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Special Report

Assessing the Effectiveness of Online Interprofessional Education Simulations: A Pre-Post Comparison of Student Learning

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ABSTRACT

Historically, most interprofessional simulations with standardized patients have occurred via face-to-face encounters; however, the COVID-19 pandemic necessitated rapid pivoting to (re)create meaningful, online experiences for individuals separated due to social distancing. This study integrated e-learning strategies into a simulation scenario where interprofessional learners worked collaboratively online to care for a standardized patient presenting with subacute stroke symptoms. E-learning strategies emphasized "real world" applicability (e.g., telehealth), encouraged asynchronous self-directed learning, required learners to incorporate previous educational knowledge, built communities of learning, necessitated completion of team-based deliverables, and included "elements of surprise" to evoke emotions. A total of 376 students participated in the online simulation, from medicine, nursing, occupational therapy, physical therapy, physician assistant, and social work programs. Matched pre- and post-session responses to a validated instrument assessing interprofessional values and interactions were available for 319 students (85%). Statistically significant advancements in self-reported skills were apparent in students' pre- to post-session responses for both the interprofessional interactions and values domains of the Interprofessional Education Collaborative (IPEC) self-assessment tool (P<0.001). Incorporating e-learning strategies into a complex simulation conducted online via Zoom was effective in helping students achieve desired interprofessional competencies.

Keywords: Education, Medical, Distance, Interprofessional Education, Simulation, Standardized Patients, Medical Education

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Problem

For five years, our College of Medicine held an in-person Interprofessional Education (IPE) activity with students from various professions, working collaboratively to assess a Standardized Patient (SP) who portrayed subacute stroke symptomatology. The in-person scenario and associated educational outcomes have been previously reported (1, 2). In this activity, learning objectives were derived from the Interprofessional Education Collaborative (IPEC) competencies and included demonstrating integrity and respect for team members, identifying roles for oneself and others in a subacute care situation, demonstrating appropriate and effective

communication strategies using historical and clinical information to inform effective teamwork, and reflecting on performance (3).

Social distancing protocols associated with the COVID-19 pandemic necessitated a shift to remote education beginning with the 2021 iteration of our stroke simulation. For the health of students, faculty, and standardized patients, meeting in person was impossible. Thus, modifications were necessary to actively engage learners in an online environment in a way that allowed them to practice skills, collaborate with peers, and solve problems, all while highlighting real-world relevance. The restructured scenario drew from e-learning educational principles to (a) emphasize and incorporate the relevance of "real world" applicability (e.g., telehealth); (b) encourage asynchronous active exploration, self-learning, and application prior to the event; (c) stimulate learners to incorporate previous educational knowledge and experiences into the simulation encounter; (d) assign deliverables to visually represent (*graphic organizers*) content/ideas from teammates; (e) provide opportunities for learners to build communities; and (f) integrate emotionally-driven content into the scenario by adding some "elements of surprise" (4, 5).

The simulation was restructured using a c*onstructivist* framework – where learners used their previous knowledge as a foundation and built on it with new information they learned while actively engaging with others. An activity built on constructivism focuses on *learning* (not teaching); faculty involvement is limited to facilitation and guidance. Constructivist learning environments require students to be self-directed and intrinsically motivated; teachers provide only context and feedback. Furthermore, grading is replaced by self- and peer-evaluations, which increase students' motivation to be self-directed (6).

Our primary objective was to determine if a clinical IPE simulation activity that mimics a complex healthcare situation such as subacute stroke management could be successfully (re)designed using e-learning principles and accomplish the same learning outcomes related to interprofessional interactions and values that had resulted when conducted face-to-face.

Solution

We implemented an online clinical simulation with interprofessional learners from medical (year 2), nursing (year 4), occupational therapy (year 5), physical therapy (year 5), physician assistant (year 1), and social work (various years) programs; standardized patients and faculty facilitators were also present. The group of students was a convenience sample since participation in the IPE simulation was required for students enrolled in the various health professions programs.

Prework

The admission notes for the case did not change from what was reported previously (1), but additional active learning elements were incorporated to engage adult learners online (Table 1).

Briefly, unlike prior iterations of the activity, where information was provided to learners only after they arrived at the simulation center for their "pre-session team huddle," a Learning Management System (LMS) housed the required pre-work, session information, and post-session requirements, including the IPEC self-assessment tool that was used to measure session effectiveness (7).

Prior to the event, admission notes, profession-specific information, profession-specific discussion boards, and interprofessional team discussion boards were launched to challenge learners to incorporate and apply prior knowledge asynchronously. In some cases, profession-specific information reinforced/enhanced information from the admission notes (received by all team members), but in other cases, profession-specific information provided new information and deliberately contradicted information in the admission notes. This was purposeful to see if learners were empowered to speak up and communicate new information with their teammates (e.g*., the admission notes received by all learners indicated the patient was not to eat anything by mouth (NPO) until swallowing*

Table 1: Comparison of in-person versus online simulation activity, highlighting the distance-learning elements added for the online iteration and their rationale.

Specific Elements to Support Learning	In-person Simulation (Historical Control)	Online Simulation	Rationale for Adding New Distance-Learning Strategies to Online Activity
Prior to the Simulation			
LMS	N	Y	D, E
Electronic invitation to complete IPE Collaborative Self-Assessment	Y	Y	NN
Profession-specific learning objectives (in addition to overall session objectives)	N	Y	C
Online student introductions of team members using Voice Thread embedded in the LMS	N	Y	E
Video and team discussion board in LMS depicting a dysfunctional team meeting	N	Y	E
Video regarding SIBR and suggestions for how teams could implement SIBR	N	Y	B, C
Pre-reading: An article describing specific interventions different healthcare team members perform for patients with recent stroke	N	Y	B, C
NIHSS tool (blank)	Y	Y	NN
Completed NIHSS assessment of patient at the time of admission	Y (provided on paper)	Y (video depicting nurse doing the assessment provided in advance)	NN
Challenge: calculate the patient's NIHSS score at the time of admission (based on video of the nurse performing the assessment)	N	Y	A, B, C
Pre-reading outlining different types of facilities/ rehabilitation to which a patient with a recent stroke might be discharged	N	Y	B, C
Video describing the telestroke service the academic health system provides to rural community facilities	N	Y	A
Setting the stage for the simulation activity as a telestroke team consult	N	Y	A
Profession-specific information provided to each profession in advance	Y	Y	NN
Prompts for students to answer profession-specific discussion board questions based on profession-specific information	N	Y	B, C, E
Admission notes about the patient provided	Y (at session)	Y (in LMS in advance)	NN
Identifying team-specific roles (e.g., leader, scribe, time-keeper, technology coordinator, and so on)	N	Y	E
Time for students to pre-brief as a team to strategize the flow of the patient encounter	Y	Y	NN

During the Simulation Encounter			
Students conducted profession-specific assessments	Y (Query-based and physical assessments)	Y (Mostly query-based)	NN
Videos depicting healthcare professionals conducting physical exam assessments with the patient	N	Y	C*
Team Google Doc included prompts for discussion (e.*g., what safety concerns were apparent in the pre-recorded videos?*)	N	Y	D, E †
"Surprise" elements and information were time-released in the LMS (e.g., the patient's spouse had left a list of specific questions to be answered; the patient had specific questions about MRI and CT images)	N	Y	F
Students huddled to discuss a discharge plan to the patient	Y (in the simulation room)	Y (in ZOOM break-out room)	NN
After the Simulation			
Facilitator-led debrief using the GAS model and debriefing with good judgment frameworks	Y	Y	NN
Facilitator feedback to individual learners using a rubric that included professionalism, respect, teamwork, communication, and responsibility domains	Y	Y	NN
Peer feedback using a rubric	N	Y	G
Self-reflections using a rubric	N	Y	H
Invitation to complete the IPE Collaborative Self-Assessment and program evaluation	Y (in room)	Y (via LMS)	NN

Y= Yes (present); N= No (Not present); A= Emphasize the relevance of telehealth; B= Promote asynchronous, active learning/preparation before the event; C= Incorporate previous knowledge/experiences into the event; D= Assigned deliverables; E= Build communities; F= Emotionally-driven content; G= Immediate feedback; H= Self-reflective practice; NN= Not New (*although methodology may have changed*). IPE: Interprofessional Education; LMS: Learning Management System; SIBR: Structured Interdisciplinary Bedside Rounds; NIHSS: National Institute of Health Stroke Scale; GAS: Gather-Analyze-Synthesize. *Videos of faculty (RN, PT, OT) performing various assessments with the SP were due to the necessity of social distancing and the inability to have learners together; in some cases, the faculty intentionally did things "improperly" (e.g., bed rails were not put up, and so on.) to generate discussion among students related to patient safety – which was a prompt in the team Google Doc deliverable†.

was evaluated; in contrast, nursing-specific notes indicated that speech-language pathology colleagues had already cleared the patient to eat). A talking-point for facilitators during the debrief pertained to learners' empowerment to speak up and to educate their colleagues when one profession had information that the rest of the team did not.

Simulation Event

The simulation encounter was held synchronously via Zoom using break-out rooms. Each group had a team-specific Google Doc (e.g., deliverable) with prompts to: (a) assign team-specific roles to team members (e.g., co-leader, scribe, time-keeper, technology manager, and so forth) that were independent of profession-specific roles, (b) outline things their profession would do for the patient, (c) list unknowns that remained, (d) list safety concerns, and so forth. This allowed learners to build community with

teammates, assured that everyone contributed to the group effort, and provided a deliverable that visually represented content/ideas from teammates.

Students were informed that the context of this encounter was that they were part of a *telehealth stroke team* providing support for a rural medical facility lacking a dedicated stroke team. The SPs, while physically in beds in their own homes, wore hospital gowns with intravenous catheters taped in place and connected to their assigned Zoom breakout room via computers that were on their laps. Notably, the SPs' Zoom backgrounds depicted the wall of an intensive care unit (e.g., hospital monitors, and so on) to enhance the realism. SPs were trained to integrate some "emotionally-driven content" by demanding answers about their CT and MRI scans (which were time-released into the LMS), demanding answers to questions on a "note left by the spouse" (also time-released into the LMS), and the SP initially refused to consider team suggestions that a rehabilitation facility would be the best discharge plan. These "surprise elements" caught students off-guard, a reaction which is known to trigger emotional responses that reinforce learning, and, in the latter situation, required students to probe deeper into the patient's values/concerns and attempt to educate the patient regarding the benefits of rehab versus home discharge.

Facilitators turned off their microphones and cameras until the debriefing to promote a sense of community among learners and prevent faculty from interjecting during the scenario.

Post-session

After the session, students submitted post-activity responses to the IPEC self-assessment instrument, which assesses interprofessional interactions and values. Changes in post-session responses compared to those submitted before the activity were used to measure the effectiveness of the endeavor.

Data Analysis

All variables from the IPEC self-assessment tool were summarized before analysis to assess their distributions, including the continuous outcome variables for normality. Individual students' pre- and post-session responses were matched, and pre-and post-session means were compared with a paired t-test for each domain overall, within each gender, and in each profession. Significance was set at $P<0.05$, and all analyses were performed using SAS statistical software version 9.4 (SAS Institute, Cary, NC).

Results and Conclusion

In total, 376 students were assigned to 68 small groups facilitated by 39 faculty facilitators (most faculty facilitated multiple groups); each group had two facilitators representing different professions. Each session lasted 125 minutes.

Before the session, 366 students (97%) completed the IPEC self-assessment; following the session, 323 (86%) completed it. Matched pre- and post-session IPEC self-assessment responses were available for 319 students (85%) (225 female, 87 male, and 7 students did not indicate gender). The average age of these students was 24±2.96 years (range 21-42 years). Statistically significant shifts (advancements) in student self-reported competency with the IPEC self-assessment tool were apparent in the overall cohort and for most individual professions (Table 2). The only exceptions for not achieving statistically significant changes were the physician assistant students (values domain) and the social work students (values and interaction domains).

Health professions programs needed to alter learning strategies quickly during the pandemic. While some schools were able to incorporate virtual reality and instant messaging into their curricula, we relied heavily on strategies known to be effective for distance learning by re-setting the stage to highlight the applicability of the scenario to telehealth modalities, an increasingly critical component of healthcare delivery; encouraging self-learning and application of the information in ways that cause students to retrieve and utilize prior knowledge and experiences;

Table 2: Interprofessional Education Collaborative (IPEC) Self-Assessment Results.

Learners	N	Pre (Mean±SD)	Post (Mean±SD)	Difference (Mean±SD)	P value
Values Domain					
All	319	34.55±3.16	35.53±3.59	0.98±3.08	<0.001
Female	225	34.77±3.10	35.72±3.37	0.95±2.93	<0.001
Male	87	34.08±3.24	35.36±3.84	1.28±3.43	<0.001
MD	142	34.25±3.49	35.08±3.89	0.83±3.45	0.005
OT	44	34.11±2.63	35.25±3.17	1.14±2.66	0.007
PA	28	34.50±2.55	35.11±3.36	0.61±2.86	0.27
PT	36	34.50±2.93	36.22±3.56	1.75±3.03	0.001
RN	57	35.93±3.02	36.72±3.12	0.81±2.53	0.019
SW	11	33.45±1.92	35.00±2.86	1.55±3.01	0.12
Interaction Domain					
All	319	30.6±3.30	33.9±3.50	3.31±3.45	<0.001
Female	225	30.5±3.24	33.9±3.21	3.37±3.15	<0.001
Male	87	30.8±3.45	34.2±4.10	3.43±4.11	<0.001
MD	142	30.8±3.58	33.9±3.74	3.08±3.81	<0.001
OT	44	30.0±2.80	32.9±2.88	2.91±2.78	<0.001
PA	28	30.6±3.11	33.64±3.57	3.07±2.94	<0.001
PT	36	30.5±3.22	34.81±3.59	4.33±3.61	<0.001
RN	57	30.4±3.28	34.68±3.16	4.25±2.79	<0.001
SW	11	31.3±2.28	31.82±2.27	0.55±2.98	0.56

*Seven students did not select a gender, and one student did not indicate a profession. MD: Medical; OT: Occupational Therapy; PA: Physician Assistant; PT: Physical Therapy; RN: Registered Nurse; SW: Social Work

appealing to students with different learning styles (e.g. visual, auditory, reading/writing); encouraging accountability in communities of learning (both profession-specific and interprofessional team discussion boards); incorporating immediate feedback and self-reflection; and evoking emotional reactions during the session to reinforce concepts (e.g., patient's values/agenda offer differs from that of the healthcare team) (4, 5, 8-11). Based on student self-reports using the IPEC self-assessment tool, the stroke simulation scenario achieved learning outcomes in an online format consistent with those attained when conducting the session in-person (1).

In the years since we implemented the inaugural simulation event (2016), a great deal has changed within our institution and the consortium of IPE partners with whom we collaborate. For example, prior to this session in 2021, every medical student spent an entire year partnered with a health professional (typically a social worker or nurse) in the context of patient navigation. In addition, nearly every participant in the distance learning iteration of the stroke IPE activity had already participated in multiple "foundational" IPE events and simulations, highlighting the shared values and ethics that exist across professions; the educational background, roles, and scope of practice of different professions; and mechanisms of effective communication during times of conflict. Thus, it would not have been a surprise if the IPEC self-assessment tool was not sensitive to detect any further self-perceived growth regarding individuals' interprofessional competence. Despite the cohort's wide array of prior IPE and collaborative practice experiences, and also the inability of these learners to meet in-person, our results suggest that students had not yet "maxed out" in terms of being collaborative-practice-ready and were still able to advance their personal interprofessional competence like what had been obtained when the activity was held face-to-face even when collaborating in a

remote learning environment (2).

As may be expected, the nature of conducting this IPE simulation presented several unique challenges. However, these challenges provided an opportunity to demonstrate creativity and create new educational tools. For example, prerecorded videos depicting professional encounters with the SP were developed. Although it was not ideal for students to miss out on observing hands-on contact and assessments when their peers interacted with the SP, the pre-recorded videos did invite opportunities for incorporating safety issues that became essential learning points for students to discuss in their teams (e.g., a healthcare professional failed to put the bedrail up; another healthcare professional failed to put anti-skid socks on the patient before attempting ambulation, and so on). While patient safety issues were certainly discussed during past face-to-face debriefings, if a student made a patient safety error, they might have felt singled out and left the session with a sense of shame or guilt for forgetting an important aspect of patient care. In contrast, the pre-recorded patient-provider interactions removed that culpability from the students and reinforced patient safety as a consistent learning outcome for all groups.

Moreover, the use of peer feedback proved beneficial. Although students have consistently received individualized feedback from facilitators regarding their performance, adding the extra element of peer feedback seems to have improved engagement throughout the scenario. Not only did students want to receive "good" feedback from their peers, but also knowing that they were simultaneously responsible for providing feedback to others seems to have heightened their awareness of the contributions made by other team members.

Additional positive outcomes were associated with providing admission notes and profession-specific information in advance and tasking students with discussing profession-specific information with peers. These activities seem to have boosted confidence in learners, enabling them to participate to the fullest extent. Using a shared document among team members that helped students generate and track ideas before and throughout the session, as well as the assignment of team-specific roles, seemed to enhance accountability and improve team efficiency and function. Finally, the high rate of matched data in pre- and post-session questionnaires was most likely because links to the IPEC self-assessment questionnaire were included in the LMS, where all other course materials were located, as opposed to being received as separate emails before and after the simulation.

One of the strengths of this study is the use of the same validated tool to assess student learning outcomes as was used before the COVID-19 pandemic when sessions were held in-person (2). This consistency allows for a more direct comparison of outcomes and demonstrates the efficacy of the format used. The following limitations have also been identified.

First, the SP in the pre-recorded videos was not the same as the SP assigned to groups during the encounter for most groups. This inconsistency could have been confusing for some students. Future iterations could address this by pre-recording a series of patient-provider videos using a wide array of SPs. Additionally, we recognized that pre- and post-self-assessments might not reflect actual learning, and the long-term outcomes and transferability of IPE skills in simulation environments to authentic patient care situations onwards are unknown. Because of the differing number of learners representing each profession, not all teams had the same professions present. Thus, these limitations may limit the generalizability of our observed outcomes to other environments where different professions are available to participate.

Many of the modifications made to the simulation due to shifting to an online platform were maintained even after we could return to hosting in-person events. For example, interprofessional team discussion boards allow learners to form

learning communities before sessions, and profession-specific discussion boards allow uni-professional learners to converse and test thoughts/concepts/ideas in a familiar environment within their peer groups.

In conclusion, even complex interprofessional simulations with standardized patients can be successfully executed in remote learning environments by intentionally incorporating distance-learning principles. These modifications are generalizable to various educational events and may make it more feasible for others to develop and implement engaging IPE activities when large geographical distances separate learners.

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Authors' Contribution

KK contributed to conceptualization, study design, data acquisition, and manuscript preparation. CB was involved in manuscript preparation. DL conducted data analysis and contributed to manuscript preparation, and EL performed statistical analysis.

Conflict of Interest

The authors declare no conflict of interest.

Ethical Considerations

This activity was reviewed by the Penn State Health Milton S. Hershey Medical Center and Penn State College of Medicine Investigational Review Board under study ID#15528 and was determined to be exempt from oversight since it was designated as programmatic evaluation rather than human subjects research.

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Availability of Data and Materials

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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