

ORIGINAL RESEARCH PAPER

# Longitudinal outcomes of simulation enhanced interprofessional education within a physical therapist education program

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## Abstract

**Purpose:** Simulation-enhanced interprofessional education (Sim-IPE) has been shown in cross-sectional studies to be beneficial in improving students' perceptions of interprofessional teamwork and collaboration. However, there is limited literature regarding the progression of these perceptions over time. Therefore, this study aimed to explore the influence of multiple sim-IPE embedded across a physical therapy education program on student perceptions of collaborative patient care over a 2-year period.

**Methods:** A sample of convenience of students in an entry-level Doctor of Physical Therapy program ( $n = 94$ ) was utilized. Students were placed in one of three groups with students completing either three sim-IPE experiences across the first 2 years of the program ( $n = 57$ ), one simulation at the beginning of the program ( $n = 17$ ), or one experience prior to their second full-time clinical experience ( $n = 20$ ). The Interprofessional Socialization and Values Scale-21 (ISVS-21) was used to assess student perceptions of interprofessional collaboration. Scores across the program were analyzed using a Friedman analysis with a post hoc Wilcoxon matched pairs test. To assess the influence of maturation on student perceptions, performance on the ISVS-21 for students completing three experiences was compared with students completing one sim-IPE experience within the program.

**Results:** Overall, scores on the ISVS-21 demonstrated a statistically significant improvement across the three simulations occurring within the program ( $P < 0.001$ ). Furthermore, students completing three sim-IPE experiences demonstrated statistically significantly higher scores on the ISVS-21 compared to students completing just one experience, regardless of the placement of the experience within the program.

**Conclusion:** Multiple sim-IPE performed across a professional education program may be an effective learning strategy to influence perceptions of interprofessional collaboration. Further research is needed to determine the number and placement of simulations for optimal preparation for interprofessional practice.

**Keywords:** *simulation; interprofessional education; physical therapy; interprofessional communication; Interprofessional Socialization; Valuing Scale*

Received: 4 March 2023; Revised: 4 August 2023; Accepted: 8 August 2023; Published: 20 September 2023

Interprofessional education (IPE) refers to learners from multiple healthcare professions engaged in learning experiences that promote the development of interprofessional competencies and behaviors.<sup>1</sup> The World Health Organization (WHO) has developed a framework for action on IPE and collaborative practice.<sup>2</sup> The WHO recommends implementing IPE opportunities for all healthcare students to promote the development of professionals who can effectively cooperate in providing quality healthcare.<sup>2,3</sup> Furthermore, the United States

Interprofessional Education Collaborative (IPEC) established the core competencies for interprofessional practice to provide a foundation across professions. These competencies include: (1) values/ethics for interprofessional practice, (2) roles/responsibilities for collaborative practice, (3) interprofessional communication practices, and (4) interprofessional teamwork and team-based practice.<sup>4</sup>

Simulation-enhanced interprofessional education (sim-IPE) allows students from different professions to apply knowledge and skills from their respective education to

provide care for simulated patients while accomplishing shared learning objectives and outcomes.<sup>1</sup> Sim-IPE has been shown to promote students' understanding of successful teamwork and improve their knowledge of other team members' roles.<sup>5</sup> In a systematic review by Olson and Bialocerkowski, sim-IPE positively influenced student participants' attitudes towards interprofessional interaction and teamwork, along with their understanding of health professional roles, compared to lectured-based IPE.<sup>6</sup> Furthermore, sim-IPE has improved physical therapy (PT) students' perceptions of collaborative practice and patient care.<sup>7-17</sup>

However, longitudinal studies may provide a more accurate representation of learner development.<sup>18</sup> Longitudinal assessments of students' perceptions of collaborative practice have been limited when integrating multiple IPE experiences across professional education programs. Three studies have explored students' perceptions of interprofessional care when completing multiple IPE experiences over 2 to 3 years, with gradual improvements in students' perceptions over time.<sup>19-21</sup> In contrast, a study by Curren et al. noted no changes in nursing and allied health student perceptions towards IPE or interprofessional collaboration with the completion of up to nine IPE experiences over a 3-year period although satisfaction with the experiences was high.<sup>22</sup> Similarly, McFayden et al. found a reduction in nursing and allied health student perceptions of interprofessional collaboration when completing multiple experiences over a 3-year period.<sup>23</sup> This study aimed to explore the influence of multiple sim-IPE, embedded across a physical therapist education program, on student perceptions of collaborative patient care over a 2-year period.

## Methods

### *Simulation experiences*

Creating relevant and meaningful learning experiences, while influencing student perceptions of collaboration and teamwork, may be challenging for professional education programs. To assist students in their development across the IPEC core competencies, a doctor of physical therapy (DPT) education program developed sim-IPE experiences in collaboration with faculty from nursing and emergency medical services (EMS) programs. The simulation scenarios were developed based on the cognitive load theory to support student integration of patient care skills based on their advancement through their professional curriculum.<sup>24</sup> Faculty from the physical therapy, nursing, and EMS programs met on multiple occasions to discuss common curricular outcomes and goals as well as the optimal placement of the simulation experiences in each program's curriculum based on the students' knowledge and clinical experience. The focus of all three sim-IPE

experiences included: (1) anticipation of possible complications and patient care needs, (2) safe performance of essential skills for patient care, (3) communication and collaboration with other health professionals, and (4) improved understanding of the roles of healthcare providers in the acute care and home health environment. Each simulation began with a pre-briefing and interprofessional huddle with students from all professions. The students discussed the patient's diagnosis, potential complications, ideal assessment measures, and anticipated treatment as an interprofessional team. Following each simulation experience, an interprofessional debriefing was performed. Full descriptions of the simulation scenarios can be found in the appendix.

The first simulation experience (Sim-1) occurred in the first month of the first fall semester in the entry-level DPT program. The simulation was performed with physical therapy and nursing students focusing on the collaborative and complementary skills between the professions. Students were placed in small interprofessional teams of one to two physical therapy students and up to three nursing students. The 3-h simulation experience was developed to allow students to engage in three clinical scenarios representing a variety of patient diagnoses in an acute care environment. The scenarios included: (1) trauma secondary to a motor vehicle accident, (2) community-acquired pneumonia, and (3) post-operative open appendectomy. During the simulation experience, students discussed the common skills within their professions and provided their unique perspectives on the implications of the care provided. In addition, the students collaborated to provide optimal care and coordinate interventions with each patient.

The second simulation experience (Sim-2) occurred in the spring of year one prior to the students' first full-time, 12-week clinical experience. The simulation scenario involved caring for a patient one day following a total hip replacement. The patient in the simulation scenario, played by a standardized patient, was an 82-year-old female. She was recently widowed and living with her daughter and son-in-law. She fell at home with a resulting hip fracture. She presented to the emergency room the same afternoon, and a total hip arthroplasty was performed. Two physical therapy and two to three nursing students participated in each scenario. The physical therapy and nursing students performed a collaborative clinical reasoning activity before initiating the simulation experience. The students discussed their perspectives on the proposed patient care activities and developed a plan to provide coordinated patient-centered care as a team.

The third simulation experience (Sim-3) occurred in the program's second year before the students' second full-time, 12-week clinical experience. A 3-h, two-part home health care simulation experience with a standardized patient was

developed to promote communication and collaboration among physical therapy, nursing, and EMS students. Part one included the evaluation of the patient by both physical therapy and nursing students. Students completed part one in teams of two students. Following the evaluations, the students discussed care priorities as an interprofessional team. Part two of the simulation included a follow-up visit with the same patient. During the follow-up visit, the patient demonstrated a significant decline in cognitive status and appeared agitated. A new team of one physical therapy and one nursing students completed part two. Physical therapy and nursing students consistently contacted emergency services due to the patient's change in status during the scenario. In case students did not contact emergency services, a neighbor would have called due to the patient's confusion. Two EMS students would arrive and perform the patient transport to the hospital. One key learning objective, across all three professions, was the recognition of the symptoms of delirium and the ability to differentiate the acute change in mental status from dementia.

### Methods

The Radford University Institutional Review Board approved this study. A sample of convenience of students across four consecutive cohorts (2019–2023) enrolled in an entry-level DPT program was utilized ( $n = 94$ ). Fifty-seven students (cohorts 2019–2020) participated in three sim-IPE experiences (Sim-1, Sim-2, Sim-3) within the program's first 2 years (Table 1). Due to structural changes within the school of nursing and the associated clinical simulation center, cohorts 2021 ( $n = 30$ ) and 2022 ( $n = 29$ )

only had the opportunity to participate in one sim-IPE experience providing an opportunity to compare perceptions of interprofessional collaboration based upon number of simulations completed and the placement within the program. Thirty-seven students completed one sim-IPE experience and agreed to participation in the study, with 17 students only completing Sim-1 in the first year of the program, and 20 students completing Sim-3 in the second year of the program. All students completed the Interprofessional Socialization and Valuing Scale-21 (ISVS-21) prior to and following each sim-IPE experience and prior to their second full-time clinical experience. The ISVS-21 encompasses the core competencies of the IPEC, including interprofessional practice values and ethics, defining professional roles and responsibilities, interprofessional communication, and teams and teamwork.<sup>25</sup> The survey contains a Likert rating scale from zero to seven (e.g. 0 = not applicable, 1 = not at all, 7 = to a very great extent) to assess participant perceptions of socialization.<sup>14</sup>

A Friedman analysis for all questions on the ISVS-21 across the three sim-IPE experiences was conducted. In addition, a post hoc analysis using Wilcoxon-signed ranks tests was completed to compare student perceptions between the individual simulation sessions. Due to the number of comparisons, the Bonferroni correction was utilized with a significance level of 0.002 determined for the individual questions on the ISVS-21. To compare students completing all three sim-IPE experiences and one sim-IPE experience, a Mann U Whitney test was performed.

**Table 1.** Program organization and placement of sim-IPE experiences

Year	Fall	Spring	Summer
0			Gross Anatomy
1	Exercise Physiology Kinesiology Clinical Medicine I (Integumentary) Patient Management I (Basic Exam Skills) Theory and Practice I (Basic Care Skills)	Neuroscience Research/ Scientific Inquiry I Clinical Medicine II (Orthopedic Pathology) Patient Management II (Orthopedic Examination) Theory and Practice II (Exercise Instruction)	Clinical Experience I (12 weeks)
2	Professional Affairs Differential Diagnosis and Imaging Psychosocial Elements of Illness and Disability Clinical Medicine III (Neurological Pathology) Neuromuscular Development and Control I	Health Policy and Administration Research/ Scientific Inquiry II Principles of Teaching and Learning Prosthetics and Orthotics Advanced Orthopedics Neuromuscular Development and Control II	Clinical Experience II (12 weeks)
3	Preventative Health and Wellness Scientific Inquiry III Cardiopulmonary Patient Care Comprehensive Patient Care Pediatrics	Research/ Scientific Inquiry IV Clinical Experience III (12 weeks)	

## Results

A total of 57 DPT students participated in three simulations throughout 2017 and 2019. The Friedman analysis for all questions on the ISVS-21 demonstrated a statistically significant difference across the multiple simulations ( $P < 0.001$ ). Mean scores on the ISVS-21 prior to and following each of the three simulations are presented in Table 2. A statistically significant improvement in perceptions was found for all 21 questions prior to and following each simulation (Table 2). The post hoc analysis using Wilcoxon-signed ranks found that students demonstrated an improvement in perceptions between sim-2 and sim-3 on the majority of questions (Table 2). Conversely, a statistically significant decline ( $P < 0.002$ ) in students' perceptions towards interprofessional collaboration was found for the majority of questions on ISVS-21 between sim-IPE experiences. Additionally, no statistically significant difference was found for the majority of ISVS-21 questions when comparing sim-1 and sim-2 (Table 2).

Thirty-seven students completed one sim-IPE experience between 2019 and 2022. When comparing student perceptions following the completion of one simulation to the completion of three simulation experiences, students that only completed sim-1 demonstrated significantly lower scores than those students completing all three experiences on 16 of the ISVS-21 questions. Students completing only sim-3 demonstrated significantly lower scores than those completing all three simulation experiences on six of the 21 questions. When comparing a composite score on the ISVS-21, students completing all three experiences demonstrated significantly higher scores than students completing one experience (Table 3 and Fig. 1).

## Discussion

For each sim-IPE experience, there was a significant increase in students' perceptions, beliefs, and attitudes regarding interprofessional collaboration following the simulation. These results were expected, as multiple studies involving sim-IPE with physical therapy students found an immediate increase in students' perceptions.<sup>7-17</sup> Researchers have found that sim-IPE promotes positive student reactions, increases student understanding of successful teamwork, and improves their knowledge regarding roles and responsibilities.<sup>7-17,26</sup> The initial ISVS-21 scores prior to sim-1 compared to the final scores after sim-3 indicate an overall statistically significant improvement in students' perceptions, attitudes, and beliefs regarding collaboration. The student's final ISVS-21 composite score following the completion of three sim-IPE experiences was a mean of 6.08 out of seven possible points compared to an initial pre-Sim-1 mean of 4.58 ( $P < 0.001$ ). These results are similar to studies of longitudinal IPE experiences with healthcare students demonstrating significant

positive improvements in students' perceptions and collaborative behaviors.<sup>18-20</sup>

Despite the short-term and longitudinal increase in students' ISVS-21 scores, there was a significant decline in students' attitudes, beliefs, and perceptions of interprofessional collaboration for nearly all ISVS-21 questions from the time the previous simulation ended and the subsequent simulation began. This decline likely indicates that the length of time between sessions negatively affects students' perceptions of interprofessional collaboration. In addition, learning and progression in understanding have been described as irregular, with periods of improvement followed by regressions.<sup>27</sup> Completing a full-time, 12-week clinical experience and an additional semester of didactic curriculum between sim-2 and sim-3 did not prevent this decline.

Improved student knowledge of other professions and positive attitudes towards IPE have been noted after clinical experiences in interprofessional environments.<sup>28</sup> However, an exploration into physical therapy students' interprofessional practice within clinical experiences reported limited exposure to collaborative patient care.<sup>29</sup> The interprofessional collaboration that did occur was 'informal, unstructured and unplanned'.<sup>29</sup> Without effective mentoring of interprofessional patient care by clinical instructors and healthcare systems during clinical experiences, students' professional growth in this competency will be limited.

Of the few ISVS-21 questions that did not exhibit a statistically significant decline in scores, two were related to the ability to defend or describe the professional role within a healthcare team. We speculate that these questions did not experience the same overall score decline due to students' increased confidence in their professional roles as they progressed within the curriculum. Therefore, scores on these two questions may be attributed to maturation.

Furthermore, when evaluating ISVS-21 outcomes between post-session scores, results showed no significant increase in scores comparing sim-1 and sim-2 performance. This may be due to the simulations occurring within the same year of the program and the format of the simulations. Sim-1 was faculty guided by faculty members from the nursing and physical therapy programs. Faculty provided prompts during the simulation scenario to guide students to consider assessment and treatment alternatives. The faculty members demonstrated strong collaboration as an IPE team and encouraged dialogue between students from different professions. This may have bolstered student perceptions of interprofessional collaboration. Sim-2 was fully immersive, with faculty only involved in the prebriefing and debriefing to guide reflection and discussion of the case scenario within the interprofessional team.

**Table 2.** Mean scores and Wilcoxon matched pairs on individual questions and composite scores (ISVS-21) pre and post-each of three sim-IPE experiences and between each of the simulation experiences ( $n = 57$ )

At this point in time, based on my participation in inter-professional education activities and/or clinical practice...	Simulation 1 (Sim-1)			Post Sim-1 to Pre Sim-2	Simulation 2 (Sim-2)			Post Sim-2 to Pre Sim-3	Simulation 3 (Sim-3)			Post Sim-1 to Post Sim-2	Post Sim-2 to Post Sim-3	Post Sim-1 to Post Sim-3
	Pre Sim-1	Post Sim-1	<i>P</i>	<i>P</i>	Pre Sim-2	Post Sim-2	<i>P</i>	<i>P</i>	Pre Sim-3	Post Sim-3	<i>P</i>	<i>P</i>	<i>P</i>	<i>P</i>
I am aware of my preconceived ideas when entering into team discussions	4.02	5.39	<0.001	<0.001	4.59	5.38	<0.001	0.008	4.86	5.80	<0.001	0.489	<0.001	0.002
I have a better appreciation for using a common language across the health professionals in a team	4.56	5.79	<0.001	<0.001	4.96	5.85	<0.001	0.004	5.23	6.05	<0.001	0.160	0.044	0.086
I have gained an enhanced awareness of my own role on a team	4.20	5.87	<0.001	<0.001	4.76	6.02	<0.001	<0.001	5.00	6.03	<0.001	0.093	0.373	0.155
I am able to share and exchange ideas in a team discussion	4.72	5.81	<0.001	<0.001	4.98	5.79	<0.001	<0.001	4.74	5.91	<0.001	0.977	0.059	0.266
I have gained an enhanced perception of myself as someone who engages in inter-professional practice	4.18	5.79	<0.001	<0.001	4.74	5.77	<0.001	<0.001	5.05	6.03	<0.001	0.910	0.003	0.025
I feel comfortable being the leader in a team situation	4.02	5.29	<0.001	<0.001	4.33	5.35	<0.001	<0.001	4.59	5.52	<0.001	0.860	0.026	0.098
I feel comfortable in speaking out within the team when others are not keeping the best interests of the client in mind	5.06	5.87	<0.001	0.002	5.07	5.73	<0.001	<0.001	4.97	5.72	<0.001	0.704	0.359	0.952
I feel comfortable in describing my professional role to another team member	4.48	5.77	<0.001	0.013	5.11	5.83	<0.001	0.005	5.21	5.90	<0.001	0.402	0.220	0.185
I have a better appreciation for the value in sharing research evidence across different health professional disciplines in a team	4.68	5.81	<0.001	<0.001	4.93	5.94w	<0.001	<0.001	5.02	5.97	<0.001	0.327	0.555	0.128
I am able to negotiate more openly with others within a team	4.58	5.79	<0.001	0.002	5.02	5.92	<0.001	<0.001	5.02	5.83	<0.001	0.246	0.580	0.765

Table 2. (Continued)

At this point in time, based on my participation in inter-professional education activities and/or clinical practice...	Simulation 1 (Sim-1)			Post Sim-1 to Pre Sim-2	Simulation 2 (Sim-2)			Post Sim-2 to Pre Sim-3	Simulation 3 (Sim-3)			Post Sim-1 to Post Sim-2	Post Sim-2 to Post Sim-3	Post Sim-1 to Post Sim-3
	Pre Sim-1	Post Sim-1	P	P	Pre Sim-2	Post Sim-2	P	P	Pre Sim-3	Post Sim-3	P	P	P	P
I have gained an enhanced awareness of roles of other professionals on a team	4.20	6.17	<0.001	<0.001	5.07	6.06	<0.001	0.007	5.31	6.24	<0.001	0.883	0.036	0.630
I am comfortable engaging in shared decision making with clients	4.46	5.77	<0.001	<0.001	5.09	5.79	<0.001	0.004	5.15	5.93	<0.001	0.674	0.136	0.595
I feel comfortable in accepting responsibility delegated to me within a team	5.10	5.98	<0.001	0.004	5.35	5.98	<0.001	<0.001	5.34	6.10	<0.001	0.922	0.166	0.386
I have gained a better understanding of the client's involvement in decision making around their care	4.34	5.56	<0.001	0.051	4.91	5.73	<0.001	0.004	5.00	5.98	<0.001	0.051	0.013	0.051
I feel comfortable clarifying misconceptions with other members of the team about the role of someone in my profession	5.60	5.63	<0.001	0.009	4.93	5.58	<0.001	0.080	5.18	6.05	<0.001	0.48	0.003	0.015
I have gained greater appreciation of the importance of a team approach	5.12	6.33	<0.001	0.009	5.70	6.27	<0.001	<0.001	5.34	6.40	<0.001	0.915	0.038	0.591
I feel able to act as a fully collaborative member of the team	4.88	5.98	<0.001	<0.001	5.26	6.08	<0.001	<0.001	5.21	6.24	<0.001	0.503	0.054	0.099
I feel comfortable initiating discussions about sharing responsibility for client care	4.50	5.94	<0.001	<0.001	4.85	5.83	<0.001	<0.001	5.08	6.14	<0.001	0.931	0.009	0.404
I am comfortable in sharing decision making with other professionals on a team	4.80	5.85	<0.001	<0.001	5.00	5.90	<0.001	0.002	5.16	6.07	<0.001	0.594	0.046	0.068
I have gained more realistic expectations of other professionals on a team	4.04	6.13	<0.001	<0.001	4.96	5.96	<0.001	<0.001	5.13	6.29	<0.001	0.768	0.005	0.304
I have gained an appreciation for the benefits in interprofessional teamwork	4.62	6.31	<0.001	<0.001	5.50	6.19	<0.001	<0.001	5.48	6.47	<0.001	0.575	0.013	0.094
Composite Score	96.16	122.6	<0.001	<0.001	105.1	123.0	<0.001	<0.001	108.0	127.7	<0.001	0.641	0.003	0.003

Significance level after Bonferroni correction,  $P < 0.002$ .

**Table 3.** Comparison of student final performance on the ISVS-21 based on number of sim-IPE experiences ( $n = 94$ )

At this point in time, based on my participation in inter-professional education activities and/or clinical practice...	3 simulations Mean scores $n = 57$	1 simulation Mean scores $n = 37$	$P$
I am aware of my preconceived ideas when entering into team discussions	5.80	4.75	<0.001
I have a better appreciation for using a common language across the health professionals in a team	6.05	5.33	0.002
I have gained an enhanced awareness of my own role on a team	6.03	5.08	<0.001
I am able to share and exchange ideas in a team discussion	5.91	5.14	<0.001
I have gained an enhanced perception of myself as someone who engages in interprofessional practice	6.03	4.92	<0.001
I feel comfortable being the leader in a team situation	5.52	4.79	<0.001
I feel comfortable in speaking out within the team when others are not keeping the best interests of the client in mind	5.72	4.71	<0.001
I feel comfortable in describing my professional role to another team member	5.90	5.23	<0.001
I have a better appreciation for the value in sharing research evidence across different health professional disciplines in a team	5.97	5.01	<0.001
I am able to negotiate more openly with others within a team	5.83	5.07	<0.001
I have gained an enhanced awareness of roles of other professionals on a team	6.24	5.41	<0.001
I am comfortable engaging in shared decision making with clients	5.93	5.63	0.270
I feel comfortable in accepting responsibility delegated to me within a team	6.10	5.60	0.015
I have gained a better understanding of the client's involvement in decision making around their care	5.98	5.49	0.030
I feel comfortable clarifying misconceptions with other members of the team about the role of someone in my profession	6.05	5.16	<0.001
I have gained greater appreciation of the importance of a team approach	6.40	5.91	0.120
I feel able to act as a fully collaborative member of the team	6.24	5.60	0.002
I feel comfortable initiating discussions about sharing responsibility for client care	6.14	5.46	0.003
I am comfortable in sharing decision making with other professionals on a team	6.07	5.50	0.013
I have gained more realistic expectations of other professionals on a team	6.29	5.38	<0.001
I have gained an appreciation for the benefits in interprofessional team work	6.47	6.07	0.100
COMPOSITE SCORE	127.70	111.24	<0.001

$P$ -value-Mann UWhitney.

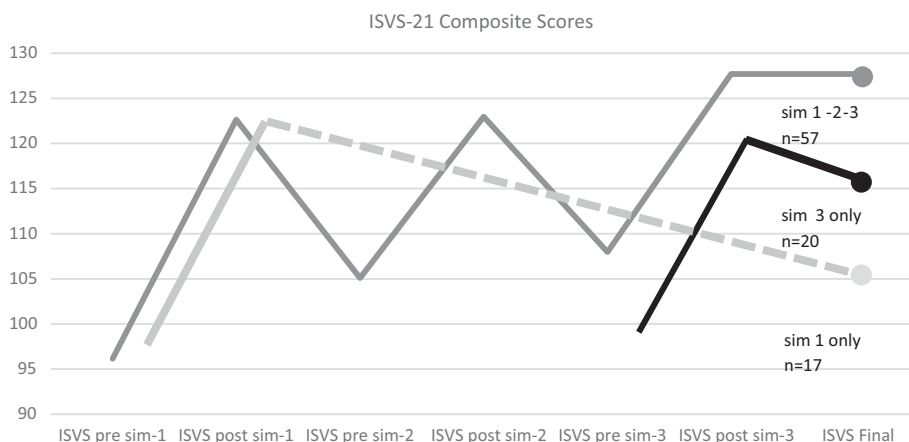
Significance level after Bonferroni correction,  $P < 0.002$ .

The overall improvement in composite scores and scores on individual questions comparing student performance when completing one versus three experiences suggests that the number of simulations and spacing throughout the 2 years in the program positively influenced student performance. The students completing one experience in the program's first year continued to decline their perceptions over time. The students that completed only sim-3 did not achieve the same scores as those that completed all three simulations. This positive shift suggests multiple simulations may prepare students for entry-level interprofessional teamwork; however, more research is necessary to determine the optimal ISVS-21 score for entry-level practice. Using numerous opportunities for sim-IPE focusing on decision-making, care planning, and communication may provide programs with an effective learning strategy to meet the IPEC core competencies. The optimal

number of simulations may depend on various factors, including the complexity of the scenario, the learners' level of experience, and the program's specific learning objectives.<sup>30</sup>

Implementing sim-IPE prior to full-time clinical experiences may have assisted with student confidence, competence, and preparedness for clinical practice.<sup>30</sup> Sim-IPE allows students to practice and develop clinical skills in a controlled and safe learning environment.<sup>16</sup> Moreover, the use of realistic, simulated patient cases in interprofessional teams enables students to enhance their clinical reasoning, problem-solving, and communication skills. This collaborative approach fosters their ability to work effectively as part of a team.<sup>30</sup>

This study had multiple limitations, including small sample size and multiple comparisons, although a conservative interpretation was made after the Bonferroni



**Fig. 1.** Longitudinal trends of mean composite ISVS-21 scores across the three simulations and composite scores following one simulation prior to the third clinical experience.

ISVS-21, Interprofessional Socialization and Values Scale-21; Sim, Simulation.

correction. In addition, the results may not be generalized due to this study's small sample size of convenience. The ISVS-21 is beneficial for assessing students' perceptions, attitudes, and beliefs about interprofessional teamwork. However, it does not directly reflect communication skills integral to healthcare practice.

### Conclusion

Using multiple opportunities for sim-IPE focusing on decision-making, care planning, and communication may provide programs with an effective learning strategy to promote interprofessional collaboration for patient care. Students in this pilot study demonstrated an improvement in their perceptions of collaborative patient care over a 2-year period. This appears to be related to the placement of multiple sim-IPE throughout the program as compared to the maturation of the students over time. However, further research is needed to determine the optimal number and placement of sim-IPE to optimize student perceptions of interprofessional collaboration in an entry-level DPT program to prepare students for interprofessional practice.

### Conflict of interest and funding

The authors have no conflicts of interest to declare. There was no funding for this project.

### Research/ethical approval

This study was approved by the Radford University Institutional Review Board (2021-411).

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## Appendix

Element	Descriptor
<b>Sim-1: Foundational Boot Camp</b>	
Prebriefing	Faculty established a safe space for learning, discussed the fiction contract and confidentiality, and oriented participants to the environment for all three patients (hospital floor, discussed time allotment for the care of each patient (45 min), and learning objectives). In addition, students completed a collaborative clinical reasoning activity to facilitate the think-aloud strategy used in simulation. During the activity, students listed potential patient diagnoses or problems, data necessary to confirm or refute the potential problem, and ideal interventions to address the problem based on the provided written patient case history. The students used an interactive whiteboard to document and share their ideas.
Simulation Environment	All scenarios were performed at the simulation center in a multifunctional hospital room. In each scenario, the patient was using common equipment found in the acute care environment (Intravenous catheters, urinary catheters, sequential compression devices, nasal cannula-oxygen, Jackson-Pratt surgical drains, electrocardiograms, noninvasive blood pressure monitoring, pulse oximeter, gait belts, assistive devices etc.). All patients were positioned supine in the hospital bed when students arrived in the room. Each room was equipped with a workstation on wheels with a fully functioning electronic medical record for each patient.
Scenario	The scenarios included patients with three diagnoses: (1) new onset right femur and left radius fracture following motor vehicle accident, (2) pneumonia, and (3) open appendectomy. The students performed patient care at the bedside in groups consisting of one physical therapy student and three nursing students.
Objectives (Scenario specific)	The focus of the scenarios included: (1) anticipation of possible complications and patient care needs based on the patient diagnosis and past medical history, (2) safe performance of essential skills for patient care, (3) communication and collaboration with other health professionals, and (4) improved understanding of the roles of healthcare providers in the acute care environment. In addition, this experience served as an orientation to the simulation center including common equipment, electronic medical record, and function of the high-fidelity manikins.
Case summaries (provided to students prior to experience)	<p>1. 26-year-old patient with fractures to his left arm and right leg; has an ACE wrap on his arm and a splint secured by an ACE wrap on his leg. He is awaiting surgery for repair of his extremities.</p> <p><u>Medication list:</u> oxycodone per oral (PO), morphine sulfate intravenous (IV)</p> <p><u>Possible interventions:</u> non-pharmacological comfort measures, mobilization post-operative internal fixation of fractures of both the upper extremity and lower extremity</p> <p>2. 28-year-old patient admitted to the hospital with respiratory distress and community acquired pneumonia; requires intervention to treat respiratory problems.</p> <p><u>Medication list:</u> acetaminophen PO, lispro insulin subcutaneous, cefazolin sodium intravenous, methylprednisolone IV, albuterol nebulizer, albuterol metered dose inhaler (MDI).</p> <p><u>Possible interventions:</u> Albuterol administration (nebulizer and MDI), applying and titrating oxygen, blood glucose testing, positioning and cuing to assist with breath control.</p> <p>3. 29-year-old post-operative patient with a ruptured appendix; has open abdominal wound with Jackson Pratt drain and a foley catheter.</p> <p><u>Medication list:</u> ertapenem IV, ketorolac IV, oxycodone PO, promethazine IV, piperacillin-tazobactam, omeprazole PO.</p> <p><u>Possible interventions:</u> Emptying and recharging a Jackson-Pratt drain, dressing change, empty and measure urine from indwelling catheter, and mobilization of a patient with an abdominal wound, intravenous catheter, and urinary catheter.</p>
Debriefing	Debriefing occurred following the care of all three patients in a large group (three PT students, nine nursing students) with faculty from both programs. Debriefing occurred for approximately 45 min. The advocacy inquiry method was used during the debriefing. The focus of the debriefing was on common and complementary skills between the professions and strategies for effective communication to perform patient-centered care.
<b>Sim-2 Total Hip Arthroplasty</b>	
Prebriefing	Faculty established a safe space for learning, discussed the fiction contract and confidentiality, and oriented participants to the environment for care of the patient (hospital floor, discussed time allotment for the care of each patient (45 min), and learning objectives). In addition, students completed a collaborative clinical reasoning activity to facilitate the think-aloud strategy used in simulation. During the activity, students listed potential patient diagnoses or problems, data necessary to confirm or refute the potential problem, and ideal interventions to address the problem based on the provided written patient case history. The students used an interactive whiteboard to document and share their ideas.
Simulation Environment	The scenario was performed at the simulation center in a medical surgical hospital room. Equipment in the room included sequential compression devices, noninvasive blood pressure monitoring, pulse oximeter, incentive spirometry, gait belt, assistive devices (walker and cane), wheelchair, and bedside commode. The standardized patient was positioned supine in the hospital bed when students arrived in the room. The room was equipped with a workstation on wheels with a fully functioning electronic medical record.

**Appendix:** (Continued)

Element	Descriptor
Scenario	The simulation scenario involved the care of a patient one day following total hip arthroplasty secondary to a fall at home and femoral fracture.
Objectives (Scenario Specific)	<ol style="list-style-type: none"> <li>1. Communicate with interprofessional team members using think-out-loud process.</li> <li>2. Complete focused musculoskeletal assessment and reassessments as needed based on patient condition and interventions.</li> <li>3. Identify patient problems and learning needs (medical and/or physical therapy).</li> <li>4. Prioritize &amp; perform interventions based on patient's problems and physician orders.</li> <li>5. Discuss out loud during scenario and debriefing possible problems, pathophysiology and/or rationale for assessment interventions.</li> <li>6. Communicate effectively with the patients and interprofessional team members providing care.</li> <li>7. Identify and respect the patients' values and preferences in all professional activities.</li> <li>8. As an interprofessional team, apply current knowledge, theory, and professional judgment while considering the patient/client perspective and the environment.</li> <li>9. Perform a medical record review using an EHR to determine possible complications, precautions and contraindications for physical therapy.</li> <li>10. Identify signs and symptoms of abuse and report findings appropriately based on practice setting while respecting the patient's desire to protect other family members currently in the abusive environment.</li> </ol>
Case Summary (provided to students prior to experience)	<p>81-year-old post-operative patient with a total hip arthroplasty. Past medical history includes hypercholesterolemia, hypertension, mild rheumatoid arthritis, coronary artery disease, and a pack a day smoker × 50 years</p> <p><u>Initial lab work:</u></p> <p><b>CBC:</b> WBC-11.4, RBC-3.8, Hgb-10.6, Hct-31.8, MCV-83.6, MCH-27.8, MCHC-33.2, RDW-11.9, Platelets-146</p> <p><b>BMP:</b> Na+-146, K+-4.4, Cl--106, CO2-32.2, BG-140, BUN-16, Creatinine-1.0, Ca+-7.2</p> <p><b>Magnesium-2.3, Phosphate-2.1, PT-12.0, PTT-28</b></p> <p><u>Medication list:</u> celecoxib PO, lansoprazole PO, Zofran IV, Milk of Magnesia PO, ondansetron IV, magnesium oxide PO, acetaminophen with oxycodone PO, metoprolol PO, atorvastatin PO, docusate sodium PO, Dulcolax suppository PR, enoxaparin sodium SC, D5 ½ NS+ 20 mEq KCL IV</p> <p><u>Interventions:</u> Skills performed throughout the scenario: assessment of vital signs: heart rhythms, heart sounds, extremity pulses, breath sounds, oximetry, effects of pain on vital signs, medication effects on vital signs (narcotics), assessment of signs and symptoms of surgical site infection, incentive spirometry education, integumentary assessment, sensory assessment, manual muscle testing or general strength screen, bed mobility, transfer training, gait training with walker, toilet transfers, and instruction in hip precautions.</p>
Debriefing	Debriefing occurred with faculty from both programs. Debriefing occurred for approximately 45 min. The advocacy inquiry method was used during the debriefing. The focus of the debriefing was on common and complementary skills between the professions, strategies for effective communication to perform patient-centered care and the role of the mandatory reporter for elder abuse.
<b>Sim-3 Home Health Care</b>	
Prebriefing	Faculty established a safe space for learning, discussed the fiction contract and confidentiality, and oriented participants to the home health equipment bag (gait belt, gloves, stop watch, blood pressure cuff, pulse oximeter, towel, theraband, and outcome measures). Students were also oriented to use of the ventriloSCOPE for taking vital signs and simulated glucometer. The format of the two-part scenario was discussed. In addition, students completed a collaborative clinical reasoning activity to facilitate the think-aloud strategy used in simulation. During the activity, students listed potential diagnoses or problems, data necessary to confirm or refute the potential problem, and ideal interventions to address the problem based on the provided written patient case history. The students used an interactive whiteboard to document and share their ideas.
Simulation Environment	The simulation occurred at the simulation center using a fully functioning one-bedroom apartment with kitchen, living room, bathroom, and laundry room. The patient had a walker from her late husband. The apartment was not handicap accessible with multiple safety concerns: throw rugs, non-functioning smoke detector, rolling desk and kitchen chairs, and cluttered hallways.

**Appendix:** (Continued)

Element	Descriptor
Scenario	72-year-old female was recently discharged from inpatient care to the home. She had been admitted to the hospital with the diagnosis of uncontrolled diabetes and dizziness. Insulin therapy was initiated while the patient was admitted to acute care. In part one of the scenario, PT and nursing students perform profession specific evaluations of the patient, share findings in a case conference and develop an interprofessional care plan for the patient. In part two of the scenario, students arrive for a follow up visit with the patient. The patient demonstrates signs and symptoms of delirium associated with new onset urinary tract infection. A telephone consult is performed with the patient's physician and/or EMS contacted for transport to the emergency department. If students do not contact 911, EMS arrives reporting a neighbor contacted 911 due to concerns over the patient's safety. Students communicated with each other regarding patient history and current presentation. The EMS students assess and prepare the patient for transfer to the hospital at which point the scenario ends.
Objectives (Scenario specific)	<ol style="list-style-type: none"> <li>1. As an interprofessional team complete functional &amp; environmental assessment to include Katz ADL, Lawton IADL, Mini Mental Status exam and other ConsultGer tools as appropriate.</li> <li>2. As an interprofessional team complete physical assessment (heart, lung, vital signs) as appropriate.</li> <li>3. Establish care priorities and perform interventions based on care priorities.</li> <li>4. Recognize and manage the consequences of polypharmacy including Beer's Criteria.</li> <li>5. Recognize signs and symptoms of mild dementia and adjust communication/ education accordingly.</li> <li>6. Communicate effectively with the patient and interprofessional team members providing care.</li> <li>7. As an interprofessional team, apply current knowledge, theory, and professional judgment while considering the patient perspective and the home environment.</li> <li>8. Perform a home safety assessment and identify risks present in the home.</li> <li>9. Participate in a case conference to discuss community and healthcare resources necessary to allow the patient to remain safely at home, referrals to additional healthcare providers (social work, pharmacist and diabetes educator), and expected discharge plan.</li> <li>10. Recognize signs and symptoms of delirium and adjust communication strategies.</li> <li>11. Perform an effective telephone consultation to include a description of illness severity, a patient summary, action list, situation awareness and synthesis by receiver.</li> <li>12. Perform an effective hand off to EMS providers to include a description of illness severity, a patient summary, action list, situation awareness and synthesis by receiver.</li> <li>13. Students will appropriately prioritize key information and concerns during consultations and hand offs.</li> <li>14. Understand the continuum of care of a patient during transport to the emergency department.</li> </ol>
Case Summary (provided to students prior to experience)	<p>Ms. Jones was recently discharged from acute care; admitted with hyperglycemia, poorly controlled diabetes and dizziness. Insulin therapy was initiated and diabetic education was done. Length of hospitalization was 4 days. Dr. Lee ordered home health PT and nursing to assess and treat patient at home.</p> <p><u>Past Medical History:</u> Type 2 diabetes, diabetic retinopathy and early macular degeneration, hypertension, non q-wave MI 2 years ago, osteoporosis and arthritis in knees and ankles.</p> <p><u>Education level:</u> 5th grade</p> <p><u>Social History:</u> Widow – husband died 2 months ago. Family lives out of state.</p> <p><u>Surgeries/Procedures:</u> Cholecystectomy 10 years ago</p> <p><u>Potential Skills for Scenario:</u> Motivational interviewing skills, functional assessment, medication analysis, home safety assessment, diabetic patient education and interdisciplinary consultation.</p> <p><u>Medication List:</u> Lantus FlexPen and Aspart FlexPen, Norvasc, Hydrochlorothiazide, Calcium, Vitamin D, Baby Aspirin, Celebrex, Metformin, Simvastatin, Meloxicam.</p>
Debriefing	Debriefing occurred with faculty from all three programs. Debriefing occurred for approximately 45 min. The advocacy inquiry method was used during the debriefing. The focus of the debriefing was on common and complementary skills between the professions, strategies for effective communication to perform patient-centered care and hand-offs, differentiation of dementia and delirium, and recognition of emergent situations in the home environment requiring patient transport to a hospital.

PO, per oral; IV, intravenous; MDI, metered dose inhaler; EHR, electronic health record; CBC, complete blood count; WBC, white blood cells; RBC, red blood cells; Hgb, hemoglobin; Hct, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; RDW, red cell distribution width; Na<sup>+</sup>, Sodium; BG, blood glucose; BUN, blood urea nitrogen; Ca<sup>+</sup>, calcium; PT, prothrombin time; PR, by rectum; SC, subcutaneous; KCL, potassium chloride; ADL, activities of daily living; IADL, instrumental activities of daily living; EMS, emergency medical services.