BRIEF

A Mapping Review of Teamwork Training and Assessment in Pharmacy Education

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Objective. To explore how teamwork is taught (ie, skills and format), measured, and assessed within pharmacy education.

Methods. A mapping review was conducted to provide a selection of articles to specifically capture how teamwork is taught, measured, and assessed within pharmacy education.

Results. Of the 114 references retrieved, 18 studies from 17 schools or colleges of pharmacy met the inclusion criteria for review and data abstraction. Ten of the studies (56%) described how teamwork training was integrated into courses while the other eight studies described workshops, clinical rotations, modules, interprofessional simulations, long-term projects, and retreats on teamwork. Learning activities involving patient cases were the most common teaching method described (n = 12, 67%). For the teamwork principles taught, all articles included leadership training or evaluating leadership skills in their program. To assess teamwork, 17 (94%) of the programs used students' self-reported measures of skills and behaviors, attitudes, and/or knowledge. Fourteen studies (78%) demonstrated improvements in students' attitude-related outcomes, 13 (72%) studies demonstrated improvements in skills-related outcomes, and six studies (33%) described improvements in knowledge related outcomes.

Conclusion. Teamwork is regarded as an integral component of being an effective health care professional. While teamwork is common in pharmacy curricula, few studies describe strategies for teaching effective teamwork strategies to pharmacy students. The articles reviewed revealed a wide range of approaches to teaching, measuring, and assessing teamwork skills within pharmacy education. This review highlights an opportunity to further explore and identify the teamwork skills that are requisite for success in pharmacy practice, which could then be supported by standardized teamwork training programs and assessments.

Keywords: pharmacy student, teamwork, training, education

INTRODUCTION

A growing body of health sciences literature emphasizes the importance of teamwork. Health care experts increasingly agree that including pharmacists on health care teams can improve patient outcomes.^{1,2} Similarly, employers of pharmaceutical sciences graduates recognize collaboration as a key skill for success in today's workplace.³ Effectively preparing students for the realities of team-based care and other collaborative environments remains a key focus and challenge as pharmacy schools work to develop curricula aligned with the health care needs of society.⁴⁻⁶

Teamwork in pharmacy education is prevalent and diverse, varying in its context, purpose, and structure. Students may encounter teamwork through the use of classroom-based pedagogies such as project-based learning or team-based learning (TBL).^{7,8} Experiential education, such as introductory pharmacy practice experiences (IPPEs) or advanced pharmacy practice experiences (APPEs) may also involve collaboration with technicians, pharmacists, or other members of the health care team.^{9,10} Further, students may experience teamwork within educational environments and groups, such as research laboratories, academic committees, and cocurricular organizations.¹¹

Research studies on group-based pedagogies, such as TBL and interprofessional education (IPE), generally describe positive outcomes. Compared to traditional lecture formats, TBL can result in increased student engagement and improved learning outcomes.¹²⁻¹⁴ Similarly, interprofessional

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immersion can improve learner views of collaborative ability, confidence, and importance.¹⁵ While clear consensus exists concerning the importance of teamwork, there is a lack of literature and related research describing strategies for teaching pharmacy students how to work in teams (ie, how teamwork is taught, measured, and assessed).

The purpose of this manuscript was to review published research in pharmacy education that described how students were taught to work in teams and/or assessed as collaborators. The following questions were explored: How is teamwork taught (ie, skills and format) within pharmacy education? How is teamwork measured and assessed within pharmacy education?

METHODS

The protocol for this mapping review was developed to provide the most comprehensive selection of articles and to specifically capture how teamwork is taught, measured, and assessed within pharmacy education. To be included in this paper, studies had to meet the following criteria: included students enrolled in a PharmD curriculum at an accredited pharmacy school, were peer reviewed, were published between 2000-2019, and described teaching teamwork and/or how teamwork is measured and assessed within pharmacy education. Furthermore, specific outcomes related to teamwork skills and behaviors, attitudes, and/or knowledge as defined by Baker and colleagues needed to be reported in the study to be eligible for inclusion. Studies were excluded if they were only a review of the literature (eg, meta-analysis, systematic review, literature review), had not been peer reviewed (eg, commentaries, dissertations, book chapters), focused solely on survey development (ie, studies on developing a survey to be used to assess teamwork), only assessed student readiness but not how teamwork was taught, or had only been published as an abstract.

The databases selected for this review included PubMed/Medline, SCOPUS, PsychINFO, EMBASE, and ERIC. PubMed/Medline, SCOPUS, and EMBASE are databases commonly used to identify studies that are related to health care and interventions; ERIC was selected to find additional education articles as it is the largest education database in the world; and PsycINFO was selected to capture interdisciplinary research in education and the social sciences.¹⁶⁻¹⁸ The search terms selected for this review were “pharmacy education” AND “teamwork” to provide the most comprehensive, inclusive, and broad selection of articles related to teamwork in pharmacy.

Journal articles were cataloged in Mendeley Reference Manager (Mendeley) and were uploaded to Covidence, a software used for abstract and article screening, data extraction, and quality assessment. The abstract of

each of the articles identified by the search was screened by two reviewers to determine which articles should be included in the full article screening. Conflicts were resolved by a third reviewer. Subsequently, the full version of each of the selected articles was screened by two individuals to determine whether the study would be included in the review. Again, conflicts were resolved by a third reviewer. For the full review, data extraction was completed by two individuals, who each extracted data from half of the included articles for the 13 different variables of interest. Ten percent of the articles were then randomly selected for review and audit by a third reviewer, with more than 95% agreement found across variables.

Variables of interest for this study included the teamwork training program design or intervention; duration of the program; learner characteristics or demographics; teaching methods used; teamwork knowledge, skills, and behaviors emphasized as defined by Baker and colleagues; teamwork model/instrument used; outcomes expected/measured; individual(s) performing the assessment; and intervention results, among others (Table 1).¹⁹ The teamwork framework created by Baker and colleagues was used as these knowledge, skills, and behaviors had previously been determined to meet the Institute of Medicine’s recommendation for organizations to develop effective, evidence-based interdisciplinary team training programs.¹⁹ A review with similar methodology used the Baker and colleagues framework to assess teamwork training in medical student and resident education.²⁰ All variable information and related data were cataloged using Excel.

RESULTS

Of the 114 references initially identified, 21 duplicate articles were removed. Of the remaining 93 articles identified, 50 were deemed irrelevant during the initial screening phase and an additional 25 were excluded based on the eligibility criteria. This resulted in 18 studies which described teaching teamwork and/or how teamwork was measured and assessed within pharmacy education and fulfilled all criteria for inclusion and data extraction.^{9,21-37} The included studies represented 17 different pharmacy schools. Pharmacy student involvement in the programs ranged from first-year to fourth-year students. Nine studies (50%) described programs that included students from other health professions, with the most common being nursing (n=7, 39%) and medicine (n=6, 33%).

The characteristics of the teamwork training programs published within pharmacy education are presented in Table 2. Ten studies (56%) described how teamwork training was integrated into courses, while other programs included workshops (n=2, 11%), clinical

Table 1. Variable Information for Literature Review Data Extraction Conducted as Part of a Study of Teamwork Training and Assessment in Pharmacy Education

Variable Name	Variable Description	Variable Example
Teamwork Training Program Design/ Intervention	How different programs or interventions were designed to better understand how pharmacy students interact with others.	Interprofessional education programs and programs that were solely comprised of pharmacy students.
Duration of the Program	Documented how long the teamwork intervention lasted.	Semester, Month, Year, Two-Weeks, etc.
Learner Characteristics or Demographics	Defined the sample and group features, such as specific health professions disciplines, student year, and learner environment.	Health professions disciplines (ie, medical, pharmacy, nursing, etc.); student year (ie, first-year, second-year, third-year, etc.); learner environment (ie, online, face-to-face, etc.).
Teaching Methods Used	Description of how information was proliferated to the students.	Simulations, lectures, case scenarios, etc.
Teamwork Principles	Characterized using Baker and colleagues (2005) defined mechanism of teamwork. ¹⁹	Team leadership, mutual performance monitoring, backup behavior, adaptability, team/collective orientation, shared mental models, mutual trust, and closed-loop communication.
Teamwork Model/Instrument	Identifying the different model/instrument used to measure different aspects of teamwork.	Readiness for Interprofessional Learning Scale (RIPLS), Team-Based Learning (TBL), etc.
Outcomes Expected/Measured	How the expected outcomes were measured	Data collection, analysis, study design, and the specific tenants of teamwork that were included as outcome variables.
Individual Performing the Assessment	Person who conducted the assessment	Students, faculty members, preceptors, etc.
Intervention Results	Identified whether the intervention or study was deemed “favorable.”	Statistically significant results indicating that an intervention may measure or increase teamwork within pharmacy education

rotations (n=2, 11%), modules (n=1, 6%), interprofessional simulations (n=1, 6%), long-term projects (n=1, 6%), and retreats (n=1, 6%). Learning activities involving patient cases were the most common teaching methods described with patient simulations, role-play exercises, and patient encounters included in 12 articles (67%). Duration of programs ranged from a one-day workshop to a semester-long course.

With regards to the teamwork principles that were taught, all of the programs described in the studies included leadership training or evaluation of students' leadership skills. Specifically, 16 (89%) articles described programs addressing the solicitation of team member ideas in defining goals and objectives, and 13 (72%) described programs addressing fostering trust between team members. Nine studies (50%) did not describe a specific teamwork model used to teach teamwork within the program designs (Table 2).

The reported outcomes of the teamwork training programs are described in Appendix 1. Seventeen (94%) of the programs used self-reported measures of skills and behaviors, attitudes, and/or knowledge. No standardization existed between the skills and behaviors, attitudes, and knowledge attributes assessed or the method in which these attributes were assessed. Examples of skills and behaviors measured included communication, ability to integrate information into a therapeutic plan, and ability to work cohesively as a team. Attitude measures used in the studies included assessing the importance students placed on collaboratively working with peers or as part of a team, and whether students believed that teamwork skills could be learned. Of the five studies that reported on knowledge-related outcomes, four (80%) assessed student understanding of roles within a team and the roles of other health care professions.

Six (33%) programs used instruments that had undergone reliability testing and had been previously validated,

Table 2. Characteristics of Teamwork Training Formats Identified in a Mapping Review of Published Articles in Pharmacy Education

Author (year)	Format of Teamwork	Duration of Program	Learner Characteristics	Teaching Principles Included ^a	Teamwork Model
Camiel et al (2017) ²¹	TBL; in-class group-based activities following Readiness Assurance Tests	14-week course	324 pharmacy students	a, b, c, e, f, g	TBL
Collier and Baker (2017) ²²	Group presentations	Semester course	299 first-year pharmacy students	a, b, d, e, h	None Described
Elmore et al (2014) ²³	Adapted TBL activities	Two-semester course	116 third-year pharmacy students	a, e, f, g	TBL
Hameen-Anttila et al (2010) ²⁴	Students worked in groups to create materials that schoolteachers could use to teach children about rational use of medicines	Semester	21 fourth-year pharmacy and 10 students completing their final year of pharmacy school (9 participants).	a, d, h	None Described
Hasnain et al (2012) ²⁵	Interprofessional experience with pharmacy and medical students designed to demonstrate the value of functioning effectively in interprofessional teams	3-week course	6 third-year medical students and 6 fourth-year pharmacy students	a, e	None Described
Janke et al (2009) ²⁶	Off-campus retreat that combined organized learning activities and social/networking opportunities	28-hour	42 second-, third-, and fourth-year PharmD students	a, b, d, e, f, g, h	None Described
MacDonnell et al (2012) ²⁷	Interdisciplinary workshop; teams alternated between working together on patient cases and on the evaluation of standardized patients	1-day workshop	101 third-year pharmacy students, 83 second-year medical students, and 67 fourth-year nursing students	a, c, d, e, f, g	None Described
Maldonado et al (2013) ²⁸	APPE rotation where students participate on an interdisciplinary solid organ transplant team	1-month rotation experience	37 fourth-year pharmacy students	a, c, d, e	None Described
Ottis and Gregory (2016) ²⁹	Interprofessional team simulation comprised of nursing and pharmacy students	OSCE simulation comprising ~20 minutes	86 third-year nursing students and 257 third-year pharmacy students	a, e	IPEC
Peeters et al (2017) ³⁰	Interprofessional teams engaged in simulations, standardized-patient interviews, case-based communications exercises, vital signs training, and patient safety rotations	16-week course	554 first-year health sciences students from eight professions (medicine, nursing, occupational therapy, pharmacy, physical therapy, physician assistant studies, respiratory therapy, speech-language pathology)	a, c, e, f, g, h	TeamSTEPPS

(Continued)

Table 2. (Continued)

Author (year)	Format of Teamwork	Duration of Program	Learner Characteristics	Teaching Principles Included ^a	Teamwork Model
Pittenger et al (2013) ³¹	IPE groups created a communication plan for coordinating and collaborating on the care of diabetes patients in an ambulatory setting	15-week course	34 pharmacy students, 17 undergraduate nursing students	a, b, c, d, e, f, g, h	IPEC
Rotz et al (2016) ⁹	Interprofessional experiential course series	6 semesters	163 students (49 pharmacy, 114 medical students)	a, b, c, d, e, f, g, h	IPEC
Saini et al (2011) ³²	Interprofessional learning module that included completing a 1-day interprofessional workshop and teaching students in interprofessional teams	3-day module	4 medical students, 4 nursing students, 9 pharmacy students	a, b, c, d, e, f, g, h	None Described
Sevin et al (2016) ³³	Elective course where students provided patient care in an interprofessional clinic and participated in bi-weekly workshops in which students reflected on their experiences and discussed roles, team dynamics, communication skills, and challenges	Semester course	15 students (7 nursing, 6 pharmacy, and 2 social work students)	a, b, c, d, e, f, g, h	IPEC
Snyder Franklin et al (2016) ³⁴	Phenytin pharmacokinetics workshop that utilized a TBL format	Groups met face-to-face over a 3-day weekend or online over a 2-week period	222 non-traditional pharmacy students online and 70 students face-to-face	a, e, f	TBL
Vyas et al (2012) ³⁵	Interprofessional course utilizing patient simulation designed to teach patient safety and teamwork skills	Four-week course	208 health professions students	a, b, c, d, e, f, g, h	None Described
Zakaria and Awaisu (2011) ³⁶	Shared learning experience with third-year students working in smaller groups mentored by fourth-year students.	Semester	87 third-year and 51 fourth-year pharmacy students	a, c, f, h	None Described
Zaudke et al (2016) ³⁷	Interprofessional practice experience during family medicine clerkship	1-month rotation experience	252 students (153 medical, 23 nursing, and 46 pharmacy students)	a, b, c, d, e, f, g, h	IPEC

TBL = team-based learning; IPEC = interprofessional education collaborative; OSCE = objective structured clinical examination; APPE = advanced pharmacy practice experience; IPE = interprofessional education

^a Eight teamwork principles related to knowledge, skills, and behaviors: (a) the curriculum included leadership training or evaluated leadership skills; (b) team members monitor one another's performance and provide feedback; (c) the curriculum addressed redistributing tasks upon demand by anticipating team member's needs through accurate knowledge of their responsibilities; (d) the curriculum addressed the ability to adapt to changing situations; (e) the curriculum addressed soliciting team member ideas in defining goals and objectives; (f) the curriculum addressed fostering trust between team members; (g) the curriculum included communication training or evaluated communication skills; (h) the curriculum addressed ensuring team members are "on the same page."

including the Interdisciplinary Education Perception Scale (IEPS), the Readiness for Interprofessional Learning Scale (RIPLS), the Performance Assessment of Communication and Teamwork (PACT), and the Student Perceptions of Physician-Pharmacist Interprofessional Clinical Education (SPICE) instrument. Fourteen studies (78%) demonstrated improvements in students' attitude-related outcomes, 13 (72%) studies demonstrated improvements in students' skills-related outcomes, and six studies (33%) described improvements in students' knowledge-related outcomes.

DISCUSSION

Within the pharmacy profession, increased emphasis has been placed on the importance of teamwork across health professions to improve patient care and patient safety.³⁸ Previous studies have demonstrated that teamwork and successful team performance can be developed in health professions students through training, specifically when team members learn key tenants of teamwork, as well as practice and continuously develop their teamwork skills.³⁹ To encourage the incorporation of teamwork training within pharmacy curricula, this review examined programs that were designed to teach, measure, and assess teamwork within pharmacy education.

As stated previously, literature within the health professions emphasizes the importance of effective teamwork, and the articles we identified through our review demonstrate the various collaborative learning approaches used within pharmacy curricula.^{7,40} While group-based pedagogies such as team-based learning or project-based learning are commonly used within health professions curricula and have been shown to enhance student knowledge, retention, and problem-solving skills, our findings suggest that there is not a consistent way in which pharmacy schools teach teamwork to students (ie, different concepts of teamwork, skills taught, and assessment strategies are used within pharmacy education).⁴¹

While specific teamwork training programs exist for specific purposes, such as TeamSTEPPS for interprofessional teamwork training, there is not a standardized format or program used to teach teamwork skills within pharmacy education. Additionally, most teamwork formats were incorporated within an isolated course in the curriculum, which only accounted for approximately half of the programs described in the literature. This mapping review can be used by others in the Academy to determine formats used to teach teamwork and outcomes used to measure and assess teamwork. However, given the importance of being able to effectively work within a team in the pharmacy profession, educators should consider whether it is more prudent and feasible to adapt an existing standardized teamwork training program for pharmacy education or create a new one. Baker

outlines principles to include within the teamwork format, explaining that teamwork should be distinct from taskwork and that formats which allow individuals to function with only the knowledge and skill of the task at hand is not enough.¹⁹ Teamwork depends on each group member being able to anticipate the needs of others, adjust to each other's actions and the changing environment, and to have a shared understanding of how a procedure should happen. Based on the teamwork formats described in the articles included in our mapping review, a format that includes all of Baker's principles may not currently exist within pharmacy education.

Under the theory of social regulation of learning, optimal collaborative learning includes students monitoring and controlling for their own, their peers', and the group's cognition, motivation, and emotions during a group task.⁴² While our review indicates that some programs that use teamwork formats incorporate some of these principles, there still appears to be a deficiency in formats, which teach students how to regulate within groups. A study by Lyons and colleagues introduced a new web-based tool for fostering social regulation of learning within collaborative learning.⁴² Tools such as this may be beneficial to use within a variety of teamwork formats in order to help create metacognitive awareness and allow students to identify and develop strategies to overcome challenges within teams.

One reason for the lack of standardization among teamwork training in pharmacy education may be the limited consensus within the Academy regarding core competencies in this area for pharmacists. The Center for the Advancement of Pharmacy Education (CAPE) 2013 Educational Outcomes state that, to meet patient care needs, pharmacists should actively participate and engage as a health care team member by demonstrating mutual respect, understanding, and values.³⁸ However, the CAPE educational outcomes do not provide guidance on specific teamwork skills pharmacy curricula should emphasize to meet the associated outcome and instead defer to each school to determine their own interpretation. All of the programs described in the published articles we reviewed incorporate some combination of the eight teamwork principles outlined by Baker, but the emphasis and priority placed on each principle is not known.¹⁹ This suggests there is an opportunity to define core competencies related to teamwork to guide how pharmacy schools achieve the CAPE educational outcome.

In addition to defining teamwork core competencies for the pharmacy profession, our findings indicated that variability exists among pharmacy schools in how students' teamwork skills are assessed. Published studies demonstrate that teamwork skills are widely self-assessed by students using surveys or questionnaires.^{9,21,23-26,28,29,31-33,35,36} While

self-assessment of teamwork skills may prompt crucial self-reflection in students about their need for improvement, having pharmacy educators complete student evaluations may also foster growth in students in these areas. The findings from our mapping review also suggest that assessments measuring the degree to which participants were able to apply what they learned while in a training environment to their behavior post-training are lacking. We postulate that the development of pharmacy core competencies related to teamwork may serve as the impetus for the creation of best practices in teaching teamwork skills with standardized and holistic assessments.

Several of these points were addressed in 2019 by pharmacy educators at the University of Florida College of Pharmacy.⁴³ Farland and colleagues reasoned that teamwork should be developed and evaluated longitudinally across the pharmacy curriculum rather than within a single course or program. Additionally, teamwork assessment plans should incorporate a process to assess individual contributions and team dynamics. To address these points, Farland and colleagues implemented a model of Continuous Development of Teamwork skills using longitudinal self, peer, and team feedback processes across multiple courses. The researchers found that the program identified individual students and teams that met the teamwork standards established by the school as well as those students and teams that needed further coaching to achieve the designated learning outcomes. This model may serve as a starting point to address the teamwork training needs that we identified in our review.

This review is not without limitations. First, publication bias may have occurred as our review included only articles published in peer-reviewed journals. Therefore, other effective designs related to teamwork training may exist in unpublished papers or in published articles that did not align with our designated inclusion or exclusion criteria. Second, we only determined whether Baker's teamwork principles were present in or absent from the articles identified in our search. We did not determine the quality of the content or extent to which Baker's principles had been included in a school's teamwork program as this information was not described in the majority of articles. Finally, our literature search only identified articles describing activities embedded within the PharmD curriculum. As teamwork skills are taught in other educational environments, such as research laboratories, academic committees, and co-curricular organizations, looking only within the PharmD curriculum, as we did in this study, could be perceived as a limitation. For example, pharmacy students have reported that communication, collaboration, and influence were skills emphasized in co-curricular activities in which they participated.¹¹ This suggests that future research focusing

on how teamwork is taught, measured, and assessed in other settings is needed.

CONCLUSION

Although teamwork is regarded as an integral component of effective health care, there is a paucity of literature describing strategies for teaching pharmacy students how to work effectively in teams. This mapping review describes the approaches taken to teach, measure, and assess teamwork within pharmacy education. The findings from this review highlight an opportunity to further explore and identify core competencies for teamwork in pharmacy, with corresponding standardized teamwork training programs and assessments.

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Appendix 1. Reported Outcomes of Teamwork Programs as Part of a Study of Teamwork Training and Assessment in Pharmacy Education

Author (Year)	Outcomes Expected/Measured	Person(s) Performing Assessment	Outcome Results (S=skill/behavior, A=attitude, K=knowledge)
Camiel et al (2017) ²⁰	During a course survey to assess team members on teamwork and satisfaction with the team; course completion survey to assess the CATME software and elements of teamwork	Student	S: On peer evaluation grades ranging from 1 to 5, contribution to team, interaction with team, keeping team on track, expecting quality significantly higher in higher GPA team than in either lower GPA or mixed GPA teams ($p < .05$) A: Satisfaction with team members was highest in lower GPA teams ($p < .05$)
Collier and Baker (2017) ²¹	Faculty assessments of the students' performance in group presentations and one-on-one counseling sessions	Faculty	S: Communication in both the professional group presentations and one-on-one counseling sessions significantly improved with the incorporation of active learning simulation exercises ($p < .001$)
Elmore et al (2014) ²²	Professionalism, teamwork skills, and perception evaluated using the Chisholm survey instrument before and after implementation of program	Student	S: Students responded that adapted TBL methods significantly improved their verbal communication and teamwork skills ($p < .001$) and ability to convey ideas diplomatically ($p = .016$) A: Students felt more respected by team members following implementation of TBL ($p = .026$); students were less likely to attend class ($p = .03$) and did not feel that they learned more from TBL than from studying alone ($p = .048$)
Hameen-Anttila et al (2010) ²³	Questionnaire and focus group regarding the importance of competencies associated with program activities	Student	S: The competencies that the respondents reported having acquired the most during the activities were teamwork, project work, social interaction, and long-term working. During focus group discussions, the most important skills learned during the activities were identified as teamwork skills and working together with other people.
Hasnain et al (2012) ²⁴	Written program evaluation with 7 Likert-type questions and 2 open-ended questions; 2 questions included asking about working with colleagues from other professions	Student	A: On a 10-point visual analogue scale, the mean score related to statement "this program will influence my practice behavior with colleagues from other professions" was 7.8 ± 2.77 ; students noted as among the "most effective" and "important impacts" of the course the opportunity to work collaboratively with peers from another discipline
Janke et al (2009) ²⁵	Pre- and post-retreat survey regarding perceptions on leadership, commitment to service, the power of relationship building and teamwork, and the importance of self-reflection	Student	A: Moderately or strongly agreed responses increased from 77% to 95% related to statement "as a new practitioner, I will be able to shape my practice environment regardless of my role, position, or title"; increased from 82% to 95% related to statement "leadership can be learned. Leaders are not just born"; increased from 87% to 95% related to statement "collegial relationships will play an important role in my ability to change practice"

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Appendix 1. (Continued)

Author (Year)	Outcomes Expected/Measured	Person(s) Performing Assessment	Outcome Results (S=skill/behavior, A=attitude, K=knowledge)
MacDonnell et al (2012) ²⁶	Faculty members and standardized patients evaluated the students using the teamwork global rating scale; students surveyed pre- and post-workshop to assess attitudes towards interdisciplinary education and surveyed after patient encounter regarding their experience as participants in a teamwork exercise	Faculty Standardized patient Student	S: 85% of students reported working cohesively as a team; 79% of student teams earned a rating of good or better in the standardized patient encounter, denoting students working cohesively as a team and sharing equally in decision-making A: 67% of students strongly agreed that it was important to work with students from other health professions ($p < .001$); increase from 49% to 64% who strongly believed that workshops promoting idea and experience of teamwork with other healthcare professionals could prove invaluable in the professional development of students ($p < .001$); increase from 39% to 57% who strongly believed these workshops should be required ($p < .001$); increase from 51% to 64% who strongly believed that health professional schools should offer workshops in which healthcare professionals work together ($p < .001$); 52% strongly believed that patient would benefit from interprofessional team approach; 74% had positive perception regarding collaborating with other healthcare professionals in future K: 84% of students reported better knowledge of what medical students learn in school, 74% reported better knowledge of what nurses learn in school, 82% reported better knowledge of what pharmacists learn in school ($p < .001$); 77% of students strongly agreed that they had an understanding of their role on team; 67% and 72% of students demonstrated understanding of advantages and disadvantages of working in a team with other healthcare professionals
Maldonado et al (2013) ²⁷	Online pre- and post-APPE survey instrument examining perceptions of interprofessional roles, communication, and teamwork	Student	S: Improvement in scores was seen on 2/2 skills-related survey items A: Improvement in scores was seen on 11/16 attitude-related survey items K: Improvement in scores was seen on 4/4 knowledge-related survey items
Ottis and Gregory (2016) ²⁸	Pre- and post-simulation survey that contained questions addressing interprofessional teamwork during the simulation	Student	S: Increased ability to work with an interprofessional team to develop a treatment plan ($p < .001$), communicate therapeutic recommendations with other members of the healthcare team ($p = .0017$), and integrate information into a plan ($p = .016$) A: Improvement in 13/15 items in attitude scale regarding interprofessional teamwork K: 42% of students reported increased knowledge regarding roles in patient care, 22% reported learning more about other professions' clinical knowledge base, 17% reported increased knowledge in utilization of other team members for efficient and safe patient care
Peeters et al (2017) ²⁹	Self-assessment questionnaire of students' achievement of course learning objectives (objectives mapped to IPEC competencies); word-cloud analysis used to provide insight into breadth and frequency of students' perceptions of other professions; end of course evaluations to describe student satisfaction with course	Student	S: Self-assessment of competency for learning objectives mean (SD) total scores were pre: 2.8 (0.9) and post: 3.5 (0.8); A: Word cloud analysis suggests overall net positive shift in perceptions of professions involved in interprofessional learning (ie, broader appreciation for the skills and roles of some professions, enhanced clarification of roles of professions); Course evaluations demonstrated overall satisfaction with the course
Pittenger et al (2013) ³⁰	IEPS and RIPLS were administered at baseline and the end of the course	Student	S: Qualitative analysis found that students felt more confident that they could work with another profession K: Qualitative analysis found that students felt more confident that they could understand other profession's skills/areas of expertise to best optimize patient care

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Appendix 1. (Continued)

Author (Year)	Outcomes Expected/Measured	Person(s) Performing Assessment	Outcome Results (S=skill/behavior, A=attitude, K=knowledge)
Rotz et al (2016) ⁹	Students evaluated using the PACT and SPICE Instrument	Faculty performed the PACT evaluation Students completed the SPICE Instrument	S: Descriptive statistics suggest that a majority of teams demonstrated appropriate competence with respect to interprofessional communication and teamwork A: Majority of students expressed positive perceptions of interprofessional collaboration with respect to teamwork, roles and responsibilities, and patient outcomes
Saini et al (2011) ³¹	Completion of the Asthma Knowledge for Health Professionals Scale, Attitudes Toward Health Care Teams Scale and RIPLS	Student	A: Significant changes seen in mean scores for the Attitude Toward Healthcare Teams (81.0 ± 4.7 to 85.2 ± 5.9) and the Teamwork and Collaboration subscale of RIPLS (41.4 ± 2.7 to 43.2 ± 2.7).
Sevin et al (2016) ³²	Validated 42-question survey in a retrospective post-then-pre design; survey instrument assessed IPEC competencies in four domains: Values and Ethics, Roles and Responsibilities, Interprofessional Communication, and Teams and Teamwork	Student	Students' self-assessment of IPEC competencies significantly improved in all four domains after completion of the course ($p < .0001$)
Snyder Franklin et al (2016) ³³	Survey to assess the learners' perceptions of their teamwork competencies, team interdependence, and perceived understanding of phenytoin PK	Student	A: 6 out of 6 items related to teamwork competencies and team interdependence were higher in the face-to-face cohorts compared to the online cohort ($p < .01$) K: No difference seen in items related to PK principles understanding between face-to-face cohort and online cohort
Vyas et al (2012) ³⁴	30-item survey of knowledge, skills, and attitudes administered pre- and post-intervention	Student	Pharmacy students' scores on 8 of 30 items on a post-simulation survey of knowledge, skills, and attitudes improved over pre-simulation scores; students' scores on 3 of 10 items on a team building and interprofessional communications survey also improved after participating in the simulation exercise; over 90% of students reported that simulation increased their understanding of professional roles and the importance of interprofessional communication
Zakaria and Awaisu (2011) ³⁵	23-item questionnaire to assess the value of shared learning during clinical assignments involving third- and fourth-year pharmacy students and to compare the perceptions held by the 2 student groups	Student	S: Majority of students ($>75\%$) believed that they learned to work as a team during their practice experiences and that the shared learning approach provided an opportunity to practice their communication skills A: Most respondents ($>70\%$) agreed that the new approach would help them become effective members of the healthcare team and would facilitate their professional relationships in future practice; almost two-thirds of students believed that the shared learning enhanced their ability to understand clinical problems; 31% of pharmacy students felt that they could have learned clinical problem-solving skills equally well working only with peers from their own student group
Zaudke et al (2016) ³⁶	RIPLS completed pre- and post-rotation	Student	A: Statistically significant pre-post differences for all respondents for Teamwork and Patient-Centeredness ($p < .05$); medicine responses less favorable for Teamwork and Professional Identity than nursing and pharmacy

Abbreviations: CATME=comprehensive assessment of team member effectiveness; APPE=advanced pharmacy practice experience; IPEC=interprofessional education collaborative; IEPS=Interdisciplinary Education Perception Scale; RIPLS=Readiness for Interprofessional Learning Scale; PACT=Performance Assessment of Communication and Teamwork; SPICE=Student Perceptions of Physician-Pharmacist Interprofessional Clinical Education