effects. However, the Assessment of Interprofessional Collaboration Scale (AITCS) (76) and the Interprofessional Socialization and Valuing Scale (77, 78) were also used in the self-reported evaluation of HIPSTA (60). The AITCS, which includes aspects

of patient-centeredness in the subscale “*Coordination*” showed a highly significant change in the mean sum score both in the pre-post as well as in the pre-follow-up comparison, and the ISVS, which covers patient-centeredness in terms of involving patients' interests and understanding and conducting collaborative decision-making together with patients, showed significant pre-post and pre-follow-up mean changes in the sum score and in the specific items (60). Within the analysis of learners retrospective evaluations of the HIPSTA, it has been shown that especially medical undergraduates had the impression of improved competencies in interprofessional communication in terms of listening to and understanding patient's needs (62). Still, these are all self-reported competencies, which do not guarantee performance. Hence, the results of this study give a better impression of how the undergraduates actually demonstrate their self-perceived competencies. The patient is central to the frameworks for interprofessional collaboration and the starting point for the call for more ICPC and IPE (1, 6, 38, 39). Analyses of the concept of “*patient-centeredness*” show that it is rich in perspectives and dimensions and requires further research to be operationalized for the health professions (79–82). Spaulding et al. (83) identify a lack of research on the patient-centeredness outcome of IPE. Orchard (84) sees the nursing leader's role as key between patients and other health providers. Interestingly, no significant differences in the patient-centeredness items from t0 to t1 were found in the NU group, and the sum score in the subscale “*Patient-Centeredness*” was significantly lower in the group of NU compared to the group of MU sum scores at both points in time. This could be related to the way in which patient-centeredness was recorded in the ward rounds, namely primarily with the extent to which the patient was involved in obtaining information and the extent to which questions were motivated and answered. Also, since ward rounds serve to clarify the patient's medical condition, it is not that surprising that there was a certain patient-centeredness present and observable. This explains the difference in “*ensures that the patients' questions are asked and answered*”, which is also significant at t1. Furthermore, there was a given structure for the ward round that was co-developed by the learners, saying that in the first step, the nursing undergraduate introduces the patient and reports on the process; second, the medical undergraduate takes the lead of the round; third, the patient is asked an open question (“*how are you*”); and fourth, a joint evaluation of the situation and background takes place. Having the lead of the round could have made the medical undergraduates feel more responsible for patient involvement than the nursing undergraduates in this specific situation. In addition to that, most nursing undergraduates have already visited the patients' rooms and talked to them in the morning before the ward round. For them, it might have been artificial to have the same conversation a second time. Since the undergraduates followed a structure, medical undergraduates' improvement in patient-centeredness does not necessarily mean that they actually change their attitude toward the patient; it could also indicate that they were better able to implement the instructions on the round. Within the team performance scale, no statistically significant improvement in the sum score “*Patient-Centeredness*” was shown. Still, the mean score of patient involvement in information collection was rather positive at t1.

#### 4.1.3.2. Individual development of nursing and medical undergraduates

Regarding the subscale “*Leadership*”, the nursing undergraduates underwent a significant change, although the item “CanMEDS professional” was the only item where the mean change of both groups differed significantly. Also, at t1, the nursing undergraduates paid more attention to ensuring that all team members received all relevant information and backed this up. They also took on more of a managerial role (CanMEDS Manager) compared to that in t0. If this is viewed in parallel with the development of medical undergraduates, who developed especially in terms of goal definition and the assumption of tasks, professional socialization can be surmised. Wenger (85) described in the “communities of practice”, which was later described as a concept in health education (86), that professional identity forms in dependency on the relations and activities of other members of the community. This can also be seen in the statistically significant improvement of values regarding role assignment within the team performance scale. From this perspective, the interprofessional setting of the ward round could be conducive to the professional identity of medical and nursing undergraduates. This has also been shown by the longitudinal quantitative analysis of the HIPSTA within the ISVS that also measures role clarification (60) and within follow-up interviews with the participants, where they described an improvement in confidence and self-efficacy in their professional role due to the experience on the HIPSTA (62). In this study, it has been observed that medical students acquired and applied skills in collaborative clinical reasoning and decision-making, whereas nursing undergraduates acquired leadership skills. The importance of collaborative clinical reasoning skills in medical education has been widely acknowledged (87). Leadership skills for nursing are key for ward management and team performance in healthcare. It might have a central role in education and should be further investigated. In her review, Cummings et al. (88) analyzed factors and educational interventions that influence nursing leadership. However, they were unable to include any studies in an interprofessional setting. Orchard et al. (89) advocate nursing leadership as a dual role in interprofessional teams, namely, managerial and disciplinary. They suggest that in areas nurse leaders are responsible for, “their ability to support health providers use of knowledge, skills, and expertise to address the complex and uncertain needs of those persons seeking help can result in improved care”.

The concept of professional identity was further developed by Khalili et al. (90, 91) for the interprofessional context, forming the concept of dual identity and professional socialization (interprofessional socialization framework). Thistlethwaite (92), referring to Miller’s competence pyramid (93), describes it similarly by asking if it needs a fifth competency level “is” above “does”. Mink et al. (61), referring to the concept of dual identities, examine in a reconstructive analysis of the focus groups of the first cohorts of HIPSTA the extent to which interprofessional socialization has occurred and conclude that it cannot be reliably anticipated. The data of cohorts 8–11 examined here show, in comparison to the constant with random tandems, that the former tended to plan the further procedure together significantly more often than the random tandems. The mean score for the constant tandem

at t1 is above the middle, resembling a positive evaluation of their collaborative planning. However, no statement can be made about the participants’ sense of belonging to the interprofessional community or about how sustainably team performance can be implemented in the subsequent everyday work.

The problem, also in evaluating interprofessional teaching by means of patient-relevant outcomes, is that little insight is gained into the black box between IPE and IPCP. IPE is important and has a positive impact on attitudes and competencies. Good IPCP increases patient safety and quality of care. But how does the former relate to the latter? One approach could be to break down the huge field of IPCP into small bites by asking what clinical problem is specifically to be solved by better interprofessional collaboration. This study is based on the premise that interprofessional competencies can be observed particularly well in interprofessional rounds. The ward round could therefore be seen as a clinical problem, as a unit of care structure in the clinical setting in need of optimization, which should be solved or optimized through IPCP. About half of all adverse events in the surgical setting occur outside the operating room (94) and are associated with poor organization of inpatient care. The ward round is a central element of quality assurance because it is used to exchange information, record the patient’s condition, and plan further procedures within the team, if things are going well. If things are not going well, this can have a correspondingly negative effect on patient care. Klaas et al. (95) propose a taxonomy of non-technical skills for the surgical ward round and define good and bad behavior for the team and the team leader in four categories, namely, “Leadership”, “Situation awareness”, “Decision-making”, and “Communication and teamwork”, which was evaluated for nurses (96), and which are complemented by our study results very well. In this respect, a very small crack in the black box is opened in that the IPTW setting enhances a concrete clinical activity, ward rounds.

## 4.2. Discussion of methods and limitations

The study was single-centered and was conducted without a control group. The sample is small, which limits the statistical possibilities, and due to this, it should be considered that statistical tests have low power with small effect sizes. Therefore, both “almost” significant and non-significant changes have been reported and discussed.

For the interpretation of the results of this study, differences in the group comparisons between nursing and medical undergraduates might not (only) result from the professional background but from age or gender, or at least co-variances exist, which could not be examined in more detail due to the small sample size. In Germany, the medical study program takes twice as long as nursing school, and nursing is still predominantly female.

The data presented here were collected using the previous version of the IP-VITA (IP-VITA<sup>Pre</sup>), which has so far only been validated descriptively (63, 97) and not statistically. There were a few adaptations after the observations in the four cohorts, the

results of which are presented here. The CanMEDS roles in IP-VITA<sup>pre</sup> were adopted as items without critically appreciating previous publications on the recording of CanMEDS and its complexity (98–104). Although this framework was initially physician-specific, it has been successfully transferred to other health professions (105–108). However, the researchers did not operationalize further into the items but instead referred to the role model in interpretive intersubjective exchange to assess the undergraduate's behavior. This worked well for the observations in the HIPSTA setting. However, for a transfer to other sites and the use of the instrument, possibly with only one observer, more extensive descriptors and a further operationalization of the roles would have been necessary. As a consequence, the CanMEDS roles were removed. The two individual items “Discusses current patient information with patient involvement” and “Ensures that the patients' questions are asked and answered,” were split into five more distinct items (see IP-VITA in the [Supplementary material](#)). Adjustments were also made to the team performance scale, aimed at a clearer delineation of the items. In addition, it was also scaled to six-point instead of four-point Likert, and a distinction was made between observable interaction during the ward round and during debriefing.

The ward round observations were conducted by three researchers (AMit, CA, and JM) in different constellations of two. The observers had nursing ( $n = 2$ ) and gerontological ( $n = 1$ ) backgrounds, each with academic degrees. None had a medical background, and none of the three had specific training as observers; nonetheless, all had experience in quantitative and qualitative research. Because assessment practices are by no means trivial (109), assessment literacy (110) may be questioned, at least with respect to items related to medicine (e.g., physician decision-making and goal setting). The way the researchers handled this was to involve the physician learning facilitators when there was uncertainty.

For the interpretation of the data, especially the changes from t0 to t1, it is important to point out again that the group of tandems was naturally half as large as the group of individuals. The fact that there were more significant changes in the mean values of the individual scale from t0 to t1 could be due to the fact that the tandem sample is smaller than the individual one.

IPTWs are highly complex learning interventions. This complexity is highly conducive to the cause of IPL/IPE late in vocational training and study (111) – but not to its research. The setting of the observations that produced the data presented varied in terms of the number of patients, others (passively) involved, and the participants themselves to be observed. The setting was not meticulously recorded for each observation in this study. For exploration in the pre-post design, it would be necessary for the tandems to be composed of the same individuals at t1 as at t0. This was only the case to a very small extent in this study. The effects of the different individuals in the tandems were accounted for in the linear mixed model, but this still limits the interpretation.

For further studies, it would be advisable to reduce some of the complexity of the setting and to standardize the framework conditions as far as possible. Since patients cannot be standardized with regard to their illnesses and real-patient contact is the special

attraction of observing interprofessional interaction, the other parameters should be adjusted. First and foremost, the tandems or teams from which data are collected should be identical at the time of collection. On the other hand, perhaps the very fact that they are not is the right approach. If the premise were that individual competencies in any healthcare team should have a positive impact on quality of care, then this might be an interesting idea to think about further, at least for formative feedback. What could be standardized for a follow-up survey would be that the individuals who participate in the ward round are defined, and clear guidelines also apply regarding their contribution. Furthermore, the course of the round could be standardized insofar as it was often not clear in this study when exactly the visit and thus the observation began and when it ended. Our study collected data on a small but important part of the IPTW, the ward round. However, multi-center approaches should also have the learning process of the IPTW itself in focus. Further studies could observe other team tasks on IPTW, like handovers and collaborative clinical reasoning. Also, longitudinal studies with repeated data collection and analysis several weeks and months after an IPTW placement should be conducted.

## 5. Conclusion

This study describes how interprofessional tandems at the end of an IPTW assignment interact more clearly in terms of their roles and tasks, are more patient-focused, and are better able to obtain and share information to set goals for treatment and plan next steps as a team. Our evidence suggests that tandems that stay consistently together perform better than tandems with changing partners. If this finding manifests itself, IPTW could be organized so that learning teams should be stable and not change. Alternately, IPTW research could focus on developing learning support approaches with prompts and intermediate learning goals that allow medical and nursing post-graduates to bring interprofessional competencies to performance independent of the tandem partner or team. We consider the latter to be the more promising way to foster the transferability of individual competencies to later team performance. In a work environment, healthcare teams change quite regularly. Therefore, the aim of IPTW should be to prepare healthcare team members for this change. Further studies will also focus on the translation of learned interprofessional competence into later professional practice. Perhaps IPTW, with its externally valid approach and high complexity, are one of the messiest research settings in healthcare education. Because of their high cost and organizational effort, it is our duty as healthcare education researchers to design IPTW for the best learning environment possible. Aside from team stability, there is much to be found out.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.



## Ethics statement

The studies involving humans were approved by the Ethics Committee of the Medical Faculty Heidelberg (S-072/2017). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

AMit, JM, and CM conducted the study, acquired financial support, and developed the design of methodology. AMit, JM, and CA collected data, conducted the research, and investigation process. BT-H and AMih provided resources that enabled the study to be conducted. AMit conceptualized this work, led the analysis, interpretation, and wrote the initial draft of this manuscript. AMit and AMö performed the statistical analysis. CU supervised the development of the IP-VITA instrument and the qualitative aspects of the observations. JK supervised the work. All authors corrected and approved the revisions and final version of the manuscript.

## Funding

The Robert Bosch Stiftung, a German charitable foundation, funded the development and implementation of the Heidelberg Interprofessional Training Ward from 08/2016 until 07/2018 (32.5.A381.0026.0). The funder was not involved in the study design, collection, analysis, and interpretation of data, the writing of this article, or the decision to submit it for publication.

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## Acknowledgments

The authors thank Dr. Katja Krug for giving statistical support and feedback during the development of the IP-VITA instrument and Dr. Larry Kamees for the native language proofreading.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2023.1241557/full#supplementary-material>



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RECEIVED 10 August 2023

ACCEPTED 08 September 2023

PUBLISHED 11 October 2023

## CITATION

Abu-Rish Blakeney E, Baird J, Beaird G, Khan A, Parente VM, O'Brien KD, Zierler BK, O'Leary KJ and Weiner BJ (2023) How and why might interprofessional patient- and family-centered rounds improve outcomes among healthcare teams and hospitalized patients? A conceptual framework informed by scoping and narrative literature review methods. *Front. Med.* 10:1275480. doi: 10.3389/fmed.2023.1275480

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# How and why might interprofessional patient- and family-centered rounds improve outcomes among healthcare teams and hospitalized patients? A conceptual framework informed by scoping and narrative literature review methods

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Poor communication within healthcare contributes to inefficiencies, medical errors, conflict, and other adverse outcomes. A promising model to improve outcomes resulting from poor communication in the inpatient hospital setting is Interprofessional Patient- and Family-Centered rounds (IPFCR). IPFCR brings two or more health professions together with hospitalized patients and families as part of a consistent, team-based routine to share information and collaboratively arrive at a daily plan of care. A growing body of literature focuses on implementation and outcomes of IPFCR to improve healthcare quality and team and patient outcomes. Most studies report positive changes following IPFCR implementation. However, conceptual frameworks and theoretical models are lacking in the IPFCR literature and represent a major gap that needs to be addressed to move this field forward. The purpose of this two-part review is to propose a conceptual framework of how IPFCR works. The goal is to articulate a framework that can be tested in subsequent research studies. Published IPFCR literature and relevant theories and frameworks were examined and synthesized to explore how IPFCR works, to situate IPFCR in relation to existing models and frameworks, and to postulate core components and underlying causal mechanisms. A preliminary, context-specific, conceptual framework is proposed illustrating interrelationships between four core components of IPFCR (interprofessional approach, intentional patient and family engagement, rounding structure, shared development of a daily care plan), improvements in communication, and better outcomes.



## KEYWORDS

interprofessional, patient- and family-centered care, hospital, rounds, communication, safety, team-based care, routines

## Introduction

Gaps in patient safety exist in inpatient hospital care. Research to improve safety for hospitalized patients has focused primarily on technological reporting and interventions. Medical errors have been recognized as the third leading cause of death in the United States for nearly a decade, and 40 % of hospital admissions are thought to include an adverse event or error (1–4). Further, errors and harms occur disproportionately for some groups (5–7). For example, a recent systematic review by Chauhan et al. (7), found higher rates of medication errors and hospital acquired infections among patients from ethnic minority backgrounds and those that use a language other than English for healthcare. A major driver of these challenges is thought to be poor communication within and between healthcare teams (1–3, 8). Health policy makers have repeatedly called for interventions to improve communication in practice (2, 8).

New and innovative approaches to improving safety, equity, and patient- and family-centeredness of hospital care need to be developed and studied to identify evidence-informed interventions that can be implemented into practice. One possible direction is identification and implementation of models, processes, or routines that change how care is organized and delivered. Team-based or interprofessional care models, including a model of daily inpatient care planning rounds known as interprofessional patient- and family-centered rounds (IPFCR), offer a promising approach. IPFCR brings two or more health professions together with patients and families as part of a consistent, team-based routine to share information and collaboratively arrive at a daily plan of care in inpatient hospital settings.

Rounds occur for almost every single patient, almost every single day in almost every hospital in the United States. Within this daily routine, however, formats vary widely and there are multiple overlapping and sometimes competing perspectives on the purpose of hospital rounds (e.g., patient care, updating families, formulating plans, teaching trainees) (9). Rounding as a care process is historically varied in terms of who is present, who contributes, when it occurs, where it occurs, what is discussed, and what decisions or outcomes are expected as a result (10–12). This combination of ubiquity and high variability is what makes rounds an opportune focus for study and improvement efforts. Recent growth in IPFCR interventions also suggests timeliness and front-line interest.

Despite a growing body of literature reporting promising results from IPFCR interventions, descriptions are highly variable and predominantly atheoretical (13). Further, evaluations of IPFCR across settings and populations have not been synthesized. The *objective* for this review is to begin to close these gaps by synthesizing existing IPFCR literature within the context of relevant theories and frameworks from related fields. The *overarching goal* is to offer a preliminary conceptual framework that guides the use of IPFCR and how it might be expected to lead to improvements in care and

outcomes. This will provide a foundation upon which more generalizable knowledge can be built.

## Review scope and approach

This review was carried out in three parts. First, manuscripts included in a recently published systematic scoping review, which described new implementations of IPFCR models, were qualitatively reviewed and analyzed to identify themes (13). Second, a focused literature search was conducted to explore existing theories and frameworks that could inform a context-specific IPFCR conceptual framework. Finally, an IPFCR conceptual framework is proposed that includes four core components and illustrates relationships between these components and improvements in communication that have the potential to lead to safer, more equitable, and more patient- and family-centered care.

### Part 1: Systematic scoping review to identify common themes in published IPFCR literature

As a first step, articles included in a recent scoping review led by the first author of this paper were revisited to qualitatively explore whether and how they described how implementation of IPFCR leads to improved team and/or patient outcomes (13). The review methods, including search terms and inclusion/exclusion criteria, are described in detail elsewhere (13) and used a systematic approach to search PubMed, CINAHL, PsycINFO, and EMBASE to identify manuscripts describing new implementations of IPFCR models in pediatric and adult settings. The review identified 74 studies dating from 1988 and a recent steepening growth trajectory with 5 to 13 articles published each year from 2014 to 2020 (13). It described trends and gaps in the IPFCR literature and identified predominantly positive or neutral impacts following IPFCR implementation across an array of outcomes—including team communication, length of stay, and safety (13).

Of the 74 studies included in the scoping review, 42 (53.2%) described, explicitly or implicitly, how they expected implementation of IPFCR to improve team and/or patient outcomes as well as how these outcomes are interrelated (see [Appendix A](#)). Whether or not an article addressed this topic was determined during REDCap-based data abstraction and was confirmed by the lead author. Data abstractors answered two questions during full text review that provided the basis for the qualitative analysis described below. The first, a yes/no question, asked “does the study describe a tested or hypothesized ‘mechanism of action’ for the rounding model and/or its implementation?” The second was short answer item: “If yes, please describe and be sure to include whether the description is about the rounding model itself or the implementation of the rounding model.”

The lead author of this manuscript iteratively reviewed and made notes while reading the short answer items and cross-referenced them with the original manuscripts to identify implicit and explicit ways in which the authors expected implementation of IPFCR to improve team and patient outcomes. A qualitative synthesis of these descriptions pointed to three common themes:

*Theme 1: Implementing a standardized model or approach to rounding provides an explicit framework for care planning and delivery.*

Utilizing a consistent approach was described as helping to decrease variation (14), to increase use of evidence-based care and checklists by way of shared accountability and/or nudging (15, 16), and to make teaming among frontline care professionals possible by routinizing/synchronizing times and places for them to coordinate with each other (17, 18).

*Theme 2: Engaging patients, families, and interprofessional team members is made possible when a standardized approach becomes routine.*

As described in several articles, shifting rounds to the patient bedside is a key strategy to increase and sustain involvement of patients and family members in information exchange and decision-making during care planning, which can help improve patient- and family-centeredness of care, hospital experience, and mitigate safety errors and risks (19–24).

*Theme 3: Providing regular opportunities for communication among interdependent care team members from multiple professions improves team relationships and contributes to the development of a shared understanding and agreement of patient care plans and goals (13, 18).*

The result of improvements in communication and development of a shared mental model are then thought to improve the safety and quality of care by decreasing omissions or duplication of needed care, helping to prevent or decrease medical errors, and enhancing the hospital experience (14, 23–26). Improvements in communication are also described as improving job satisfaction among care team members (18, 20).

These themes suggest a shared belief among study authors that implementation of an IPFCR model can improve team and patient outcomes. Conversely, ineffective communication and unavailability of team members can negatively influence care and outcomes, create barriers to teamwork associated with adverse events, decrease satisfaction among care team members, patients, and families, and increase costs (25, 26).

## Part 2: Existing theories and conceptual frameworks to support or contradict emergent themes

Following identification of common themes in the first phase of this review, we conducted a focused literature search using a narrative review approach (27) to explore existing theories and conceptual

frameworks to increase understanding of the emergent themes and inform a context-specific IPFCR conceptual framework.

In the above-described IPFCR scoping review, twenty-five studies (31.7%) cited a conceptual framework or theory supporting their work (13) (see Appendix A). Of those, the most commonly cited theories or frameworks originated from the fields of change management, quality, or systems improvement ( $n=17$ , 68%) (28–32). A smaller number of studies, three each, referenced an interprofessional framework or a model of change framework. While each of the cited theories and frameworks provided useful framing for the studies in question, none were specific to rounds. Also absent were equity considerations within the existing frameworks.

This prompted additional literature review following a narrative approach (27) and subsequent identification of existing theories that focus on alternative models of rounds. Databases iteratively searched in this phase included PubMed, CINAHL, PsycINFO and EMBASE and utilized two primary search terms “rounds” and “theory” both individually and then combined (e.g., rounds and theory). For both terms, related concepts and key words were also searched (e.g., hospital rounds, physician rounds, nursing rounds; conceptual framework, theoretical framework, model). Abstracts and full text manuscripts were reviewed as they were identified and retained if they supported or contradicted emergent themes from Part 1. Described and synthesized below are the manuscripts and theories selected during this phase of searching and how they support or contradict emergent IPFCR themes identified above.

Two sets of papers were identified that focused specifically on uniprofessional models of rounds (e.g., physician-only or nurse-only models). In the first, Perversi et al. (33) focused on reasoning mechanisms in uniprofessional ward rounds used by physician teams to plan daily care. After observing 11 days of physician ward rounds for 94 individual patients, using a critical realist multiple case study approach, the authors identified several group reasoning mechanisms concerning sharing, agreeing, and recording information in the categories of information accumulation, sense-making and decision making to form a program theory of physician ward round reasoning. This paper provides compelling justification for the routine of daily care planning rounds to support information sharing and development of a shared mental model among participants. Notably absent from this model are patients, families, and other care team members (i.e., nurses, pharmacists, social workers), all of whom have information to share and whose life and daily work are impacted by the decisions made during these important rounding discussions. Further missing from this model is a consideration of how these approaches contribute to team, patient, and family outcomes.

The second set of papers, by Harris et al. (34) and Sims et al. (35), focused on a uniprofessional nurse rounding model. These studies used a realist evaluation and realist synthesis approach to studying “intentional rounding” by nurses during handoffs between shifts to improve engagement between nurses and patients (34, 35). The authors synthesized the results of a three-stage literature search and stakeholder consultation to identify eight *a priori* program theories to further understand what works in intentional rounding, for whom, in what circumstances, and why. The eight propositions that they identified were: (1) when implemented in a comprehensive and consistent way, intentional rounding improves healthcare quality and satisfaction; (2) embedding intentional rounding into daily routine practice gives nurses ‘allocated time to care’; (3) documenting



intentional rounding increases accountability and raises fundamental standards of care; (4) when workload and staffing levels permit, more frequent nurse–patient contact improves relationships and increases awareness of patient comfort and safety needs; (5) increasing time when nurses are in direct vicinity of patients promotes vigilance, provides reassurance, and reduces potential harms; (6) more frequent nurse–patient contact enables nurses to anticipate patient needs and take pre-emptive action; (7) intentional rounding documentation facilitates teamwork and communication; and (8) intentional rounding empowers patients to ask for what they need to maintain their comfort and well-being. Thus Harris et al. (34) and Sims et al. (35) contribute to our understanding of the types of interactions and activities that occur on twice- or thrice-daily nursing handoff rounds (at each nursing shift transition) and how they might influence overall care and outcomes. While this model describes increased nurse–patient contact as improving relationships and increasing awareness and vigilance among nurses it does not address the perspective of patients or families in this process or explicitly engage them. However, like the physician-focused study of Perversi et al. (33), the Harris (34) and Sims (35) studies omit key partners in the process of care by focusing on nurses, as opposed to the interprofessional care team (33, 34).

In contrast to the uniprofessional nurse- or physician- focused rounding models described above, Kydonaki et al. (36) applied an integrative approach to their review of 15 articles to explore family involvement in ward rounds for adult ICU patients. They summarize their findings in a 3-part framework of “involvement of family members in rounds.” This is broken down into three concepts: (1) interactions and communication during rounds, (2) organization of rounds, and (3) ICU culture. Each of the three concepts is further broken down into two or three sub-concepts. Interactions and communication during rounds is divided into two sub-concepts of: (1) increase of situational awareness and involvement in decision making and (2) advancing emotional experience (e.g., satisfaction, experience). Organization of rounds is divided into: (1) structure and process of rounds, (2) use of communication tools, and (3) roles in rounds. ICU culture is broken down into (1) value in family-centered rounds and (2) barriers in family-centered rounds. The authors identify positive attitudes of family members and patients toward involvement in family rounds, but the review does not provide quantitative data on other patient- and family-centered outcomes, such as mental health outcomes, nor qualitative data to understand the barriers, processes, and facilitators to implementing family-centered rounds in ICUs. Kydonaki et al.’s review included both uniprofessional and interprofessional rounding approaches so long as the approaches focused on engaging family members in rounds. One notable finding they report is a mismatch between healthcare professionals’ perceptions of family member desire to participate in rounds (they perceived 38% of family members as wanting to participate) and expressed desire of family members to participate in rounds (97% indicated that they would like to participate) in the same setting (37). This review focused more on what was done and what was found in the included articles in terms of family engagement in rounds and less on mechanisms of how rounds worked or why they did or did not meet the needs of patients, family members, or other care team members.

Similar to Kydonaki et al., Reeves et al. used a comparative ethnographic approach. (observations, interviews, and document

review) to explore the culture of interprofessional collaboration and family member involvement in 8 ICUs in North America. While not focused explicitly on rounds, rounds were observed and the researchers utilized a 4-domain interprofessional conceptual framework to guide their data collection and analysis. Domains include (1) relational factors (i.e., how power, hierarchy, and leadership influence relationships), (2) processual factors (i.e., time, space, and task complexity as processes of collaboration), (3) organizational factors (i.e., impacts of local institutional structures and management processes), and (4) contextual factors (broader cultural, political, social, and economic issues as they influence interprofessional collaborative practice) (38, 39). The authors found that interprofessional collaboration occurred most commonly during emergent situations and less commonly during more routine activities, such as rounds or handoff activities, which the authors found to be predominantly uniprofessional and heavily influenced by historic professional hierarchies. They also found that family members played important roles in communication and care both for the patient as well as *within and between different professions*. Similar to Kydonaki et al. (36), the framework and findings described by these authors are illustrative of what was happening in ICUs as it related to interprofessional collaboration and family member involvement. However, they do not shed light on the mechanistic aspects of rounds’ cognition and dynamic interaction described in the two uniprofessional papers.

### Part 3: Integration of scoping and narrative reviews to inform a preliminary IPFCR model and theory

Based on a synthesis of existing literature and relevant theories in Parts 1 and 2 above, we propose four core components (Table 1) and a preliminary context-specific IPFCR conceptual framework (Figure 1).

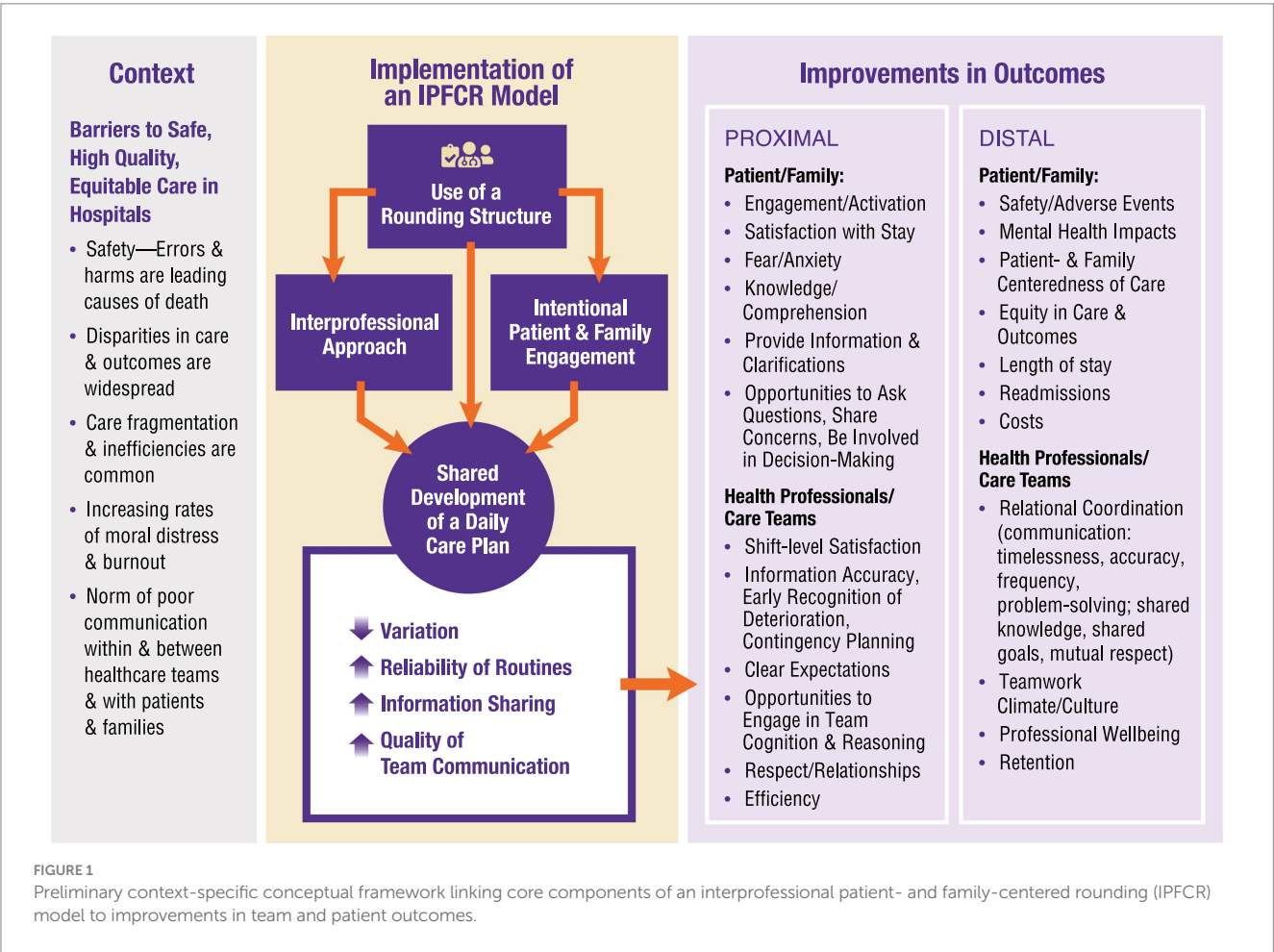
Each of the four core components defined—(1) interprofessional collaboration, (2) intentional patient and family engagement, (3) rounding structure, (4) development of a daily shared care plan—are distinct but interdependent and each is hypothesized to be necessary to achieve safe, high quality, equitable hospital care and ensure intervention effectiveness (40). The underlying theory is that introducing structured routines like IPFCR can help foster “high-reliability” practices in healthcare organizations reducing variations in care through standardized approaches and improved communication, thereby leading to better outcomes (41, 42). This theory is consistent with the themes identified in Part 1 of this review and supported by a growing body of research that associates IPFCR with improvements in team and patient outcomes (13, 43–47).

Figure 1 illustrates proposed connections between the four core components, as well as proximal and distal outcomes. The draft visual model was developed iteratively using the structure-process-outcome models in Parts 1 and 2 of this review, and a recently published toolkit: “Building Implementation Roadmaps: A Toolkit for Creating Causal Pathway Diagrams” (48, 49).

The draft model, which moves from left to right, begins with acknowledging the many long-standing challenges and barriers to safe, high quality, equitable care in the United States healthcare. Next, interrelationships between the four proposed core

TABLE 1 IPFCR model definition and core components.

Definition: Rounding model that brings two or more health professions together with patients and families as part of a consistent team-based routine to share information and collaboratively arrive at a daily plan of care	
Component	Description
1. Interprofessional collaboration	Rounding as an interprofessional team with representatives of multiple professions/disciplines (e.g., nurses and physicians).
2. Intentional patient and family engagement	Performing rounds at the bedside (if permitted by patient and family) and inviting information and perspective sharing and questions during care planning & decision making.
3. Rounding structure	Utilizing a predetermined process for speaking roles, presentation order, and suggested content (e.g., vitals, assessment, plan).
4. Shared development of a daily care plan	Review of patient data during rounds results in the formulation of a plan of care for the day and beyond with input from the entire team (including patients and family members/caregivers).



components of an IPFCR model are portrayed, illustrating how the use of a rounding structure provides a supportive structure for interprofessional care team members to come together with patients and families to develop a shared care plan. It is hypothesized that the result of implementing the four IPFCR core components increases in the reliability of rounding routines that support information sharing and better team communication. Together, we hypothesize that these activities lead to improvements in both proximal and distal outcomes for patients, families, health professionals, and the overall care team.

Discussion

This review uses literature review and thematic analysis to propose a conceptual framework of IPFCR that highlights the importance of

interprofessional collaboration, patient and family engagement, structure, and development of a daily shared care plan. This framework will enable future studies to clarify whether similar-sounding models described in the literature are in fact, similar, in both form and function. Additional research is necessary, because it is unclear from the current literature what is essential or core to an optimal IPFCR model and how an IPFCR model might improve team and patient outcomes that to make care safer, more equitable, and more patient- and family-centered.

As a process that introduces principles of high reliability, IPFCR models provide an environment for team cognition as described in phase 2 of this review (41, 50). Utilizing high reliability as a foundational concept provides important perspective, as it includes an appreciation that patient care is complex and complexity is better addressed when an interprofessional care team, including patients and families, is involved. Principles of high reliability also guide users to avoid harmful oversimplification, unconsidered variation, and inequities and the proposed model helps to account for this complexity and current variability in care processes.

Another body of research that supports the potential impacts of IPFCR models on patient care is around organizational routines. Across many sectors, routines are used to help coordinate processes and reduce uncertainty. When IPFCR models are implemented consistently, they serve as a structuring device of collaboration and organizational learning (51). As effective communication plays such a critical part in improving outcomes, there is inherent value in increased focus on the routine structures designed for information sharing across professions, patients, and families (52). As for future research on IPFCR, using guidance from existing research on organizational routines and from the implementation science literature may be helpful for establishing consistency in reporting important details of the routine (i.e., who is involved, leadership, location, any variability from established guidelines, etc.). Sharing these details will allow scholars to compare findings more accurately across studies (53, 54).

## Limitations

This manuscript review delved into multiple areas of literature. Because Part 2 presented a focused, rather than formal systematic, search there is possibility of bias through the omitting or limiting of relevant literature in that section.

## Conclusion

The proposed conceptual framework offers a synthesis of practice-based evidence and theory about how and why rounds “work.” Inherent in this framework is an assumption that rounds can work even better when they use a standardized approach that is more inclusive of interprofessional care team members, patients, and families. By defining this IPFCR framework in terms of core components informed by theory, an opportunity for more rigorous future study is created. Studies using an explicitly defined conceptual framework of IPFCR are essential to determining

whether it is important to optimize, scale, and spread IPFCR models (54).

## Author contributions

EB: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JB: Writing – review & editing. GB: Writing – review & editing. AK: Writing – review & editing. VP: Writing – review & editing. KO'B: Writing – review & editing. BZ: Writing – review & editing. KO'L: Visualization, Writing – review & editing. BW: Supervision, Visualization, Writing – review & editing.

## Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. EB received funding to support her time during the conceptualization, analysis and manuscript writing for this project from a National Heart, Lung, and Blood Institute K23 (1K23HL144910-01A1). EB also received funding from the University of Washington School of Nursing Symptom Science Award Program to pay for open access publication fees.

## Acknowledgments

EB would like to gratefully acknowledge the feedback and mentorship of the late J. Randall Curtis during early drafts of this manuscript.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2023.1275480/full#supplementary-material>

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RECEIVED 20 July 2023

ACCEPTED 06 October 2023

PUBLISHED 18 October 2023

## CITATION

Schlicker A, Nitsche J and Ehlers J (2023)  
Special challenge interprofessional education –  
how should lecturers be trained?  
*Front. Educ.* 8:1260820.  
doi: 10.3389/feduc.2023.1260820

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# Special challenge interprofessional education – how should lecturers be trained?

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To enable interprofessional collaboration in practice, it is important to practice interprofessional action during education. Teachers in interprofessional education (IPE) in Germany are insufficiently prepared for joint teaching and often lack pedagogical-didactical training. Teachers who have been used to working unprofessionally up to now are expected to be able to teach competently across professions. This overlooks the fact that the admission requirements for teaching at the various institutions such as technical colleges, universities of applied sciences and universities are different. In addition, interprofessional teaching is characterized by a special feature: it should be carried out in team teaching. This poses the challenge for the teachers not only to prepare for the teaching in terms of content, but also to get involved with another teaching person. This study asks what interprofessional faculty need to feel well prepared to teach together and focuses on three professions: human medicine, nursing, and physiotherapy. For this purpose, 15 experts were interviewed, five from each of the three professions. The interview material was analyzed according to the structuring qualitative content analysis by Kuckartz, where categories were created to answer the research question. As a result, the analysis showed that three levels are important for the interviewees: the personal prerequisites that contribute to the success of IPE as well as good preparation on a structural and content-related level. Based on this, a concept for further education for interprofessional teachers will be developed.

## KEYWORDS

interprofessional education, interprofessional qualification concept, interprofessional teachers, focus on three professions: human medicine, nursing, physiotherapy, teamwork

## 1. Introduction, theoretical background and research question

The basis for teaching at universities is the Framework Act for Higher Education. It is explicitly stated that German university lecturers perform their tasks in science, art, research, teaching and further education independently (*Hochschulrahmengesetz, 2019*). No information is given on the qualifications that a university lecturer should possess. Moreover, teachers at universities often find themselves in a dual role. They are not only teaching, but also pursuing a research interest. Reconciling these roles presents them with challenges, as teaching and research function according to different logics. If a central point of interprofessional teaching is

togetherness and the logic of research is a competitive one, the question may be raised how a well-functioning togetherness in teaching can be realized.

## 1.1. Introduction

Patient care is not possible without cooperation between the different professions in the health care system. In order to improve care and ensure good cooperation between professions, learners from different professions should be brought together in education (Wissenschaftsrat, 2012). The focus of research is mostly on the learners, with the role of the teacher less well studied (Reeves et al., 2016). However, they are the ones who are responsible for teaching, planning and implementing. For inter-professional education (IPE) in Germany, learners from different education can come together - from technical colleges, universities of applied sciences and universities (Cichon and Klapper, 2018). The entry requirements for teachers to be allowed to teach are very different in the institutions. The basis for teaching at universities is the Framework Act for Higher Education (2019). It is explicitly stated that university lecturers perform their tasks in science, art, research, teaching and further education independently (Hochschulrahmengesetz, 2019). No information is given on the qualifications that a university lecturer should possess. At universities, further training in didactics and pedagogy is only partially required (Strauss et al., 2020).

Thus, the scope for deciding which persons with which existing or non-existing qualifications are employed in teaching is relatively large. For technical colleges and universities of applied sciences, there are no uniform federal specifications, which is why there are considerable differences. In most cases, however, not only professional competences in the sense of the professional title are required for teaching, but also pedagogical competences (MPhG - Masseur- und Physiotherapeutengesetz, 1994; PflBG - Pflegeberufegesetz, 2017; Zusatzqualifikation von mind - Deutscher Verband für Physiotherapie, 2018). What exactly is meant by this varies from region to region. It should be noted that pedagogical competencies are at least considered in technical colleges and universities of applied sciences, but are not mentioned in the university setting according to the Higher Education Framework Act (2019).

## 1.2. Theoretical background

In the university setting, the assumption of teaching for lecturers usually comes suddenly. In the university setting, it is assumed that lecturers can teach even if they have previously worked exclusively in the practical setting, for example. They are often inexperienced and are not prepared for the new challenges. From the management level it is assumed that teaching teaching occurs naturally (Böss-Ostendorf et al., 2014). Individual, non-mandatory programs show that quality improvement in teaching through professionalization offers are advertised and accepted by teachers (Babbe et al., 2020). However, knowing about teaching competence or acquiring it are two different aspects. Moreover, the development from novice to teaching professional is not automatic. Winteler and Batscherer (2004) outline five phases of development that are occur in the best case: The first phase is characterized by 'survival', the teacher is preoccupied with

him/herself and his/her own role. In the second phase, the teacher is still uncertain, but recognizes that the learners are interested in the lesson content. In the third phase, the teacher focuses more on the content rather than the learners. If the teachers perceive and reflect on their fixations on the lesson content, they can enter the fourth phase. If this self-fixation cannot be abandoned, they remain in the third phase. In the fourth phase, the teacher focuses on the learners and the learning process and is able to adjust the content and teaching style accordingly. In the fifth phase, the teacher adapts the variety of methods and the use of media to the learners, as he or she recognizes that they are more likely to retain what they have worked out for themselves. These developmental stages show that teaching is fraught with challenges. If pedagogical and/or didactic competencies are lacking, it does not become easier for the teacher to navigate the classroom.

In uniprofessional teaching, one teacher is responsible, so there is no need to cooperate with other teachers. However, this ability to cooperate is an important element in interprofessional education (Crow and Smith, 2003). It is about thinking as a team, planning and implementing lessons together. Through collaborative competence, teachers can engage in reflective dialogue with colleagues and plan, deliver, and evaluate teaching together (Feldmann, 2005). Team teaching is more than the existence of another teacher. The goal should be to become communicative and cooperative team players and to turn away from individualism and lone wolf existence (Rohr et al., 2016). To be able to collaborate across professions, it is necessary to work together at eye level and to overcome silo thinking (Sottas et al., 2013). Cooperation at eye level can be made more difficult if teachers also pursue a research interest in addition to their teaching activities. Research interests are competitive and joint teaching places its emphasis on good cooperation. Combining this could be a big challenge for IPE teachers (Viebahn, 2009). If a central point of interprofessional teaching is togetherness and the logic of research is a competitive one, the question may be raised how a well-functioning togetherness in teaching can be realized.

## 1.3. Research question

Reeves et al. (2016) note that the research interest is more on learners and less on teachers. However, since teachers train and accompany learners on their way, they have a special task. The different institutional requirements for teachers make equal cooperation in teaching difficult. Therefore, an adapted preparation for interprofessional teaching is needed. According to Hattie, in order for good teaching to work, certain requirements must be fulfilled, which were compiled by Steffens and Höfer (2016):

- Concrete action on the part of the teacher
- Knowledge about instructional planning, forms of instruction, learning strategies and forms of learning
- Knowledge of feedback strategies
- Dealing with feedback

Thus, adapted preparation for interprofessional teaching is needed. Our quantitative preliminary study (Schlicker and Ehlers, 2023) shows that of the 76 online respondents, 14 have an additional pedagogical qualification and seven have an interprofessional one.

TABLE 1 Main and detailed questions of the guideline questionnaire used in the interviews.

Domains	Main questions	Possible detailing questions
Definition of IPE	What do you personally understand by Interprofessionality?	<ul style="list-style-type: none"> <li>What constitutes interprofessionality for you?</li> <li>Is there an official definition that you work with?</li> </ul>
Own IPE courses	What do the interprofessional courses you give/are involved in look like?	<ul style="list-style-type: none"> <li>Which professions are involved?</li> <li>What is the scope of the LV?</li> <li>How often do they take place?</li> <li>What are the learning objectives?</li> </ul>
Optimal IPE courses	How do you imagine an optimal interprofessional education at universities of applied sciences, vocational schools or universities, or how should it look like?	<ul style="list-style-type: none"> <li>You have reported what your LV look like. Are there other formats that you find good? And if so, what do they look like?</li> </ul>
Basic knowledge of other professions	A first step is to get to know other professions first. Do you think that as an interprofessional teacher one needs basic knowledge of the other professions or should the teacher act as a facilitator or tutor to assist the learners?	<ul style="list-style-type: none"> <li>What does the role of an IPE learning facilitator entail for you? Is it more content-based or organizational?</li> </ul>
IPE competencies	In your view, are uniprofessional competencies different from interprofessional competencies?	<p>If so, what are the differences?</p> <ul style="list-style-type: none"> <li>What competencies should an interprofessional teacher have in general?</li> </ul>
Joint assumption of responsibility	In the questionnaire that you kindly filled out online, three quarters had mentioned interprofessional communication as an important competence, but only less than half had mentioned the joint assumption of responsibility. Why does this aspect seem to play a rather subordinate role?	<ul style="list-style-type: none"> <li>Could legal aspects play a role? In what way?</li> <li>Could it be due to the profession-specific professional identity in combination with hierarchical thinking? How could this be changed through interprofessional courses?</li> </ul>
Interprofessional qualification course	What are your expectations of an interprofessional qualification course? What should it look like so that you feel well prepared for joint teaching?	<ul style="list-style-type: none"> <li>What contents should this have?</li> <li>Which methods are useful in your opinion?</li> <li>What should not be missing under any circumstances?</li> <li>What could the time frame look like?</li> <li>Which formats do you find useful? E.g. blended learning formats or similar?</li> </ul>

This indicates that there is currently no preparation that fits exactly. There are currently no special interprofessional training courses for teachers throughout Germany. Some institutions offer in-house training for their interprofessional staff, which is not accessible to outsiders. The content that is covered is not communicated to the outside world, so that it remains unclear which topics are being dealt with.

Since uniprofessional teaching formats differ from interprofessional ones, our research question is:

- What do interprofessional educators in Germany need to feel well prepared to teach together?

This research project focuses on the three professions of human medicine, nursing and physiotherapy, as they have a large overlap in the provision of care.

## 2. Materials and methods

A mixed methods approach was chosen. Mixed-methods design makes it possible to better understand a complex issue. The quantitative perspective of counting is combined with the qualitative perspective of understanding meaning with the aim of exploring research problems more comprehensively (Kuckartz, 2014). In a preliminary study (Schlicker and Ehlers, 2023) quantitative data were generated. The qualitative inquiry conducted here was designed to fill explanatory gaps in more depth. The answers of the quantitative questionnaire provided first indications of what is important for the teachers in interprofessional teaching (Schlicker and Ehlers, 2023).

More detailed answers should be obtained from the interviews. Therefore, expert interviews were conducted.

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The ethics committee of Witten/Herdecke University decided that no “ethical or legal concerns were apparent and that the study could therefore be carried out (No214/2018). The participants provided their written informed consent to participate in this study.

## 2.1. Qualitative study design

### 2.1.1. Questionnaire

The quantitative study (Schlicker and Ehlers, 2023) formed the basis for the development of the guideline questionnaire. To elaborate on selected topics for the guideline-based expert interviews, the guideline contained seven areas: Definition of IPE, own IPE courses, optimal IPE courses, basic knowledge of other professions, IPE competencies, joint assumption of responsibility, and interprofessional qualification course. Each area contained main and detailed questions (Table 1).

### 2.1.2. Sample

We invited interviewees based on their returned questionnaires. The online survey determined whether respondents were available for an interview. If they were, they were asked to provide their email address. In the selection, the greatest

possible heterogeneity we aimed for with regard to gender, age, qualification for teaching as well as duration and scope of interprofessional teaching. A total of fifteen interviewees were selected, three physiotherapists, three physicians and three nurses. If theoretical saturation was not achieved after the fifteen interviews, additional individuals would be solicited based on the aforementioned criteria. The interview partners received a detailed information letter about the research request when contacted and an informed consent form when the appointment was confirmed. All interview partners participated voluntarily and agreed to anonymous publication of their data.

### 2.1.3. The interviews

The interviews were conducted from late January 2020 to mid-February 2021. We carried out the first eight interview in person at each facilities, and the last seven via the cloud-based Zoom videoconferencing service due to Corona restrictions. Eleven women and four men between the ages of 31 and 60 with 3.5 to 32 years of work experience were interviewed. The interviews ranged in length from 20 min to 70 min. The length of the interviews was not dependent on the profession. All recorded interviews were transcribed, anonymized, and analyzed using MAXQDA computer-assisted qualitative data and text analysis software (Analytics Pro 2022).

### 2.1.4. Analysis of the data

JE and AS separately read the transcribed interviews. The data were analyzed according to the structuring qualitative content analysis of Kuckartz (2018). In a first step, the text material was open-coded and divided into main and subcategories, which took place in close exchange. In parallel, category formation via summaries was developed with the aim of comparing the codings with each other in order to be able to close gaps in the coding, if necessary. The main categories were developed deductively and inductively. Deductively, the interview guide served as orientation to introduce main categories. Inductively, these were supplemented by the open text work in the main categories and subcategories.

Categories and codings were discussed and decided together. The category manual in Table 2 lists the individual categories and subcategories.

## 3. Results

The categories can be grouped into three themes in the results: personal prerequisites, which are considered important for interprofessional teaching, structural design and organization of a qualification course, and content-related topics.

### 3.1. Personal prerequisites which are considered important for interprofessional teaching

Openness in cooperation is important to the interviewees: To be open in order to recognize the expertise of other professions, to look at the fields of activity of other professions and thus to get to know them. This applies to the practical setting as well as to teaching.

TABLE 2 Presentation of the categories and subcategories generated from the interviews.

<i>Main categories</i>
• subcategories
<i>Definition of interprofessionality</i>
• Own definition
• Official definition
• Terminology used
<i>Course(s)/Teaching organisation</i>
• Course/organisational
• Realisation Bottom-Up
• Course/Content
• Learning objectives
• Professions involved in relation to pupils/students
• Professions involved in relation to teachers
<i>Ideal interprofessional courses</i>
<i>Overarching goals of IPE and the interprofessional courses as a whole (across the entire training)</i>
• Theory-Practice-Transfer
• Thinking as a team
• Sustainability/Continuity
• Changes of perspective
• Appreciative handling
• Openness/Curiosity
• Reflection
• Conditions for interprofessional education
<i>Need for IPE/IPC (IPC: Interprofessional Collaboration)</i>
• Patient orientation
• Professional Identity/Professional Biography
• Clarifying roles and tasks together
<i>Basic knowledge</i>
• Boundaries of competence
<i>Competences of the teacher</i>
• Difference interprofessional - uniprofessional competences
• Curiosity/Openness/Esteem
• Thinking as a team
• Changes of Perspective
• Authenticity
• Role model' function
• Role of the teacher - current
• Role of the teacher - idea
• Understanding as learning support
• Understanding one's own role
<i>Hierarchical order</i>
• Taking responsibility
• Legal
• Moral
<i>Elements of a qualification concept</i>
• Transfer theory-practice
• Continuity
• Didactic Skills
• rerequisites for a qualification concept
• Structural design
• Blended Learning

"And this participation, this being allowed to experience the other training, i.e. observing colleagues teaching, I would still personally feel as an increase and would probably still help me to understand the other profession better." [Interviewee No. 9, Physiotherapist]

For many of the interview partners, openness in the practical setting is expressed in the fact that they would like to accompany other professions in their work. They want to get to know the field of activity by looking over the shoulders of other professions in their everyday work, asking questions, discussing cases with them and, if possible, reflecting on them afterwards.

"I would actually look at their practical field of activity and have it explained to me. I would actually look at their everyday life. What do they do, how do they do it. I would talk to them." [Interviewee No.8, Physiotherapist]

Other personal prerequisites mentioned are an empathetic approach, a willingness to engage with other professions, and a high degree of self-awareness through self-experience in order to be able to reflect on one's own patterns of thought and action. If a discussion of the various topics only takes place on a theoretical level, the practical reference in dealing with people from other professions is missing.

"But I think a certain degree of self-awareness, because otherwise self-enlightenment is almost impossible, I think that is extremely important, because I think otherwise you run directly, without wanting to, into all these traps that you also encounter in everyday life, in everyday work." [Interviewee No.1, Physician]

### 3.2. Design of a qualification course – on the structural level

A very important point mentioned for the design of interprofessional teaching is time. Each profession makes its own initial thoughts, which are then compiled. Thus, a first structure is created, which is adapted again and again in further steps. If the planners of the different professions see themselves as equals, appointments must be found that allow everyone to participate in the planning. This is a complex process due to different framework conditions. In addition to the planning of IPE events, the implementation of the teaching as well as a subsequent reflection is equally time-consuming.

"But the most important thing is really time. Development takes time, implementation takes time. [...]. And the time should also allow us to keep asking what can be done differently. That this is not so firmly encrusted, but that we have a flexibility in it, that's what I think is the most important thing in the meantime." [Interviewee No. 12, Nurse]

Furthermore, the time is mentioned, which can be spent for the participation in a qualification course. This depends on many factors, such as course duration, work substitution, travel times and childcare. The tasks in the individual areas of activity are varied and complex, so that it is difficult for some to take or be able to take the time for further qualification.

"Well, I find that a very difficult question, because, I mean, nobody has time."

[Interviewee No. 6, Nurse]

On the one hand, the respondents find it difficult to take the time for a qualification course. On the other hand, repetition and continuity are important to them for implementation in practical everyday life and in terms of sustainability. These two poles reveal a certain discrepancy. A certain degree of continuity is desired for the implementation of a qualification course. Through the repetitions and the recurring confrontation with different topics, the probability is higher to be able to implement ideas into the daily work. IPE means to initiate changes in the facilities. Change takes time and practice. In order to be able to practice, topics must be regularly reflected upon and thought and action patterns must be adapted accordingly.

"So, I always think repetition is good. I think a one-time thing like that is the case with every continuing education program, because you always have so many ideas, but they always fizzle out again very quickly or are difficult to implement, and then you lose the thread a bit. That's why I think repetition is very good." [Interviewee No. 6, Nurse]

As a result of the Corona pandemic, many stakeholders have become accustomed to using online tools, which is seen as an opportunity in interprofessional work, but rather in the area of knowledge acquisition. The desire is expressed to make materials available online in order to be able to familiarize oneself thematically. An exchange in small groups is also seen as useful to get to know each other on a personal as well as professional level and to discuss and analyze cases.

"So, especially when it comes to the exchange, to opinions, (...) so, when it comes to subjective sensitivities and views must be exchanged, then it is indispensable that you come together and then I think it is also imperative that you sit across from each other. What happens between people cannot be solved in any way electronically, it is too divisive and there is simply a lack of closeness to each other." [Interviewee No. 9, Physiotherapist]

The interviewees would like to see a theory-practice transfer. They want to get to know the field of activity of other professions, but also their practical field of work. This can be achieved through job shadowing, for example. The time for this should be provided by the qualification course and considered in the planning.

### 3.3. Structure of a qualification course – at the content level

On the content level, good theory-practice transfer can be achieved through observation if the respective field of activity is experienced and explained in its many facets in a practical manner. The knowledge gained increases when the different professions exchange views on the cases during observation, bring in their own perspectives and discuss them.

"If I want to understand the other person, I have to go to his island and not the other way around" [Interviewee No. 8, Physiotherapist].



Further wishes include a teaching of didactic skills. These relate to teaching methods for the classroom - *Which methods are particularly useful in interprofessional teaching?* - but also preparation on a human level - *How do I give appreciative feedback? How do I accept appreciative feedback? How do I really engage with others?* These questions also reflect the desire to be prepared on a personal level. *What does it take for me to be able to deal with other people in a way that is as free of hierarchy as possible, as free of prejudice as possible, and as sensitive to discrimination as possible?* The interviewees mention terms such as openness, appreciation and reflection. However, these must be filled with content.

"Just because you mean well and want to do interprofessional cooperation or teaching, it doesn't mean that you don't secretly run after your prejudices and transport them and that's why I think self-education is a real basis for something like this" [Interviewee No. 1, Physician].

One's own attitude towards interprofessional work is relevant for cooperation. Questions about the voluntary nature of teaching, the choice of topics, the view of other professions, teamwork and conflict management should be answered by each person individually, because for interprofessional work to be fruitful, "everyone must be behind it.

"[...] everyone must be behind it. And if not everyone is behind it, and as free of hierarchy as possible, then quality management goes wrong, so interprofessional work with each other also goes wrong. Or it becomes very difficult, let's say so" [B8, Physiotherapist].

Interprofessional teaching means working together, relying on each other and designing teaching together.

"That we not only complement each other and make each other a little bit easier, but that we have this more, the sum is more than the whole of its parts, ne. So these energy gains that we have through that as well." [Interviewee No. 12, Nurse].

## 4. Discussion

### 4.1. What personal prerequisites are needed for interprofessional teaching?

The interviewees mentioned openness on different levels as an important concept for them in the cooperation with other professions. Cooperation is characterized by the internalization of stereotypes, which in turn have an influence on attitudes and behavior (Petersen and Six, 2008). Since the term stereotype tends to have a negative meaning in everyday life, disdainful behaviors are assumed as a consequence. Since stereotypical patterns are mostly automated, the consequences on the level of one's own thought and action patterns are unconscious (Schmid Mast and Krings, 2008). Attitudes and perceptions are already developed at an early stage of training through profession-specific socialization and form the basis for later interaction (Sottas et al., 2016). This can be counteracted by the job

shadowing mentioned by the interviewees (Monahan et al., 2018). In the practical setting, previously negative assumptions about other professions can be revised by accompanying them in their everyday work. Experiencing what tasks other professions have, what expertise they possess, what their everyday work looks like in all its facets, can change the empathy and the view of these professions. It is possible to form one's own picture and to enter into a targeted exchange with the actors. In most cases, job shadowing is arranged on an individual basis, and there are few opportunities in the health care system to get to know other professions in this way. The Charité Universitätsmedizin Berlin (2023) offers a "Hospitationswoche im klinischen Qualitäts- und Risikomanagement" (Hospitalization week in clinical quality and risk management). Since this week is not remunerated and an application is required, it is questionable how many people have the possibilities and resources to accept this offer. Teaching observations also help the respondents to better understand other professions.

There are fears of contact between the teachers due to their different educational backgrounds. The idea of being observed by other teachers in their own lessons is described as unusual (Arens, 2017). In addition, the norm in teaching is to give lessons alone, which is why teachers are not used to working in a team (Feldmann, 2005). By observing other teachers in the teaching context, insights can be gained and implemented in one's own teaching (Burgsteiner, 2014). A joint reflection afterwards can be beneficial for observers and teachers, as difficulties and questions can be discussed from different perspectives. It is essential that the observer expresses criticism constructively and that the teacher accepts it as well (Zankel-Pichler, 2014). Since interprofessionality thrives on cooperation, teaching should also be done in a team (Sottas et al., 2013). Through the preparation and implementation of joint teaching, the various professions get to know each other on a variety of levels - from the content of the training courses to practical activities and teaching skills. By working together as a team, individuals are relieved, lone wolves are reduced and silo thinking can be overcome (Arbeitsstab Forum Bildung, 2001; Sottas et al., 2013). Professional practice is characterized by an ambivalence between what the actors say and what they show. The joint cooperation is seen as quite important, which indicates a positive basic attitude of the persons. In practical everyday life, however, this attitude is less visible. Kerres et al. (2022) outline this using the example of interprofessional rounds. A ward round in which several professions are involved does not necessarily mean that interprofessional exchange takes place and ideas, suggestions, feedback and impulses are accepted respectfully.

### 4.2. What kind of structure does an IPE qualification course need?

Time is an essential factor for the interviewees in order to be able to adequately plan, carry out and reflect on joint teaching. In this context, it is not enough to talk about IPE. In order to be able to develop an understanding of the perspective of other professions, guidance for critical reflection is needed (Charles et al., 2010). To what extent the participants have time for this process of planning, implementation and critical reflection remains an open question. Interprofessional education in Germany is currently still carried out in few institutions (Schlicker and Ehlers, 2023) and teachers are rarely given additional time for this type of

teaching. The reasons for this are manifold. Above all, the lack of support from the institution in terms of resources such as money, staff and rooms is mentioned. Co-teaching is often covered by dedicated staff. The problem does not only relate to time resources.

It is also difficult for interprofessional teachers to access interprofessional teaching-learning materials. Although the Robert Bosch Foundation with the program 'Operation Team' (Sottas, 2020) as well as the national model curriculum (IMPP, n.d.) are strongly committed to interprofessional education, there is relatively little material available for the planning of interprofessional courses (Kerres et al., 2022). Without the possibility of accessing existing material, time is again needed in addition to the methodological-didactic skills for planning.

Studies on how many interprofessional lecturers carry out joint teaching within the framework of their actual field of activity could not be found at present. If joint teaching, which is still the exception in Germany but common in international comparison (Crow and Smith, 2003; Cimino et al., 2022; Piper-Vallillo et al., 2023), is already performed as an additional task, the question can be asked what priority interprofessional continuing education has. The calendar of events of the Medical Association of Schleswig-Holstein (Aeksh De, n.d.) shows that the topic of "interprofessional training" is listed, but no training courses are currently offered. In many professions, continuing education credits must be earned in order to ensure medical quality. It is questionable what priority is given to training in interprofessional collaboration and to what extent it is offered. There is no central register for continuing education in which continuing education points can be acquired for the professions from the health care sector. And if, using the example of the medical profession, 250 continuing education points have to be acquired within five years and part of these must be subject-specific (Ärztefortbildungen.de, n.d.), it is questionable how much capacity the individual persons want to invest in interprofessional topics.

### 4.3. What content structure does an IPE qualification course need?

Since interprofessional teachers in Germany, in contrast to international comparisons (Paradis and Whitehead, 2019). Hardly have access to adequate teaching and learning material, they would like to see didactic skills taught in the context of a qualification course. This is aggravated by the fact that teachers at different institutions have considerable differences in their teaching skills (see introduction), which can lead to difficulties in cooperation. We can only speculate here about the reasons why things are done differently in Germany than internationally. IPE has only become an important topic here in recent years, so there is certainly still some catching up to do. Also the didactic training of lecturers in medicine has a much shorter tradition than in other countries. Positively, this opens up some possibilities to learn from other countries and to convey these learnings in newly designed courses.

Taking the two professions of human medicine and physiotherapy as an example, the practice in Germany is that physiotherapists provide therapy according to the doctor's instructions. In the educational situation, teachers in physiotherapy colleges are expected to have "relevant professional qualifications and pedagogical aptitude"

(MPhG - Masseur- und Physiotherapeutengesetz, 1994; Zusatzqualifikation von mind - Deutscher Verband für Physiotherapie, 2018), which is not the case for teachers in the university context. It has to be considered how the actors in the cooperation deal with the reversed roles. If the physiotherapy teacher has a higher pedagogical-didactic qualification for teaching, can the teacher from medicine, who may not have these qualifications, get involved? This is where the personal prerequisites mentioned by participants for a qualification course intertwine with what they want from a course in terms of content. Preparation on the human level seems to be an important aspect. Appreciative interaction is mentioned, as is reflection on one's own attitudes. This joint preparation seems all the more important in view of the fact that, for example, the professional expertise of nurses is often not recognized by physicians (Dienhart et al., 2022). In the context of a qualification course, the aim should be for people to learn to relate to each other as human beings, to respect others in their field of activity, and to be able to give and accept feedback constructively. Thus, a course should not only cover the professional level of interprofessional cooperation, but rather bring the actors who work together in the practical setting for the patients together on a human level. To this end, it is essential to reflect on one's own thought and action patterns vis-à-vis other professions and to critically question one's own sensitivities, so that the WHO goal formulated as early as 1988 "Learn together to work together for health" (World Health Organization, 1988; p. 1) can already be achieved at the training level.

## 5. Limitations of the study

In this study, the three professions of human medicine, nursing and physiotherapy were included. This does not mean that other professions are unimportant in interprofessional education and care.

Not all respondents provided their contact details in the online survey, so that only some of them could be requested for an interview. From this response, an attempt was made to generate as heterogeneous a group as possible.

The first eight interviews were conducted in person. By visiting the interview partners on site, a relaxed atmosphere could be created in advance through small talk, and in some cases this was combined with a presentation of the institution. As the last seven interviews took place via the digital provider ZOOM, there was no need to get to know each other in advance, as the interview partners only took the previously agreed time for the interview.

## 6. Conclusion and outlook

Even after intensive research, no cross-professional and openly accessible qualification concept for interprofessional teachers could be found in the German-speaking area (Germany, Austria and Switzerland). Internationally, these already exist (Steinert, 2005; Williams and Gregory, 2012). Due to the different framework conditions in Germany, a transfer is often challenging. Nevertheless, the opportunity to learn from other countries should be used to develop qualification concepts in German-speaking countries and offer them across professions. According to informal information, in-house training courses could be identified in

individual facilities, but these were only available to their own staff. In addition, there was no way to access interprofessional teaching-learning materials through public channels. In 2020, the Robert Bosch Stiftung published a “*Handbuch für Lernbegleiter auf interprofessionellen Ausbildungsstationen*” (Handbook for learning facilitators on interprofessional training stations; Sottas, 2020), which also addresses the topics of role understanding, methodological competence, and strategies for the implementation of learning objectives. However, since this manual is not based on any accompanying joint training, it is questionable to what extent good cooperation can be achieved in practice if one's own attitudes in dealing with other professions are not questioned. In addition, only the cooperation at interprofessional training stations is focused on, but not the teaching in the preceding training sections. This study focuses on interprofessional teachers already in the early training context. The focus is not exclusively on the development of pedagogical-didactic skills, but above all on the confrontation with one's own thought and action patterns. Through an intensive own as well as common reflection a real basis can be created to work on eye level with each other. If these preconditions are met - the existence of pedagogical-didactic skills and the confrontation with one's own thought and action patterns - the probability is higher to be able to engage in a good cooperation and to come closer to the formulated goal of the [World Health Organization \(1988, p. 1\)](#) “Learning to work together for health.”

In the context of this study, only the three professions of human medicine, physiotherapy and nursing were included. It would make sense to include other professions involved in the health care system.

This study addresses the needs of interprofessional faculty. The aim was to find out what they need in order to feel well prepared for joint teaching. It became clear that, in addition to professional content, collaboration on a personal level is most desired.

On the basis of these findings, the next step will be to work out complexes of topics that will serve as a starting point for creating a concept for a qualification course in terms of content and content.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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## Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## Author contributions

AS: Writing – original draft. JN: Writing – original draft. JE: Writing – original draft.

## Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This study is financially funded by the Federal Ministry of Education and Research (BMBF) and supported by the Federal Institute for Vocational Training (BIBB), grant number 21INVI0301.

## Acknowledgments

The authors would like to thank all respondents who participated in this study.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## OPEN ACCESS

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RECEIVED 23 June 2023

ACCEPTED 06 October 2023

PUBLISHED 18 October 2023

## CITATION

Nawagi F, Munabi IG, Vyt A, Kiguli S, Rabin T,  
Waggie F and Mubuuke AG (2023) Using the  
modified Delphi technique to develop a  
framework for interprofessional education  
during international electives in health  
professions training institutions in Sub-Saharan  
Africa.

*Front. Med.* 10:1225475.

doi: 10.3389/fmed.2023.1225475

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# Using the modified Delphi technique to develop a framework for interprofessional education during international electives in health professions training institutions in Sub-Saharan Africa

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**Background:** International electives provide a learning platform where interprofessional education and collaborative practice (IPECP) skills can be cultivated. However, hardly any frameworks to guide the implementation of interprofessional education (IPE) during international electives, especially in the context of low-income settings have been published. To address this gap, this study used the modified Delphi approach to develop an IPE framework guide for international electives to be used by health professions training institutions in Sub-Saharan Africa.

**Methods:** A rapid literature review and a study among students and faculty in four African health professional training institutions were done to inform the process. This was followed by the modified Delphi technique that used three Delphi rounds with a panel of eight experts to build consensus on the final framework for IPE during international electives. The level of consensus was set at  $\geq 70\%$  on each of the statements in all rounds.

**Results:** Out of the 52 statements in round 1 ( $n = 37$ , 71%) reached consensus while ( $n = 15$ , 29%) of the statements did not reach consensus and were discussed in round 2. Round 2 led to 42 statements to be utilized for round 3. In round 3, all statements (42) reached a consensus and an IPE framework to guide the implementation of international electives was developed. The framework consists of three sections. Section one highlights the various IPECP competencies to be gained by learners in the areas of teamwork, interprofessional communication, roles and responsibilities of interprofessional collaborative practice, values and ethics of interprofessional collaboration, and reflection and evaluation of oneself and the team. Section two gives guidance on the structuring of the IPE international electives in health professional training institutions. This includes subsections on operational/institutional needs, acculturation considerations, teaching strategies, assessment strategies, mode of delivery, and public health considerations. Section three consists of the various practical guides and approaches that health professional training institutions could use according to what works best in their setting.



**Conclusion:** The modified Delphi technique was an adequate approach to aid the development of an IPE framework to guide implementation during international electives in various health professional training institutions.

#### KEYWORDS

framework, interprofessional education, interprofessional collaboration, international electives, Africa

## Introduction

Interprofessional education (IPE) in health is defined as when two or more professions learn with, from, and about each other to enable effective collaboration and improve health outcomes (1). A few institutions in Africa have made strides in the integration of IPE competencies in the curriculum through didactic and experiential learning, especially during community-based field attachment modules and within the training of the basic sciences (2). However, efforts to offer IPE and build frameworks that include self-evaluation to guide interprofessional education and collaborative practice (IPECP) implementation and learning in international electives, especially in Africa remain minimal, yet key (3).

The World Health Organization has supported IPE by developing a framework for action on IPECP that proposed new models of educating healthcare providers (1). This framework further proposed syncing education with health care systems with an interprofessional approach to lead to enhanced quality of health care (1). Despite its relevance till today, it did not provide learning environment-specific guidelines to implement IPE among learners. Specifically, it did not provide guidelines on teaching, assessment, and orientation approaches for IPE in various learning environments like the clinical, community, simulation, lectures, and international electives, among others.

The Interprofessional Education Collaborative (IPEC) defined the key competencies of IPE as; values/ethics for IPECP, roles/responsibilities for IPECP, interprofessional communication practices, interprofessional teamwork, and team-based practice (4). All these competencies should be implemented with approaches that are family-centered, patient-oriented, and for the community at large (4). These approaches have a similarity with those of the Canadian Interprofessional Health Collaborative (CIHC) (5). In addition, the European Interprofessional Practice and Education Network (EIPEN) has developed a framework for interprofessional collaboration in health care which involves key competencies that include: consult and collaborate, plan and manage, handle issues and opportunities, refer and transfer, and reflect and evaluate in all areas of work, all involving an interprofessional approach (6).

Despite the relevance of all the above frameworks on IPE competencies that also include aspects of respect for culture and uniqueness of other professions, it is challenging to develop guidelines for implementing IPE in various learning contexts including international electives. International electives are defined as the time of learning where students have a choice of where to learn, and the discipline they should be taking across borders from their own country (7). These mainly occur in another country at a particular host institution that has a partnership agreement that may be unilateral, bilateral, or multilateral with the student's home institution (8).

International electives as a form of teaching and learning are part of various health professions training institutions globally (9, 10). The majority of the international electives are clinical or community-based and often have the elective visiting students interact with local students and faculty of the same discipline at the host institution (11). The majority of the students are from the medicine and nursing disciplines, respectively, among others (11), with hardly any interaction or joint activities (12). International electives are often 4 weeks at the undergraduate level and often students have to find sponsorships or self-fund (12). Most of the evaluation is done through reflective reports, scoring sheets from the home institution of the student which are given to the supervising faculty, and post-elective surveys (12). International electives have been documented to enhance the learners' global perspectives, knowledge and skills, interpersonal and professional development, and positive attitudes to better health service delivery (13). Furthermore, international electives provide a learning platform where IPECP skills can be cultivated especially if offered with a structured approach (3).

IPE international electives though scarce, have been implemented between Vanderbilt University USA and Nicaragua Eye Hospital and were perceived to be effective to enable students gain IPECP (14). However, hardly any frameworks to guide the implementation of IPE during international electives, especially in the context of low-income settings, where social care issues and aspects of resource limitation can determine interprofessional health care to a large extent have been published (15). Health professional line of command and practice, which is an aspect of culture, largely differ in various African countries and globally (16). Some cadres of professionals may be able to perform some tasks during clinical care while in other countries it may not be possible (16). Given that IPE international electives require mobility to another country, a guide for intercultural orientation hardly exists.

Much of the research on IPE and learning has been informed by psychological and cognitive theories pushing aside the role of the learning environment and cultural context. This study was guided by the social constructivism theory, a social-cultural theory advanced by Vygotsky et al. (17). This theory postulates that individuals work together to construct and develop ideas through dialogue that builds on prior knowledge and understanding. Here, the importance of culture, context, and social interaction are key to shaping one's knowledge gain. For the social constructivist, knowledge is socially and culturally constructed (18). Individuals create meaning through their interactions with each other and with the environment they live in. In relation to structuring learning in IPE international electives, learners within an international elective placement do interact with each other and learn about and from each other in a social environment which eventually will influence their learning. Furthermore, the social

constructivism theory emphasizes the zone of proximal development (17). This postulates that an individual will have skills/abilities they develop on their own but cannot perform them independently because they will need structured guidance from someone who has mastered the skill already to enable them to learn and be able to practice independently (17). Therefore, meaningful learning occurs when individuals are guided by experts utilizing a framework in a given field, engaged in social and collaborative activities within a community of practice such as that formed within an international elective placement, and optimally if done interprofessionally (18).

## Study aim

To address this gap, the purpose of this study was to develop an IPE framework guide for international electives to be used by health

professions training institutions. Though the study was conducted in Sub-Saharan Africa, the framework developed can be adapted to various settings where international electives do occur.

## Methodology

### Setting

This study was conducted in Sub-Saharan Africa utilizing faculty and experts in representative health professions training institutions. The training institutions offer electives as part of their curriculum and conduct training for various health professional disciplines at the undergraduate level. Table 1 shows the details of the institutions and the respective expertise of the experts included in this study.

### Study design

In this study, we employed the modified Delphi technique to develop the IPE implementation framework for international electives in health professions training. In the Delphi approach, the first round could involve unstructured open-ended questions/statements to guide the discussion with a panel of experts (19). When a set of structured selected questions/statements obtained from literature on the topic are used, this is called a modified Delphi technique and thus the approach used in this study (20). The Delphi technique is a structured process that uses a set of questions/statements in various rounds with a panel of experts to gain consensus on a particular topic at hand (21). This technique was chosen because it is an appropriate method for topics with scanty evidence (22) such as IPE and its implementation in international electives in various training institutions where there is a lack of existing guidelines. It is also a method of choice just like in this study when there is a need to avoid individual opinions of the researcher dominating the process of seeking consensus across a wide expert panel. Furthermore, just like in this case, the Delphi method is an appropriate method of use when the panel of experts, who are the main participants are from various geographical locations which were key in this study (19). Many other researchers and educators have utilized the Delphi approach in developing frameworks and a consensus on various health agendas with an interprofessional approach (23–25). Given its variable success in other studies largely due to low response rate from experts, this technique was chosen in this study as the most appropriate technique to develop a framework to guide the implementation of IPE in international electives given the fact that it was to be done online and allowed each expert to select the dates and times that best work for them to participate.

### Informing the Delphi process

The Delphi process involved a series of stages before coming up with a final framework. These included conducting a rapid literature review, exploring opinions from students and faculty, and finally engaging the panel of experts for consensus building.

TABLE 1 Frequency distribution of the characteristics of the Delphi panel experts  $N = 8$ .

Variable	Frequency (N)
<b>Gender</b>	
Female	6
Male	2
<b>Discipline</b>	
Medicine	3
Nursing	2
Physiotherapy	1
Occupational therapy	1
Pharmacy	1
<b>Institutional affiliation</b>	
Busitema University, Uganda	1
Stellenbosch University, South Africa	2
University of Free State, South Africa/ African Interprofessional Network (AFRIPEN)	1
University of Global Health Equity, Rwanda/ African Forum for Research and Health (AFREhealth)	1
Makerere University Uganda/Yale University USA	2
University of Western Cape, South Africa	1
<b>Country location</b>	
Rwanda	1
South Africa	4
Uganda	1
United States of America (USA)	2
<b>Expertise</b>	
IPECP	3
International Elective placements	3
Health Professions Education	2

## The rapid literature review (stage 1)

Firstly, a rapid literature review was conducted to inform the Delphi process for our study. This was done to enable a detailed understanding of IPE and international electives in line with the study objectives and to identify learning theories to be used. The rapid review was conducted using PubMed accessed through HINARI *via* Makerere University to identify literature on key concepts related to the topic under study. These included: internationalization in health professions education, international electives, the importance of IPECP in health care, current global disease burden, IPE during international electives, perceptions of faculty and students on IPE during international electives, IPE frameworks and their development, Learning theories for IPE, IPE competencies, the importance of IPE, the value of international electives, operational needs for international elective programs, teaching and assessment methods for IPE in international electives, and delivery approaches to teaching IPECP during international electives. The specific search terms used were: interprofessional education, international electives, interprofessional collaboration, Africa, IPE frameworks, Delphi technique, internationalization in health professions education, multidisciplinary, collaborative, interprofessional, interdisciplinary, teamwork, IPE teaching, assessment, theories, health professions education, and teaching.

We searched PubMed for manuscripts written in English, and from the years 2000 to 2022 as our inclusion criteria to enable us to have more articles included since there is scanty literature on this topic. The earliest year of the manuscript included was 2000 while the highest was 2021 with the majority being published in the last 10 years as shown in [Supplementary Appendix 1](#). Papers that were just abstracts of a proposed study and did not report study findings were excluded. The rapid review approach provides more timely information for decision-making and is an appropriate method to inform the framework development using a Delphi approach (26). The rapid review was conducted by one researcher (FN). FN went ahead to develop a literature review write-up and shared it with IGM, AV, and AGM for review and appraisal. This approach and all the approaches used (one search engine, published papers, limiting inclusion criteria by language and date, one researcher (FN) conducting the review, and a senior team doing a secondary review and appraisal of the literature review findings) are acceptable approaches when conducting a rapid review for a consensus approach like the Delphi technique (26).

In this process, 84 manuscripts were identified and included (see [Supplementary Appendix 1](#)). The references in these papers were inspected for any additional evidence data and findings in line with this study's aim. We conducted a framework analysis (27) to enable us to develop the literature review write-up from the rapid review. This enabled us to group articles into categories, themes, and narrative paragraphs in line with the study topic.

## Seeking opinions from students and faculty (stage 2)

In addition to the rapid literature to inform the Delphi process, we sought opinions from students and faculty from four African health training institutions that participated in the study to understand their perceptions of IPE during international electives and their suggestions and views on an IPE framework for international electives. The students and faculty were given a brief orientation on what IPE is

so that they could give meaningful responses related to IPE. The opinions and perceptions of the students and faculty were further utilized to enable the identification of some key constructs to be added to the draft framework that was used to build consensus. This study was conducted qualitatively among faculty using key informant interviews and quantitatively among students using an online survey. AtlasTI version 8 software was used for qualitative data analysis while SPSS IBM statistics 21 was used for quantitative data analysis. The various training institutions included: Makerere University Uganda, Kenyatta University Kenya, University of Ibadan Nigeria, and the University of Zimbabwe.

The specific details of the findings from the students have been published in the *Journal of Interprofessional Care* (28). The findings from the faculty have been accepted for publication in the *Journal of Global Health Case Reports* (29).

## Engaging the panel of experts (stage 3)

The last stage was engaging the panel of experts to develop a draft framework. The draft framework was used to build consensus from the panel of experts and gain validation of the final framework.

## Draft framework used for consensus building

Through the rapid review, a Delphi guide developed by Bentley et al. (30) to develop a framework to implement IPE in primary health care was identified. Although this was used for primary health care, many international electives happen in the primary health care setting of the host institution country through clinical and community placements among others (31). Bentley et al's Delphi guide further informed the refinement of the developed draft framework from stages 1 (rapid literature review) and 2 (student and faculty perceptions) before engaging the panel of experts for consensus building. It is this latter framework that was then used to seek and build consensus on various constructs of the IPE framework for international electives among the identified experts. The draft framework consisted of 8 sections as shown in [Supplementary Appendix 2](#). These included; the relevance of IPE training in international electives in Africa, operational/organizational needs for IPE during international electives, acculturation needs, competencies to be gained by students participating in IPE international electives in Africa, IPE teaching approaches that can be utilized during international electives at host institutions, IPE assessment approaches during international electives at host institutions, mode of delivery and public health considerations. In the beginning, the public health consideration was labeled as COVID-19 precautions, but this later changed in the preceding rounds. In total, there were 52 statements over the eight sections. Each of these sections had various statements with two response options, i.e., agree and disagree to enable the experts to submit their views and guide consensus building.

## Recruitment of the experts

Experts in IPECP, health professions education, and international electives were purposively sampled. Recruitment was from Makerere University and Busitema University in Uganda, Yale University USA, Stellenbosch University South Africa, University of Free state South Africa, University of the Western Cape, South Africa, and the

University of Global Health Equity Rwanda. Some of the experts were members of the African Forum for Research and Education in Health, Ghana (one) and the African Interprofessional Network (one) while some (five) did not belong to any of these professional bodies in Africa. Furthermore, multidisciplinary representation was considered, and the experts were from various disciplines, i.e., medicine (three), nursing (two), pharmacy (one), occupational therapy (one), and physiotherapy (one). This enabled us to gain a heterogeneous panel, a key requirement for the Delphi approach. In total, eight experts were recruited which is an acceptable number for the Delphi method. All eight members of the panel were academic experts in IPECP, health professions education, and international electives, with more than 5 years of experience as an academic faculty, and have had exposure to guiding and conducting international electives in Africa for more than 5 years.

## Sample size estimation for the panel experts

The Delphi method lends itself to the concept of the researcher assessing the scope of the problem and the available resources to determine the panel size that would be appropriate (19). Furthermore, it emphasizes that the researcher should consider the panel size depending on the experts' skills and knowledge in the field, representation variability, experience, and work in the construct being studied (19). Thus, with the above guidelines on the selection of panel size, the number of experts included was 8 for this study. Furthermore, this number is within the acceptable panel size (8–1,685) for a Delphi method (32).

## The Delphi process

Engagement with the experts was done virtually due to their various geographical locations. The Delphi process involved three rounds. We began engagement with the panel of experts jointly as one group through email to generate interest and commitment. An email introduction to the 8 experts was done detailing the study aims, the process of participation, the time frame, etc. To ensure we capture full commitment to participate, a doodle poll was sent for all the experts to indicate their time of availability for Rounds 1 and 2. They were given 2 weeks to have this completed. All data collection and rounds were done online using Zoom meeting software for Rounds 1 and 2 (that were recorded), and email sharing for Round 3. Rounds 1 and 2 lasted one and a half hours while Round 3 lasted 3 weeks.

### Round 1

For capturing the ratings of each expert on all 52 statements, the study tool was built in Microsoft Forms on an online survey platform. During the Zoom session, each of the participants was sent the online link. The researcher (FN) led the sessions and shared her screen to enable the experts to see the statements but also jointly go through them one by one as each of them submitted their responses using the online survey link as per the draft framework that was developed (Supplementary Appendix 2). This was done anonymously. Upon completion of Round 1, all the ratings and scores were in as shown in Table 2, and the researcher was able to access them in real-time. These were shared and projected to the experts online de-identified.

Globally, there is a lack of uniform guidelines on what constitutes consensus in a Delphi study (21). Different studies use different approaches that suit them best (21). Three consensus measurements have been used by various studies (21). These include percentage level of agreement, median scores, and interquartile ranges (21). Because the statements in the tool had two options to establish agreement, i.e., agree and disagree, and no scores *per se* or Likert scale, we used a percentage level of agreement to establish consensus. A score of  $\geq 70\%$  on a particular statement was deemed as relevant and important to be included in the framework while a  $\leq 69\%$  score on any statement meant that there was a lack of consensus and thus needed to be discussed and taken up for Round 2. This percentage level of agreement and disagreement was adopted from existing literature from studies that have used the Delphi process for health issues consensus building.

### Round 2

During Round 2, participants were given the scores on all statements, i.e., those that achieved consensus and those that did not. Participants were invited to comment, discuss, and rate the 15 statements that did not reach consensus, i.e., statements with scores of  $\leq 69\%$ . Each of the participants was given a chance to discuss and give their views on these statements and all the suggestions were captured by the researcher. An agreement was reached to leave out the section on the importance of international electives in Africa. This is because the framework is meant to guide the implementation of IPE during international electives and the importance of IPE is already well elaborated from the various existing frameworks and literature (1). The COVID-19 consideration section was condensed into one statement and the name changed to Public Health Considerations. This is because health considerations go beyond COVID-19 and thus it makes it more relevant to adhere to the host country's public health considerations at the time one participates in the international elective. The statement on misconceptions clarification in the section for IPE competencies and lectures in the section on IPE teaching during international electives was dropped. The section on IPE assessment was subdivided into two sections to reflect formative and summative assessment methods. The section on acculturation was split into 3 statements instead of one. Furthermore, all statements that met the agreement score were also discussed for better wording and presentation.

Upon completion of Round 2, all comments and suggestions from Round 2 coupled with overall suggestions on all statements including those that achieved consensus were taken into consideration. All the changes were made, and a revised version of the draft revised framework was shared with the experts for a rating in round 3. While Round 1 had 52 statements, upon revision and consideration of all suggestions from Round 2, the framework had 42 statements to be used for Round 3.

### Round 3

Round 3 involved sharing the revised version of the statements with the experts via email. Supplementary Appendix 3 shows the revised framework used for Round 3 consensus building. Each of them was allowed to rate and give their view on each statement within 3 weeks. Table 3 shows the scoring for Round 3 from all the experts who responded. After this, all statements had reached a consensus and thus the revised framework was organized into a final framework format with grammatical edits made. The experts were also given a chance both in Rounds 1 and 2 to share their ideas on



TABLE 2 Round 1 consensus on the IPE framework for international electives statements  $N = 8$ .

Panel questions	Agree (%)	Disagree (%)
<b>Relevance/Suggestions of IPECP training in international electives</b>		
1. Interprofessional training needs to be integrated across international elective placements in various health disciplines	75	25
2. More evidence is needed on the organizational and systemic facilitators, determinants, and barriers of interprofessional education for collaborative practice in international electives.	87.5	12.5
3. IPE in International Electives will foster efficient multinational teamwork and IPC among different countries, especially in epidemics and pandemics	50	50
4. It will lead to overall improved quality of health care at the patient, community, institution, and personal levels	50	50
5. This framework will guide students, faculty, institutional leaders, and Administration on how to effectively structure and implement IPE electives in Health Training Institutions	50	50
<b>Organizational/Operational needs</b>		
6. Committed home and host institutional leadership to supporting the program	100	0
7. Effective and well-oriented administrative support to lead students' logistical needs and preparation	87.5	12.5
8. Committed IPE faculty at the host institution to support student learning and training	75	25
9. Effective agreements that allow reciprocity with home and host institutions	100	0
10. Learning facilities, infrastructure, and premises to aid student learning	62.5	37.5
11. Effective and clear application system in place to guide students on application requirements	62.5	37.5
12. Effective communication between home and host institution during preparations	87.5	12.5
13. Adequate financial support to cater to logistical costs	100	0
14. Students from 2 or more different professional disciplines from home and host institutions (preferably those in the clinical training years)	62.5	37.5
15. The IPE student groups during the elective placement at host institutions should include a minimum of 2 or more disciplines	75	25
16. Each IPE student group during the elective should have 2–8 students to enable adequate learning	62.5	37.5
<b>Acculturation needs</b>		
17. Effective Pre elective orientation courses/ workshops offered to students, faculty, clinical and community instructors, and administrators to enable effective understanding of roles, expectations, and the domains of IPEC training, culture, setting, and flow of activities	62.5	37.5
18. Onsite Orientation by the admin and supervising faculty	62.5	37.5
<b>Defining and understanding Competencies to be gained</b>		
<b>This section covers knowledge, competencies, capabilities for interprofessional education and training during international electives in any discipline of choice.</b>		
19. Interprofessional learning outcomes relating to teamwork, i.e., Knowledge of, and skills for, teamwork	87.5	12.5
20. Interprofessional learning outcomes related to roles and responsibilities, i.e., Knowledge and understanding of the different roles, boundaries, responsibilities, and expertise of health professionals.	75	25
21. Being able to challenge misconceptions in relation to roles	25	75
22. Interprofessional learning outcomes related to communication, i.e., Ability to communicate effectively with other health professional students	62.5	37.5
23. Awareness of cultural differences in health profession command and conduct in another country	87.5	25
24. Ability to express one's opinions with others involved in patient care	87.5	12.5
25. Interprofessional learning outcomes relating to learning/reflection, i.e., Ability to reflect critically and evaluate their performance and that of the team	87.5	12.5
26. Ability to transfer interprofessional learning gained during the international elective back home in the clinical, community, or public health setting	87.5	12.5
27. Interprofessional learning outcomes relating to the patient/client, i.e., Ability to recognize the central role of the patient in collaborative care	87.5	12.5
28. Interprofessional learning outcomes relating to ethics/attitudes, i.e., Ability to acknowledge the views and ideas of other professionals during an international elective placement	100	0
29. Understanding the ethical issues relating to teamwork	87.5	12.5

(Continued)



TABLE 2 (Continued)

Panel questions	Agree (%)	Disagree (%)
<b>IPECP Teaching Approaches that can be utilized during international electives</b>		
30. Simulation-based IPE training	87.5	12.5
31. Observership-based interprofessional learning.	50	50
32. Team-based approaches during clinical ward rounds and bedside teaching	100	0
33. Community placements with local students from various health disciplines	100	0
34. Case study-based interprofessional learning with local students	87.5	12.5
35. Lecture/seminar-based education and training sessions	37.5	62.5
<b>IPEC learners assessment approaches during international electives</b>		
36. Pre-post course knowledge/skills/attitude surveys	100	
37. Peer-to-peer Assessment	100	
38 Self-assessment/reflection (metacognitive skills) (Elective Report)	75	25
39. Portfolio-based assessments (collection and review of individual and group work projects or assignments done)	100	
40. Team Observed Structured Clinical Examination (TOSCE)	75	25
41. Simulated cases involving inter-professional practice	87.5	12.5
42. Group feedback sessions	75	25
<b>Mode of elective delivery</b>		
43. Online utilizing the teaching and assessment approaches that can be applied in a virtual platform, e.g., country-specific case studies	87.5	12.5
44. Actual outbound mobility physical mobility to a specific host institution	75	25
45. Blended approach with both online and actual mobility	100	0
<b>COVID 19/considerations</b>		
46. Adherence to the public health guidelines for home and host institutions	100	0
47. The blended model can be used	100	0
48. Negative COVID-19 tests before and after elective placement	75	25
49. Vaccination is mandatory before rotation	75	25
50. Wearing of PPE and hand sanitization always	87.5	12.5
51. Fewer cohorts of students hosted at a time	37.5	62.5
52. Social distancing in all activities	37.5	62.5

Consensus was at  $\geq 70\%$  per statement if the panel selected agree.

practical guidance for the implementation of each of the statements. These points were captured by the researcher and developed into section 3 as a practical guide on how to implement the developed framework. The final framework format was shared with the experts one more time for final review and validation. All responses or scores were analyzed within MS forms, automatically calculating the percentage scores.

## Results

This section describes the key outcomes of the Delphi process undertaken to develop an IPE framework during international electives for various African training institutions. We had all eight experts fully participating in all the rounds, thus a 100% response rate. The details and characteristics of the Delphi panel of experts are displayed in [Table 1](#).

The results from Round 1 and Round 3 are displayed in [Tables 2, 3](#) respectively. The results and outcomes of Round 2 are presented as

a narrative. The final framework developed is described and attached in [Supplementary Appendix 4](#).

Round 2 involved discussions on statements in Round 1 that had not reached a consensus. Furthermore, there were suggestion on how to phrase the statements that had reached a consensus. The actual changes made have been described in the data collection process section for Round 2 above. All these revisions were made, and [Supplementary Appendix 3](#) shows the revised framework developed for use in Round 3 for consensus building.

## The developed IPE framework

The key outcome of this study is the IPE framework ([Supplementary Appendix 4](#)). IPE Framework that has been developed. This framework is illustrated in [Supplementary Appendix 4](#). The framework aims to guide health education institutions on how to incorporate and implement IPE in international electives for health and allied health programs. The framework begins by mentioning its

TABLE 3 Round 3 consensus on the IPE framework for international electives Delphi guide statements  $N = 8$ .

Home and host training institution's operational needs for IPE during international electives	Agree (%)	Disagree (%)
1. Home and host institutional leadership support for IPE in international electives programs	100	
2. Home and host institution administrative support to handle students' logistical needs before, during, and after the IE placement	100	
3. Faculty trained in IPE at the host institution to support and supervise students	87.5	12.5
4. Partnership agreements that explore and allow reciprocity with home and host institutions	100	
5. Learning facilities to aid student learning	75	25
6. Clear application system in place to guide students on IPE elective application requirements	100	
7. Communication strategy between home and host institution during preparations, implementation, and post-participation	100	
8. Adequate financial support to cater to students' logistical costs	100	
9. Students from 2 or more different professional disciplines from home and host institutions (preferably those in the clinical training years)	87.5	12.5
10. The IPE student groups during the elective placement at host institutions should include a minimum of 2 or more disciplines	87.5	12.5
11. Each IPE student group during the elective should have 2–8 students to enable adequate learning	87.5	12.5
<b>Acculturation considerations</b>		
12. Pre-elective IPE orientation didactic sessions or seminars offered by the host institution to students, to enable understanding of roles, expectations, the domains of IPE, and the flow of activities	100	
13. Pre-Elective IPE training (workshops or seminars) offered to faculty, clinical and community instructors, to enable understanding of roles, expectations, the domains of IPE, and the flow of activities	87.5	12.5
14. Onsite Orientation by the host institution on various social aspects and living to enable acclimatization of students in consideration of language, cultural humility, and equity.	87.5	12.5
<b>Competencies to be gained by students participating in IPE international electives.</b>		
<b>By the end of the international elective students should be able to;</b>		
15. Demonstrate Knowledge attitudes, and skills for, teamwork	100	
16. Demonstrate knowledge and understanding of the different roles, boundaries, responsibilities, and expertise of various health professionals in the team	100	
17. Communicate effectively and respectfully with other health professionals' students, faculty, patients, community, etc.	100	
18. Demonstrate an awareness of cultural differences in health profession command and conduct in another country	100	
19. Express one's opinions with others involved in patient care with respect and humility	100	
20. Reflect critically and evaluate their performance and that of the team	100	
21. Develop a plan on how to apply interprofessional education and skills gained during the international elective back home in the clinical, community, or public health setting	100	
22. Recognize the central role of the patient/ community in collaborative care	100	
23. Acknowledge the views and ideas of other professionals during an international elective	100	
<b>IPE teaching approaches that can be utilized during International Electives at Host institutions</b>		
24. Simulation-based IPE teaching	87.5	12.5
25. Interprofessional community placements	100	
26. Country-specific case study-based interprofessional teaching	100	
27. Joint tutorials using a flipped-classroom approach	100	
28. Joint clinical placements through joint ward rounds and bedside teaching	100	
<b>IPE learner's assessment approaches during international electives at host institutions</b>		
<b>Formative (ongoing assessment)</b>		
29. Pre-elective course knowledge/skills/Attitudes Surveys	100	
30. Portfolio-based assessments (collection and review of individual and group work projects or assignments done)	87.5	12.5
31. Simulated cases involving interprofessional practice	100	
32. Peer to Peer assessment	75	25
33. Team Observed Structured Clinical Examination (TOSCE)	100	

(Continued)

TABLE 3 (Continued)

Home and host training institution's operational needs for IPE during international electives	Agree (%)	Disagree (%)
<b>Summative assessment (end of program assessment)</b>		
34. Post Elective course knowledge/skills/attitude surveys	100	
35. Self-reflection through Elective Report at the end	87.5	
36. Team Observed Structured Clinical Examination (TOSCE)	100	
37. Simulated cases involving interprofessional practice	100	
38. Group feedback sessions	75	25
<b>Mode of elective delivery</b>		
39. Online: utilizing the teaching and assessment approaches that can be applied in a virtual platform, e.g., country-specific case studies	87.5	12.5
40. Actual outbound physical mobility to a specific host institution	100	
41. Blended approach with both online and actual mobility at the host institution	100	
<b>Public health considerations</b>		
42. Adherence to the public health national guidelines for home and host institutions and countries with respect to health and safety requirements for traveling trainees.	100	0

Consensus was at  $\geq 70\%$  per statement if the panel selected agree.

intended aim and a clear definition of the terms being used. The framework consists of three sections. Section 1 highlights the various IPECP competencies to be gained by learners in the areas of teamwork, interprofessional communication, roles, and responsibilities of interprofessional collaborative practice, values, and ethics of interprofessional collaboration, and reflection and evaluation of oneself and the team. Section 2 gives guidance on the structuring of the IPE international electives in health professional training institutions. This includes subsections on operational/institutional needs, acculturation considerations, teaching strategies, assessment strategies, mode of delivery, and public health considerations. Section 3 consists of the various practical guides and approaches that health professional training institutions could use according to what works best in their setting. Both home and host institutions should be able to utilize the framework to enable a well-structured international elective.

## Discussion

We set out to develop a framework to guide IPE training during international electives in various health professions training institutions in Sub-Saharan Africa. With the use of a modified Delphi approach, we were able to develop an IPE framework for international electives adaptable to various settings including Africa. The modified Delphi approach allowed the appreciation of the social constructivism theory in relation to various environments shaping one's knowledge and learning. This method allowed us to have experts from various locations jointly interact and share their perspectives from their context and harmonize what would eventually lead to structured IPE international electives through a framework to guide learning for the students and the experts that deliver the learning. This also aligned with the aspects of the zone of proximal development as per the social constructivist theory. International electives are learning environments that are key to the development of global perspectives on various disease burdens and approaches to addressing them (33).

International electives are also a key ground to cultivate various approaches to healthcare delivery for enhanced patient outcomes while gaining more global exposure to articulate clinical knowledge and skills (34). Given their relevance, a drive to have International electives structured with innovative approaches has been ongoing to enable meaningful engagement for students with transformative learning experiences (3).

IPE is an innovative approach to international electives and another key ground that can be used to foster IPECP (35). However, globally and in Africa, there is hardly any framework to guide training institutions to implement IPE during international electives. The majority of the international electives occur in silos with most of the students mainly exposed to the faculty of their disciplines and only rotating with students of similar disciplines (33). Various training institutions have international offices that could be used as a ground for innovation in health professions education (36). However, these are mainly administrative and handle the needs of incoming and outgoing elective students (36). To address this gap and steer the momentum for IPE during international electives among various training institutions, we developed a framework to guide the implementation of IPE during international electives using a modified Delphi approach. This approach was adequate to enable us to build consensus on the various parameters and domains. The framework can enable institutions and faculty to structure IPE international electives feasibly. The Delphi approach usually has been reported to have various limitations that include a drop-off in participation by the experts, self-selection of participants, researcher bias, and non-responder bias (37). However, in this study, we had a high response rate with all the experts actively participating in all rounds. This can be attributed to the fact that we had a manageable low number of experts (38), who are very well experienced (39) in all domains of the topic, coupled with an online approach that enabled each of them to indicate their availability and thus allowing us to fit in the experts' schedules.

A high consensus mark of  $\geq 70\%$  was used for addressing the aspects of validity. This mark ( $\geq 70\%$ ) has been used in other studies

to build consensus in various health professions education research including IPE (30). Many times, various studies in health professions education and IPE that have used the Delphi approach have used Likert scales for consensus building among the experts (21). However, at the time of computing consensus, to enable a unified understanding of agreement and disagreement, the various Likert categories are often grouped into two, i.e., agree and disagree (30). It is on this premise that we used two options for consensus building, i.e., agree and disagree for all the statements and constructs to avoid any confusion. Furthermore, Round 2 enabled each panel expert to explain and seek clarification on any statement thus being able to make an informed decision of agreement or disagreement. Furthermore, the online approach (despite differences in time zones and geographical location) is a key strength in enabling experts to meet and actively participate thus addressing the usual limitations of Delphi through asynchronous correspondence. A study done by Donohoe et al. (40) has shown the strength of an online approach as key in addressing the nonresponse limitation. Furthermore, the online approach enables the effective building of consensus through timely consensus score submission. It has been used in this study and similarly in the development of the IPE framework to guide IPE in primary health care (30).

In this study, we had representation from various geographical locations, disciplines, and expertise which enabled triangulation and adaptability in various training institutions including Africa (21). Although the framework was developed in Sub-Saharan Africa using the modified Delphi approach, it can be used in other international electives settings even beyond Africa where interprofessional education is being sought.

The IPE core competencies of this framework were tailored toward gaining IPECP skills that can be applied in all areas of healthcare practice for the students in their future practice. These competencies in our framework were adapted as a combination of various IPECP competencies developed by the European Interprofessional Practice and Education Network (6), the Interprofessional Education Collaborative (4), and the Center for the Advancement of Interprofessional Education (41). This allowed us to compare each of them, identify the strengths of each, and utilize them to develop competencies that are appropriate for an international elective learning environment. This approach has not only been used in this study but in other Delphi approaches that have attempted to develop structure around IPE in health care and training (30).

Structuring any new approach in health professions education involves various levels of preparation. This includes the leadership, administration, teaching faculty, training facilities, teaching and assessment methods, public health safety considerations, and modes of delivery among others. Section 2 of the framework covers this in detail. It gives guidance and approaches on how to enable leadership support for IPE during international electives. For international electives, this should be done through institutional partnerships with home and host institutions. Our framework emphasizes reciprocity to enable equity which is key in building equitable partnerships for training, especially in international electives where there is often an imbalance in opportunities for students from various African training institutions (8). In this framework, we emphasize ensuring that all academic faculty that would be involved in IPE in international electives are trained on IPECP. This is because various studies in Africa have shown a significant gap among faculty on IPECP (42). This can be done through online or in-person workshops that are focusing on the various core

competencies and principles of IPE, the importance of IPE in health care, approaches to teaching, and assessment coupled with the mode of delivery. This in the long run enables faculty to gain the skills on how to handle training for students from various healthcare disciplines and capitalize on interprofessional student teams achieving the various IPE learning outcomes during the international electives.

The teaching and learning approaches put across as options in this framework have been described in the literature that was used to inform this process. In particular small group learning (i.e., 2–8 students) has been efficient in various approaches to group training (43). This, therefore, means that for efficient IPE training during international electives, this should be done in small groups to enable faculty to pay attention to each of the students, coupled with enabling maximum interaction of the students with each of the group members. Furthermore, this number still falls in the prescriptions of interprofessional team composition (i.e., 2 or more healthcare professionals from various care disciplines) (44).

Utilization of bedside teaching (45), clinical placements (46), community placements (47), simulation (48), case studies (49), and tutorials (50) are well-established training approaches in various healthcare training institutions in Africa and thus forming a premise of methods that are applicable and available to be used for IPE during international electives depending on each institution's resources available. This, therefore, means that faculty have a wide range of choices based on the various methods they use for their regular teaching to utilize for IPE international electives. Lectures are deemed a very important method or approach of training in health professions education globally (51). However, in this framework, this is not listed as a form of training to be used to teach IPE during international electives. This is because the expert's view was that IPE requires practical involvement to essentially gain the IPECP skills. Lectures, therefore, in this framework were deemed appropriate to be under acculturation to enable the faculty to articulate the core principles and competencies of IPE to the students and thus in the long run give them an orientation on the IPECP concepts. This can be done through (online or physical) lectures which are efficient in providing an overview and knowledge of the IPE core competencies and not necessarily enabling students to gain IPECP skills (52).

Clinical observerships as a form of training commonly used in international electives in developed countries (53) did not reach a consensus of agreement in Round 1. In Round 2 this was dropped and not included in Round 3. This is because the panel of experts ascribed gaining of IPECP skills to practical engagement which observerships lack. This, therefore, means that any IPE teaching methods like those described in the framework we have developed should have avenues for practical student engagement activities.

Assessment of acquisition of IPECP competencies during international electives should be formative and summative as exhibited in this framework to capture the various IPECP skills gained by the students as they participate in an IPE international elective. Pre and Post-elective surveys have been popularly used to establish the IPECP gained (54). In the practical guide of the framework regarding assessment tools, i.e., pre and post-participation surveys, the Interprofessional Collaborative Competencies Attainment Scale 2018 (ICCAS 2018) (55) is recommended for assessment of the attainment of the IPECP before and after the elective. This is because this scale allows scoring and has a guide on the interpretation of the total scores and categories and what they mean for the learner and the faculty performing the assessment.

Furthermore, the behavioral indicators of interprofessional practice assessment tool by EIPEN is one of the most recent tools developed to ascertain interprofessional practice. In this study, this tool is being recommended for long-term assessment of IPECP given that behavioral change toward interprofessional practice needs ample time to measure. The other approaches of assessment (i.e., peer to peer assessment, report writing, and team-based objective structured exams) are those that have been used widely in IPE and encourage student team participation (56). To a larger extent, they encourage student-led assessment which often is key in enabling a learner to have a reflection on themselves and that of the team during IPE international electives an important competency for interprofessional collaboration (6).

Globally various modes of delivery have been used to deliver IPE. These include the physical or in-person approaches that involve face-to-face interaction of interprofessional teams of students with faculty (57), and the blended approach that has both online and in-person interaction (58). Although the latter are key approaches that can also be utilized in international electives, what has recently picked momentum is the virtual mode of delivery of international electives (59), mainly accelerated by the COVID-19 pandemic that has enhanced the use of the internet and digital platforms in health professions education even in Africa (60). This, therefore, means that depending on the resources and the information technology systems available at various institutions, the virtual mode of delivery for IPE during international electives can be done utilizing platforms like Zoom or MS Teams, which are widely used in various training institutions. This can be through country-specific case studies, joint tutorials, and discussions all guided by IPE-trained faculty (61). This in the long run could be an approach that makes international electives even much more cost-effective given the elimination of various travel and accommodation costs required for physical and blended approaches of international electives. It is key to note that this requires reliable internet which despite its hardships in Africa has been steadily enhanced in various African countries (62) since the COVID-19 pandemic (60).

## Conclusion

The modified Delphi technique was an adequate approach to aid the development of an IPE framework to guide implementation during international electives in various health professional training institutions. The IPE framework developed is adaptable and can be implemented in various health professional training institutions. The framework developed enables effective structuring of IPE international electives given that it has all domains required in implementing international electives, i.e., the core competencies to be gained, the operational institutional needs, teaching and assessment methods, modes of delivery, and public health considerations, especially for the fact that international electives require mobility to another country. Unlike other frameworks, this framework also provides some practical guidance on various approaches to implementing IPE during international electives thus creating a benchmark for new approaches to learning during international electives, especially in low-income settings.

IPE is one of the key health professions education research priorities for sub-Saharan Africa (51). Our work to a large extent contributes to this agenda but also creates a new platform for more research by the users of our framework by various institutions, in

various health specialties. Structuring IPE in health professional training institutions is possible and our framework creates a starting point for this specifically, in international electives.

## Recommendations

The modified Delphi approach is an adequate approach to be used to develop IPE frameworks to support IPE training in various learning environments including international electives. With the framework now in place to guide the implementation of IPE in international electives, a pilot has been done in the four institutions that participated in this study's Delphi information process. The results have been published by BMC Medical Education (63). However, there is a need for more institutions to pilot its use and document their findings to enhance its validity.

## Quality control

Given the qualitative nature of the Delphi approach, trustworthiness and rigor were observed. For credibility, prolonged engagement with the experts, various rounds to enable consensus, having a cut-off point for consensus, review of the final framework by the experts were done. To ensure triangulation the use of both a research study and rapid literature review to inform the process, experts from various training institutions, and disciplines was done. A detailed description of the methods used was done to enable transferability in similar contexts. To ensure the dependability of the findings various rounds with scores to establish consensus were done. Lastly, confirmability was observed by having the final framework reviewed by the study team and the panel of experts for accuracy and alignment with the study objectives.

## Limitations and strengths

The panel of experts was in different countries and time zones thus leading to the use of online options to conduct all the other rounds. However, despite the online virtual approach, we were able to record the sessions thus enabling the replay of the sessions for point articulation. Furthermore, the online approach enabled timely rating of the statements which allowed a quick turnaround time. The number of experts involved may be seen as a limitation to some however, this was still within the acceptable number for a Delphi panel recommended (8–1,685) (38). Four institutions were involved in seeking opinions from the students and faculty. These were few compared to the number of health professional training institutions in Sub-Saharan Africa. However, it is key to note that the institutions selected were those that provided credit for the participation of international electives and were in the various cardinal regions of Africa. The number of faculty and students may be seen as few however the number of those involved was arrived at using scientific sample size calculation for the students and point of saturation for the faculty given that it was a qualitative study. One of the strengths of this study is the consideration of experts from various disciplines, geographical locations, and with experience in IPE, health professions education, and international electives. This thus enabled the development of a framework that can be applied in various settings in



Africa and promote IPE among various health professional disciplines during international electives. Furthermore, the consensus-building approach enabled the elimination of any researcher bias as consensus was dependent on the full panel and not the research alone.

## Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

## Ethics statement

This study followed all the required regulations and guidelines by the Helsinki Declaration. Ethical approval to conduct the study was granted by the Makerere University School of Medicine Research Ethics Committee (SOMREC) Mak-SOMREC-2021-96 and the Uganda National Council for Science and Technology (UNCST) HS2078ES. Administrative clearance was obtained from the University of Ibadan, the University of Zimbabwe, and Kenyatta University. Written Informed consent was sought from all participants of the study.

## Author contributions

FN, IM, AV, SK, and AM conceptualized and developed the study and jointly drafted the manuscript. FN implemented the study. FN, IM, and AM cleaned and analyzed the data. TR and FW contributed to the final review and development of the framework developed in this study.

## Funding

This study was funded by the AFREhealth National Institute of Health (NIH) grant award number R25TW011217–3 and the Makerere University HEPI-NIH Grant award number 1R25TW011213.

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## Acknowledgments

The authors acknowledge the Makerere University Health Professions Education Partnership Initiative (HEPI) for all the expert and operational support, AFREhealth for providing the platform to run this study and the IPE experts. Research reported in this publication was supported by the Fogarty International Center of the National Institutes of Health, U.S. Department of State's Office of the U.S. Global AIDS Coordinator and Health Diplomacy (S/GAC), and President's Emergency Plan for AIDS Relief (PEPFAR). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The researchers also acknowledge the support of the Foundation for Advancement of International Medical Education and Research (FAIMER) a division of Intealth for all the technical and operational infrastructure to implement this study.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2023.1225475/full#supplementary-material>

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## OPEN ACCESS

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RECEIVED 07 June 2023

ACCEPTED 11 October 2023

PUBLISHED 20 October 2023

## CITATION

Albrecht L, Reismann L, Leitzmann M, Bernardi C, von Sommoggy J, Weber A and Jochem C (2023) Climate-specific health literacy in health professionals: an exploratory study.

*Front. Med.* 10:1236319.

doi: 10.3389/fmed.2023.1236319

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# Climate-specific health literacy in health professionals: an exploratory study

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**Background:** Health professionals such as physicians and nurses may play an important role in the transformation process towards a healthy, sustainable and climate-sensitive society. However, little is known about their climate-specific health literacy. This study aimed to assess knowledge regarding climate change and its impacts on health and climate-specific health literacy in health professionals.

**Methods:** In July/August 2022, a cross-sectional, questionnaire-based study was carried out at the University Hospital Regensburg, Germany, to assess climate-specific health literacy in nurses and physicians from various clinical specialties. Descriptive and exploratory statistical analyses were performed.

**Results:** The study population consisted of 142 participants (57.7% women; response rate: 24.7%). Most participants (93%) considered climate change to be highly relevant. However, only 12% of respondents stated to be very well informed regarding the general consequences of climate change. Although 57% of all participants had never mentioned climate change in relation to health to their patients, participants with higher levels of knowledge regarding the effects of climate change were more likely to mention it compared to those with lower levels of knowledge. The most frequently stated obstacle to integrate the topic of climate change in clinical work was lack of time during work (79%), not enough information (42%) and lacking materials (39%). Differences between health professions were apparent.

**Conclusion:** The results of our survey suggest that the current state of climate-specific health literacy differs between different groups of health professionals. There is a need to improve health professionals' levels of climate-specific health literacy and to increase the potential in interprofessional cooperation regarding planetary health.

## KEYWORDS

climate-specific health literacy, health professionals, physicians, nurses, climate change

## 1. Introduction

Climate crisis is seen as the biggest global health threat in the 21st century (1). There is a broad scientific consensus about the urgency of transformative action to limit climate change (2). Every year, 150,000 deaths could be avoided by more ambitious climate protection in Germany (3). Climate-specific health literacy might be crucial for climate change mitigation and

improving individual and planetary health (4). According to Reismann et al., the concept of climate-specific health literacy encompasses knowledge about the present and long-term health risks of climate change and knowledge about the health co-benefits of health promoting behaviours related to climate change. Moreover, the concept includes emotional integration of knowledge and feelings of concern related to climate change and health and the ability to implement this knowledge into action and climate-friendly behaviour (4). Planetary health is defined as “the health of human civilization and the natural systems on which it depends” (5).

The health care sector, aiming at protecting the human health, is a relevant player in the needed transformation process towards a climate sensitive and thus healthier society as it has an impact on climate and environment, and at the same time supports society in health and disease. Nurses and physicians, who have important roles within the health care sector, regularly rank first in relevant international surveys in regard to society's trust in them and their recommendations (6–9). Since the climate crisis has numerous consequences for health, health professionals nowadays have a great opportunity and responsibility to make appropriate use of the trust placed in them to promote climate-sensitive societies (10). In their daily work routine, health professionals have a lot of opportunities to address climate change and health. This can enable patients to become more climate-sensitive themselves and thus protect the climate and be better prepared to deal with the inevitable impacts of climate change (4). Furthermore, health professionals can contribute to health promotion and sustainable development through their own behaviour, e.g., healthy and sustainable nutrition and active transportation. These enumerated behaviours require the aforementioned climate-specific health literacy.

Therefore, the climate-specific health literacy among health professionals plays an important role in tackling climate crisis and in coping with climate crisis related impacts. It is particularly important that different health professionals work together on this issue and create synergies. However, until now, little is known about the climate-specific health literacy of health professionals. To our knowledge, there has been no study in the German-speaking world that has investigated the climate-specific health literacy among health professionals (11). What is the current state of climate specific health literacy among health professionals? Does the status differ between the different health professions? What are obstacles and what is conducive to the development and exercise of this skill? To answer these questions, we conducted the following study at a German university hospital.

## 2. Materials and methods

### 2.1. Setting and time

During July and August 2022, we conducted a cross-sectional, questionnaire-based study on climate-specific health literacy in health professionals (nurses and physicians) of the University Hospital Regensburg (estimated number of people who were invited to participate  $n = 575$ ), Germany. The link to the online questionnaire was distributed by email, by posters and by direct talks to employees of all levels of seniority aged at least 18 years.

All participants gave informed consent to the anonymous and voluntary data collection. The study protocol was approved by the ethics committee (University of Regensburg), approval number 22–2893-101.

### 2.2. Study instrument

We designed an online-based questionnaire in German language with 22 items using LimeSurvey Professional (12). The questionnaire consisted of closed-ended questions with single (yes/no) or multiple-choice items or 5-point Likert-type items. 13 questions originated from a questionnaire that was developed based on scientific literature by Reismann et al. (4). These questions have been used before and showed good face validity (4, 13). Another three questions from this tool were adapted to our target group and six new self-generated questions were added to the survey: status quo, barriers, and enabling factors of climate-specific health literacy of health professionals. The English version of the questionnaire used in the present study is shown in [Supplementary material 1](#).

The questionnaire consisted of four sections, namely: (1) Demographic characteristics (four questions on gender, age, job (physician or nurse) and medical discipline); (2) Self-assessed awareness and knowledge of climate change in general and willingness for climate friendly behaviour (seven questions); (3) Climate change and health (four questions); (4) Climate change mitigation in the healthcare system and climate-sensitive health advice (seven questions). The questionnaire was pilot tested in health professionals ( $n = 25$ ) and was revised accordingly. Reporting was voluntarily for each question.

### 2.3. Data analysis

We carried out descriptive statistics and exploratory data analyses. For categorical data, we computed frequencies and proportions. Medians and interquartile ranges were computed for continuous data. We used multivariate regression analyses to examine relations of gender, age, job and self-assessed knowledge regarding climate change. We employed ordinal logistic regression for responses on the ordinal scale (e.g., Likert scale) and logistic regression for binary responses. We adjusted all regression models for the potential confounding variables of age and gender. All tests were two-sided and a value of  $p < 0.05$  was deemed statistically significant. R (statistical software version 4.2.1) was used for the statistical analyses (14).

## 3. Results

### 3.1. Demographic characteristics

Of the 575 health professionals receiving the link to the questionnaire, 180 filled in the online questionnaire. Of these, 38 were excluded due to missing information on gender, age, and job leading to an analytic sample of 142 participants (57.7% women; response rate 24.7%), including 84 physicians and 58 nurses. Most participants worked in internal medicine (34%), followed by surgery (30%) and



**TABLE 1** Demographic characteristics of respondents according to job (physician/nurse) (*n* = 142).

	Physicians ( <i>n</i> = 84)	Nurses ( <i>n</i> = 58)
Gender		
Women ( <i>n</i> = 82)	35	47
Men ( <i>n</i> = 60)	49	11
Non-binary ( <i>n</i> = 0)	0	0
Age		
Median (25th percentile – 75th percentile)	38.0 (31.0–45.0)	44.5 (29.0–51.8)
Specialization		
Internal Medicine ( <i>n</i> = 48)	25	23
Surgery ( <i>n</i> = 43)	23	20
Anesthesia ( <i>n</i> = 18)	17	1
Radiation/ Nuclear Medicine ( <i>n</i> = 9)	5	4
Others* ( <i>n</i> = 22)	13	9
NA ( <i>n</i> = 2)	1	1

Others\*: Ear/ Nose/Throat Medicine (*n* = 6), Ophthalmology (*n* = 6), Dermatology (*n* = 5), Neurology (*n* = 3), Pediatrics (*n* = 2).

anaesthesia (13%). While physicians and nurses from internal medicine and surgery were almost equally represented (52% vs. 48% / 53% vs. 47%), mainly physicians took part from anaesthesia (94% vs. 6%). Participants were aged 18 to 63 years. The median age was 38 years in physicians and 45 years in nurses (Table 1).

### 3.2. Self-assessed awareness and knowledge of climate change in general and willingness for climate friendly behaviour

The majority of the participants (93%) considered climate change to be (very) important. Self-assessed knowledge about the consequences of climate change was stated to be very good by 12%, good by 45%, moderate by 40% and rather low by 3%, respectively. Physicians reported higher levels of willingness to pay higher prices for climate-friendly products ( $p < 0.05$ ) and to ride a bike ( $p < 0.05$ ) compared to nurses (Figure 1). Compared to men, women (physicians and nurses) were more willing to eat a vegetarian ( $p < 0.001$ ) or vegan ( $p < 0.01$ ) diet. Also, participants with higher level of self-assessed knowledge regarding the general consequences of climate change were more likely to eat vegetarian diet ( $p < 0.05$ ), and to volunteer for sustainability ( $p < 0.05$ ) compared to participants with lower levels of self-assessed knowledge.

Most participants (81,9%) considered knowledge about health co-benefits followed by knowledge about health benefits (81,8%) as very likely or likely to increase their willingness for climate-friendly behaviour. Acting together in the peer group or acting as role models was identified as a reinforcing factor by the majority of participants (70 and 65%, respectively).

### 3.3. Climate change and health

Most of the participants affirmed climate change as a (very) likely cause of global health problems and a (very) likely risk factor for their own and their patients' health (83, 71, and 77%, respectively). Compared to physicians, nurses more frequently reported climate change as a (very) likely cause of global health problems (90% vs. 80%) and as a (very) likely risk factor related to the health of their own patients (85% vs. 73%) and their own health (88% vs. 58%).

Physicians affirmed they had already heard about global malnutrition (81%), infectious diseases (76%), respiratory symptoms (75%) and heatstroke (74%). Nurses had most often heard of respiratory symptoms (79%), global malnutrition (78%), infectious diseases (67%) and cardiovascular issues (64%) (see Figure 2).

### 3.4. Climate change mitigation in the healthcare system

When asked if medical professionals should be committed to climate change mitigation to ensure long-term health, 75% of physicians responded, "yes definitely" or "rather yes," while 18% chose "neither nor" and 6% "rather no." Nurses' responses were similar with 69, 28, and 3%, respectively.

Health workers stated that medical staff should be committed to sustainability in form of "reducing plastic" (80% of physicians, 88% of nurses), "research on climate change and health" (68% of physicians, 53% of nurses), "information campaigns" (43% of physicians, 48% of nurses) and "education of patients" (36% of physicians, 33% of nurses), see Figure 3.

### 3.5. Climate-sensitive health advice

Most participants (57%) never mentioned climate change in relation to health in their clinical context. Participants with higher levels of knowledge regarding the effects of climate change were more likely to mention it (49%) compared to those with lower level of knowledge (34%). While surgery physicians were less likely to mention climate change in relation to health in contrast to internal medicine physicians (21% versus 57%), surgical nurses were more likely to mention the connection (60%) than internal medicine nurses (52%).

"Time to be able to address the topic in my daily work" (79% of physicians and nurses), "Information about the scientific background of the topic" (36% physicians / 52% nurses), "Materials, that I can use to explain the topic" (35% physicians/ 47% nurses) was selected as helpful to better educate the patients about climate change and health.

## 4. Discussion

The key findings from our work were that the participating health professionals viewed the climate crisis as an important issue and recognized the connection between the climate crisis and health. Furthermore, the majority of health professionals surveyed did not have sufficient knowledge regarding climate-specific health literacy.

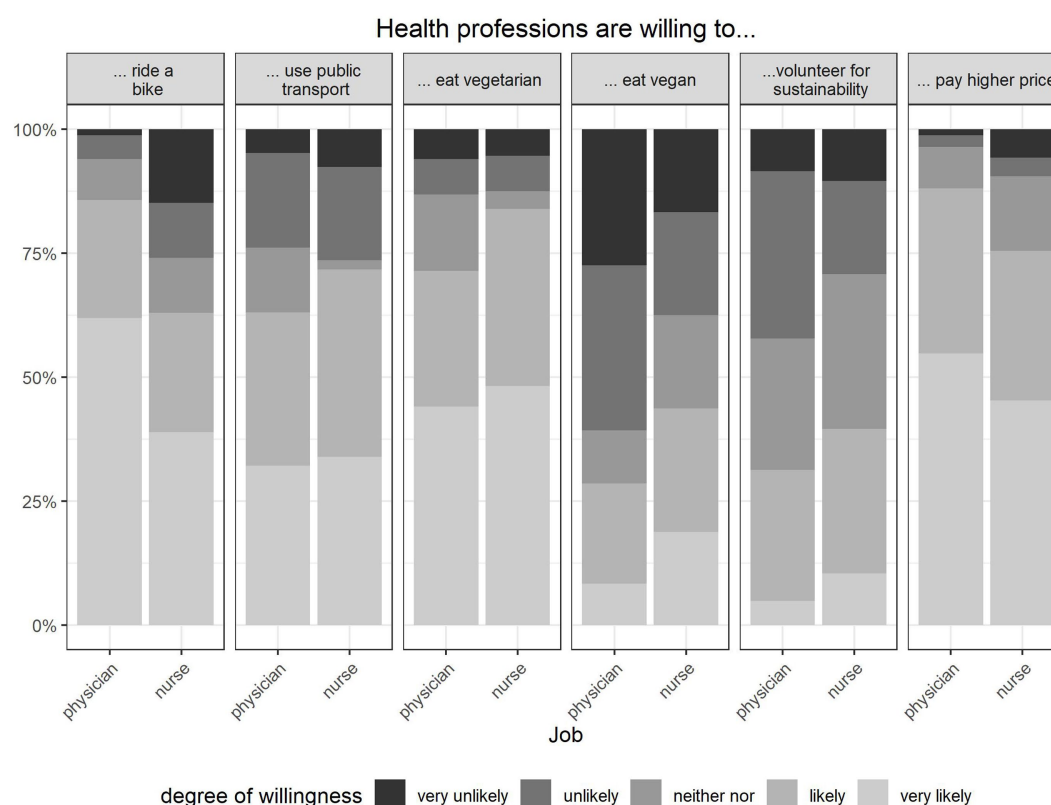


FIGURE 1

Willingness to engage in climate-friendly behaviour in different behaviour-items by physicians and nurses, Percentage of respondents who self-reported their willingness to implement health co-benefits in everyday life. Multiple choice was possible,  $n = 142$ .

Obstacles to develop and practice these skills are primarily a lack of time and a lack of information and materials, with nurses citing the latter two most often. Components of climate-sensitive health literacy differ across health professions. In perspective, there is scope for improvement, for example through more education and better information material. These findings are in line with previous study results, where large proportion of participants also reported not being well informed about the consequences of the climate crisis or being prevented by, e.g., lack of time from counselling their patients (15, 16).

Study participants were ready to adopt various climate-friendly behaviours for example, riding a bicycle or using public transport instead of driving a car, eating a vegetarian diet and paying a higher price for climate-friendly products. These actions affect the health professionals individually in their daily lives and, in part, already actively protect the climate and their own health as health co-benefits.

However, the fact that a large proportion of health professionals themselves have never addressed the issue of climate crisis in relation to their patients' health in their clinical work indicates that it is important to educate health professionals that by doing so they can positively impact their patients and support and improve their climate-specific health literacy.

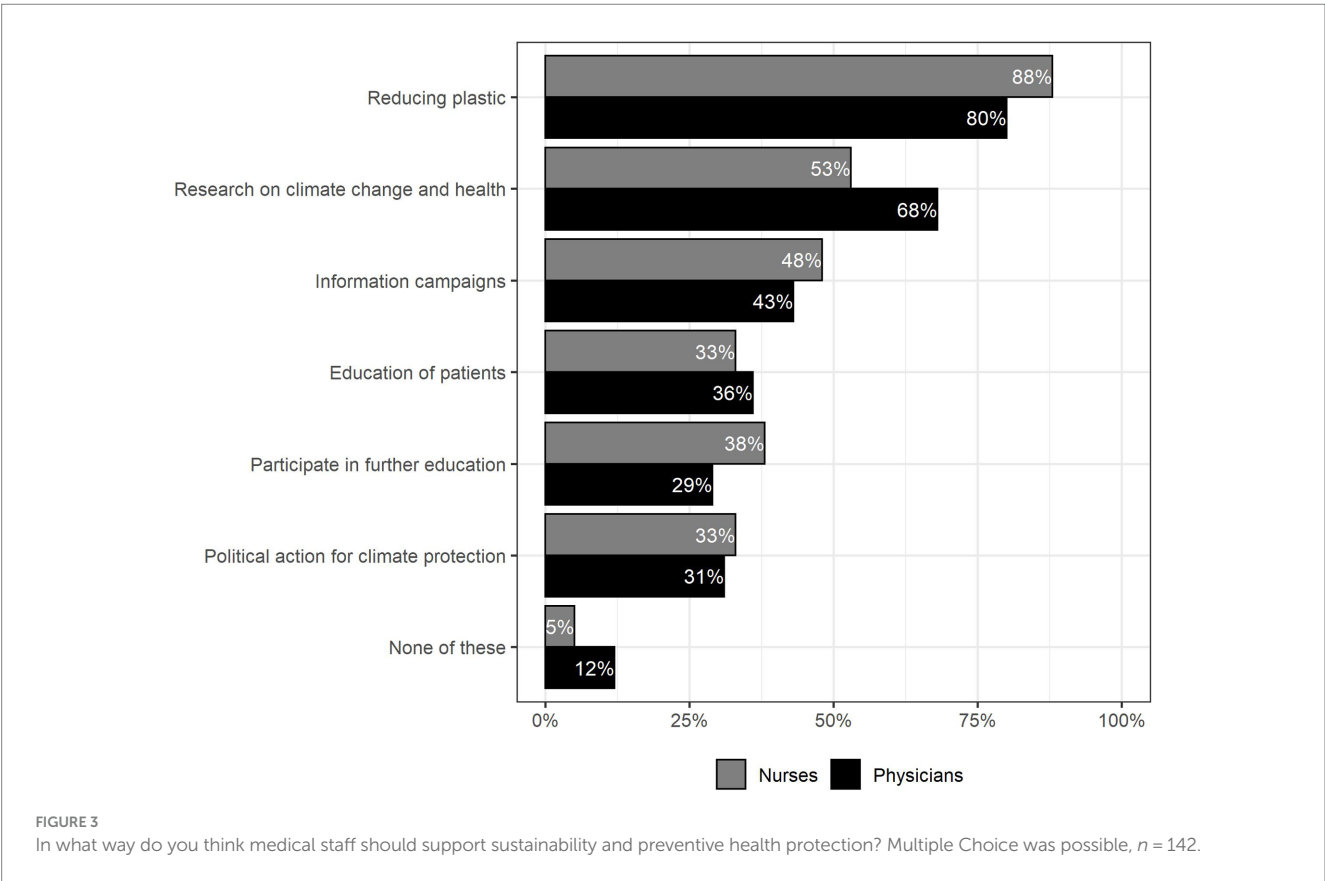
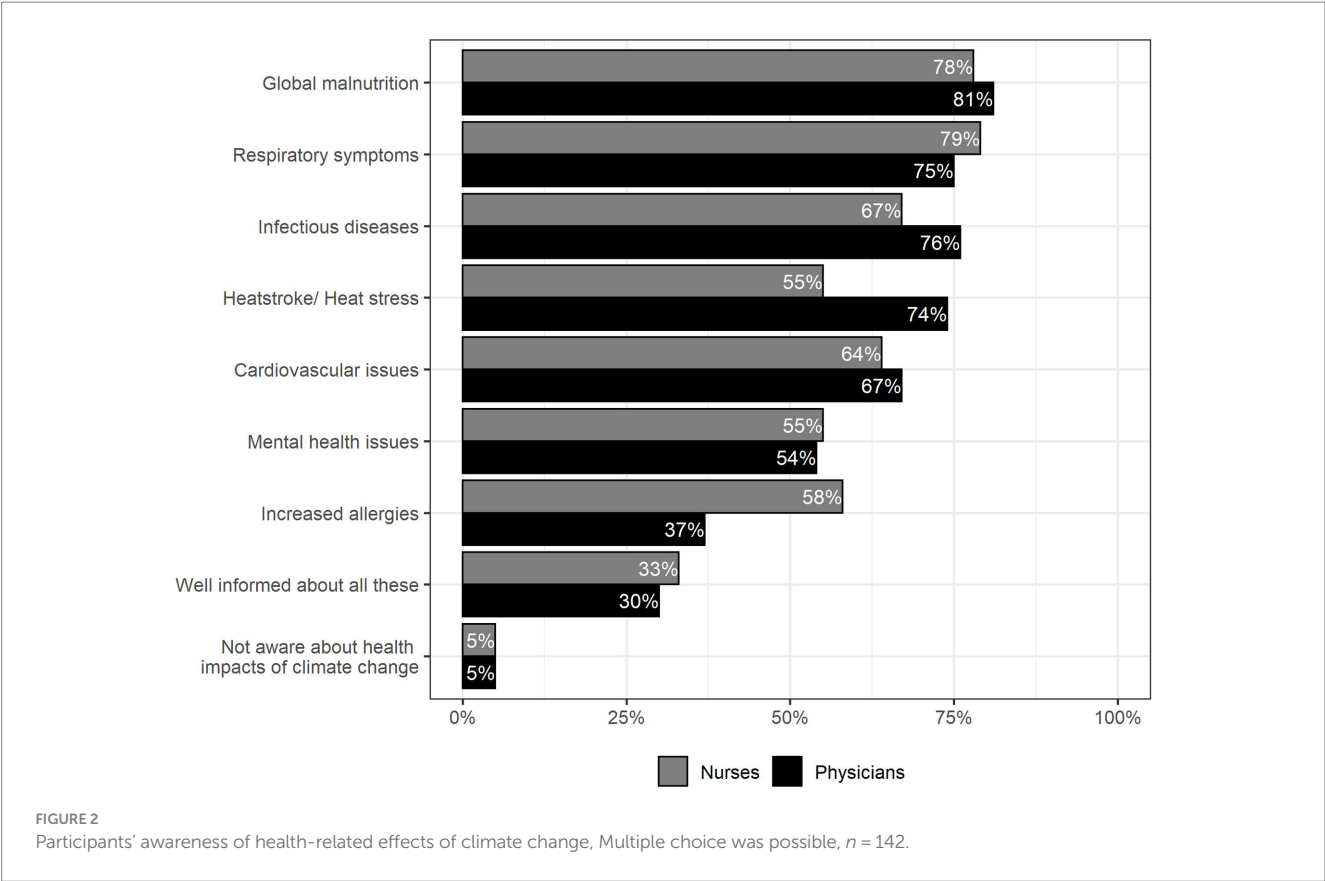
#### 4.1. Climate-specific health literacy

The aforementioned concept of climate-specific health literacy, with its various components mentioned above, can be an important

tool for taking climate action. If health professionals were themselves well trained in climate-specific health literacy, and had good resources to educate patients about relationships between the climate crisis and health, great potential could be tapped. In their study, Reisman et al. were able to show that patients who were informed by physicians about the consequences of the climate crisis on their health had higher awareness about climate related health risks and behaved in a more climate-sensitive manner (4). In a study in university students, Weber et al. (13) confirmed this assumption and showed that students who reported to be better informed about the relationship between the climate crisis and health were consistently more willing to engage in climate-friendly behaviours and actually did so. Other studies also indicated that the climate crisis becomes more tangible for people when the consequences for their health are brought to the fore: People are more motivated to take climate action when they know about the impact on their own health (17, 18).

Information about the climate crisis has a greater reach when it is health-related than other types of information about the climate crisis (18). In line with previous data, our findings suggest that the climate crisis is still seen as a global health problem rather than a problem for one's own health or for the health of one's own patients (4, 18). This finding underlines the importance of direct education of patients by health professionals, as both trusted advisors and role models, regarding the impact of the climate crisis on health.

As the climate crisis is no longer a remote optional event that can be prevented in its entirety, and thus numerous impacts on human health are already being experienced today (19), health professionals



should not only demand climate protection and mitigation measures, but also actively invest in the adaptation of their patients and educate them about health risks through appropriate counselling (20).

## 4.2. Interprofessional training and team collaboration

The results of our survey suggest that the current state of climate-specific health literacy differs between the two different groups of health professionals under study. These differences, e.g., in risk perception and counselling, are not yet fully investigated. A potential explanation could be that the respective professional groups spend different amounts of time with patients and thus have different amounts of time to talk about the topic. Another explanation could be that the topic has been taught to different degrees so far. To our knowledge, the topics of climate crisis and health/planetary health have not yet been comprehensively integrated into the compulsory curricula of nursing and medical students. Nevertheless, there is great potential in this area, for which basic ideas already exist (21). Further research is needed to explain the differences in climate-specific health literacy among the professions to then best develop and promote them subsequently. Furthermore, we see great potential in interprofessional cooperations. There is consensus that interprofessional working among health professionals is important for safe and successful patient care (22–24). This may also be the case when addressing the issue of the climate crisis and health/ planetary health. It is already within the basic understanding of this discipline that planetary crises can only be confronted together in a transdisciplinary manner, as their magnitude and significance involve numerous fields (25). For this reason, too, successful interprofessional working can and should be fostered through appropriate promotion of the necessary skills in education and training (24). One possible interprofessional activity is through simulation, in which the different health professional learners carry out consultations together addressing climate related health problems and education with simulated patients, followed by debriefing and reflection (26).

## 4.3. Barriers and promotion to climate-specific health literacy for health professionals

Looking for the main obstacles for health professionals including climate-specific health advice in their work, our questionnaire mainly revealed the three obstacles lack of time, lack of information and materials.

Nurses are working under great time pressure, which has been exacerbated during the COVID-19 pandemic, and therefore do not have time to educate their patients on additional topics (27, 28). Nevertheless, health care professionals are committed to protecting human life (29) and to participate in the preservation of the natural foundations of life in view of their importance for human health (30). Recommendations for effective policy-level engagement already exist for staff with limited time (31). To integrate climate sensitive health advice in communication with patients, measures are needed to support nurses and physicians and to create opportunities to perform this important task. One approach could involve health insurance

providers in Germany compensating physicians to provide climate-sensitive health advice, although this would probably not solve the time problem.

It would be preferable if climate change resilience education became part of all health professional curricula and was illustrated with relevant and everyday clinical examples, e.g., in form of burdens and risks of vulnerable groups. An approach already occasionally implemented by physicians takes patients' concerns as an opportunity to include planetary health references in the consultation where appropriate (32).

Further research is needed to develop and evaluate methods that enable health professionals to provide climate sensitive health advice despite time constraints.

Many participants in our study stated that they need more knowledge and materials to better educate patients about the topic. Therefore, we agree with the demands of Guzman et al. as well as the Lancet Policy Brief Germany 2019 & 2021 (33) and the resolution of the 126th German Medical Congress (34) that the topic of climate crisis and health/ planetary health should be an obligatory part of the education and training of health professionals (35). It has been shown that health professionals (15) and students (36) are interested in this topic and appreciate an integration in their education. Experiences, ideas and concepts of what planetary health education could look like have already been outlined in studies and models (35, 37–40).

## 4.4. Strengths and limitations

As one of the first studies in a German maximum care hospital, we were able to survey physicians and nurses and compare the answers depending on profession and specialty. Although fewer nurses participated in the questionnaire, the proportions are better balanced than in previous studies.

Although our sample size is not very large it was possible to identify trends and to derive first exploratory results. As in all self-report methods, the answers to our questionnaire might be affected by social desirability.

While the study provides initial exploratory quantitative results, further multicenter and multinational mixed methods studies including qualitative methods are needed.

Selection bias could be present if mainly individuals interested in the topic of climate change participated in the study. This might distort our results to the extent that climate-sensitive health literacy appears to be more developed than it actually is. Our questionnaire focused mainly on climate-specific knowledge, thus leaving out some relevant planetary health references. A broader approach that also focuses on other planetary crises in addition to the climate crisis would also be very important and should be focused on in future work.

## 5. Conclusion

In conclusion, our study demonstrates that the health professionals surveyed perceive the relationship between climate crisis and health as an urgent issue and are aware of numerous impacts of the climate crisis on health. Respondents largely indicate that health professionals should advocate for climate action to ensure long-term health. Nevertheless, the majority has not yet mentioned the connection in

their daily clinical work. The primary obstacles preventing interviewees from carrying out climate action during their work include a lack of time, materials and information. In private, however, the study participants are mainly already willing to engage in climate-protecting behaviour such as active mobility and a plant-based diet. There is a need for strengthening the climate-specific health literacy of health professionals and for the establishment of concepts that make climate-sensitive health advice possible despite the lack of time. In practice, a broad implementation of education on climate crisis and health and planetary health is needed, for example based on existing proposals. These actions underscore, the critical role of health professionals during the climate crisis, promoting both healthy and sustainable societies.

## Data availability statement

The datasets presented in this article are not readily available because of privacy restrictions. Requests to access the datasets should be directed to the corresponding author.

## Author contributions

LA, LR, ML, CB, JS, AW, and CJ contributed to the conception and design of the study and directly participated in interpretation of the results, provided critical comments to the manuscript and revised the text. LA and LR provided the questionnaire. LA performed the

data collection and data preparation, performed the statistical analysis and data presentation, and wrote the first draft of the manuscript. CJ and AW supervised the project. All authors contributed to the article and approved the submitted version.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2023.1236319/full#supplementary-material>

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## OPEN ACCESS

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RECEIVED 08 June 2023

ACCEPTED 26 October 2023

PUBLISHED 01 December 2023

## CITATION

De Wever J, Hainselin M and Gignon M (2023)  
Applied improvisation and transdisciplinary  
simulation: a necessity for any health  
curriculum?  
*Front. Med.* 10:1237126.  
doi: 10.3389/fmed.2023.1237126

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# Applied improvisation and transdisciplinary simulation: a necessity for any health curriculum?

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From practising a procedure, such as a lumbar puncture, to explaining the aim and method and listening to concerns, the practice of health professionals requires a range of skills, often classified into technical and non-technical skills. Just as gestures and procedures can be taught, so can empathy and communication skills. This article introduces an innovative approach that unites both necessary types of skills. The specific framework of improvisational theatre (“improv”) has widespread application, including the training of health professionals (health training improv). By sharing close contexts and skills, health training improv provides a valuable, safe, and effective learning environment that allows practitioners to practice exercises and situations that align with particular objectives. We created a transdisciplinary team to develop a programme of Health Professional Training Improv (HPTI), bringing together the fields of health, psychology, simulation, and arts. Since 2019, various health student groups (nurses, midwives, medical doctors, and speech therapists) have participated in a 16-h applied improv training workshop under the supervision of a professional improv facilitator. Additionally, drama students completed applied improv for health courses, which trained them to act as simulated patients, with a view to the implementation of transdisciplinary improv simulation sessions at SimUSanté (a multidisciplinary health simulation facility located in France). Students’ feedback emphasized their interest in HPTI, the realism of the simulation sessions, and the skills they felt had improved. This feedback needs to be supplemented with quantitative data from standardised assessments. The development of this rich pedagogical and research framework, based on a transdisciplinary approach, has brought different fields together to prepare students for real patient encounters. It is essential to continue this training and conduct research to evaluate the curricula developed.

## KEYWORDS

improv, simulation, health occupations, health student, communication, decision-making, empathy

## Introduction

### Background and rationale for this educational innovation

Health professionals are not machines; they are individuals who interact with others. However, future professionals are sometimes trained like robots. Skilled health professionals should have mastered specific procedures (e.g., lumbar puncture), should act quickly when a symptom appears (e.g., pain radiating from the leg), and should also be able to efficiently explain to patients the aim of an examination and listen to their concerns. Innovative training methods, based on transdisciplinarity and supported by research, are crucial, as not all health professionals receive specific training including explicit learning about communicating or empathising. This article explores how students from various health fields, including speech therapy, nursing, midwifery, and medicine, can benefit from collaboration with psychologists and improvisation actors. We examine how this collaboration helps to change their perspectives towards patients and argue for its inclusion in the health curriculum.

### Skilled health professionals and challenges in training non-technical skills

Researchers, clinicians, and educators of health professionals frequently divide medical skills into technical skills, such as performing a lumbar puncture, and non-technical skills, such as communicating information (1). This division can often lead to a hierarchy, with non-technical skills receiving less emphasis in curricula and scientific publications than technical skills (2). One might question the value of mastering cardiac resuscitation without also being able to handle time-critical decisions, or of excelling in stitching a child but faltering in reassuring them. Providing excellent care requires both technical and non-technical skills. While the usefulness of simulation training in the development of technical skills is now widely accepted (3), the type of training required to develop non-technical skills is less clear.

The belief that creativity cannot be taught, or that empathy is innate, can lead to bias in the design of curricula, and an inventive approach to learning is needed. This study examines an innovative learning approach that links crucial technical and non-technical skills. Can this approach lead to improvement in mastering them? Published studies suggest yes, and our approach also integrates expertise from other fields, enabling “thinking outside the box” (4–6).

### A New approach to train so-called non-technical skills: improvisation

Actors trained in improvisational theatre (“improv”) can use body language to express emotions, make quick decisions (e.g., in instantly choosing to behave pleasantly or to become angry in response to a health care student’s reactions), listen carefully, and adapt to the unpredictable. These skills are necessary whether they are performing on stage or working in a hospital setting. Empathic health professionals have been found to be associated with improved patient outcomes, both subjectively and objectively (7, 8). Furthermore, quick

decision-making is critical because of the potential for life-threatening complications (9). However, it remains uncertain how many midwives, nurses, or other health professionals have received specific training in empathic communication or quick decision-making.

Therefore, the specific framework of improv may be a crucial component of the training of healthcare providers, and this role needs to be clarified. Recently, an increasing number of publications on this topic have emerged (4, 5, 10–18). This has led us to bring together health, psychology, and art in an unexpected but harmonious mix.

### From improvisational theatre to health professional training improv

Improvisational theatre, commonly known as “improv,” is a theatrical practice of improvised performance without a written script. Guided by core values of goodwill, mutual support, and active listening, improvisers collaborate to create stories. This embodied and integrative approach to human functioning, involving cognition, emotion, and the body in interaction with the environment, has been shown to have positive effects on participants’ memory (19), creativity (20), and tolerance of uncertainty (21). Improv techniques can have multiple applications, including in education (22), science (23), and health (13, 24). Both applied improv and emergency health care situations share common features, such as: (1) an unscripted setup with countless possibilities, (2) a dynamic environment, (3) multiple characters, (4) and an emergency that requires immediate action.

Medical improv is a form of applied improv designed for training of a variety of health professionals (24, 25), not limited to medical doctors. The more specific and inclusive term of Health Professional Training Improv (HPTI) is used here to describe such training. HPTI aims to improve health professionals’ skills, such as communication, empathy, response to time pressure, and creativity (5, 17, 24). Using the same technique as simulations, improv rehearsal provides a safe, secure, and efficient learning environment for the training of health professionals and students. Particular exercises and scenarios are selected according to the trainees’ specific needs and objectives, ensuring an optimal learning experience.

Depending on the skill being trained, HPTI facilitators have access to thousands of exercises (26, 27) and can modify them in real time during workshops. To develop empathy, health trainees can swap roles with another health improviser on stage, embodying the character and their traits. For instance, the health student playing the caregiver can become the patient, and the one playing the patient can become the caregiver, at any point during the exercise. Empathy can be conveyed (10) in various ways, including verbal, non-verbal, and paraverbal. Improv can help in improving expression of empathy by allowing individuals to embody characters in unprepared scenarios. Afterwards, constructive feedback from the audience or fellow improvisers can be provided to offer valuable insights for improvement and enable the trainee to try again in a safe place, which is not feasible in a clinical setting with actual patients.

After each exercise, the facilitator highlights the clinical relevance of the elements addressed through debriefing. The practice of applied improvisation, similar to simulation, can be divided into several stages: (1) soliciting and enhancing the emotions of the players, (2) eliciting the emotions of the observers, and (3) providing feedback to

the participants and facilitating an interactive exchange (28). While in theatrical improvisation this third phase provides feedback on the participants' artistic performance, in applied improvisation the aim is to highlight the skills required during the exercise and draw a link to the applied discipline (28).

Thus, HPTI could, to begin with, provide an opportunity for trainees to mobilise and develop cognitive skills (perspective-taking; expression and recognition of appropriate emotions) as well as behavioral skills (verbal, non-verbal, and para-verbal communication). These skills could be applied and contextualised to clinical themes in a neutral environment, before proceeding to realistic medical environments, through simulation. Consequently, participants will be better equipped to apply these skills in real clinical contexts. The HPTI developed method is enhanced by transdisciplinary improv simulation to develop the non-technical skills of health professionals. We propose this as an innovative and viable technique to complement health professionals' skill sets.

## Method

### The transdisciplinary educational team

We formed a transdisciplinary team in order to create the HPTI programme and associated simulations, working alongside the mental health association for health students, as well as the Theatre, Psychology, and Health departments, an experienced improv facilitator, and staff from the medical simulation centre. Transdisciplinarity "integrates the natural, social and health sciences in a humanities context, and in so doing transcends each of their traditional boundaries" and corresponds to an integrative and holistic approach which aims to integrate expertise, knowledge, and methods from the different team members and to set goals in a participatory manner (29). We prefer the term 'transdisciplinary' over 'multidisciplinary' (under which the knowledge of the various disciplines remains within the limits of their fields) or 'interdisciplinary' (which relates to the study and identification of links between disciplines), because this work gathered the social and health sciences in a human science context, extending traditional boundaries, which corresponds more closely to the definition of 'transdisciplinary' (29). Indeed, the topics of empathy and communication are not specific to any one discipline, which supports transdisciplinary work. The transdisciplinary team facilitated the amalgamation of various skill sets: medical proficiency, to ensure the clinical accuracy and pertinence of the scenarios; theatre proficiency, to instruct the actors and mentor them during the simulations; and psychological proficiency, to enhance communication and empathy in the development of scenarios and during debriefing.

The transdisciplinary team, which also represents a form of interprofessional education, convened prior to the development of HPTI and simulation training to establish the target objectives. Members of the health students' association and medical professionals presented challenges frequently encountered by health students during their internships. Additionally, the psychologists (who are also researchers) provided guidance on emotional and relational issues and implemented the research protocol. The professional improv facilitator devised the improv training based on the objectives and needs identified.

For the second set of transdisciplinary improv simulations, the members of the health students' association and medical practitioners collaborated to devise scenarios based on real-life situations encountered by health students. The medical practitioner attended to medical coherence and symptoms in the scriptwriting and provided medical guidance during simulation debriefings. The psychologists also contributed to the design of scenarios and debriefing, providing advice on emotional and relational issues, and oversaw the research protocol. Prior to the simulation sessions, the improv facilitator trained the simulated patients (drama students) and provided feedback on body language during debriefings. The simulation centre staff prepared the simulated environment from a technical and material viewpoint.

### The HPTI learning environment: transdisciplinary health student participants

Over the last four years, including during the COVID-19 pandemic, 63 health students (in their 2nd to 5th years of study) from various disciplines, including medicine and speech therapy, participated in a 16-h HPTI workshop, led by a professional improv facilitator. This workshop was offered as an optional course. During the HPTI workshop, the health students engaged in exercises such as the "yes and." Professionals can employ this technique in clinical settings, for example to acknowledge a patient's feelings during a panic attack (acknowledge with the "yes") and collaborate to plan medical follow-up (build on it with the "and"). Additionally, they received training on using an appropriate tone of voice and maintaining professionalism in their body language, a skill that many of them needed to learn for the first time.

To prepare for the simulation sessions, third- to fifth-year drama students from the arts department underwent 12 h of training in applied improv to portray patients. This training was conducted through a separate workshop from the HPTI. The students worked on the patients' backgrounds by improvising situations such as marital problems and were trained to realistically portray symptoms, including panic attacks. The comprehensive HPTI programme and simulation details can be accessed on the Open Science Framework (OSF) website at <https://doi.org/10.17605/OSF.IO/J8WUC>. The use of standardised patients entails embodiment by actors of patients executing the same actions; standardised patients are prevalent in simulations, particularly during an evaluation process. In contrast, simulated patients, who are authentic and adaptable, are beneficial for training purposes, as they enable infinite variations on the same scenario with pedagogical significance. The use of improvisational actors to portray simulated patients represents a novel approach that addresses an important need. While such actors convincingly manifest realistic symptoms and emotions, their unique preparation allows for heightened flexibility and the ability to adjust mood and language in response to live interactions.

### Transdisciplinary improv simulations

Beyond HPTI, health students were provided with the opportunity to attend non-mandatory simulated scenarios in



which they assumed a caregiving role, while drama students acted as patients. Ultimately, 15% of the health students who previously trained with the HPTI programme have volunteered to be part of the improvisation simulations (more could be involved). We plan to make the simulation sessions mandatory for all HPTI-trained health students, as the culmination of their participation in their chosen optional course, and even for all health students. We carefully scheduled simulation days months in advance, taking into consideration exams and internships so as not to hinder the students' academic progress. It may be feasible to expand the interdisciplinary team in the future by means of recruitment of additional colleagues or an increase in the available time for the existing unit, thus accommodating more students. The simulations were conducted at SimUSanté, a European multidisciplinary health simulation facility where health students are trained in both technical and non-technical skills. Health professionals are trained to manage a patient's panic attack and draw blood samples within the same building, on the university hospital campus.

The simulation scenarios enabled students to confront clinical situations involving relational issues (e.g., the concerns of a stroke patient's wife; the anxiety of a pregnant patient awaiting further investigations) and did not require technical actions. The documentation for each scenario included: (1) a section for the facilitators, listing the required materials, the environment, the number of arts and health students, and the possible health speciality or learning outcomes; (2) a section for the health students, providing background information and theoretical knowledge that may be useful for the situation; (3) a section for the arts students, outlining the family and professional background of their character, which they were encouraged to use to improvise in the given setting. The authors designed two versions of the scenarios by dividing the documentation into specific sections. Section 2 pertained to the health students, while section 3 was designed for the drama students. The drama students were introduced to the scenarios during their applied improv training, whereas the health students received their introduction to each scenario a few minutes before the corresponding simulation.

On the day of the simulation session, the objectives and rules were introduced during a briefing. Before each simulation, facilitators presented the scenario to the health students. Subsequently, depending on the script, one or two health students (e.g., a health professional and their colleague) joined one or two drama students (e.g., a patient with a family member as their accompanying person) in the simulation. The simulation occurred in a simulated hospital room and was broadcast live to other students, professors, and staff in a separate room. The duration of each simulation was between 5 and 10 min, and the facilitators ended the simulation once its primary objective had been achieved. Following each simulation, several facilitators, comprising at least one professional from each field (health, psychology, and arts), conducted debriefings (Figures 1, 2). Each debriefing was based on the impressions and feelings of the health and drama students who participated in the simulation, followed by those of the observers. The students were then encouraged to identify and improve on positive aspects of the simulation collaboratively, and to work together to find ways of improving other aspects. Depending on the issues raised (medical, interpersonal, communication-related), each facilitator provided advice, additional information, and leads based on their field of expertise. As the simulated patients were

portrayed by arts students who engaged in improvisation, each simulation was a new experience within the same scenario, a feature that holds pedagogical value. Each simulation introduced new behaviors to observe and debrief on, providing opportunities to try, explore, and discuss a wide range of clinical situations.

From the improv training to the simulation, both health and drama students enjoyed a secure setting, with the opportunity to halt proceedings by signalling (either verbally or via an agreed-upon gesture) to the live broadcasting camera. The only instance in which a simulation was interrupted involved a student who had encountered a creative dead end.

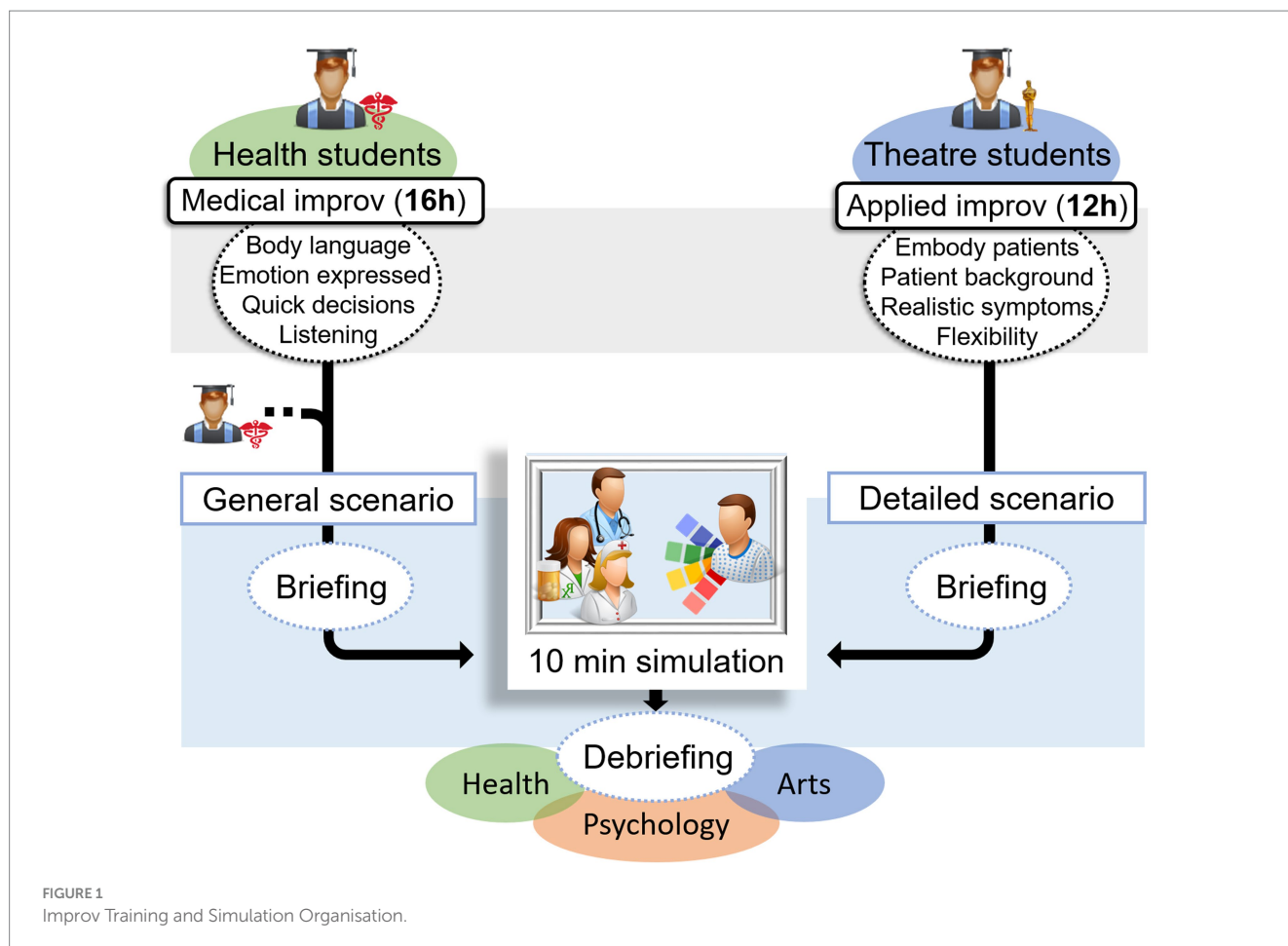
## Evaluation

Since 2019, eleven half-day simulation sessions have been conducted, and the sessions have been refined over time. Each session has comprised five different scenarios and has included groups of three to eight drama students and nine to seventeen health students from various fields, such as medicine, speech therapy, midwifery, and nursing care. We employed a post-improv satisfaction questionnaire and a post-simulation questionnaire to collect the health students' impressions of the improvisation training and simulation session and improve them on this basis (example questions from the post-improv questionnaire: "Do you think that attending more similar improvisation workshops would be beneficial for your professional life?" example question from the post-simulation questionnaire: "In your opinion, what is the advantage of involving improvisational actors rather than colleagues?"). The satisfaction questionnaire was initially (before the pandemic) administered on paper, immediately following the improvisation training and the simulation session. After the pandemic, the questionnaire was administered online a few hours later and included open-ended questions and a 10-point Likert scale. This satisfaction questionnaire was part of a larger protocol that also assessed communication, empathy, and decision-making skills.

## Results: students' feedback

To date, 61 respondent health students in their 2nd to 5th year of study in medicine and speech therapy have reported having both a professional and a personal interest in HPTI. One second-year medical student stated that "humanity plays a critical role in the medical field, and undergoing improv training provides us with a novel outlook that aids us in presenting innovative idea to enhance our patient care practices." Students found the HPTI workshops particularly valuable for empathic communication skills. According to the feedback received, this training helped them "to put ourselves in the patient's shoes" (comment by a second-year medical student) and "to control [my] own emotions [...], to react quickly and effectively without breaking the bond of trust" (comment by a fourth-year speech therapy student). Most believed they could apply improv concepts and principles when interacting with patients or relatives, regardless of the situation or circumstances: "On the whole, it is suitable for a wide range of individuals; however it is particularly relevant for those with psychological co-morbidities or young individuals who suffer from ADHD" (comment by a





fourth-year speech therapy student); “I come here and do this non-mandatory course because I really think medical professionals treat too many symptoms and not enough human, unique people with their own humanity. I think that knowing how to adapt to each person’s individuality is something we need to do, regardless of their illness or reason for consultation” (comment by a third-year medical student).

Feedback from the 93 health students (in their 2nd to 5th year of study, studying medicine, speech therapy, and pharmacy) who attended the simulation session highlighted the emotional and clinical realism of the simulation: “It would not have been the same if it had involved two health professionals or colleagues” (comment by a second-year medical student). They highlighted the particular value of using actors trained in improvisation in contrast to both their peers and non-improvising actors. A third-year pharmacy student commented: “Improvising actors are essential because they can simulate real-life scenarios with remarkable similarity.” They also valued the transdisciplinary nature of the approach and found it insightful to engage with medical students and their perspectives: “Being surrounded by medical students was interesting to see their points of view. What I really like about the simulations is debating afterwards, all the debriefings that are done afterwards, being able to discuss our postures, our ways of acting, it’s very interesting” (comment by a third-year nursing student). They also believed that their

communication and empathy skills had been enhanced through participation in simulations, such as by observing simulations.

## Discussion: what to do now?

This innovative transdisciplinary programme prepares future healthcare professionals for real-life patient encounters. To our knowledge, we are among the first to combine the fields of health, psychology, and art in an improvisation and simulation curriculum. The most important lesson is the development of a very rich pedagogical and research framework, based on this transdisciplinary approach. Improvisation is one of the several tools used to enable transdisciplinary collaboration during the programme.

The HPTI training and simulation sessions were non-mandatory, which means that the positive feedback from health students should be viewed in this context. This could have led to a motivational bias (30). We can assume that all participants who chose to take part in simulation sessions placed importance on their communication skills. To overcome this limitation, it would be worth considering including these training sessions as standard practice for health students in their curricula.

During the final session break, students from the speech therapy and medicine courses engaged in a discussion regarding their respective professions, the potential for interaction, and the



FIGURE 2  
Health professional improv training and transdisciplinary simulation illustration.

essential knowledge required of one another. Although this discussion took place after a debriefing session and was unscripted, we think this anecdote is another story that reinforces the impact of this pedagogical framework. Using simulation sessions through interprofessional education is a viable method of facilitating communication and the acquisition of interdisciplinary knowledge among students from various healthcare fields. While this is already common for technical activities (e.g., simulated surgery with a surgeon, nurse, etc.), transprofessional communication simulation workshops need to be more common and need to be evaluated. This article shows that it is possible to bring together health students from different backgrounds and foster their interest in learning together and learning to work together. The presence of arts students in the simulation is also a way to facilitate interdisciplinary simulation; such students bring a very different perspective because they have no specific medical knowledge and are focused on the communication component. The enhancement of the improv sessions that we have previously carried out should continue with

the administration of highly complex group scenarios, such as emergency room coordination, and the evaluation of curricula through research.

To enhance the training of healthcare professionals, we strongly recommend that educators worldwide incorporate improv actors and psychologists into the curriculum, cross-training across disciplines (including nurses, midwives, physicians, speech therapists, and pharmacists) (31). These professionals will all learn to communicate together through improv and over time. This type of training is essential because we are diverse and we need every single strength to produce skilled health professionals, not robots.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The requirement of ethical approval was waived by CERNI Université de Picardie Jules Verne, Amiens, France for the studies involving humans because CERNI Université de Picardie Jules Verne, Amiens, France. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any identifiable images or data included in this article.

## Author contributions

JW wrote the article. MH and MG contributed to the writing of the article and to its review. All authors contributed to the article and approved the submitted version.

## Funding

JW is funded by the Région Hauts-de-France and the Centre Hospitalier Universitaire Amiens Picardie. Improv training sessions were supported by the ASMES (health student mental health association). Support for publication fees was provided by the Maison Européenne des Sciences de l'Homme et de la Société (MESHS) and the CRP-CPO lab.

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## Acknowledgments

The authors would like to thank Magali Quillico (La Boite d'Improv, Mouvement d'Improvisation AMiénois) for running the improv sessions and for all her valuable insights; Marion Boudier and the arts students for their simulation characters and feedback; and the SimUSanté Epione staff for their help during the simulation.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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RECEIVED 22 June 2023

ACCEPTED 17 November 2023

PUBLISHED 05 December 2023

## CITATION

Straub C, Bode SFN, Willems J,  
Farin-Glattacker E and Friedrich S (2023)  
Challenges and opportunities of evaluating  
work based interprofessional learning: insights  
from a pediatric interprofessional training ward.  
*Front. Med.* 10:1244681.  
doi: 10.3389/fmed.2023.1244681

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# Challenges and opportunities of evaluating work based interprofessional learning: insights from a pediatric interprofessional training ward

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**Introduction:** Interprofessional collaboration among healthcare professionals is fostered through interprofessional education (IPE). Work-based IPE has demonstrated effectiveness within interprofessional training wards. We developed the Interprofessional Training Ward in Pediatrics (IPAPED) and employ a combination of established assessment tools and a newly created IPAPED questionnaire, directed at to assess both students' learning experiences and program structure. This paper presents the development and analysis of the psychometric properties of the IPAPED questionnaire.

**Methods:** Nursing trainees and medical students participated in IPAPED. The IPAPED questionnaire was developed to complement established instruments, based on IPE frameworks. Interprofessional collaboration and communication were represented in subscales in part 1 of the questionnaire. Part 2 focused on the IPAPED program itself. Statistical analyses included calculation of internal consistency for part 1 and exploratory factor analyses for part 2.

**Results:** All IPAPED participants between November 2017 and November 2022 completed the questionnaire ( $n = 105$ ). 94 of 105 questionnaires were analyzed. Internal consistency for part 1 was low (Cronbach's  $\alpha < 0.58$ ). Exploratory factor analyses revealed three distinct factors: teaching and learning material, interprofessional learning facilitation and professional guidance by nurses on the ward.

**Discussion:** Our results illustrate the challenge of performing high quality, theory based evaluation in a work-based setting. However, exploratory factor analyses highlighted the opportunity of focusing on both learning facilitators and staff on the wards to ensure a maximum learning output for participants. Developing program-specific questionnaires to gain insight into local structures has the potential to improve work-based IPE formats.

## KEYWORDS

interprofessional training ward, interprofessional learning, medical education research, work based learning, questionnaire, psychometric properties



# 1 Introduction

Interprofessional Collaboration (IPC) among healthcare professionals is recognized as a vital strategy to address contemporary healthcare complexities (1). Continuous interprofessional education (IPE) is a crucial prerequisite for equipping learners with the necessary skills, beginning with pre-qualification education and extending through continuing professional development (2). Long-term effects of IPE on later IPC were shown, longitudinal exposure to IPE having an especially positive effect (3). One way of implementing IPE are work based learning formats, such as interprofessional training wards. Compared to seminars, simulations and other, more theory-oriented formats, IP training wards are both particularly challenging to implement and yet rewarding for participants, patients and learning facilitators as they allow for realistic work-placed learning (4). As with many IPE concepts, evaluating effects remains a challenge and there is a need for more data on which concepts do or do not work (5).

In 2017 we implemented the Interprofessional Training Ward in Pediatrics (IPAPED) in a university hospital in south-west Germany (6). From day one of the planning phase, finding and using suitable instruments for evaluation was one of the core ideas behind IPAPED. The concept of frameworks for IPE served as a backbone for both designing the IPAPED concept and deciding on the right kind of evaluation (7). From a range of excellent options, we decided to use the Interprofessional Socialization and Valuing Scale (ISVS) in the 9 item versions and the Interprofessional Collaboration Scale (ICS) (8, 9). While both instruments were validated and widely accepted, we wanted to look at some particularities of our own program in more detail, still bearing in mind the IP frameworks.

Therefore, we developed the IPAPED questionnaire, for both internal evaluation and more insight into effects of the interprofessional intervention. Specifically, we wanted to understand in which way we were able to reproduce theoretical constructs of the program in our findings and how psychometric properties could inform about the continuous improvement process of the program. We wanted to understand whether developing a program-specific questionnaire would be beneficial to the program and could be recommended to teams of other interprofessional training wards as well. After 5 years of running the program and more than 100 students having participated, we evaluated the psychometric properties of the IPAPED questionnaire to answer the following research questions:

1. In which way can we reproduce the theory-based approach in analyzing the psychometric properties?
2. Which factors have an influence on psychometric properties of the questionnaire and how can we address them in the context of the program?
3. How can we use insights from the psychometric testing of the questionnaire to improve the program?

# 2 Methods

## 2.1 The IPAPED program

The IPAPED program was launched in a general pediatric ward in 2017, welcoming participation from both final-year medical

students (MS) and nursing trainees (NT) in their 2nd or 3rd year of training. Interprofessional teams consist of two MS who work 8 AM – 5 PM and four NT who cover morning (6 AM – 2 PM) and afternoon (2 PM – 9 PM) shifts. MS and NT care for 6–8 patients. Nights and weekends are covered by the regular ward team. During the two-week program participants are supervised by registered nurses and board-certified pediatricians as interprofessional learning facilitators who are trained according to an internal curriculum (10, 11). The rotations start with an introduction into interprofessional education, interprofessional collaboration, competencies and roles, handover skills and teamwork. Daily interprofessional handovers and reflections are core elements of the program. Peer teaching elements and an interprofessional resuscitation/CPR simulation-training are included in the 2-weeks course (Figure 1) (12). Parents and patients appreciated the care on IPAPED (13). Participants were very satisfied with supervision, learning success and felt they were able to take on responsibility for patients. They showed an increase of self-perceived interprofessional competencies after the rotation and some positive aspects persisted for up to 1.5 years (5).

## 2.2 Designing the IPAPED questionnaire

The planning phase for the IPAPED program started roughly 18 months before the first run of the interprofessional training ward. Organizational planning that included all relevant stakeholders in medicine and nursing was crucial. During the planning phase, the IPAPED team screened multiple available questionnaires for implementation on the IPAPED. The internationally accepted frameworks for interprofessional education serve as theoretical backbone (7). The Interprofessional Socialization and Valuing Scale (ISVS) in the 9 item versions and the Interprofessional Collaboration Scale (ICS) were selected (8, 9). Participants responded to ISVS-9A/-B and ICS questionnaires at the end of their rotation. These results have been reported previously (6).

Learning facilitators are crucial to successful IPE. Improving our understanding of their role was one aim of the IPAPED program. However, neither ISVS nor ICS contained specific items on the role of learning facilitators and neither do other established instruments. After thorough discussion, the IPAPED team decided against using additional well established instruments, such as the Readiness for interprofessional collaboration scale (RIPLS) or the University of the West of England Interprofessional Questionnaire (UWE IP) (14, 15). As both instruments cover additional aspects of interprofessional learning and collaboration, we decided to develop an additional IPAPED questionnaire, containing elements of both RIPLS and UWE IP. Specifically, RIPLS item 2 and UWE IP item 18 were adapted and specified for items 9 and 10 in the IPAPED questionnaire. IP frameworks and a thorough literature review regarding learning facilitation on interprofessional training wards were taken into account to develop new items for our own instrument. Additionally, the new questionnaire addressed specific aspects of the IPAPED program as well as the learning facilitators.

The IPAPED questionnaire contains 28 items in total. Three are related to sociodemographic data, one is a free-text answer, one relates to IP communication in general and 23 are related specifically to IPAPED. The concepts of interprofessional collaboration and interprofessional communication serve as internal structure (7). Items 5, 6, 7, 8, and 10 were attributed to IP collaboration in the IPAPED

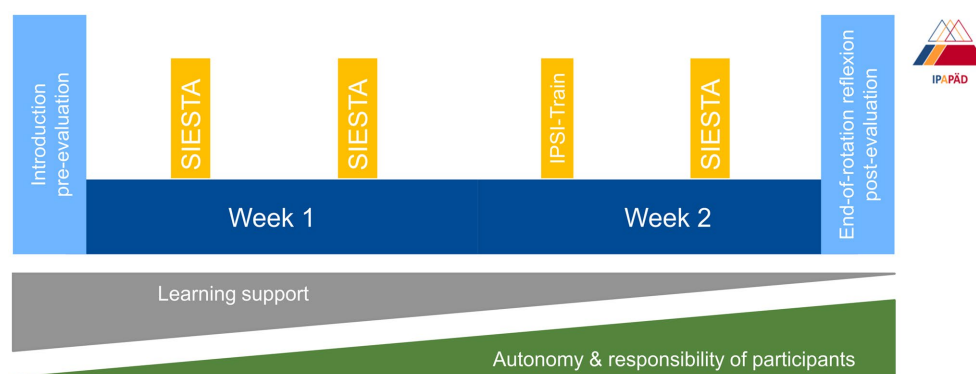


FIGURE 1

IPAPED – the concept. The two-week rotation is flanked by an introduction session and an end-of-rotation reflection. Pre- and post-evaluations include the ICS, ISVS-9A/B, and the IPAPED questionnaire. Participants need more learning support during the first days of the IPAPED rotation but gain more autonomy and take on more responsibility for patients during the course of the rotation. ICS, interprofessional collaboration scale, IPAPED, Interprofessional Training Ward in Pediatrics, IPSI-train, interprofessional (CPR/resuscitation) simulation, ISVS, interprofessional collaboration and valuing score, SIESTA, speed interprofessional peer teaching pediatric.

context, items 4, 9, 11, and 12 to IP communication on IPAPED. We developed the IPAPED questionnaire in German. For this publication, two members of the research group, one of them being a Native English speaker, translated an English version. The English version of the questionnaire is displayed as [Table 1](#).

## 2.3 Data collection

Data were collected during IPAPED rotations between November 2017 and November 2022. During that time, 44 MS and 61 NT participated in IPAPED. The IPAPED rotations took place on three wards, with two of them in the same hospital. The 105 participants all completed the paper-based questionnaire at the end of their rotation. The answers were transferred into an electronic spreadsheet by an independent member of the IPAPED team who was not involved in the analyses.

## 2.4 Statistical analysis

Based on the theoretical considerations, we tested the questionnaire for internal consistency (Cronbach's  $\alpha$  and McDonald's  $\omega$ ). As a second step we performed exploratory factor analyses (EFA; extraction method: principal component analysis after varimax rotation) to allow for the identification of new scales and concepts. We decided to only include items 14 to 28 for the EFA because of their consistent Likert scale. Items 4 to 12 had Likert scales, but with varying labels, making them difficult to include for further analysis. Item 13 was omitted because it was a free text answer. Kaiser-Mayer-Olkin (KMO) coefficient and Bartlett sphericity test were used to analyze the suitability of the data for EFA. Items for EFA were first screened in a missing value analysis, excluding items with more than 20% missing values. After a first EFA, items 19, 21, and 24 were removed because of double loading on two separate factors. Because the first EFA was mainly conducted to provide support for selecting items, only the second EFA's results are reported in detail below. We performed factor analyses in IBM SPSS® version 29.0.0.

## 3 Results

### 3.1 Sample characteristics

There was a 100% return rate of the surveys ( $n=105$ ), with 58% ( $n=61$ ) NT responses and 42% ( $n=44$ ) from MS. The majority of the participants were female ( $n=93$ ; 88.5%), with all but one of the male cohort being MS. The mean age was 22.2 years for NT and 26.8 years for MS. Full sample characteristics can be found in [Supplementary Table S1](#).

### 3.2 Psychometric properties

Items 5, 18, and 26 were excluded from the analysis due to a high rate of missing values (>20%). Items 4–12 were separated into two different subscales, based on frameworks of interprofessional education (7). Because items 14–28 were tailored to meet IPAPED specific aspects they were not included in the first analyses. The first theory-based subscale referred to the concept of “interprofessional collaboration,” comprising items 4, 5, 6, 7, 8, and 10. The second subscale referred to the concept of “interprofessional communication,” comprising items 9, 11, and 12. For both subscales, internal consistency was low with Cronbach's alpha  $\alpha = -0.378$  for subscale 1 and  $\alpha = 0.505$  for subscale two (see [Table 2](#)). We were thus not able to reproduce the theory-based background of the questionnaire by testing for internal consistency of the subscales. Potential factors relating to this finding are addressed in detail in the discussion section of the manuscript.

The second part of the questionnaire consisted of items 14–27. From the original dataset of 105, only 94 were explored for EFA because of missing data. The KMO coefficient (KMO = 0.700) and Bartlett sphericity test ( $\chi^2 = 217.74$ ,  $p < 0.001$ ) indicated that data were suitable for exploratory factor analysis. As described in the methods section, items 19, 21, and 24 were removed from the analysis. After removal of these items, Kaiser-Guttman criterion suggested a three-factor solution. The three factors explained 58% of the variance (factor 1: 32%, factor 2:

TABLE 1 IPAPED questionnaire (English translation).

Item No.	Question	Possible answers
<i>Sociodemographic information</i>		
1	Please tell us your profession	Nurse trainee / Medical student
2	Please tell us your gender	Female / male
3	Please tell us your age	.... years
<i>Please indicate the number that represents your opinion best</i>		
4	How important do you consider participating in IPAPED during your training?	(1) very important / (2) important / (3) neutral / (4) not important / (5) not at all important
5	How do you rate interprofessional collaboration during daily clinical work on IPAPED?	(1) very good / (2) good / (3) fair / (4) poor / (5) very poor
6	After your rotation on IPAPED, how clear is the understanding you have acquired of your own professional role?	(1) very unclear / (2) unclear / (3) do not know / (4) clear / (5) very clear
7	After your rotation on IPAPED, how do you rate your level of knowledge on the work of the other profession? <i>Do not rate your own profession</i>	(1) none / (2) low / (3) sufficient / (4) high / (5) very high
8	After your rotation on IPAPED, how would you rate your motivation to ask the other profession (nurses/doctors) for support regarding patient care in the future?	(1) very high / (2) high / (3) medium / (4) low / (5) very low
9	How much importance would you attribute to interprofessional communication for patient care?	(1) very high importance / (2) high importance / (3) some importance / (4) little importance / (5) very little importance
10	How would you describe the effects of structured interprofessional collaboration during IPAPED on patient care?	(1) very positive effects / (2) positive effects / (3) neither positive nor negative / (4) negative effects / (5) very negative effects
11	Giving and receiving feedback is a core element of IPAPED. How satisfied are you with the feedback culture during your rotation on IPAPED?	(1) very satisfied / (2) satisfied / (3) indifferent / (4) unsatisfied / (5) very unsatisfied
12	What suggestions would you provide the organizers about running the IPAPED course in future?	Keep the program without changes / keep the program with changes / abolish the program / do not know
13	If you marked „keep the program but change it“, what would you change?	<i>Free text answer</i>
<i>Please rate your satisfaction during your rotation on IPAPED regarding...</i>		
14	...guidance of the interprofessional collaboration by nurse learning facilitators.	(1) very good / (2) good / (3) fair / (4) poor / (5) very poor
15	...guidance of the interprofessional collaboration by physician learning facilitators.	
16	...professional guidance and support from the nursing staff on the ward.	
17	...professional guidance and support from the doctors on the ward.	
18	...the IPSI emergency training	
19	...the introductory event	
20	...the interprofessional midday reflection	
21	...the SIESTA teaching session	
22	...the learning objectives	
IP 22	...the selected medical conditions	
24	...the feedback rules	
25	...the IPAPED pocket guide	
26	...the learning diary	
27	...the teaching and information materials as a whole	
28	Please provide an overall grade for IPAPED	
		(1) very good / (2) good / (3) fair / (4) poor / (5) very poor

15%, factor 3: 11%). The items' standardized loadings were  $\geq 0.60$  on factor 1 (items 20, 23, 25, 27, and 28);  $\geq 0.64$  on factor 2 (items 14, 15, and 17) and  $\geq 0.69$  on factor 3 (items 16 and 22). Factor 1 showed sufficient reliability (Cronbach's  $\alpha = 0.725$ , McDonald's  $\omega = 0.731$ ). Factor 2 had limited reliability (Cronbach's  $\alpha = 0.571$ ), with McDonald's  $\omega$  not reportable (only 3 items). Factor 3 consisted of two items only, thus no internal consistency testing

was possible. Loadings for all factors and reliability measures can be found in [Table 3](#).

The final step was evaluating the factor content. Factor 1 items focused mainly on teaching and learning material, medical conditions and overall appreciation of the IPAPED program, so it was named "teaching and learning material." Factor 2 was named "interprofessional learning facilitation" because it contained items

TABLE 2 Values for internal consistency of theory-based subscales.

Subscale	Interprofessional collaboration	Interprofessional communication
Items	5, 6, 7, 8, 10	4, 9, 11, 12
Cronbach's $\alpha$	−0.378	0.505
McDonald's $\omega$	Not available	0.552

TABLE 3 Loadings for all factors 1–3 of exploratory factor analysis, including values for internal consistency.

	Factor 1	Factor 2	Factor 3
Item 25	0.746		−0.218
Item 28	0.659	0.342	0.313
Item 20	0.651	0.105	
Item 23	0.624		0.503
Item 27	0.600	0.128	0.160
Item 15		0.798	−0.127
Item 17	0.173	0.740	0.130
Item 14		0.638	0.227
Item 16	−0.107	0.337	0.761
Item 22	0.436		0.692
Cronbach's $\alpha$	0.752	0.57	−
McDonald's $\omega$	0.731	−	−

focused on the interprofessional nurse and physician facilitation and guidance by ward physicians. Factor 3 “professional learning” consisted of the professional guidance by nurses on the ward and learning objectives.

## 4 Discussion

In this study, we describe the development, implementation and analysis of psychometric properties of a questionnaire designed for evaluation of the interprofessional training ward in pediatrics, named the IPAPED questionnaire. Areas of evaluation comprise self-reported aspects on interprofessional communication and collaboration as well as feedback on aspects specific to the program itself, including interprofessional learning facilitators.

The IPAPED questionnaire was designed as a complementary tool for our interprofessional training ward, with the main focus of evaluation of the program itself. Our short, complementary survey focused on interprofessional collaboration, communication and learning frameworks, covering aspects missing from the ISVS-9A/-B and ICS questionnaires. We did not identify any other established instrument that would have covered all aspects of the IPAPED that we deemed important, especially learning facilitation.

However, we were unable to reproduce the theory-based background of the questionnaire by testing for internal consistency of the subscales. There are several possible reasons for this challenge: Firstly, only the first section of the questionnaire (items 4 to 12) related specifically to the concepts of interprofessional collaboration and communication (7). The numbers of items for both concepts (IP collaboration: five, IP communication: four) are comparable to other

established questionnaires. The ICS, for example, contains three subscales with 5, 5, and 3 items each (9). One major problem with items 4–12 of our questionnaire might be the inconsistent labeling of the Likert type answer scales. To achieve consistent answers and facilitate analysis of psychometric properties, questions should be re-phrased in a way to allow for one same Likert scale for all items. Feasibility of this approach in an IP context has been elegantly demonstrated by the ISVS and the individual Teamwork Observation and Feedback Tool (iTOfT) (8, 16).

One other challenge is presented by the fact that answers were collected over a relatively long period after rotations with 4 to 8 students each. Answers might have been influenced more by the individual experience related to the particular group than by the program itself. Emotions, both positive and negative have an important impact on IP learning experiences (17). These limitations are related to the work-based nature of the program, which prompted constant small changes in the program and a relatively small number of students per rotation. However, the work-placed learning and the living program with constant changes are suggested by participants, patients, and faculty, as major strengths of the IPAPED program.

The second half of the questionnaire was directed at more specific aspects of the IPAPED, such as learning aids and learning facilitation. Exploratory factor analyses revealed different opportunities:

Factor 1, “teaching and learning material,” had the strongest influence on overall rating and variance. This is consistent with findings by other groups that emphasize the importance of a clear structure in the changing context of work based interprofessional education (18). In our case, this included structured concepts for ward rounds on pocket cards and a selection of patients with clearly defined medical conditions in order to leave more space for interprofessional aspects of learning (6, 10). Notably, the daily team reflection at lunchtime is part of this most important factor. These 30 min were dedicated at reviewing on the past 24h, giving space for urgent problems and enabling the team to adjust the learning goals and learning process. Learning facilitators encouraged a culture of speaking up and listening, creating a “safe place with space for learning” (19).

Factor 2, “interprofessional learning facilitation,” summarized ratings for interprofessional learning facilitators, both nurses and physicians and guidance by physicians on the ward. The latter gave profession-specific instructions and medical advice to the team. Faculty development for interprofessional education in general and work based formats in particular has recently been a field of increasing interest (20, 21). Among IPE experts, there is a consensus that high-quality IPE needs effective faculty training, comprising reflection on roles and responsibilities, team communication and professional identity (22). One of core roles of physicians as defined in the CanMEDs concept is being a “member of a team” (23).

Factor 3 yielded the most surprising results, distinguishing the item “...professional guidance and support from the nursing staff on the ward” alongside the “learning objectives” from the other items mentioned above. There are several possible explanations for this finding, some of which might be transferrable to other wards and contexts: Ward nursing teams tend to be more permanent and stable than residents or other junior doctors, who frequently change. For example, on the three wards where IPAPED took place, two residents worked on the ward for a period of 6 months, whereas some of the nursing staff had more than 30 years of experience and had been part



of the same ward team for several years. The nursing teams might thus be considered small examples of communities of practice (24).

Introducing a change process, such as an interprofessional training ward, can be challenging. This holds particularly true when teams work in shifts and it is never possible to have all members of a team present at meetings, workshops etc. Establishing the structures needed for a sustainably successful IP training ward involves convincing important stakeholders as well as the colleagues affected by the teaching format (1). The possible explanations given so far focus on the nursing teams “being different from the rest.” From a students’ perspective it could also be a sign of appreciation: Guidance from the nursing staff on the ward was associated with the formal learning objectives. These included both profession-specific, as well as interprofessional items. The questionnaire does not distinguish between those two groups. Yet, informal learning from nurses has been reported for junior doctors, with implications for interprofessional education (25). Findings from our EFA should encourage faculty development including nursing teams of interprofessional training wards. Making this resource available to learners can be crucial and having the nursing team on board is essential to ensuring a successful program in the long-term.

Strengths of our study include the work-based nature, since evidence on real life IP is still scarce. One excellent example was able to demonstrate optimized antimicrobial treatment, improved quality of care and economic outcome (26). In addition, the continuous implementation over 5 years can be considered beneficial, since data come from a well-established program that is still ongoing and can be used for further iterations. Lastly, our high response rate of 100% was possibly due to small groups, with personal contact to each student and questionnaires kept to a minimum in length.

Limitations include a relatively long time of data acquisition, which naturally led to constant changes within the relevant wards (e.g., physician teams). Also, despite a structured training program, there were frequent changes in learning facilitators (5 nurse learning facilitators and 4 physician learning facilitators in total) (21). Even though  $N = 105$  is a considerably high number of participants for work based IP programs, it is still relatively small for robust statistical analyses. The reported statistical results should therefore be considered with caution and provide more of an exploratory framework regarding a potential structure of the questionnaire. Items 4 to 12 had Likert scales, but with varying labels. This can be a challenge when discussing further analysis.

Values for internal consistency were rather low even for data driven EFA. Further statistical tests, such as fitting the data to classical-test-theory-based models (CFA), could not be performed. Item 21 on “feedback” was removed from the analysis at the very beginning, because of double loading on two factors. Feedback is considered a crucial element of IP learning formats and collaborative practice (1). However, our item did not distinguish between feedback among students (peer feedback), feedback from learning faculty and the overall feedback culture, e.g., between learning facilitators and the staff on the ward. Future studies could explore this aspect more closely.

Future improvements of the questionnaire should also aim at identifying additional items, based on existing concepts, such as IP frameworks, or by using qualitative methods such as focus groups (7).

In conclusion, our analysis of the psychometric properties of the IPAPED questionnaire did not allow us to replicate theory-based subscales in the first section of the questionnaire. Nevertheless, these aspects were already well addressed by established instruments like ISVS and ICS. The attempt to provide additional granularity through a supplementary questionnaire encountered challenges. For specific aspects of our program, however, the data driven analysis yielded interesting results. Establishing short, program-specific instruments with analysis of psychometric properties could therefore be useful to identify areas of improvement on interprofessional training wards.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by University of Freiburg ethics committee, permit no. 561/17. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

CS and SB designed and implemented the IPAPED program. CS designed the IPAPED questionnaire. SF prepared the data for analysis. JW and EF-G analysed the data. SB and SF wrote the manuscript and prepared the figures. All authors revised the manuscript and agreed on the final and revised version.

## Funding

The implementation of the IPAPED was financially supported by the Robert-Bosch-Foundation (“Operation Team”); funding number: 32.5.A381.0030/MA01 as well as a non-restricted grant (“Instructional development award”) from the University of Freiburg, Germany. The funders had no role in study design, data collection, data analysis, the decision to publish, or the writing of the manuscript.

## Acknowledgments

We thank all participants of the IPAPED as well as the team on the ward. Special thanks to Alexandra Duerkop, Helena Wilcken, Stephanie Peters, Nikolaus Schaefer and Christian Kimmig, who supported the IPAPED as nurse and physician learning facilitators. We thank Sunil Rodger for help with translating the questionnaire and Andres Daniel Spinner for transferring the data to an electronic spreadsheet. We acknowledge support by the Open Access Publication Fund of the University of Freiburg.



## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2023.1244681/full#supplementary-material>

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## OPEN ACCESS

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RECEIVED 11 September 2023  
ACCEPTED 27 November 2023  
PUBLISHED 13 December 2023

## CITATION

Eid J, Brattebø G, Jacobsen JK, Espevik R and  
Johnsen BH (2023) Distributed team processes  
in healthcare services: a scoping review.  
*Front. Med.* 10:1291877.  
doi: 10.3389/fmed.2023.1291877

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# Distributed team processes in healthcare services: a scoping review

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**Objective:** High-quality healthcare services is delivered by teams rather than individuals and depends heavily on multidisciplinary cooperation between dispersed healthcare professionals. The aim of this scoping review is to identify common barriers and innovative applications of technology supporting team processes and patient safety, in geographically dispersed healthcare services.

**Methods:** Studies were identified from searches in APA PsychINFO, Epistemonikos and Medline databases, from 2010 to 2023. A detailed search strategy was performed, and studies were included, based on prior established criteria.

**Results:** Among the 19 studies that fulfilled our inclusion criteria, the majority (85%) were from Europe or North America, and most studies (53%) were quantitative, with a cross-sectional study design. Several reported observed distributed team processes in training and education. Most studies described barriers and detailed how innovative approaches and technological solutions were introduced to improve communication, coordination, and shared mental models in distributed healthcare settings. A small proportion of studies (16%) used health services data to examine interpersonal exchange and team processes.

**Conclusion:** The scoping review offer recommendations to enhance future research on distributed team processes in healthcare services.

## KEYWORDS

patient safety, healthcare, distributed teamwork, coordination, shared mental model, prehospital

## Introduction

Modern healthcare depends on teamwork and cooperation between healthcare professionals (1, 2). However, accumulating evidence suggests that human factors and psychological processes may compromise patient care due to staff distress and communication issues (3–5). The significance of team composition, team processes, assessment and training of healthcare teams are seen as key factors in understanding how non-technical skills influence patient safety (6, 7).

Most research on team processes and team training in healthcare have focused on specific teams, such as trauma teams, or hospital units, like anesthesia and surgery, where critical decisions and effective patient care depend on the physical presence of, and direct coordination between subject matter experts (4, 8, 9). The rapid development of information communication technologies and an increased demand for high-quality prehospital services, have spurred a need for improving the

coordination and training of geographically distributed healthcare providers. The COVID19 pandemic prompted a surge in the application of remote technology to enhance the simulation, training, and coordination of geographically distributed health personnel. To date, few studies have mapped this literature to identify common barriers and innovative applications of technology in support of team processes, patient care, and safety in distributed healthcare services. This scoping review contributes to filling this gap.

A systematic review and meta-analysis indicate that teamwork is positively related to performance in healthcare teams (10). An influential strand of widely applied research on team processes has been referred to as ‘The big five of teamwork’ (11). According to Salas et al., the five core elements in teamwork are leadership, adaptability, mutual performance monitoring, backup behavior and team orientation (11). The five team processes are closely linked to performance by three coordinating mechanisms: Mutual trust, shared mental models (SMM), and closed-loop communication. These coordinating mechanisms contribute to ensuring that all critical information is relayed to all team members. Trust is seen as key in situations when team members expect potential harm or adversities if fellow team members fail in fulfilling their duties and responsibilities. Trust is a valuable team asset, since it reduces the need for constant performance monitoring, and facilitates team interaction, backup, or support behavior (12). Shared cognitive constructs, and information about system status and function, allow one to make decisions and predict possible outcomes in familiar situations (13). Over time, shared models are gradually developed and maintained through mutual experiences, training or simulations mimicking realistic operational situations and intra team communication. Inherent knowledge about individual and interpersonal knowledge, capabilities and team processes will increase efficiency by reducing the need for explicit coordination (14). Accordingly, shared mental models are more easily established in co-located than in distributed teams, where visual cues and interpersonal interaction are limited or absent (15). Closed-loop communication is an important coordinating mechanism to avoid misunderstandings; and has long been used in aviation and was later adopted by medicine (16–18). Emerging empirical evidence suggests that closed-loop communication has a direct positive effect by enhancing distributed team processes (19). It has been argued that relational communication is important to create emergent affective states like trust and cohesion, while task-oriented communication contribute significant in the creation of accurate mental models (19).

Lack of face-to-face interaction and communication across technical platforms produce barriers of a physical, temporal, perceptual or emotional nature that influence team processes (20). Such barriers could have adverse effects on team leadership, making it more difficult to engage in mutual performance monitoring and thereby foreseeing the need for backup behavior. According to Morrison-Smith and Ruiz, team challenges can often be traced back to tasks, team composition (roles and responsibilities), and distribution of workload (21). Virtual teams are rife with complex challenges, making such distributed teams less effective than face-to-face teams (22). Reduced efficiency may, in turn, lead to an increased risk of relocation and rotation of the team members, which could reduce cohesion, social relations and team orientation (20, 23). Several studies have shown that familiar teams outperform novel teams with new members in high-fidelity operational situations, such as military or police operations (24–26). Studies on the latter have shown that

familiar teams increased their performance in both technical and non-technical (i.e., interpersonal) skills, compared to unfamiliar teams. This relationship between familiar teams and performance was mediated by superior team coordination (26). In a meta-analytic study Mesmer-Magnus et al., concluded that distributed teams, compared to face-to-face teams, needed longer time to fulfill task and showed increased frequency of task-oriented communication contrasted to team oriented communication (47). Furthermore, the inherent challenges in the use of technological platforms for communication between team members also increase the need for more studies on virtual teams. Marlow et al. reported that a common finding regarding communication in distributed teams is a loss of richness in the information transfer (48). Subsequently, the impact of virtuality on the mechanisms between communication and performance as well as the simultaneous moderating effect of contextual factors on this relationship are still not fully examined (48).

While research has shown that non-technical skills, trust, effective communication, virtuality and shared mental models, all are important factors for avoiding mistakes and ensuring safe procedures and reliable performance in co-located healthcare teams. Less research has focused on geographically distributed healthcare teams (1, 9). In this scoping review, we therefore aimed to explore the following four research questions: (1) What barriers will prevent effective healthcare services in geographically dispersed teams? (2) How can technology enhance training, patient safety, and quality of care in distributed healthcare services? (3) Will team processes and coordinating mechanisms observed in co-located teams apply to geographically dispersed healthcare services? (4) How could this scoping review inform future research on healthcare services and patient safety?

## Methods

The review was informed by Arksey and O'Malley's five-stage framework, which alludes to a rigorous process of transparency, enabling replication of the search strategy and study findings (27). The five stages of this framework informed the research process: (1) identifying the initial research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing, and reporting the results.

### Identifying the initial research questions

The primary aim of our review was to provide an overview of empirical research on common barriers and innovative applications of technology, supporting team processes and coordination of geographically dispersed healthcare services, as indicated by the previous research questions. To this end, multiple databases were consulted to build a coherent search strategy and identify relevant empirical research that could inform our research questions.

### Identifying and selecting relevant studies

For the selection of databases, Epistemonikos was chosen due to its focus on evidence-based research in healthcare and technology.

TABLE 1 Key search terms and Boolean operators in the final search term.

<p>'team*' AND 'patient safety' AND 'leadership' OR 'communication' AND 'virtual' OR 'distributed'</p>
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Consequently, Ovid Medline was applied from its position as a predominant database for scientific literature in medicine. Lastly, PsychINFO widely considered to be one of the best databases for accessing psychological literature, was selected to capture team and performance-related studies within the healthcare domain. Since we only wanted to include peer review studies, Google Scholar was not used since this database also contain studies that are not peer reviewed. PubMed is a user-friendly interface to search Medline, but in this study, Ovid Medline was used since it allows a more focused search strategy. A wide range of key words related to virtual teamwork, distributed team processes, healthcare and patient safety were initially adopted as search terms to glean a 'broad coverage' of the available literature. The search techniques employed health-related subject headings and Boolean operators to narrow and combine the searches. The resulting terms and their Boolean relationships were combined to form 'Team\* AND (patient safety) AND (leadership OR communication) AND (virtual OR distributed)' as the search strategy for each database (Table 1).

Only peer-reviewed empirical studies in English, published from January 2010 to February 2023, in which the words *communication* or *teamwork* were mentioned in the title or abstract were included. Review studies, case reports and opinion papers were excluded. Studies not available in full text or studies focusing on training, quality improvement, teamwork, or team training of co-located units in hospitals were also excluded (Table 2).

A primary database search (from 2010 to 2021) was completed in April 2021 and yielded 85 hits, with 32, 15 and 38 hits from APA PsychINFO, Epistemonikos and Medline, respectively. After the first searches were completed, the researchers conducted a selection process using the Rayyan research review software<sup>1</sup> to examine the publications and weed out less relevant results (28). After the removal of duplicates and the screening of titles and abstracts, 77 studies were eliminated, and eight studies were retained. To capture relevant research from the COVID-19 period, a supplementary search was completed in the same three databases for the period from April 2021 to February 2023. This search produced 88 additional hits. The first and third author screened the additional studies, using the same exclusion criteria. Finally, 19 studies from the first and the supplementary searches were deemed to fulfill the inclusion criteria and included (Figure 1).

## Data charting, summarizing, and reporting

In the results section summaries are developed for each article related to the authors, publication year, country, study design, data collection, sample size, and a brief descriptive note. The included papers are then narratively summarized with an emphasis on main findings and general domains, followed by a general discussion and recommendation for further research.

## Results

The general characteristics of 19 studies are shown in Table 3. Six studies were conducted in Europe (17, 24–28), one in Asia (34), ten in North America (35–44), and two in Australia (40, 41). Seven studies were quantitative (17, 25–27, 32, 35, 42), three applied mixed methods, and nine applied a descriptive exploratory case study design. The study designs were cross-sectional or descriptive case study designs. No studies applied a longitudinal or a randomized controlled design. Regarding the data collection, five quantitative studies collected data using face-to-face questionnaires, and five studies used databases or online registries. The qualitative studies relied on interviews, video observations, or personal records and observations. The number of subjects in the quantitative studies ranged from 200 to 675 individuals.

Taken together, six studies addressed innovative approaches to team training and development (31, 34, 36, 37, 39, 41) ten studies addressed the implementation of new technology or assessed organizational procedures in support of improved healthcare services (24, 25, 27, 28, 30, 32, 33, 35, 38, 40), and three studies utilized registries or database records to identify basic mechanisms in distributed team processes (17, 26, 42). In the following we will chart and collate these findings in more detail.

## Technological innovation in support of team training and education

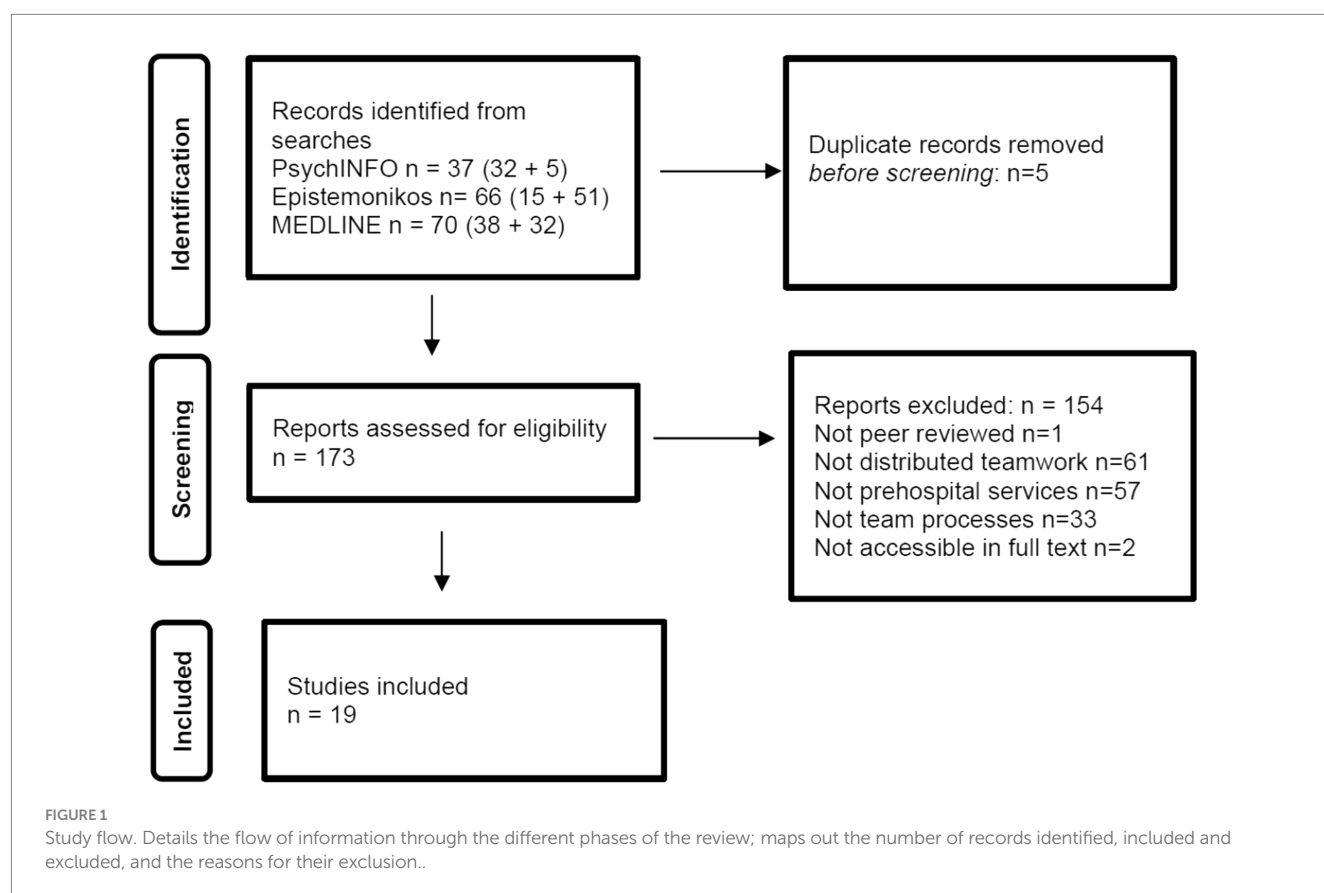
Several studies detailed team training and the feasibility of technology in support of distributed healthcare practices. Two studies focused on virtual team training (44, 46). In the Team STEPPS program, eight screen-based interactive virtual simulation cases featured typical clinical situations and formed the core of the program (44). In a similar study, virtual simulations were found to be an efficient strategy to facilitate awareness of non-technical skills, communication, and critical thinking (46). By analyzing participant perceptions, these simulations were shown to improve awareness of communication, teamwork, decision making, and problem solving (46). A more general improvement of overall situational awareness was also discovered. Whilst virtual simulations facilitated flexible, asynchronous learning adapted to the student's schedule, it was challenging for the educators to monitor and provide timely individual feedback.

Four of the training studies were designed and implemented during the COVID-19 pandemic, exploring how virtual reality was introduced in support of distributed healthcare and education. The study by Reece et al. was directly aimed at using virtually facilitated simulation to improve COVID-19 preparedness in 200 healthcare providers in rural Canada (42). Their feasibility study focused on airway management and health systems preparedness as priority objectives. Video analysis and observations indicated that the healthcare teams demonstrated increased competency, as well as cost-effectiveness and feasibility of virtual training to reach geographically isolated communities. Keiser et al. applied a mixed method, observational design to evaluate teamwork and communication following virtual/web-based deliberate practice and face-to-face simulation-based education of health service workers (39). Student evaluations were generally favorable, and the opportunity for multidisciplinary interaction was appreciated. In another program, Heginbotham et al. described an educational model using an online and in-person approach aimed at training parents,

<sup>1</sup> <https://www.rayyan.ai/>

TABLE 2 Overview of inclusion and exclusion criteria used in both searches.

Criterion	Inclusion	Exclusion
Time period	2010 to date of search (01.02.2023)	
Language	English	Non-English studies
Type of article	Original research, published in a peer review journals	Articles that were not peer reviewed or original research
Ethics clearance	Studies with approved ethics notification	Ethics notification not reported
Study focus	Teamwork, Health Care, Virtual/ Distributed teams	Studies without a primary focus on health care, medicine, and distributed teamwork
Literature focus	Studies addressing prehospital services, home care, telehealth or virtual/web-based services	Articles that made a passing or token reference to prehospital services. Review articles, editorials, or opinion papers
Population and sample	Multidisciplinary	Studies on samples other than health care workers
Abstract	Articles where the word <i>communication</i> was included in the abstract	Articles lacking the word <i>communication</i> in the abstract
Open access	Articles that were available in full text or as open access	Articles in journals not available as open access or through the library services



faculty staff and learners to ensure that children with special healthcare needs were receiving adequate home care (36). In the same vein, Miller et al. presented a descriptive case study detailing how virtual collaboratives were used to increase patient safety practices and quality of care, and to improve interprofessional collaboration in homecare settings (41). Characterized by few standardized routines and procedures, this part of the Canadian healthcare sector experienced a large proportion of patients reporting adverse and indecent treatment during their homecare. Most of these events were attributed to healthcare professionals' failure to prioritize time and assignments, as well as insufficient information and training. The introduction of virtual

collaboratives contributed to closing these gaps and raising awareness about safety practices in homecare (41).

## Innovation and improved interdisciplinary coordination

Several studies explored the increasingly complex nature of healthcare services, characterized by the need for interdisciplinary coordination and collaboration (30, 33, 35, 38, 40, 43, 45). In their study of intra-hospital care transitions, Wooldridge et al. applied



TABLE 3 Alphanumeric overview of the included studies.

Author details	Title	Location	Study design/ participants & sample	Main outcome
Anderson, N., et al. (2020)	Planning for a pandemic: Mitigating risk to radiation therapy service delivery in the COVID-10 era	Melbourne, Australia	Case study: Quality assessment of medical service providers of radiation therapy across campuses and hospitals during COVID-19	Four critical areas were identified in developing risk mitigation strategies across delivery of radiation therapy: (a) Workforce planning, (b) Workforce communication, (c) Patient safety and wellbeing, and (d) Staff safety and wellbeing.
Akşin, Z., Deo, S., Jónasson, J. O., & Ramdas, K. (2021)	Learning from many: Partner exposure and team familiarity in fluid teams.	Turkey	A database study investigated the impact of prior partner exposure on time spent during patient pick-up at the scene and patient handover at the hospital.	For the less standardized patient pick-up process, greater partner exposure directly improved performance. For the more standardized patient handover process, this beneficial effect was triggered beyond a threshold of sufficient individual experience. In addition, the beneficial performance impact from prior partner exposure was amplified in high workload periods.
Bavare A. C. et al. (2021)	Virtual Communication Embedded Bedside ICU Rounds: A Hybrid Rounds Practice Adapted to the Coronavirus Pandemic	Switzerland	Clinical case study: A continuous quality improvement study: Hybrid rounds with virtual communication were introduced during COVID-19 to facilitate social distancing while maintaining patient-centered care.	Hybrid rounds employed during pandemic facilitated social distancing while retaining patient-centered multidisciplinary ICU rounds but compromised teaching during rounds. A change to ingrained rounding habits needs team commitment and ongoing optimization. The hybrid rounds model has potential for generalizability to other healthcare settings.
Dhala, A., et al. (2021)	A Year of Critical Care: The Changing Face of the ICU During COVID-19.	Texas, USA	A case study report on how a tele-critical-care program and its infrastructure were deployed to meet the demands of the pandemic. Community hospitals played a vital role in creating a collaborative ecosystem for the treatment and referral of critically ill patients.	Tele-critical care platforms provided remote monitoring and treatment of ICU patients while extending access to critical care physicians and registered nurses along with decision-support tools necessary for ICU care. A virtual ICU or vICU program was implemented.
Heginbotham, L., et al. (2022)	A parent-led, patient-centered medical home model instruction for interprofessional undergraduate and graduate learning opportunities.	West Virginia, USA	A case study of an educational model to patient-centered medical home (PCMH) to ensure that children with special health care needs are receiving care according to their needs.	The study describes a PCMH training approach that included parents, faculty, and learners in a series of activities (online and in-person) that improve learner knowledge of the PCMH and skills necessary for establishing a PCMH in their future practice.
Hughes, A. M., et al., (2021)	Trauma, teams, and telemedicine: evaluating telemedicine and teamwork in a mass casualty simulation	Chicago, USA	The study examines the effect of telemedical support in a simulated MASCAL simulated training event. Teamwork-related attitudes, behaviors, and cognitions during the MASCAL scenario were measured by pre-post surveys and observations of use.	Overall, clinicians have positive reactions toward the potential benefits of telemedicine; further, participants report a significant decrease in psychological safety after training, with users rating psychological safety as significantly higher than non-telemedicine users.

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TABLE 3 (Continued)

Author details	Title	Location	Study design/ participants & sample	Main outcome
Hunter, K., et al. (2021)	Feasibility of Prehospital Emergency Anesthesia in the Cabin of an AW169 Helicopter Wearing Personal Protective Equipment During Coronavirus Disease 2019.	UK	Efficiency and outcomes were assessed in a simulated exercise where trained personnel wearing personal protective equipment (PPE) performed a prehospital emergency anesthesia in the form of rapid sequence intubation (RSI).	An in-aircraft RSI (aircraft on the ground) while wearing PPE for AGPs had no significant impact on the time to successful completion of emergency anesthesia (RSI) in a simulated setting.
Husain, A., et al. (2021)	A clinical communication tool (loop) for team-based care in pediatric and adult care settings: hybrid mixed methods implementation study	Canada	The objective of this study was to implement and evaluate the Loop – a web-based, asynchronous clinical communication system for team-based care.	Fundamental structural and implementation challenges persist toward realizing Loop's potential as a shared system of asynchronous communication. Barriers include health information system integration; system, organizational, and individual tension for change; and a fee structure for health care provider compensation for asynchronous communication.
Johnsen, B. H., et al. (2022)	The Effect of Complexity of Ambulance Missions on Shared Mental Models in Virtual Teams.	Norway	A database study from real life events aimed at mapping team behavior and cognition in critical real-life emergency medical missions based on the concept of SMM.	Voice recordings from real-life missions were used to investigate differences in team behavior between low and high-complexity missions. Lower frequencies of team competencies and coordinating mechanisms were found in high compared to low-complexity missions.
Johnsen, B. H., et al. (2022)	Coordinating mechanisms are more important than team processes for geographically dispersed emergency dispatch and paramedic teams	Norway	A database study investigating the suitability of the Shared Mental Model approach for teamwork between operators in emergency medical communication centers and first line ambulance personnel	Path analyses showed that SMM was positively associated with team effectiveness and negatively related to mission complexity. The coordinating mechanisms of SMM and closed loop communication was positively related to "Big Five" team scores.
Keiser, M. M., Turkelson, C., Smith, L. M., & Yorke, A. M. (2022)	Using Interprofessional Simulation with Telehealth to Enhance Teamwork and Communication in Home Care.	Michigan, USA	A mixed method, observational research design was used to evaluate teamwork and communication following virtual/ web-based deliberate practice and a subsequent face-to-face simulation-based interprofessional education activities (Sim-IPE) with a home-based patient assessment and intervention for students in undergraduate nursing, nurse practitioner, and physical therapy programs.	Teams scored very high on an interprofessional communication and teamwork scale, and students strongly agreed that the pre-briefing, scenario, and debriefing assisted in their learning. Students also valued exposure to telehealth and the ability to work with students from other health professions.
Lama, A., Hogg, J., & Olson, A. P. (2020)	Perspectives from the other side of the screen: how clinicians and radiologists communicate about diagnostic errors	Minneapolis, USA	Cross sectional survey: 240 radiologists and clinicians completed a survey on communication and diagnostic errors in health care.	Clinicians and radiologists discover diagnostic errors surrounding the interpretation of radiology images, although radiologists discover them more frequently. There is significant room for improvement in education and practice regarding how radiologists and clinicians communicate as a team.

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TABLE 3 (Continued)

Author details	Title	Location	Study design/ participants & sample	Main outcome
Miller, W., et al. (2020)	Homecare safety virtual Quality improvement collaboratives	Canada	Descriptive case study: The Canadian Patient Safety Institute and the Canadian Home Care Association conducted two learning collaboratives aimed at increasing quality improvement capability and patient safety practices in homecare settings.	The program engaged teams from across the country to increase their capacity and capability to engage patients and families, mitigate and prevent harm from homecare safety incidents such as falls and specifically address issues such as improving interprofessional collaboration, teamwork, and communication.
Mill, T., et al. (2021)	Live streaming ward rounds using wearable technology to teach medical students: a pilot study.	UK	A pilot study was conducted during COVID-19 exploring the feasibility of using a wearable headset to live stream teaching ward rounds to remotely based medical students. Three live streamed teaching ward rounds were delivered to three groups of medical students using the Microsoft HoloLens 2 device and Microsoft Teams software.	The experience of live streamed ward rounds was well received by patients, medical students, and teaching faculty. However, there remain limitations to the routine use of HoloLens 2 technology including steep learning curves, hardware costs and environmental factors such as noise and WiFi connectivity.
Peddle, M. (2019)	Participant perceptions of virtual simulation to develop non-technical skills in health professionals	Australia	A descriptive exploratory design was used to study responses from 675 health care providers engaged in a virtual simulation program. Most respondents were nurses (81%), with remaining sample from other health professions.	Results indicated that virtual simulation increased awareness of non-technical skills including communication, teamwork, decision making, critical thinking and problem solving, as well as situational awareness.
Reece, S., et al., (2021).	Use of virtually facilitated simulation to improve COVID-19 preparedness in rural and remote Canada	Canada	A feasibility study of an <i>in situ</i> virtually facilitated simulations (VFS) for COVID-19 airway management and health systems preparedness that was administered to 200 health care providers in rural Canada.	Video analysis of sequential VFS rapid cycle sessions using a standardized observational tool indicated decreased personal protective equipment (PPE) breaches by 36.6% between the first and third cycles. Teams demonstrated increased competency with airway management and VFS provided a rapidly mobilizable and cost-effective way of delivering high-quality SBE to geographically isolated communities.
Sasangohar, F., et al. (2020)	Adapting an outpatient psychiatric clinic to telehealth during COVID-19: A practice perspective	Houston, USA	Case study: A descriptive report on a rapid transition to a 100% digital outpatient mental health service.	Describes the logistics of the implementation, including modes of communication, the psychological effects of web-based services, including both the loss of the physical therapeutic environment and the unique interpersonal dynamics experienced in the virtual environment.
Umoren, R. A., et al. (2017)	TeamSTEPPS Virtual Teams: Interactive Virtual Team Training and Practice for Health Professional learners	Seattle, USA	Descriptive case study: In 2016, 1,128 unique users accessed Interactive virtual simulation scenarios designed to permit flexible, asynchronous learning and team training	Interprofessional faculty from multiple institutions and specialties created a series of eight screen-based interactive virtual simulation cases featuring typical clinical situations, with the goal of preparing learners to provide safe and effective care in clinical teams.

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TABLE 3 (Continued)

Author details	Title	Location	Study design/ participants & sample	Main outcome
Wooldridge, A. R., et al., (2019)	Complexity of the pediatric trauma care process: Implications for multi-level awareness	UK	A mixed method design with interview, archival document and trauma registry data were used to describe how intra-hospital care transitions affect process and team complexity.	Identified 53 roles, 4 physical locations and 69 pathways of pediatric trauma care. Process modeling or simulation is suggested to present a potential solution to the complex, distributed nature of the process of trauma care and the roles and interdependencies within the process.

process modeling and simulation inspired by human factors engineering methods to analyze roles and interdependencies in trauma care (33). To ensure quality care in complex healthcare systems, they proposed to strengthen clinical decision support at the individual level, to prioritize non-technical skills at the team level, and to enhance organizational awareness through process modeling and simulation. The study by Lama et al., further details the complexity and interdependence of highly specialized healthcare processes, by mapping and comparing diagnostic errors between clinicians and radiologists (40). Since radiological images are distributed and interpreted via electronic systems, radiologists and clinicians are seldom co-located. Lama et al., notes that an increasingly fast-paced, productivity-driven and fragmented healthcare system, presents systemic barriers to communication across professional and cultural barriers, which could pose an increased risk of misconceptions and adverse events (40).

The COVID-19 pandemic inspired a surge in innovative technology-driven approaches to the training, supervision, and transformation of healthcare services across geographically distributed teams (35, 38, 43, 45). The study by Anderson et al. discuss important preconditions that should be considered when providing radiation therapy across campuses and hospitals during the pandemic (45). They provided examples of critical risk-mitigating strategies that need to be addressed, and how workforce planning and communication are important for both patient and staff safety. To achieve this, the extended use of information-communication-technology becomes crucial. The study by Dhala et al. provides a timely example of how extended use of information-communication-technology becomes instrumental to implement and evaluate a program in support of virtual intensive care during COVID19 (35). In this program, virtual platforms were implemented to support remote monitoring and treatment of intensive-care patients in community hospitals. This virtual collaborative ecosystem contributed to increased patient safety and staff development.

Mental health services were significantly affected by COVID-19, and distancing requirements presented major obstacles to outpatient psychotherapy services. In their case study, Sasangohar et al. outlined how an outpatient mental health service decided to implement a 100% digital service, at the beginning of the pandemic (43). They described how logistical and technological issues, communication barriers and interpersonal relations, emerged as barriers to the therapeutic process and how these issues were addressed. Husain et al. provided a case study and evaluation of a web-based, asynchronous clinical communication system that was implemented to support team-based care (38). This web-based system ('the Loop') faced several structural and implemental challenges, from system integration to organizational

and economic disincentives, which discouraged individual application of the system. To overcome communication barriers and to comply with infection control measures during COVID-19, virtual communication and live-streaming of ward rounds using wearable technology, were introduced into bedside intensive-care rounds. While this maintained social distancing and patient care, it also made it possible to provide remote education to medical students (24, 27). Participants reported that, even though technological solutions allowed for both audio and visual input during the ongoing case-discussions by the patients' bedsides, these hybrid-rounds still were characterized by noise from the physical environment. Supervising doctors also were not able to physically assist the doctors in training, who in turn had negative effects on learning outcomes (29). Despite such barriers and technical shortcomings, the authors maintain that the hybrid-rounds method has potential to overcome its disadvantages, and thus may serve its purpose in situations where co-located teamwork is impractical or poses a health risk to patients and staff.

First-responders from the prehospital services must be prepared to perform lifesaving procedures in emergency situations that are, by nature, complex and challenging. Hughes et al. examined the effects of telemedical support on teamwork and cognitions in a simulated mass casualty event (37). Their study was not conclusively in favor of telemedical support under such circumstances, and more research is called for. Another study examined the efficacy of performing prehospital emergency anesthesia, including rapid sequence intubation, in a simulated aircraft on the ground, when wearing personal protective equipment (30). Despite the hassles associated with personal protective equipment, it had no significant impact on the time to successful completion of endotracheal intubation in this simulated setting, indicating significant patient benefits in terms of prehospital time savings and patient safety.

## Team processes and coordinating mechanisms in pre-hospital services

Three of the empirical studies of teamwork and team processes in this review, were performed by in-depth analysis of healthcare databases. Akşin et al. used data from the London Ambulance Service to investigate the impact of prior partner exposure on scene time, and patient handover at the hospital (34). For the less standardized patient pick-up process, greater partner exposure directly improved performance. For the more standardized patient handover process, the beneficial effect of partner exposure was triggered beyond a threshold of sufficient individual experience. In addition, the beneficial performance impact from prior partner exposure was amplified during high workload

periods (34). This study provides empirical evidence supporting how shared mental models may contribute to patient safety in fluid teams, as the ambulance workers rotate and collaborate across different work schedules. This indicates that individual factors, such as trust and shared mental models, become increasingly important in high-intensity situations. The study by Johnsen, et al. utilized data from operators in emergency medical communication centers and first-line ambulance personnel to investigate the proposed shared mental model approach to teamwork (11, 19). A total of 240 participants from the ambulance service in a Norwegian city were used to study team effectiveness in 80 critical care missions. Path analyses showed that shared mental models were positively associated with team effectiveness, and negatively related to mission complexity. The coordinating mechanisms of shared mental models and closed-loop communication were positively related to outcome and team processes. In another study by Johnsen, et al., voice recordings from real-life ambulance missions were investigated for frequencies of coordinating mechanisms and team competencies based on differences in team behavior, between low and high-complexity missions (31). The results indicated lower frequencies of team competencies and coordinating mechanisms in high-complexity missions, than in low-complexity missions. The authors suggest that a lack of visual input from a team member during team interaction, could lead to team process loss and a team breakdown into sub-units, in high-stress situations (31).

## Discussion

Taken together, the 19 studies in this scoping review represent a diversity of research designs and methodological approaches to studying distributed team processes in the healthcare. A notable finding is the abundance of descriptive case studies or cross-sectional studies, while more rigorous longitudinal or randomized control trial designs, are absent. Several studies that focused on how virtual training sessions can contribute to inform healthcare providers in remote regions (42), or enhance interprofessional collaboration (31, 34, 36, 44, 46), could be followed up by experimental or longitudinal studies. With notable exceptions (19, 31), the majority of studies emphasized individual training outcomes, and were less focused on a conceptual or theory driven approach to team processes and outcomes, such as ‘The big five of teamwork’ (11).

A substantial number of studies were performed in North America (53%), followed by Europe (32%) and Australia (11%), with only one study (5%) from Asia, and no studies from Africa or South America. Furthermore, our results indicate that the COVID-19 pandemic spurred an increase in research on distributed team processes. Although our first search had identified 85 potential studies over a 10-year period, the supplementary search identified 88 additional studies over a two-year period. The COVID-19 pandemic clearly inspired a surge of research in this area, and most studies originated in North America and Europe. Several studies examined innovative approaches to the training and education of distributed healthcare providers, in which technological solutions were introduced to improve communication, coordination, and shared mental models in distributed healthcare settings. Among several benefits of distributed healthcare teams are more cost-effective, safe, and eco-friendly interactions when less time and resources are spent

on travel and physical meetings (42). Another advantage of distributed teamwork is the opportunity to be exposed to diversity and other ideas and methods and to include training, supervision, and transformational outcomes into the virtual context (35, 38, 43, 45). Not surprisingly, barriers in communication and technology caused difficulties in coordination and the maintenance of shared mental models, indicating that ‘The big five of teamwork’ represents a viable model that should be further explored in research on distributed teamwork (11). This assumption is supported by the small proportion of studies which used health services data to examine team processes and coordinating mechanisms in distributed healthcare settings and prehospital services. Taken together, several notable findings from this scoping review should be considered to enhance future research on distributed team processes in healthcare:

- Ineffective communication is widely recognized as an important barrier in virtual teams. A more consistent application of communication taxonomy (e.g., closed loop communication) would allow comparison between studies.
- Likewise, several studies identified coordination issues to present a significant barrier to distributed teamwork in healthcare. Again, a more detailed classification of coordination activities will contribute to advance future research (e.g., mutual performance monitoring and backup behavior).
- Several studies have explored the effects and feasibility of technological innovations to enhance education, diagnostics, or patient care in distributed healthcare settings. These studies are typically exploratory in nature, have no control group and have a relatively small sample size. To advance research on distributed healthcare comparative studies of different technologies would be valuable.
- From research on team effectiveness, the concept of shared mental models has emerged as a key aspect in distributed teamwork. A future line of research would be to examine how distributed teamwork influence shared mental models across healthcare specialists with different professional backgrounds.
- Another strand of research would be to study distributed team processes across cultural barriers and how technological solutions could bridge cultural and professional barriers and improve access to high quality healthcare in low- and middle-income countries.
- Finally, this review points to the shortage of experimental studies, as well as the need to assess long-term trajectories and consequences from distributed teamwork in the healthcare services.

## Strengths and limitations

This scoping review followed the framework of Arksey and O'Malley, the PRISMA flow diagram and clearly determined eligibility criteria (27). This allowed a systematic process; whereby methodological considerations were considered before proceeding to the next stage. Multiple researchers assessed the outcomes, and the same three search words and databases were used in both main searches. The results clearly indicate that it was useful to conduct a second search to capture relevant research from the COVID-19 pandemic. Although the scope and outcome of the search may have



been widened with a different search strategy or less-constrictive combinations of operators, the current strategy yielded a broad selection of studies that contributed to inform our research questions. A notable shortcoming is that most of the studies were reported from Europe and North America. This clearly indicate a need for encouraging more research from low and middle-income countries, which often must be dependent on geographically distributed and scarce healthcare resources. Hopefully, this review could encourage additional studies that explore barriers and benefits to distributed healthcare services in low-and middle-income countries. Another shortcoming is the absence of randomized controlled and longitudinal studies which could have contributed to causal inferences or identified long-term outcomes. However, we believe that this our review provides a preliminary assessment of the potential size and scope of the available research on common barriers and innovative applications of technology in support of team processes. It should be noted that while there are barriers in distributed team processes, there are also real benefits. In healthcare as well as in science and industry, decentralized, asynchronous teams accomplish extremely difficult tasks across continents and time zones. Thus, a better understanding of coordinating mechanisms and efficiency of geographically dispersed teams would benefit healthcare services and society at large.

## Author contributions

JE: Conceptualization, Data curation, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing. GB: Conceptualization, Funding acquisition, Project

administration, Supervision, Writing – review & editing. JJ: Data curation, Investigation, Validation, Writing – original draft, Writing – review & editing. RE: Conceptualization, Formal analysis, Writing – review & editing. BJ: Conceptualization, Formal analysis, Funding acquisition, Investigation, Supervision, Writing – review & editing.

## Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

## Conflict of interest

JJ was employed by company Safetec Nordic AS.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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RECEIVED 11 October 2023

ACCEPTED 02 February 2024

PUBLISHED 20 February 2024

## CITATION

Schlosser-Hupf S, Aichner E, Meier M,  
Albaladejo-Fuertes S, Ruttman K, Rusch S,  
Michels B, Mehrl A, Kunst C, Schmid S and  
Müller M (2024) Evaluating the impact of  
interprofessional training wards on patient  
satisfaction and clinical outcomes: a mixed-  
methods analysis.  
*Front. Med.* 11:1320027.  
doi: 10.3389/fmed.2024.1320027

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# Evaluating the impact of interprofessional training wards on patient satisfaction and clinical outcomes: a mixed-methods analysis

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**Introduction:** Interprofessional teamwork is pivotal in modern healthcare, prompting the establishment of interprofessional training wards since 1996. While these wards serve as hubs for optimizing healthcare professional collaboration and communication, research into patient outcomes remains notably sparse and geographically limited, predominantly examining patient satisfaction and sparingly exploring other metrics like mortality or self-discharge rates. This study seeks to bridge this gap, comparing patient outcomes in interprofessional training wards and conventional wards under the hypothesis that the former offers no disadvantage to patient outcomes.

**Materials and methods:** We explored patient outcomes within an interprofessional student ward called A-STAR at a University Hospital from October 2019 to December 2022. Engaging with patients discharged between May 2021 and April 2022, we utilized digital and paper-based anonymous questionnaires, catering to patient preference, to gather pertinent data.

**Results:** Analysis of outcomes for 1,482 A-STAR (interprofessional student ward) and 5,752 conventional ward patients revealed noteworthy findings. A-STAR patients tended to be younger (59 vs. 61 years,  $p < 0.01$ ) and more frequently male (73.5% vs. 70.4%,  $p = 0.025$ ). Vital clinical outcomes, such as discharges against medical advice, complication-driven readmissions, and ICU transfers, were statistically similar between groups, as were mortality rates (1.2% vs. 1.3%,  $p = 0.468$ ). A-STAR demonstrated high patient satisfaction, underscored by positive reflections on team competence, ward atmosphere, and responsiveness to concerns, emphasizing the value placed on interprofessional collaboration. Patient narratives commended team kindness, lucid explanations, and proactive involvement.

**Discussion:** This data collectively underscores the safety and reliability of patient care within training wards, affirming that patients can trust the care provided in these settings. Patients on the interprofessional ward demonstrated high satisfaction levels: 96.7% appreciated the atmosphere and conduct of ward rounds. In comparison, 98.3% were satisfied with the discussion and information about their treatment during their hospital stay.

## KEYWORDS

interprofessional education, interprofessional training ward, patient satisfaction, clinical outcome, healthcare education, collaborative care, quality of care, internal medicine

## 1 Introduction

Effective interprofessional teamwork is fundamental in modern healthcare management, necessitating interprofessional education (IPE) integration into health profession curricula, as widely acknowledged in the literature (1–9). IPE encompasses the collaborative learning and interaction among students and professionals from diverse medical disciplines. Various tools and teaching strategies, such as simulation-based education and rotations in rural and community settings, have been identified for IPE implementation (10). Originating in Scandinavia in 1996 and subsequently globalized (11–17), interprofessional training wards within hospitals serve as multifaceted training hubs. Aspiring professionals from various healthcare disciplines, including medicine, nursing, pharmacy, and physiotherapy, autonomously deliver patient care under supervisory guidance, focusing on delivering medical excellence in patient care and fostering optimal medical collaboration (18–20).

There are already several studies that demonstrate the high value of interprofessional training wards for interprofessional education and gain of interprofessional competence (12, 17, 21–35): Brätz et al. found that final-year medical students who received training on an interprofessional training ward (ITW) showed significantly higher entrustment scores for 10 of 12 entrustable professional activities compared to a control group (25). The most significant variances and impacts were observed in relation to “Engagement with a consultant” and “Conducting a presentation about an oncology patient in a tumor board meeting.” These two aspects have demonstrated a strong correlation with the competency aspect of “Oral communication with colleagues and supervisors”. Mink et al. documented statistically significant positive impacts, both short-term and long-term, of interprofessional education within clinical settings on students’ perceptions of interprofessional socialization and teamwork (27). Specifically, participants in the interprofessional training ward IPAPAED exhibited enhanced scores in interprofessional socialization and valuation, alongside improved communication skills and adaptability within interprofessional teams. Notably, these improvements persisted over a 6 to 34-month period, indicating the enduring positive effects of interprofessional learning and collaboration within the IPAPAED framework (24). Freeth et al. highlighted the high value placed by students on “real life” clinical experiences (35), while Morphet et al. noted a positive learning environment and high satisfaction rates among students, correlating with enhanced teamwork and collaborative skills (31). Gender-related differences in perceptions of the value of Interprofessional Training Wards (IPTW) were observed, with female students exhibiting slightly more positivity compared to male students in the study by Lindh Falk et al. (30).

These studies underscore the critical role of interprofessional education in enhancing collaborative skills, communication

competencies, and professional entrustment in healthcare. It is hypothesized that interprofessional training wards not only enhance individual student learning but also contribute to the overarching goal of delivering superior patient care through effective teamwork and collaboration across various healthcare disciplines.

Ensuring excellent education for future medical professionals without compromising patient care is paramount. Numerous studies have explored interprofessional interventions and their impacts on patient outcomes (36–53), revealing that interprofessional collaboration leads to significant improvements in patient outcomes. Despite criticisms regarding methodological rigor, as noted in Lutfiyya et al.’s literature review (49), the named studies suggest that interprofessional education can have a positive impact on patient outcomes, including patient safety, quality of life, and functional status as described in the latest literature review of Purnasiwi et al. (51). However, Dow et al. cautioned against the complexities inherent in interprofessional networks that may pose challenges to effective collaboration (54).

Research specifically investigating patient outcomes within interprofessional training units remains limited (13, 16, 35, 55–65), primarily emanating from Europe (13, 35, 38, 39, 55–59, 61, 62, 66) and Australia (16, 60). Predominantly located in surgical (13, 58) and orthopedic departments (35, 55–57, 61, 66), interprofessional training wards in other specialties like general medicine (16), emergency medicine (60), pediatrics (62), and rheumatology (35, 61) are underexplored. Existing studies often prioritize qualitative evaluations of patient satisfaction (13, 16, 19, 35, 56, 57, 59–62, 66, 67), with quantitative research typically focusing on complications (19, 38–41, 55, 57, 58) and sparingly on mortality (55, 58). Notably, data regarding discharges against medical advice remain absent.

The overarching aim of this research is to ascertain whether and how IPE contributes to more effective healthcare teams and delivers better patient care. Our study examined potential disparities in patient outcomes between interprofessional training wards and conventional wards, both quantitatively and qualitatively, reflecting the complexity of evaluating educational interventions in dynamic real-world healthcare settings. Kirkpatrick’s Evaluation Model, commonly employed in evaluating interprofessional training programs (68, 69) assesses the impact of interprofessional training on students’ attitudes (reaction), knowledge and skills (learning), professional behavior (behavior), and patient outcomes (results). Our study specifically focused on the last aspect of Kirkpatrick’s Evaluation Model “results,” operating under the hypothesis that interprofessional training wards do not compromise patient outcomes. We meticulously examined patient satisfaction, perceived team competence, mortality, complications leading to readmission or ICU transfer, and discharges against medical advice on our interprofessional training ward A-STAR.



## 2 Materials and methods

### 2.1 Patients

Patients admitted to the A-STAR interprofessional ward and conventional wards within the Department of Internal Medicine I at University Hospital Regensburg (October 1, 2019 – December 31, 2022) were considered for quantitative outcome parameter analysis. To account for annual closures from December 23rd to January 1st, admissions and discharges from December 20th to January 6th were systematically excluded to mitigate selection bias. Patients discharged from May 1, 2021, to April 30, 2022, were provided an anonymous questionnaire, available in both online and paper formats (Questor Pro 5, Blubbsoft GmbH, Berlin), with details available in [Supplementary material S1](#).

### 2.2 Trial design

This monocentric, open-label, controlled study employed no formal randomization but utilized case managers who were uninvolved in the study to allocate patients to the A-STAR or conventional wards randomly. Ethical approval was granted by the University of Regensburg's Ethics Committee (20-1805\_1-101), and the study adhered to the latest Declaration of Helsinki, the International Conference on Harmonisation's Good Clinical Practice guidelines, and pertinent German regulations.

### 2.3 Understanding the application process: interprofessional training ward enrollment and clinical work on the interprofessional student ward

The WHO Framework for Action on Interprofessional Education & Collaborative Practice and other national and international interprofessional education (IPE) competencies and frameworks played a pivotal role in shaping both the conception of the A-STAR and the selection of an appropriate evaluation approach (1, 70–87).

Conventional ward care was administered by medical professionals and nurses, with added support from final-year medical students and nursing trainees. The interprofessional A-STAR unit was managed per shift by a team of up to six senior medical students and two 2nd and 3rd-year nursing trainees, all under the supervision of experienced healthcare staff. A-STAR team selection hinged on a review of applicants' motivation letters and comprehensive CVs by the department head and nursing team lead. Medical students devoted 8–16 weeks of their final year to the unit, while nursing trainees participated for approximately 4 weeks. Medical students had previously completed all theoretical and medical courses of their medical studies and the second of three final exams. The nursing trainees had completed at least 1 year of their total 3-year training.

Integrating seamlessly into conventional wards, the A-STAR unit fostered collaborative care by uniting medical students and nursing trainees in a shared base, whereas doctors and nurses in conventional wards operated from distinct bases. With an 8- to 12-bed capacity, the A-STAR unit contrasted with the conventional wards' 45- to 49-bed capacity. Both ward types catered to a diverse patient population,

addressing gastroenterological, hepatological, infectious, endocrine, and rheumatological conditions.

The A-STAR unit adhered to a structured daily routine, encompassing planning sessions, patient visits, educational interactions, and feedback dialogues. Days were initiated with a joint interprofessional plan after the night shift's nursing handover, followed by routine tasks executed by nursing trainees. Medical students and nursing trainees jointly conducted ward rounds, a practice mirrored by doctors and nurses in conventional wards. Pharmacology students, pharmacists, physiotherapists, and nutritionists contributed to A-STAR rounds every week, scrutinizing medication interactions and dosages, while conventional wards received weekly pharmacy counsel for specific cases. The conventional wards worked in the traditional way and for the most part did not have joint medical and nursing rounds. All wards benefited from daily educational visits led by a medical director or a senior medical representative. The supervising healthcare staff of the A-STAR only intervened in the event of patient-endangering behavior and treated the trainees like young professionals.

The A-STAR unit integrated medical students and nursing trainees in daily, multifaceted, interprofessional educational sessions enhanced by the expertise of varied healthcare professionals. Its inclusive training curriculum featured specialty training—spanning resuscitation, hands-on skills via models, and in-depth sonography courses—ensuring a holistic educational curriculum. This interprofessional and interdisciplinary collective, including pharmacists, physiotherapists, nutritionists, chaplains, technicians, and psychologists, gathered daily for interdisciplinary discussions and X-ray presentations, with active participation from medical students and nursing trainees. Days ended with feedback and reflective discussions, solidifying the unit's educational and collaborative approach.

### 2.4 Evaluating patient outcomes and resource utilization in healthcare settings

We examined critical patient outcomes and resource allocation through two primary lenses: mortality and Case-Mix-Index (CMI). Secondary outcomes of focus included instances of discharge against medical advice, complications, and transfers to the Intensive Care Unit (ICU). The CMI, prevalent in German healthcare, numerically represents the average resource intensity, acknowledging diverse factors like diagnoses and procedures during a patient's stay, thus symbolizing the respective care level and resources. A higher CMI suggests that patients necessitate enhanced medical attention and resource deployment. Data were procured from the hospital patient register.

Patients discharged from May 1, 2021, to April 30, 2022, were invited to contribute via an anonymous questionnaire, available online and in a paper-based format, per individual preference. The questionnaire is accessible in [Supplementary material S1](#). In the absence of a standardized questionnaire during the study planning phase, we utilized the patient questionnaire from the clinic's quality management, supplemented with inquiries on interprofessional core competences, aligned with international frameworks (1, 70, 71, 80, 85). The questionnaire, comprising 42 questions, addresses various aspects. The initial section comprises 21 questions assessing general stay information on a 5-point Likert scale. Subsequent sections evaluate organization, examinations, and nursing measures using a 5-point Likert scale. Following this, three sections gauge knowledge



and competence, communication, professional appearance, and empathy of medical and nursing students and professional staff on a 5-point Likert scale. The questionnaire concludes with queries on health status, two open-ended general feedback questions, and categorization based on age group and length of stay. Prior to implementation, the questionnaire underwent face validation in a small patient cohort.

## 2.5 Statistical analysis – statistical comparison of qualitative variables

Qualitative variables underwent comparative analysis utilizing Pearson’s chi-square test of independence. All tests were two-sided, with a *p*-value under 0.05 denoting statistical significance. Analyses were conducted using IBM SPSS Statistics for Windows, version 28.0 (released in 2021) by IBM Corp., Armonk, NY.

## 3 Results

Of the respondents, 281 completed the questionnaire, achieving an 84.6% response rate. This included 125 patients from the A-STAR

and 156 from conventional wards. Table 1 illustrates the participants’ sociodemographic data, revealing no significant group discrepancies.

### 3.1 Optimized patient interaction and communication in the interprofessional training ward A-STAR

In addressing fears and concerns, patients in the A-STAR group felt more acknowledged by the interprofessional team compared to those in conventional wards (100% vs. 91.8%,  $\chi^2(3) = 10.66$ , *p* = 0.014,  $\phi = 0.203$ , Figure 1). Furthermore, a higher percentage of A-STAR patients noted that the team addressed all their medical questions compared to the conventional wards (98.3% vs. 96.1%,  $\chi^2(3) = 11.32$ , *p* = 0.010,  $\phi = 0.200$ , Figure 1).

### 3.2 High patient satisfaction in the interprofessional training ward A-STAR

Patients in the A-STAR training ward expressed high satisfaction across various aspects of their care and ward rounds (Figure 2). Satisfaction rates in the following aspects were not significantly

TABLE 1 Patient characteristics of qualitative outcome analysis (2021–2022).

Characteristic	A-STAR ( <i>n</i> = 125)	Conventional wards ( <i>n</i> = 156)	
Age			$\chi^2(4) = 2.73$ ; <i>p</i> = 0.604
18 to 24 years	8.0% (10)	4.5% (7)	
25 to 34 years	6.4% (8)	7.1% (11)	
35 to 50 years	14.4% (18)	11.5% (18)	
51 to 70 years	50.4% (63)	51.3% (80)	
Above 70 years	13.6% (17)	17.9% (28)	
NA	7.2% (9)	7.7% (12)	
Length of stay			$\chi^2(3) = 4.55$ ; <i>p</i> = 0.208
1 to 3 days	27.2% (34)	22.4% (35)	
4 to 7 days	32.0% (40)	25.0% (39)	
8 to 14 days	20.8% (26)	26.9% (42)	
Above 14 days	10.4% (13)	16.0% (25)	
NA	9.6% (12)	9.6% (15)	
Subjective health level at admission			$\chi^2(3) = 5.85$ ; <i>p</i> = 0.119
Very good	34.4% (43)	28.2% (44)	
Rather good	24.0% (30)	28.2% (44)	
Rather poor	25.6% (32)	21.2% (33)	
Very poor	10.4% (13)	19.9% (31)	
NA	5.6% (7)	2.6% (4)	
Subjective health level on the day of the interview			$\chi^2(3) = 5.85$ ; <i>p</i> = 0.500
Very good	45.6% (57)	38.5% (60)	
Rather good	40.0% (50)	49.4% (77)	
Rather poor	6.4% (8)	5.8% (9)	
Very poor	0.8% (1)	1.3% (2)	
NA	7.2% (9)	5.1% (8)	

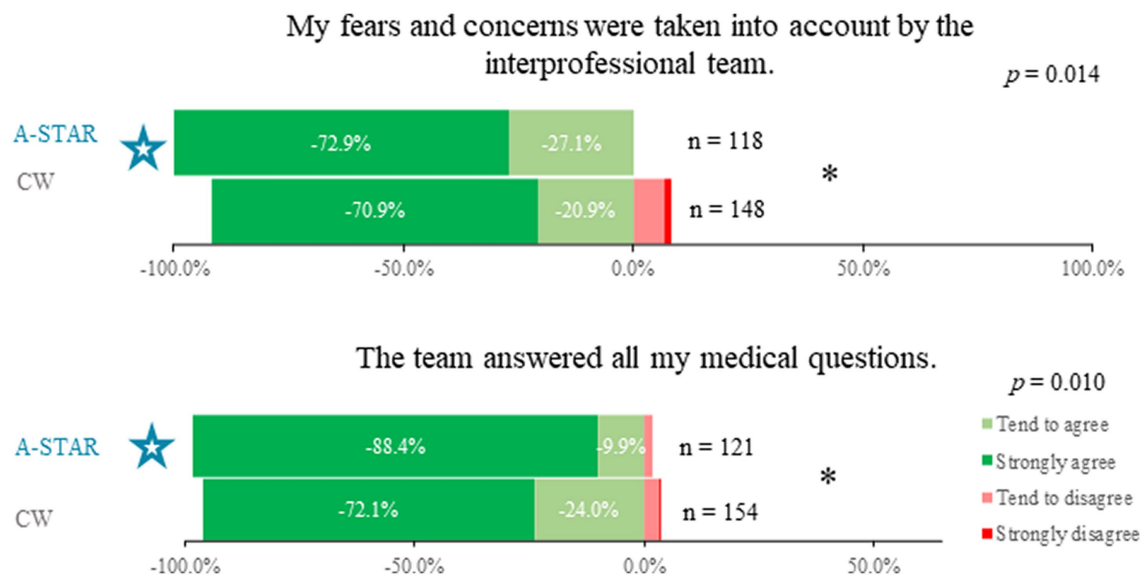


FIGURE 1

Enhanced patient interaction and query resolution in A-STAR vs. conventional wards. Patients in the A-STAR interprofessional training ward ( $n = 118$ ) experienced more consideration of their fears and concerns compared to those in conventional wards ( $n = 148$ ), ( $\chi^2(3) = 10.66$ ;  $p = 0.014$ ;  $\phi = 0.203$ ). Moreover, a significantly larger proportion of A-STAR patients ( $n = 121$ ) reported having all their medical questions addressed by the team, in contrast to patients in the conventional wards ( $n = 154$ ), ( $\chi^2(3) = 11.32$ ,  $p = 0.010$ ,  $\phi = 0.200$ ).

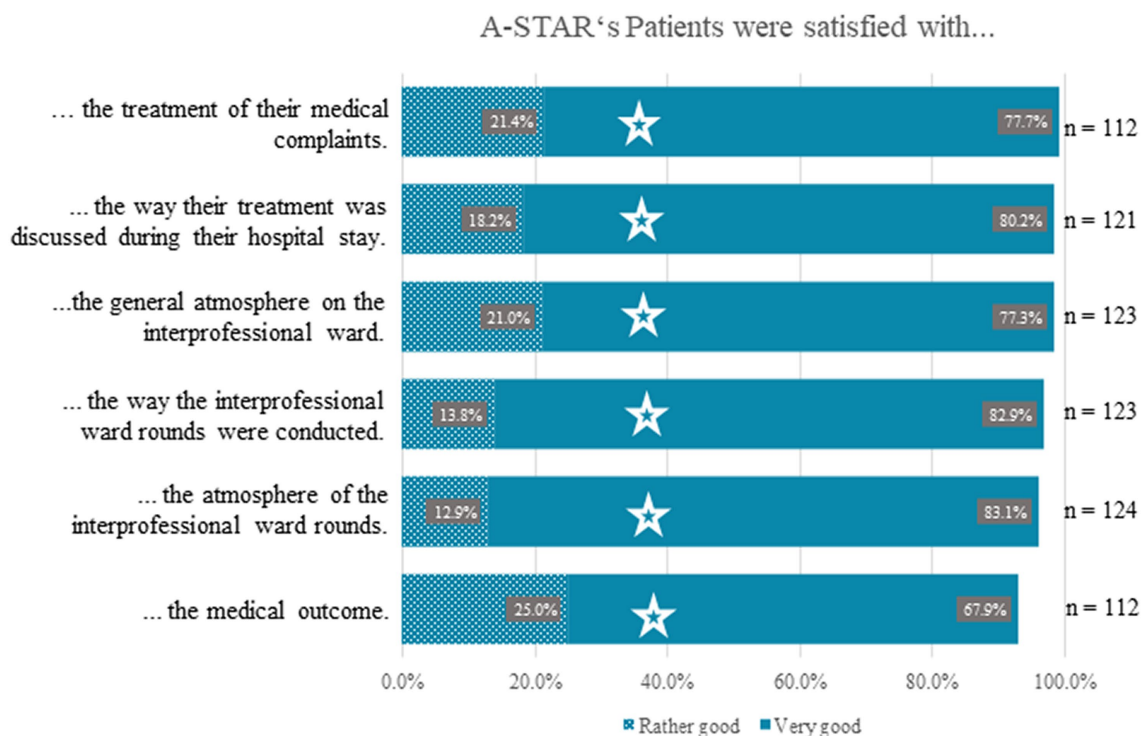


FIGURE 2

High levels of patient satisfaction across various care aspects in A-STAR interprofessional training ward. Patients in the A-STAR training ward expressed substantial satisfaction across multiple facets of their care and ward rounds. Satisfaction levels in these areas showed no significant variance compared to conventional wards, with equally excellent results across all ward types. Specifically, 99.1% ( $n = 112$ ) were satisfied with the treatment of their medical complaints ( $\chi^2(3) = 3.43$ ,  $p = 0.330$ ), 98.4% ( $n = 121$ ) appreciated discussions about their treatment during the stay ( $\chi^2(3) = 5.87$ ,  $p = 0.118$ ), and 98.3% ( $n = 123$ ) endorsed the general atmosphere on the ward ( $\chi^2(3) = 3.41$ ,  $p = 0.333$ ). Additionally, satisfaction levels remained high concerning how interprofessional ward rounds were conducted (96.7%,  $n = 123$ ;  $\chi^2(3) = 5.39$ ,  $p = 0.146$ ) and their atmosphere (96.0%,  $n = 124$ ;  $\chi^2(3) = 1.814$ ,  $p = 0.612$ ). Furthermore, 92.9% ( $n = 112$ ) were content with the medical outcome and acknowledged collaborating with the interprofessional medical team to decide on further care ( $\chi^2(3) = 1.97$ ,  $p = 0.580$ ). Notably, these results mirrored the perceptions from conventional wards, as evidenced by the Chi-Square test.

different from those in conventional wards. The results are comparably excellent regardless of the type of ward: Specifically, 99.1% ( $n = 112$ ) were content with the treatment of their medical complaints ( $\chi^2(3) = 3.43$ ,  $p = 0.330$ ), 98.4% ( $n = 121$ ) valued discussions about their treatment during the stay ( $\chi^2(3) = 5.87$ ,  $p = 0.118$ ), and 98.3% ( $n = 123$ ) endorsed the overall atmosphere on the ward ( $\chi^2(3) = 3.41$ ,  $p = 0.333$ ). Additionally, satisfaction levels remained high regarding the conduct of interprofessional ward rounds (96.7%,  $n = 123$ ;  $\chi^2(3) = 5.39$ ,  $p = 0.146$ ) and their atmosphere (96.0%,  $n = 124$ ;  $\chi^2(3) = 1.814$ ,  $p = 0.612$ ). Furthermore, 92.9% ( $n = 112$ ) were satisfied with the medical outcome and acknowledged collaborating with the interprofessional medical team to decide on further care ( $\chi^2(3) = 1.97$ ,  $p = 0.580$ ). Due to the comparable results, the figure for clarity only shows the outcomes from the interprofessional training ward (Figure 2).

### 3.3 Perceived professional competence: equivalence between A-STAR and conventional ward medical teams as viewed by patients

Patient perceptions of competence were comparable between the A-STAR's team of medical students and nursing trainees and the conventional wards' professional medical teams in areas of knowledge

(A-STAR:  $n = 75$ , CW:  $n = 83$ ;  $\chi^2(3) = 2.31$ ,  $p = 0.315$ ), communication (A-STAR:  $n = 77$ , CW:  $n = 88$ ;  $\chi^2(3) = 2.37$ ,  $p = 0.500$ ), professional demeanor (A-STAR:  $n = 75$ , CW:  $n = 86$ ;  $\chi^2(3) = 2.33$ ,  $p = 0.312$ ), and empathy (A-STAR:  $n = 77$ , CW:  $n = 82$ ;  $\chi^2(3) = 7.30$ ,  $p = 0.063$ ), as demonstrated in Figure 3. Both teams were highly rated across these domains.

### 3.4 Comparing patient outcomes: mortality and complications in A-STAR vs. conventional wards

We analyzed outcome data from 1,482 A-STAR group patients and 5,752 conventional ward patients, with sociodemographic details presented in Table 2. The A-STAR group had a notably higher percentage of male patients (73.5%) than the conventional wards (70.4%,  $\chi^2(1) = 5.12$ ,  $p = 0.024$ ). Additionally, A-STAR patients were significantly younger, averaging 59 years, compared to the 61-year average in conventional wards (Mann-Whitney-U-Test,  $p < 0.01$ ).

In examining patient outcomes, the A-STAR group and conventional wards demonstrated no significant differences in several key areas despite varying patient demographics and illness severities. Detailed findings, visualized in Figure 4, are outlined below:

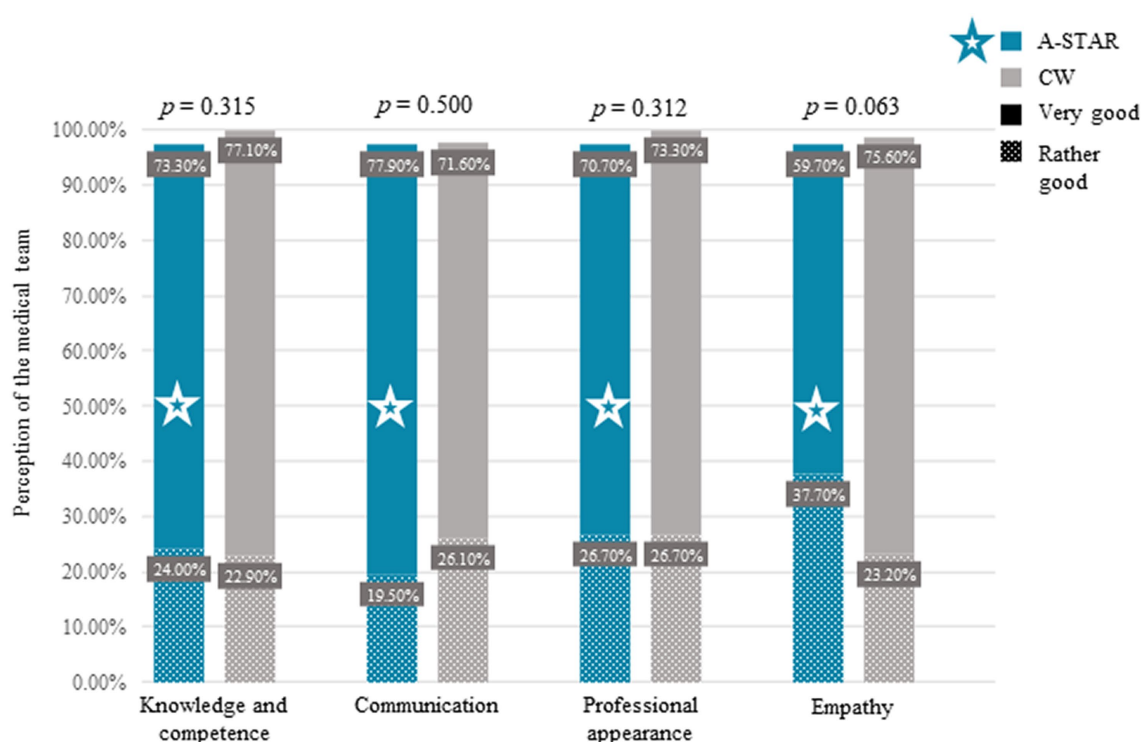
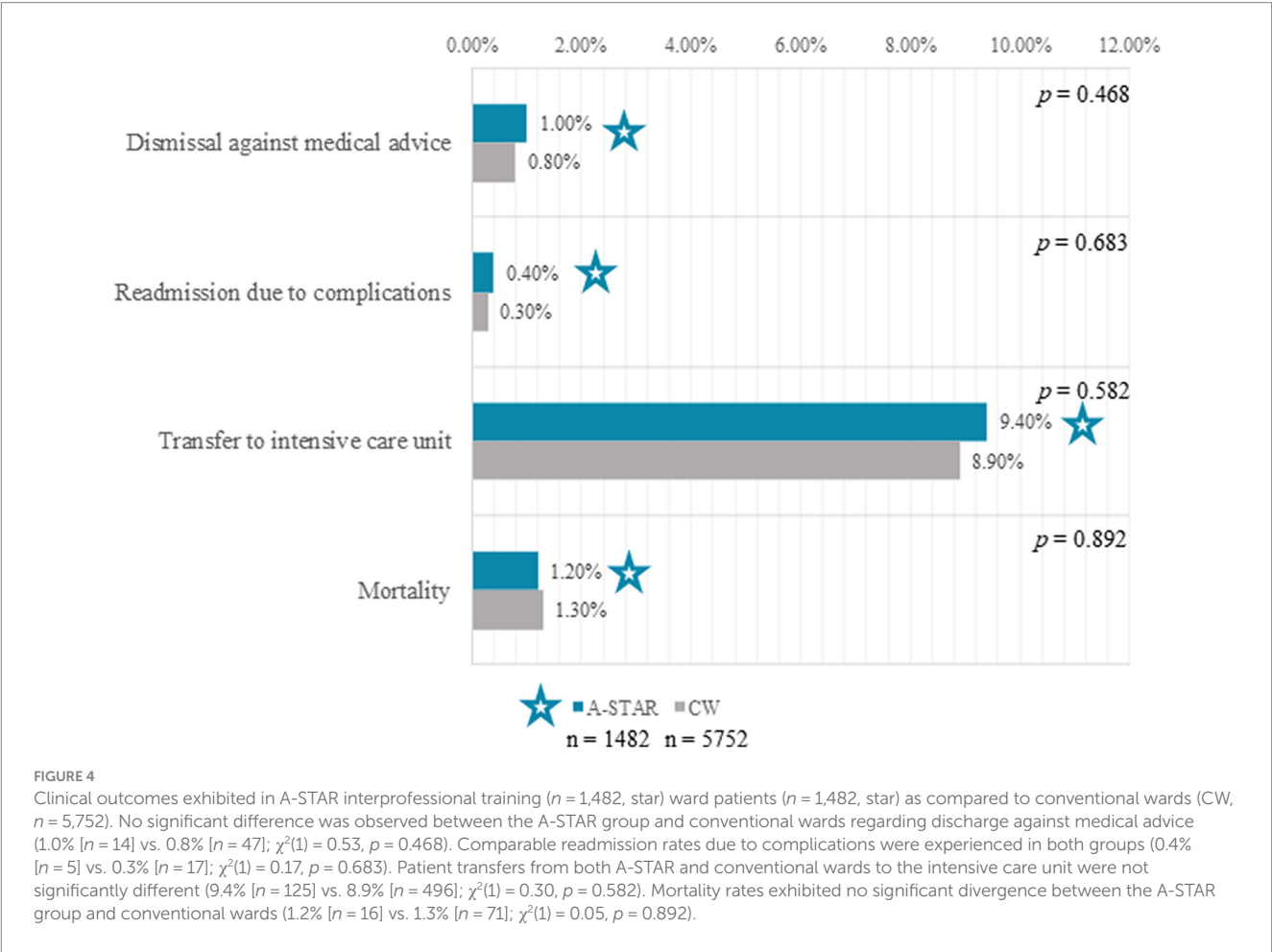


FIGURE 3

Comparative patient perceptions of medical team competency: A-STAR vs. conventional wards. Patients generally perceived medical teams in the A-STAR interprofessional training ward—led by final-year medical students and nursing trainees—as equivalently competent to the professional teams in conventional wards (CW), which professional doctors and nurses led. Notably, no significant differences were found in patient evaluations between the two ward types in terms of: Knowledge (A-STAR:  $n = 75$ , CW:  $n = 83$ ;  $\chi^2(3) = 2.31$ ,  $p = 0.315$ ), communication (A-STAR:  $n = 77$ , CW:  $n = 88$ ;  $\chi^2(3) = 2.37$ ,  $p = 0.500$ ), professional appearance (A-STAR:  $n = 75$ , CW:  $n = 86$ ;  $\chi^2(3) = 2.33$ ,  $p = 0.312$ ), and empathy (A-STAR:  $n = 77$ , CW:  $n = 82$ ;  $\chi^2(3) = 7.30$ ,  $p = 0.063$ ), as determined by the Chi-Square test.

TABLE 2 Patient characteristics of the patients included in the outcome analysis (2019–2022).

Characteristic	A-STAR (n = 1,482)	Conventional wards (n = 5,752)	
Age			$p < 0.01$
Median (range) – yr	59 (18–101)	61 (16–98)	
Sex			$\chi^2(1) = 5.12; p = 0.024$
Male – no. (%)	1,089 (73.5)	4,052 (70.4)	
Female – no. (%)	393 (26.5)	1,700 (29.5)	
CMI (2019–2022)	2.4	2.1	



- **Discharge Against Medical Advice:** Both groups presented similar occurrences of discharge against medical advice (A-STAR: 1% [n = 14] vs. conventional wards: 0.8% [n = 47],  $\chi^2(1) = 0.53, p = 0.468$ ).
  - **Readmission Rates:** Comparable rates of readmission due to complications were noted between A-STAR and conventional wards (0.4% [n = 5] vs. 0.3% [n = 17] respectively,  $\chi^2(1) = 0.17, p = 0.683$ ).
  - **Transfer to Intensive Care:** Transfer rates to intensive care units showed no significant difference between the two groups (A-STAR: 9.4% [n = 125] vs. Conventional Wards: 8.9% [n = 496],  $\chi^2(1) = 0.30, p = 0.582$ ), even with the A-STAR group hosting patients with a higher average severity of illness (Case-Mix-Index: 2.4 vs. 2.1).
- **Mortality Rates:** Mortality rates were likewise consistent between A-STAR and conventional wards (1.2% [n = 16] vs. 1.3% [n = 71],  $\chi^2(1) = 0.05, p = 0.892$ ). In both settings, 3/4 of the mortality cases were due to palliative conditions, including but not limited to cancer and acute-on-chronic liver failure.

3.5 Maximized patient engagements and positive views on care and cooperation within the A-STAR ward

The A-STAR as well as the conventional wards show notable results highlighting the positive impact of teamwork. The A-STAR

demonstrates comparable outcomes to those of the conventional wards in the following aspects:

100% ( $n=121$ ) affirmed that the team assisted them in comprehending all pertinent information ( $\chi^2(3)=5.10, p=0.165$ ),

99.2% ( $n=123$ ) felt well cared for ( $\chi^2(3)=1.78, p=0.411$ ),

98.3% ( $n=119$ ) would recommend the ward to friends or family ( $\chi^2(3)=2.19, p=0.534$ ),

97.4% ( $n=114$ ) believed the team understood what was important to them ( $\chi^2(3)=3.53, p=0.317$ ), and

96.6% ( $n=117$ ) acknowledged the team's collaboration as a positive influence on their well-being ( $\chi^2(3)=6.55, p=0.088$ ).

These findings were statistically akin to perceptions from conventional wards, as indicated by the Chi-Square test results. The figure exclusively presents the results from the A-STAR (Figure 5).

### 3.6 Elevating patient experience through compassionate and inclusive care in A-STAR

Patients consistently lauded “the universal kindness of the staff in their open-ended feedback.” One patient spotlighted the clarity and comprehensiveness with which medical students explained medical aspects, appreciating the nursing staff's availability and promptness in addressing problems or inquiries. Highlights from patient insights included:

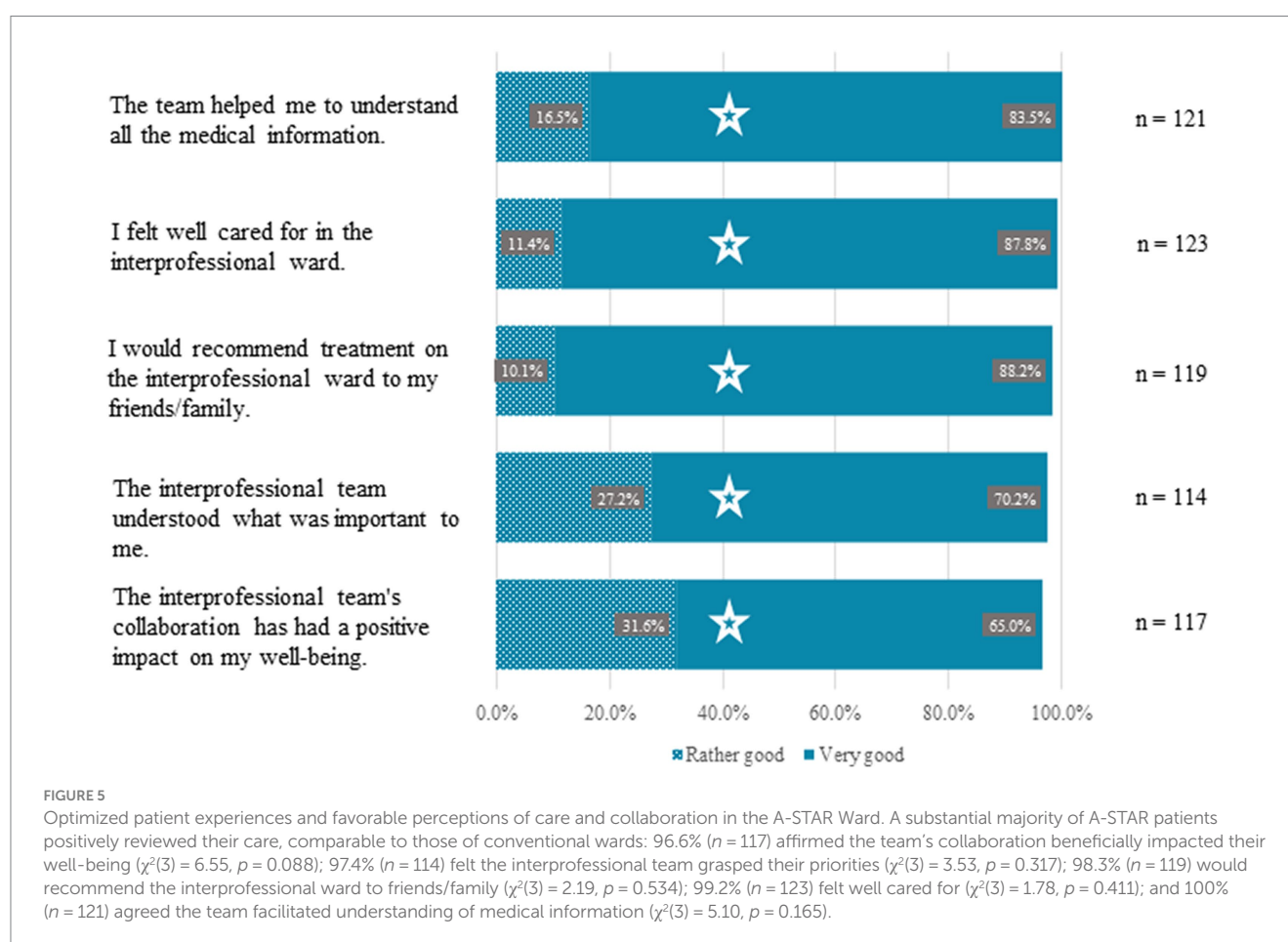
- Intensive care and candid discussions regarding risks, potential outcomes, and therapeutic alternatives by medical students,
- Meticulous preparation for potentially severe scenarios, and
- Provisions for private, post-round discussions to address lingering questions.

Another patient valued the “prompt information and active involvement in the therapeutic journey,” acknowledging the feeling of being treated as an equal and active participant due to the unhurried, attentive interactions with staff. “It seemed like all team members, spanning medical to nursing, were acquainted with my symptoms and worries. Every professional group collaborated flawlessly, each playing their specific role,” shared another patient.

## 4 Discussion

### 4.1 Enhanced health outcomes through interprofessional collaboration: a scientific exploration

In 2009, a Cochrane review substantiated that interventions fostering practice-based interprofessional collaboration can ameliorate health-related processes and outcomes (67). However, deducing generalizable conclusions regarding interprofessional collaboration's fundamental elements and efficacy proved complex due to constraints





such as the scarcity of studies, variable sample population sizes, challenges in collaboration conceptualization and measurement, and variability in interventions and context (67). After this, the body of research has seen modest augmentation, with a predominant focus on exploring patient satisfaction (13, 16, 19, 35, 60–62, 66, 67). Typically, these studies have been constrained by a restricted case pool, and only a minimal subset has undertaken comparative analyses between training and conventional wards.

Our research stands out as the most comprehensive controlled study to date, meticulously examining patient satisfaction through a detailed 42-question survey. Our findings highlight that patient care on the A-STAR ward is not only on par with, but in certain aspects, exceeds the quality observed on conventional wards, both from subjective and objective standpoints.

Patients in our study uniformly expressed significant satisfaction across diverse facets of their hospital stay. In particular, they strongly appreciated the ward's round atmosphere, its conduct, the clarity of information regarding their treatment and disease progression, and in-depth treatment discussions throughout their stay. Notably, a higher percentage of A-STAR group patients felt their medical questions and anxieties were thoroughly and considerately addressed by the healthcare team compared to those in conventional wards.

High patient satisfaction rates, especially in communication, resonate with findings from earlier studies in training ward environments. Freeth et al. pioneered patient satisfaction research in their UK rheumatology-orthopedic training ward, discovering a pronounced appreciation for enhanced attention among a cohort of 34 patients (35). A follow-up study by the same team compared patient experiences with conventional wards reinforced these insights, showing elevated satisfaction in areas like "patient question response," "patient information provision," and "meeting patient needs" (61). Lindblom et al. explored the satisfaction levels of almost 300 patients at their Swedish orthopedic training ward, surveying after medical care by students at varied educational levels (66). Patient feedback from their satisfaction questionnaire revealed prominent satisfaction, rated from good to excellent, particularly regarding disease and treatment information. The team's interaction with and accessibility to patients was also highly valued. A study by Brewer et al. indicated similarly high satisfaction scores within their general medical training ward at Royal Perth Hospital in Australia, registering top-average scores in all categories of the hospital's standard patient satisfaction survey (16). However, this study did not provide a comparison with conventional wards. In another investigation, Straub et al. evaluated satisfaction among 56 pediatric patients and 109 parents in a German pediatric training ward, finding exemplary ratings in information dissemination, interprofessional cooperation, and the influence of trainee nurses and physicians on overall care (62). Hallin et al., researching 84 patients in a Danish orthopedic training ward, found that patients felt significantly better informed and more satisfied regarding home care information (56). These patients also believed that the interprofessional training ward staff incorporated their home circumstances more comprehensively into discharge planning and reported a notably higher level of involvement in treatment decisions.

A limitation of our study involves using a non-standardized patient questionnaire. Conversely, Marcussen et al. applied the standardized Client Satisfaction Questionnaire (CSQ-8) in their study

with 129 patients at a psychiatric training ward in Denmark, discovering significantly elevated satisfaction rates compared to a control group of 123 patients (59).

The consistently high patient satisfaction in interprofessional training wards can be ascribed to an optimal patient-healthcare-worker ratio, enabling more regular discussions and continual interprofessional briefings among healthcare workers, ensuring unified information distribution to the patient.

Our study is the first to compare trainee and professional healthcare team performances, revealing that A-STAR patients perceived medical students and nursing trainees as equally proficient as professional teams in conventional wards regarding knowledge, communication, professional demeanor, and empathy. Given patients' constrained capacity to evaluate medical treatments due to their non-specialist knowledge, easily assessable aspects like communication become vital in enhancing their comfort and assurance in the care provided.

Furthermore, our study validates patient and health worker relationship perceptions in interprofessional training wards using the objective metric of discharges against medical advice. No significant differences were observed between the A-STAR group and conventional wards in this regard, indicating that trainees typically established effective doctor-patient relationships in most cases.

Despite A-STAR patients exhibiting a higher severity of illness, they experienced readmission rates and patient transfers to the intensive care unit comparable to those in conventional wards. While numerous studies illustrate that interprofessional interventions can reduce complication rates (19, 38–41, 55, 57, 58), data specifically on interprofessional training wards remain sparse. For example, Hallin et al. found no difference in 90-day readmission rates between their orthopedic training ward (1,109 patients) and conventional wards (4,653 patients) from 2006 to 2011 (55). Recent data from the HIPSTA surgical training ward in Germany, as published by Kuner et al., revealed no substantial differences in the rate or severity of postoperative complications between 232 training ward patients and 465 conventional ward patients (58). Notably, the training ward saw fewer reoperations, demonstrating a variance in surgical intervention frequencies between the two settings. Hansen et al. evaluated the quality of life in 62 patients from a Danish orthopedic training ward and 72 from conventional wards 3 months post-hospital stay, finding no significant differences in outcomes between the two groups (57).

Comparable mortality rates were observed between the A-STAR group and conventional wards, with most deaths in both contingents attributed to the palliative status of underlying conditions. This aligns with Hallin et al. and Kuner et al., who reported no significant mortality rate differences in their cohorts (55, 58).

These findings reinforce the safety and reliability of patient care in training wards, ensuring that patients can confidently receive treatment in these environments. A prevalent limitation across all studies, the present study included, is the need for more controlled patient randomization. Nevertheless, existing data suggests that implementing such randomization would not negatively impact patient outcomes. Further research, especially focusing on the quality of patient transitions to post-inpatient sectors and family care quality, is imperative to understand the impacts of interprofessional training wards on patient care and outcomes thoroughly.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by Ethikkommission bei der Universität Regensburg Universität Regensburg, 93040 Regensburg (20-1805\_1-101). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

SS-H: Conceptualization, Data curation, Formal analysis, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. EA: Data curation, Investigation, Writing – review & editing. MMe: Data curation, Investigation, Writing – review & editing. SA-F: Conceptualization, Methodology, Writing – review & editing. KR: Conceptualization, Methodology, Writing – review & editing. SR: Writing – original draft, Writing – review & editing. BM: Writing – review & editing. AM: Writing – review & editing. CK: Supervision, Writing – review & editing. SS: Writing – review & editing. MMü: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

## Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

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## Acknowledgments

We sincerely thank the devoted interprofessional teams from both the A-STAR and conventional units, whose commitment and collaboration were vital to the success of this study. Additionally, we express deep appreciation to the patients of the interprofessional training ward, whose essential participation and contributions were indispensable to this research.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2024.1320027/full#supplementary-material>

### SUPPLEMENTARY DATA SHEET 1

German questionnaire.

### SUPPLEMENTARY DATA SHEET 2

Questionnaire in English translation.

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