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RESEARCH ARTICLE

Design and evaluation of a tool to assess the impact of interprofessional education on the development of pharmacy professional competencies

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Abstract

Background: Several generic tools to assess interprofessional education (IPE) are available, but a tool specifically designed to measure the impact of IPE experiences on the development of pharmacy competencies is lacking. The aim was to develop, psychometrically evaluate, and pilot test a tool to assess the impact of IPE on pharmacy competency development. **Methods:** A tool to measure the impact of IPE on pharmacy competency development was constructed and validated through a two-round Delphi technique. The internal consistency of the tool was tested using Cronbach's alpha. The tool was subsequently distributed to students (n = 32) and alumni (n = 14) of a postgraduate pharmacy professional doctorate course who had IPE experiences. **Results:** The developed 'Interprofessional Education on Pharmacy Competencies (IPEPC)' tool consists of ten items divided into four core competencies. The tool demonstrated adequate internal consistency between the items in each of the core competencies. Significant improvements in the scores for teamwork (p = 0.026) and ethics competencies (p = 0.037) were observed when comparing scores achieved for doctorate students in the different years of study and alumni of the same course. **Conclusion:** This study could demonstrate that the tool was able to detect different IPE competencies in pharmacy education. It also revealed that teamwork and ethics competencies may be positively influenced by participants' years of study and experience.

Introduction

Interprofessional approaches to patient care improve professional relationships, increase efficiency, and enhance health outcomes (Curran *et al.,* 2010; Spaulding *et al.,* 2021; Padilla, 2024). The concept of interprofessional education (IPE) and practice focuses on teaching students from various healthcare disciplines together. This collaborative approach aims to improve the quality of patient care by preparing future healthcare professionals to work effectively as a team (Kim *et al.,* 2019; De Mendonça *et al.,* 2024).

In 2016, the Interprofessional Education Collaborative (IPEC) Board published an updated report intending to define competencies for interprofessional collaborative practice (Interprofessional Education Collaborative Expert Panel, 2016). Training programmes, educational seminars, and academic activities, which include terms such as "*competency*" and "*interprofessional*," are becoming the norm in many university curricula (Rouse & Meštrović, 2020; Arruzza *et al.,* 2023). Some of the interprofessional skills listed by the World Health Organisation were present in the development of numerous healthcare professions (Interprofessional Education Collaborative Expert Panel, 2016), while others are still inadequately addressed in many educational programmes (Muzyk *et al.,* 2020; Rouse & Meštrović, 2020; Au, 2023). Many curricular activities focus only on enhancing knowledge rather than building practical skills, attitudes, and values (Muzyk *et al.,* 2020). However, all competency components are considered critical elements for current pharmacy practice and must be translated into

meaningful changes in care delivery (Rouse & Meštrović, 2020; Arruza *et al.,* 2023).

Connecting practice to education is necessary to evaluate the impact of IPE on care delivery. Measuring the effectiveness of these interprofessional activities and assessing outcomes of interprofessional competency from pharmacy degree programmes are crucial to ensuring good pharmacy services (Rouse & Meštrović, 2020).

Measuring improved competencies, quality of services provided, and patient outcomes should be essential aspects of pharmacy educational programmes (Ocampo *et al.,* 2015; Muzyk *et al.,* 2020).

Various tools for assessing IPE have been identified in the literature (Kenaszchuk, 2013; Allvin *et al.,* 2023). Some of these tools, such as the Collaborative Healthcare Interdisciplinary Planning (CHIRP) scale (Hollar *et al.,* 2012) and the Student Perceptions of Interprofessional Clinical Education (SPICE-R2) (Zorek *et al.,* 2016), focus on the perception and reaction to IPE, while others try to assess attitudes and knowledge acquired on this topic (Baker *et al.,* 2008; MacDonald *et al.,* 2010). Kirkpatrick's model has been widely used in the literature to classify IPE tools (Shrader *et al.,* 2017). Kirkpatrick classification is a well-established and recognised method that provides structure and is time-efficient to administer (Paull *et al.,* 2016). Although this approach is not the only way to evaluate IPE tools and has been criticised, its contribution to IPE cannot be underestimated (Cox *et al.,* 2016). The simplicity, focus, and systematic approach render Kirkpatrick's Model one of the most widely used tools for evaluating and classifying IPE tools (Paull *et al.,* 2016).

Different ways and models exist to assess IPE, but best practices have not yet been identified (Shrader *et al.,* 2017; Muzyk *et al.,* 2020). While approaches to IPE have expanded and all existing tools contribute to understanding its impact, measurement techniques in this field are still evolving, necessitating further research (Allvin *et al.,* 2023). A standardised method to measure IPE's influence on care delivery is particularly needed (Cox *et al.,* 2016; Allvin *et al.,* 2023). Regarding roles and responsibilities, combining profession-specific competencies with shared healthcare competencies could enhance person-centred care (Harper, 2019; Padilla, 2024). Although IPE is a recognised competency in pharmacy education and various generic tools for IPE assessment exist, there is a lack of instruments specifically designed to measure how IPE experiences influence pharmacy competency development. This study aimed to address this gap by developing, psychometrically evaluating, and piloting a tool to assess the impact of IPE on the development of pharmacy competencies.

Methods

Tool development

The tool was developed based on existing literature (World Health Organization, 2010; Association of Schools and Programs of Public Health, 2015; Interprofessional Education Collaborative Expert Panel, 2016), highlighting topics related to ethics for practice, teamwork, and responsibilities. The IPEC report served as the foundation for developing the tool since it is supported by various international associations and institutions (Interprofessional Education Collaborative Expert Panel, 2016; Health Professions Accreditors Collaborative, 2019; Shrader *et al.,* 2022). Competencies listed in the IPEC report are applicable to the pharmacy profession and were applied in the developed tool, which, before validation, consisted of eleven items divided into the four core competencies listed in the IPEC report.

The Delphi method was used to validate the developed tool and establish an agreement between the panellists. This approach was chosen to ensure that the evaluation was applied to each item of the tool to the same extent, guarantee the anonymity of the panel participants, and prevent the "*halo effect*" that may occur when greater weight is given to the views of the more experienced members of the group (Barrett & Heale, 2020). Two expert panels, comprising seventeen Maltese and nine international healthcare professionals (pharmacists, physicians, nurses, occupational therapists, physiotherapists, social workers, and speech-language pathologists), were recruited by convenience sampling. Face and content validity were assessed.

The first Delphi panel included twelve pharmacists from different areas of practice (hospital, community pharmacy, regulatory affairs, and academia) and one physician; the second panel comprised two nurses, two occupational therapists, two physiotherapists, two social workers, two speech-language pathologists, and three physicians (Table I).

Email invitations, including instructions, the study rationale, and a link to the tool, were sent to the expert panels. In both rounds, the experts were asked to rate the clarity and relevance of each item of the tool developed on Google Forms on a Likert scale from 1 (lowest) to 5 (highest). The last question was open-ended to allow experts to provide suggestions. All experts agreed to participate in the validation process.

At the end of each round, a mean rating score out of 5 was calculated for each item. Items that obtained a mean rating score <4 were revised, optimised, and submitted for a second validation by the same panel.

Table I: Demographics of participants in the Delphi expert panels for validation

Variables	Round 1 (N = 13)	Round 2 (N = 13)
Gender		
Male	5	3
Female	8	10
Age (years)		
21-35	2	4
36-45	2	7
46-55	5	0
55-69	3	2
70+	1	0
Profession		
Pharmacist	12	0
Physician	1	3
Nurse	0	2
Occupational therapist	0	2
Physiotherapist	0	2
Social worker	0	2
Speech language pathologist	0	2
Graduate level		
Undergraduate	1	10
Postgraduate	12	3
Area of practice		
Community	1	0
Academia	7	0
Hospital	4	13
Other	1	0
Years of experience		
2-5	0	1
6-10	4	8
>10	9	4

Sample

Students and alumni of the postgraduate professional Doctor of Pharmacy course at the University of Malta were enrolled in the research (N = 51). This three-year level 8 course, offered in collaboration with the College of Pharmacy of the University of Illinois at Chicago, USA, is open to pharmacists from various countries and practice settings. The programme includes advanced interprofessional experiential rotations in diverse settings, such as community pharmacy, hospital pharmacy, and patient safety regulatory settings. These interprofessional activities consist of two sessions of four weeks during the first year and three sessions of six weeks spread between the second and third years of the course (Vella *et al.,* 2021).

Data collection

The IPEPC tool was developed on Google Forms and disseminated to all participants who had already been exposed to different IPE activities. Responses were collected over three weeks. The researcher disseminated the link after participants were invited by their academic mentors to join the project.

Data analysis

After both rounds of the Delphi validation, Cronbach's alpha was used to test the internal consistency of items within each core competency. Exploratory factor analysis (EFA) was performed to confirm the existence of a latent factor structure and determine the number of factors (core competencies). Principal axis factoring was used for factor extraction, followed by Varimax rotation to facilitate an interpretable pattern in the loading matrix. The number of factors (latent variables) was determined using the eigenvalue greater than 1 rule. Confirmatory factor analysis (CFA) was conducted to confirm the hypotheses regarding the underlying latent structure. CFA is essential to confirm this latent structure and examine the relationships between latent factors. Root mean squared error of approximation (RMSEA) values below 0.07 indicated a close model fit to the data. The comparative fit index (CFI) and Tucker-Lewis index (TLI) above 0.9 suggested a good model fit. Standardised root mean square residual values below 0.05 indicated a good model fit (Steiger, 2007; Awang, 2012). The Kruskal-Wallis test was used to compare mean core competency scores between participant groups clustered by gender (male, female, and other), age, year of study, years of practice as a pharmacist, and area of practice.

Results

Psychometrics of developed tool

After the first round of Delphi validation, item 5 was rephrased from "*Participating in continuous professional and interprofessional education to improve collaboration and patient-centred outcomes*" to "*Participating in continuous interprofessional education opportunities*," and item 9 ("*Communicating constantly the importance of teamwork in patient-centred and community-focused care*") was removed for redundancy. All items were retested, and consensus was reached, with each item receiving a mean rating score of 4 or higher. After the second round, items containing the phrase "*patient-centred care*" were amended to "*person-centred care*." All items were retested and received mean rating scores higher than 4. After validation, the IPEPC tool consisted of ten items divided into four core competencies. The tool is formatted as a self-administered questionnaire with 5-point Likert-type questions.

For the four core competencies, Cronbach's alpha values exceeded the 0.7 threshold value, indicating satisfactory internal consistency between the items in each core competency.

From the EFA, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.761, exceeding the 0.5 threshold value. Additionally, Bartlett's test of sphericity yielded a *p*-value of approximately 0, which is less than the 0.05 level of significance, indicating that a factor structure existed within the ten observable items. The four factors with eigenvalues >1 accounted for 75.14% of the total variance. Communalities ranged from 0.588 to 0.922, suggesting that the four factors (latent variables) explained between 58.8% and 92.2% of the variance in each item. The sum of the ten communalities equalled the sum of the first four eigenvalues. Factor loadings <0.4 were suppressed to facilitate the description and interpretation of the four latent variables.

Factor 1 loaded heavily on items 3, 4, 5, and 6, representing 'Responsibilities/Roles'; Factor 2 loaded heavily on items 7 and 8, denoting 'Interprofessional Communication'; Factor 3 loaded heavily on items 1 and 2, representing 'Values/Ethics for Interprofessional Practice'; and Factor 4 loaded heavily on items 9 and 10, characterising 'Cooperation and Teamwork.' The EFA analysis showed that these ten items identified the presence of four latent structures.

In the CFA (Appendix A), the factor loadings of the first item of each factor were set to 1, while the loadings of the remaining items were significantly greater than 0. This result indicates that each item contributes significantly to defining the four latent factors: Responsibilities/Roles, Interprofessional Communication, Values/Ethics for Interprofessional Practice, and Cooperation and Teamwork.

The variation in participants' responses was greater when evaluating items related to Responsibilities/Roles and Values/Ethics compared to those related to Cooperation and Teamwork. The covariance between Responsibilities/Roles, Interprofessional Communication, Values/Ethics for Interprofessional Practice, and Cooperation and Teamwork were positive and significantly greater than 0, implying that participants who scored high on Responsibilities/Roles also scored high on Values/Ethics for Interprofessional Practice and Cooperation and Teamwork and vice versa.

The RMSEA value of 0.064 indicated a close fit, being lower than the 0.07 threshold. The CFI and TLI for this model were 0.934 and 0.948, respectively, both close to the 0.95 threshold. Additionally, the SRMR value of 0.048 was below the 0.05 threshold, further supporting the model's fit.

All these tests statistically validate the developed tool.

Response

Of the 51 participants, 46 completed the tool (response rate: 90.2%): 14 first-year students, 9 students from the second and third years, and 14 alumni. Thirty-eight respondents were aged between 21 and 35 years, and 35 were female (Table II). Only completed responses were included in the analysis.

Table II: Demographics of the participants who completed the tool (N = 46)

Variables	Number of participants
Gender	
Male	11
Female	35
Age (years)	
21-35	38
36-45	5
46-55	3
Year of study	
First	14
Second	9
Third	9
Alumni	14
Area of practice	
Community	27
Hospital	8
Academia	7
Regulatory	4
Years of practice	
2-5	26
6-10	9
>10	6

When analysing responses, all items received a mean score higher than 4 over 5. The lowest mean score (4.109) was seen in item 10 ("*Using advanced strategies that increase the efficiency of teamwork and team-based care*"). The highest mean (4.478) was observed in item 3: "*Using each professional's unique skills to provide safe, timely, efficient, and effective care*" (Table III).

The four competency mean scores were compared to determine whether there were differences between genders. All the mean scores given by males were marginally higher than those provided by females in all four core competencies (0.122, 0.457, 0.333, and 0.267), but the differences were not statistically significant ($p > 0.05$).

Table III: Mean scores and standard deviations across items of the developed tool

Core competency	Item	Mean score ± SD
Values/Ethics for interprofessional practice	1. Building a trusting relationship with other professionals who support and deliver health services	4.217±1.094
	2. Contributing to placing the person at the centre of healthcare delivery systems	4.239±0.923
Roles/Responsibilities	3. Using each professional's unique skills to provide safe, timely, efficient, and effective care	4.478±0.888
	4. Building interdependent relationships with other professionals to reinforce learning experience	4.261±1.144
	5. Participating in continuous interprofessional education opportunities	4.152±1.192
	6. Understanding how the different roles of other professionals complement each other in the delivery of person-centred care	4.413±1.066
Interprofessional communication	7. Communicating with other professionals to ensure collaborative decision making	4.174±1.180
	8. Discussing with other professionals involved in person-centred care with confidence, clarity and respect	4.261±0.880
Teams and teamwork	9. Involving other professionals in shared person-centred care for therapeutic optimisation	4.283±1.026
	10. Using advanced strategies which increase the efficiency of teamwork and team-based care	4.109±1.016

When analysed by age, participants between 21 and 35 years gave the highest scores for all items. In 'Teams and Teamwork' and 'Values/Ethics for Interprofessional Practice', a statistically significant difference was found between years of the Doctor of Pharmacy course ($p = 0.026$ and $p = 0.037$), with second and third-year students showing the highest agreement (M = 4.611 and M = 4.667).

The last set of analyses, comparing core competency scores to check for differences across years and areas of practice, were not statistically significant ($p > 0.05$). Despite the absence of significance, participants with less than two years of experience as pharmacists highly agreed that IPE has helped them achieve the competencies listed in the IPEPC. Those with more than ten years of experience gave the lowest scores in all four domains.

Discussion

The assessment of students, frameworks, and programmes should grow and evolve as IPE keeps expanding (Dow *et al.,* 2014; Blue *et al.,* 2015; Lockeman *et al.,* 2020). This research led to the development and evaluation of the IPEPC tool, with confirmed internal consistency, to assess the impact of IPE competencies on the pharmacy profession. The inclusion of experts from different countries in the Delphi panel aimed to gain a better understanding of the experience and knowledge that future healthcare professionals need from IPE activities. The tool's length was designed to keep the respondents engaged, resulting in higher-quality data (Kost & De Rosa, 2018; Sharma, 2022). Non-response rates have been directly related to the length and number of questions asked, thus affecting the quantity and reliability of the data gathered (Kost & De Rosa, 2018; Sharma, 2022).

Although IPEC competencies should be achieved by every healthcare professional, a profession-specific approach was adopted to investigate the impact of IPE on the care delivered by pharmacists (Cox *et al.,* 2016; Allvin *et al.,* 2023). The ability to detect different nuances in competencies may lead to changes in pharmacy curricula, enhancing services towards person-centred care (Dash & Monaghan, 2015). Compared to other tools in the literature (Kottorp *et al.,* 2019; Lockeman *et al.,* 2020), the four-factor structure in this tool provides more granular and detailed information about the different competencies of IPE. This advantage can be leveraged to design and implement more specific interventions and changes in the organisation of pharmacy students' activities.

The items in this tool received a mean score higher than 4, indicating that IPE played a crucial role in helping to achieve IPE competencies. These results are consistent with those obtained for non-specific tools (Dow *et al.,* 2014; Lockeman *et al.,* 2020). The 'Roles/Responsibilities' core competency received the highest score, demonstrating the impact of IPE on the role of pharmacists within the team. Conversely, the lowest score was observed in the 'Teams and Teamwork' core competency, suggesting that achieving these competencies through IPE may be more challenging. In this core competency, significant differences were observed between participants of

different age groups. Those aged 21 to 35 viewed the role of IPE in the development of competencies related to team dynamics and teamwork as highly critical, while older participants demonstrated a lower level of agreement. Despite recent criticism, these findings might suggest that pre-licensure IPE activities and frameworks may be an innovative and reasonable approach for future students (Paradis & Whitehead, 2018).

Although previous studies of tools to measure interprofessional competencies have not found significant differences as students progressed through training (Dow *et al.,* 2014; Lockeman *et al.,* 2016), stratifying participants by year of doctoral studies yielded a significant change in the 'Values/Ethics for Interprofessional Practice' and 'Teams and Teamwork' core competencies. The highest level of agreement was found among second- and third-year students. This finding may be explained by the fact that the core competencies 'Values/Ethics for Interprofessional Practice' and 'Teams and Teamwork' were not adequately explored and achieved during the previous year of the course. This aspect may highlight the need to introduce an order in which competencies should be addressed, potentially entailing a change in the organisation of postgraduate pharmacy curricula.

Limitations

Limitations related to the study design should be considered. A convenience sample at a single site was used, which may limit the generalisability of the findings. The cohort comprised students enrolled in the Doctor of Pharmacy course at the University of Malta, selected due to their exposure to interprofessional rotations, providing opportunities to reflect on practice. Despite a high response rate, the relatively small sample size may limit the power of the study and the generalisability of the findings. The Delphi method for validation lacked direct discussions between panellists, and a focus group could have provided additional insights.

Despite potential arguments regarding the lack of objectivity in self-assessment tools measuring IPE competencies, it must be noted that the ability to assess one's skills is a skill in itself, requiring all the elements that every healthcare professional should possess or should have achieved during their career, such as objectivity, self-motivation, experience, and a sound understanding of the competencies involved (Karpen, 2018; Brown & Nestel, 2020). Additionally, this type of assessment can develop students' critical thinking, a crucial aspect for both their academic and future professional careers (Jung *et al.,* 2015; Lu *et al.,* 2021).

The last few years have been an example of how critical a self-assessment tool can be. Due to the COVID-19 pandemic, many faculties and universities transitioned to distance learning approaches. This shift created organisational and logistical challenges, especially for experiential and practical sessions. In these situations, where evaluation by an external preceptor may not be used or may be harder to achieve, resorting to a student self-assessment tool is optimal to overcome these obstacles.

Further studies are necessary to refine the tool and confirm the results and robustness of its structure in a larger cohort.

Conclusion

The newly developed IPEPC tool demonstrated sound psychometric properties. The findings indicate that the involvement of pre-licensure students can improve their training as future healthcare professionals. In addition, the outcome of interprofessional rotations in teamwork and ethics competencies may be positively influenced as students progress through their pharmacy studies.

Future research should involve disseminating the IPEPC tool to other schools of pharmacy to refine the instrument and establish its broader applicability and usability. Expanding the use of this innovative assessment tool would help elucidate the impact of IPE on pharmacy practice.

Ethics statement

This research was registered with the University of Malta Faculty of Medicine and Surgery Research Ethics Committee (FRECMDS_1920_157). Participants gave informed consent before taking part in this study.

Conflict of interest

The authors declare no conflict of interest.

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Appendix A: Confirmatory factor analysis

Factor loadings of each item and respective 95% confidence intervals

		Coef.	OIM Std. Err	z	P> |z|	[95% Conf. Interval]	
Item 1							
	F1	1	(constrained)				
	cons	4.217	0.159	26.44	0.000	3.905	4.530
Item 2							
	F1	0.682	0.089	7.66	0.000	0.507	0.856
	cons	4.478	0.129	34.58	0.000	4.224	4.732
Item 3							
	F1	1.033	0.095	10.87	0.000	0.847	1.219
	cons	4.174	0.172	24.27	0.000	3.837	4.511
Item 4							
	F1	0.800	0.099	8.07	0.000	0.606	0.995
	cons	4.283	0.150	28.64	0.000	3.989	4.576
Item 5							
	F2	1	(constrained)				
	cons	4.261	0.167	25.55	0.000	3.934	4.588
Item 6							
	F2	0.656	0.109	6.03	0.000	0.442	0.869
	cons	4.261	0.128	33.19	0.000	4.009	4.512
Item 7							
	F3	1	(constrained)				
	cons	4.152	0.174	23.89	0.000	3.811	4.492
Item 8							
	F3	0.920	0.109	8.48	0.000	0.707	1.133
	cons	4.413	0.155	28.38	0.000	4.108	4.718
Item 9							
	F4	1	(constrained)				
	cons	4.239	0.135	31.48	0.000	3.975	4.503
Item 10							
	F4	1.119	0.193	5.80	0.000	0.741	1.497
	cons	4.109	0.148	27.73	0.000	3.818	4.399

Item and factor variances

	Coef.	OIM Std. Err	[95% Conf. Interval]	
var (item 1)	0.123	0.050	0.056	0.272
var (item 2)	0.285	0.066	0.180	0.449
var (item 3)	0.243	0.070	0.138	0.429
var (item 4)	0.358	0.083	0.227	0.564
var (item 5)	0.322	0.109	0.166	0.626
var (item 6)	0.346	0.081	0.218	0.548
var (item 7)	0.301	0.097	0.159	0.567
var (item 8)	0.189	0.745	0.088	0.409
var (item 9)	0.255	0.089	0.128	0.507
var (item 10)	0.285	0.108	0.135	0.598
var (Factor 1)	1.047	0.246	0.660	1.660
var (Factor 2)	0.957	0.272	0.548	1.671
var (Factor 3)	1.089	0.293	0.643	1.844
var (Factor 4)	0.579	0.180	0.314	1.067

Pairwise factor covariances

	Coef.	OIM Std. Err	z	P> |z|	[95% Conf. interval]	
cov (Factor 1, Factor 2)	0.906	0.223	4.06	0.000	0.468	1.343
cov (Factor 1, Factor 3)	0.920	0.228	4.03	0.000	0.473	1.368
cov (Factor 1, Factor 4)	0.481	0.155	3.10	0.002	0.177	0.786
cov (Factor 2, Factor 3)	0.997	0.244	4.07	0.000	0.517	1.477
cov (Factor 2, Factor 4)	0.657	0.176	3.72	0.000	0.311	1.003
cov (Factor 3, Factor 4)	0.631	0.192	3.29	0.001	0.255	1.006

Fit indices for goodness of fit

Fit statistic		Value	Description
Likelihood ratio			
	chi2_ms (29)	44.171	Model vs saturated
	p > chi2	0.000	
Population error			
	RMSEA	0.064	Root mean squared error of approximation
Information criteria			
	AIC	506.307	Akaike's information criterion
	BIC	572.139	Bayesian information criterion
Baseline comparison			
	CFI	0.934	Comparative fit index
	TLI	0.948	Tucker-Lewis index
Size of residuals			
	SRMR	0.048	Standardized root mean squared residual
	CD	0.995	Coefficient of determination