BRIEF

A Mapping Review of Teamwork Training and Assessment in Pharmacy Education

Kathryn A. Morbitzer, PharmD, MS, Amanda A. Olsen, PhD, MA, Jacqueline E. McLaughlin, PhD, MS

a University of North Carolina at Chapel Hill, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina
b University of Texas at Arlington, Arlington, Texas

Corresponding Author: Kathryn Morbitzer, University of North Carolina at Chapel Hill, UNC Eshelman School of Pharmacy, 321A Beard Hall, Campus Box 7574, Chapel Hill, NC 27599. Tel: 919-966-9124. Email: kmorbitzer@unc.edu

Submitted August 20, 2020; accepted November 26, 2020; ePublished December 2020

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

Findings. Of the 114 references retrieved, 18 studies met the inclusion criteria for review and data abstraction. The included studies encompassed 17 schools or colleges of pharmacy. Ten studies (56%) described how teamwork training was integrated into courses while other studies included workshops, clinical rotations, modules, interprofessional simulations, long-term projects, and retreats. Learning activities involving patient cases were the most common teaching methods 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 self-reported measures of skills/behaviors, attitudes, and/or knowledge. No standardization existed between the skills/behaviors, attitudes, and knowledge attributes assessed nor the method in which these attributes were assessed. Fourteen studies (78%) demonstrated improvements in attitude-related outcomes, 13 (72%) studies demonstrated improvements in skills-related outcomes, and six studies (33%) described improvements in knowledge related outcomes.

Summary. Teamwork is regarded as an integral component of being an effective health care professional. While teamwork is common in pharmacy curricula, there are few studies describing strategies for teaching pharmacy students effective teamwork strategies. 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 science literature emphasizes the importance of teamwork. In health care practice, 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 (PjBL) 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 co-curricular organizations.11

Research on group-based pedagogies, such as TBL and interprofessional education (IPE), generally describes positive outcomes. When compared to traditional lecture formats, TBL can result in increased student engagement and improved learning outcomes.12-14 Similarly, interprofessional immersion can improve learner views of collaborative ability, confidence, and importance.15 While clear consensus concerning the importance (ie, why) of teamwork exists, 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 study 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 research questions were explored:

(RQ1) How is teamwork taught (ie, skills and format) within pharmacy education?

(RQ2) 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 must have met the following criteria: 1) included students in a PharmD curriculum from accredited pharmacy schools, 2) were peer reviewed, 3) were published between 2000-2019, and 4) described teaching teamwork and/or how teamwork is measured and assessed within pharmacy education. Specific outcomes related to teamwork skills/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: 1) solely reviewed the literature (eg, meta-analysis, systematic review, literature review, etc.), 2) were not peer reviewed (eg, commentaries, dissertations, book chapters, etc.), 3) were solely on survey development (ie, studies to develop surveys used to assess teamwork), 4) were only on assessing readiness but not how teamwork was taught, or 5) were solely published in an abstract format.

The databases that were 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, since it is the largest education database in the world, and PsychINFO was selected to capture interdisciplinary research in education and the social sciences. 

The search terms selected for this review were “pharmacy education” AND teamwork. These search terms were selected to provide the most comprehensive, inclusive, and broad selection of articles related to teamwork in pharmacy. Journal articles were cataloged in Mendeley (London, United Kingdom), a reference management software, and were uploaded into Covidence (Melbourne, Australia), a software used for abstract and article screening, data extraction, and quality assessment. Each abstract was screened by two individuals for inclusion in the full article screening, and conflicts were resolved by a third reviewer. Subsequently, each full article was screened by two individuals for inclusion in the review, and 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 13 different variables of interest. Ten percent of the articles were reviewed and audited by a third individual with more than 95% agreement 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 utilized, outcomes expected/measured, individual(s) performing the assessment, and intervention results, among others (Table 1). 

Baker and colleagues’ teamwork framework was utilized since these knowledge, skills, and behaviors were established to meet the Institute of Medicine’s recommendation that organizations develop effective, evidence-based interdisciplinary team training programs. 

A review with similar methodology utilized the Baker and colleagues framework to assess teamwork training in medical student and resident education. All variable information and related data were cataloged in an Excel document.

RESULTS

Of the 114 references identified, 21 duplicate articles were removed, 50 articles were deemed irrelevant during the initial screening phase, and 25 articles were excluded based on the eligibility criteria. This resulted in 18 studies fulfilling all criteria for inclusion and data extraction. The included studies encompassed 17 schools or colleges of pharmacy. Pharmacy student involvement in the programs ranged from first-year to fourth-year students. Nine studies (50%) described programs that also included students from other health professions, with the most common being nursing [n = 7 (39%)] and medicine [n = 6 (33%)].

RQ1: How is teamwork taught (ie, skills and format) within pharmacy education?

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

For the teamwork principles taught, all articles described included leadership training or evaluating leadership skills in their program. Specifically, 16 (89%) articles described their program addressing the solicitation of team member ideas in defining goals and objectives, and 13 (72%) articles described their program 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).

**RQ2: How is teamwork measured and assessed within pharmacy education?**

The reported outcomes of the teamwork training programs are described in Table 3. Seventeen (94%) of the programs used self-reported measures of skills/behaviors, attitudes, and/or knowledge. No standardization existed between the skills/behaviors, attitudes, and knowledge attributes assessed nor the method in which these attributes were assessed. Examples of skills/behaviors measured included communication, ability to integrate information into a therapeutic plan, and ability to work cohesively as a team. Attitude measures identified included assessing the importance placed on collaboratively working with peers or on a team and believing that teamwork skills can be learned. Of the five studies that reported on knowledge-related outcomes, four (80%) studies assessed student understanding of roles within a team and other health care professions.

Six (33%) programs used instruments that had undergone reliability testing and had been previously validated, 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 attitude-related outcomes, 13 (72%) studies demonstrated improvements in skills-related outcomes, and six studies (33%) described improvements in knowledge-related outcomes.

**DISCUSSION**

Within the pharmacy profession, increased emphasis has been placed on the importance of teamwork across the health professions for improving patient care and patient safety. Previous literature has demonstrated that teamwork and successful team performance can be developed through training, specifically when team members learn key tenants of teamwork, as well as practice and continuously develop their teamwork skills. In order to aid the incorporation of teamwork training within the pharmacy curricula, this review examined programs 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 identified through this review demonstrate the various collaborative learning approaches used within pharmacy curricula. While group-based pedagogies such as TBL or PjBL are commonly used within health professions curricula and have been shown to enhance student knowledge, retention, and problem-solving skills, our review suggests that there is not currently a consistent way in which students are taught how to work in teams (ie, inconsistent format of teamwork, skills taught, and assessment strategies within pharmacy education).

While specific teamwork training programs for explicit purposes exist, 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 prudent and feasible to create or adapt a standardized teamwork training program for pharmacy education. The work from Baker outlines principles to include within the teamwork format. Baker states that teamwork should be distinct from taskwork and that formats which allow those to function with only the knowledge and skill of the task at hand is not enough. Teamwork depends on each group member being able to anticipate the needs of others, adjust to each other’s actions and to 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 the mapping review, it seems reasonable to question whether a format including all of Baker’s principles currently exists within pharmacy education.

Relatedly, it has been suggested that, under the theory of social regulation of learning, optimal collaborative learning includes students monitoring and controlling for their own, peers’, and group’s cognition, motivation, and emotions during a group task. While our review indicates that some currently used teamwork formats incorporate some of these principles, there still appears to be a lack of format which utilize techniques and tools that teach students how to regulate within groups. A recent study by Lyons and colleagues introduces a new web-based tool for fostering social regulation of learning within collaborative learning. 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 may be the limited consensus regarding teamwork core competencies for pharmacists. The Center for the Advancement of Pharmacy Education (CAPE) 2013 Educational Outcomes state that pharmacists should actively participate and engage as a health care team member by demonstrating mutual respect, understanding, and values to meet patient care needs. However, the CAPE educational outcomes do not provide guidance on specific teamwork skills pharmacy curricula should emphasize to meet the associated outcome, instead deferring to each school’s own interpretation. Our review shows that all published programs incorporate some combination of the eight teamwork principles outlined by Baker, but the emphasis and priority placed on each principle remains unknown. 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 review also indicates that variability exists in how teamwork skills are assessed. Currently, published literature demonstrates that teamwork skills are widely self-assessed by students using surveys or questionnaires. While the self-assessment of teamwork skills may instigate crucial self-reflection for improvement within students, it may also be beneficial to have pharmacy educators complete evaluations to help students foster growth in these areas. This mapping review also suggests that assessments measuring the degree to which participants applied 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 recently addressed by pharmacy educators at the University of Florida College of Pharmacy. 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, a model of Continuous Development of Teamwork Skills using longitudinal self, peer, and team feedback processes across multiple courses was implemented and evaluated. The researchers found that the use of this model identified individual students and teams that met the teamwork standards identified by the school in addition to identifying those that needed further coaching to achieve the designated learning outcomes. This model may serve as a starting point to address the teamwork training needs identified through our review.

While this review generated insight into a critical area within pharmacy education, it is not without limitations. First, there may be publication bias as our review included only published articles in peer-reviewed journals. Therefore, other effective designs related to teamwork training may exist in unpublished literature or articles that did not align with the designated inclusion or exclusion criteria. Second, the inclusion of Baker’s teamwork principles within the training program was only counted as present or absent, meaning the quality or extent of the content was not included, as this information was frequently not described in each article. In addition, it is also reasonable to postulate that teamwork skills are taught in other educational environments, such as research laboratories, academic committees, and co-curricular organizations. Particularly, co-curriculum participants have reported that communication, collaboration, and influence are skills emphasized through involvement in the co-curriculum. Our literature search identified articles describing activities embedded within the PharmD curriculum, suggesting future research is needed focusing on how teamwork is taught, measured, and assessed in other educational environments.

CONCLUSION

Although teamwork is regarded as an integral component of effective health care, there was 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. This review highlights an opportunity to further explore and identify core competencies for teamwork in pharmacy, with corresponding standardized teamwork training programs and assessments.

REFERENCES

1. Giberson S, Yoder S, Lee MP. Improving Patient and Health System Outcomes through Advanced Pharmacy Practice. A Report to the U.S. Surgeon General. Office of the Chief Pharmacist. U.S. Public Health Service. Dec 2011.
2. Isasi F, Krofah E. The expanding role of pharmacists in a transformed health care system. Washington, DC: National Governors Association Center for Best Practices. 2015 Jan 13.
3. McLaughlin JE, Minshew LM, Gonzalez D, et al. Can they imagine the future? A qualitative study exploring the skills employers seek in pharmaceutical sciences doctoral graduates. PLoS One. 2019;14(9):e0222422.
4. Roth MT, Mumper RJ, Singleton SF, et al. A renaissance in pharmacy education at the University of North Carolina at Chapel Hill. *N C Med J.* 2014;75(1):48-52.

5. Accreditation Council for Pharmacy Education. Accreditation standards and key elements for the professional program in pharmacy leading to the Doctor of Pharmacy degree. Available from https://www.acpe-accredit.org/pdf/Standards2016FINAL.pdf. Accessed November 10, 2020.

6. Speedie MK, Baldwin JN, Carter RA, Raehl CL, Yanchick VA, Maine LL. Cultivating ‘habits of mind’ in the scholarly pharmacy clinician: Report of the 2011-2012 Argus Commission. *Am J Pharm Educ.* 2012;76(6):53.

7. Farland MZ, Sicat BL, Franks AS, Pater KS, Medina MS, Persky AM. Best practices for implementing team-based learning in pharmacy education. *Am J Pharm Educ.* 2013;77(8):177.

8. Vogler JS, Davis DW, Mayfield BE, Finley PM, Yasseri D. The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork. *Instructional Science.* 2018;46:457-488.

9. Rotz ME, Duenas GG, Zanon A, Grover AB. Designing and evaluating an interprofessional experiential course series involving medical and pharmacy students. *Am J Pharm Educ.* 2016;80(5):85.

10. O’Neil-Pirozzi TM, Musler JL, Carney M, Day L, Hamel P, Kirwin J. Impact of early implementation of experiential education on the development of interprofessional education knowledge and skill competencies. *J Allied Health.* 2019;48(2):e53-59.

11. Zeeman JM, Bush AA, Cox WC, McLaughlin JE. Assessing the co-curriculum by mapping student organization outcomes using mixed methods. *Am J Pharm Educ.* 2019;83(10):7354.

12. Faæzi ST, Moradi K, Ghafar RA, Akhlagh M, Keshmiri F. The effects of team-based learning on learning outcomes in a course of rheumatology. *J Adv Med Educ Prof.* 2018;6(1):22-30.

13. Farland MZ, Franks AS, Barlow PB, Rowe AS, Chisholm-Burns M. Assessment of student learning patterns, performance, and long-term knowledge retention following use of didactic lecture compared to team-based learning. *Curr Pharm Teach Learn.* 2015;7(3):317-323.

14. Bleske BE, Remington TL, Wells TD, et al. Team-based learning to improve learning outcomes in a therapeutics course sequence. *Am J Pharm Educ.* 2014;78(1):13.

15. Boland DH, Scott MA, Kim H, White T, Adams E. Interprofessional immersion: Use of interprofessional education collaborative competencies in side-by-side training of family medicine, pharmacy, nursing, and counselling psychology trainees. *J Interprof Care.* 2016;30(6):739-746.

16. Eades CE, Ferguson JS, O’Carroll RE. Public health in community pharmacy: a systematic review of pharmacist and consumer views. *BMJ Public Health.* 2011;11:582.

17. Shrader S, Farland MZ, Danielson J, Sicat B, Umland EM. A systematic review of assessment tools of measuring interprofessional education outcomes relevant to pharmacy education. *Am J Pharm Educ.* 2017;81(6):119.

18. National Center for Education Statistics. Fast facts. 2018. Retrieved from https://nces.ed.gov/fastfacts/display.asp?id=167.

19. Baker DP, Salas E, King H, Battles J, Barach P. The role of teamwork in the professional education of physicians: current status and assessment recommendations. *Jt Comm J Qual Patient Saf.* 2005;4(31):185-202.

20. Chakraborti C, Boonyasai RT, Wright SM, Kern DE. A systematic review of teamwork training interventions in medical student and resident education. *J Gen Intern Med.* 2008;23(6):846-853.

21. Camiel LD, Kostka-Rokosz M, Tataronis G, Goldman J. Performance and perceptions of student teams created and stratified based on academic abilities. *Am J Pharm Educ.* 2017;81(3):47.

22. Collier IA, Baker DM. Creation of an active learning healthcare communications course using simulations relevant to pharmacy practice. *Curr Pharm Teach Learn.* 2017;9(4):626-632.

23. Elmore L, Skelley J, Woolley T. Impact of adapted team-based learning methods on student self-assessment of professionalism, teamwork, and skills in a self-care course. *Curr Pharm Teach Learn.* 2014;6:488-93.

24. Hameen-Anttila K, Saano S, Vainio K. Professional competencies learned through working on a medication education project. *Am J Pharm Educ.* 2010;74(6):110.

25. Hasnain M, Koronkowski MJ, Kondratowicz DM, Goliak KL. Training future health providers to care for the underserved: a pilot interprofessional experience. *Educ Health.* 2012;25(3):204-207.

26. Janke KK, Traynor AP, Sorenson TD. Student leadership retreat focus on a commitment to excellence. *Am J Pharm Educ.* 2009;73(3):48.

27. MacDonnell CP, Rege SV, Misto K, Dollase R, George P. An introductory interprofessional exercise for healthcare students. *Am J Pharm Educ.* 2012;76(8):154.

28. Maldonado AQ, Bray BS, Woodard LJ, et al. Impact of participation on a solid organ transplant team on student pharmacists’ perceptions of interprofessional roles. *Am J Pharm Educ.* 2013;77(4):74.
29. Ottis E, Gregory G. An interprofessional nursing and pharmacy student simulation in acute pain management. *Pharmacy Education*. 2016;16(1):18-25.

30. Peeters MJ, Sexton M, Metz AE, Hasbrouck CS. A team-based interprofessional education course for first-year health professions students. *Curr Pharm Teach Learn*. 2017;9:1099-110.

31. Pittenger AL, Westberg S, Rowan M, Schweiss S. An interprofessional diabetes experience to improve pharmacy and nursing students’ competency in collaborative practice. *Am J Pharm Educ*. 2013;77(9):197.

32. Saini B, Shah S, Kearey P, Bosnic-Anticevich S, Grootjans J, Armour C. An interprofessional learning module on asthma health promotion. *Am J Pharm Educ*. 2011;75(2):30.

33. Sevin AM, Hale KM, Brown NV, McAuley JW. Assessing interprofessional education collaborative competencies in service-learning course. *Am J Pharm Educ*. 2016;80(2):32.

34. Franklin AS, Markowsky S, D’Leo J, Normann S, Black E. Using team-based learning to teach a hybrid pharmacokinetics course online and in class. *Am J Pharm Educ*. 2016;80(10):171.

35. Vyas D, McCulloh R, Dyer C, Gregory G, Higbee D. An interprofessional course using human patient simulation to teach patient safety and teamwork skills. *Am J Pharm Educ*. 2012;76(4):71.

36. Zakaria SF, Ahmed A. Shared-learning experience during a clinical pharmacy practice experience. *Am J Pharm Educ*. 2011;75(4):75.

37. Zaudke JK, Paolo A, Kleoppel J, Phillips C, Shrader S. The impact of an interprofessional practice experience on readiness for interprofessional learning. *Fam Med*. 2016;48(5):371-376.

38. Medina MS, Plaza CM, Stowe CD, et al. Center for the Advancement of Pharmacy Education (CAPE) 2013 Educational Outcomes. *Am J Pharm Educ*. 2013;77(8):Article 162.

39. McEwan D, Ruissen GR, Eys MA, Zumbo BD, Beauchamp MR. The effectiveness of teamwork training on teamwork behaviors and team performance: a systematic review and meta-analysis of controlled interventions. *PLoS One*. 2017;12(1):e0169604.

40. Allen RE, Copeland J, Franks AS, Karimi R, McCollum M, Riese DF, Lin AY. Team-based learning in US colleges and schools of pharmacy. *Am J Pharm Educ*. 2013;77(6):115.

41. Whitley HP, Bell E, Eng M, Fuentes DG, Helms KL, Maki ED, Vyas D. Practical team-based learning from planning to implementation. *Am J Pharm Educ*. 2015;79(10):149.

42. Lyons KM, Lobczowski NG, Greene JA, Whitley J, McLaughlin JE. Using a design-based research approach to develop and study a web-based tool to support collaborative learning. *Comput Educ*. 2021;161:104064.

43. Farland MZ, Beck DE. Collaborative learning teams to longitudinally teach and assess teamwork behaviors and attitudes. *Am J Pharm Educ*. 2019;83(9):7255.
| 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 |
Table 2. Characteristics of Teamwork Formats in Mapping Review Articles

| Author (year)                      | Format of Teamwork                                                                 | Duration of Program | Learner Characteristics | Teaching Principles Included* | Teamwork Model |
|-----------------------------------|-------------------------------------------------------------------------------------|---------------------|-------------------------|-------------------------------|----------------|
| Camiel LD et al. (2017)           | TBL; in-class group-based activities following Readiness Assurance Tests             | 14-week course      | 324 pharmacy students   | a, b, c, e, f, g              | TBL            |
| Collier IA and Baker DM (2017)    | Group presentations                                                                  | Semester course     | 299 first-year pharmacy students | a, b, d, e, h                | None Described |
| Elmore L et al. (2014)            | Adapted TBL activities                                                               | Two-semester course | 116 third-year pharmacy students | a, e, f, g                   | TBL            |
| Hameen-Anttila K et al. (2010)    | 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 M et al. (2012)           | 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 K et al. (2009)             | 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 C et al. (2012)        | 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 A et al. (2013)         | 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 E and Gregory G (2016)      | 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 M et al. (2017)           | 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     |
| Study Authors and Year | Description | Duration | Participants |
|------------------------|-------------|----------|--------------|
| Pittenger A et al. (2013) | 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 |
| Rotz M et al. (2016) | Interprofessional experiential course series | 6 semesters | 163 students (49 pharmacy, 114 medical students) |
| Saini B et al. (2011) | 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 |
| Sevin A et al. (2016) | 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) |
| Snyder Franklin A et al. (2016) | Phenytoin 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 |
| Vyas D et al. (2012) | Interprofessional course utilizing patient simulation designed to teach patient safety and teamwork skills | Four-week course | 208 health professions students |
| Zakaria SF and Awaisu A (2011) | 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 |
| Zaudke J et al. (2016) | Interprofessional practice experience during family medicine clerkship | 1-month rotation experience | 252 students (153 medical, 23 nursing, and 46 pharmacy students) |

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

*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”
| Author (year) | Outcomes Expected/Measured | Person(s) Performing Assessment | Outcome Results |
|--------------|---------------------------|---------------------------------|----------------|
| Camiel LD et al. (2017) | 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 < 0.05)  
A: Satisfaction with team members was highest in lower GPA teams (p < 0.05) |
| Collier IA and Baker DM (2017) | 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 < 0.001)  
A: Students responded that adapted TBL methods significantly improved their verbal communication and teamwork skills (p < 0.001) and ability to convey ideas diplomatically (p = 0.016) |
| Elmore L et al. (2014) | 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 < 0.001) and ability to convey ideas diplomatically (p = 0.016)  
A: Students felt more respected by team members following implementation of TBL (p = 0.026); students were less likely to attend class (p = 0.03) and did not feel that they learned more from TBL than from studying alone (p = 0.048) |
| Hameen-Anttila K et al. (2010) | 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.  
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 |
| Hasnain M et al. (2012) | 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: 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" |
| Janke K et al. (2009) | 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: 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 |
| MacDonnell C et al. (2012) | 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 | Faculty | 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 |
surveyed after patient encounter regarding their experience as participants in a teamwork exercise

A: 67% of students strongly agreed that it was important to work with students from other health professions (p < 0.001); 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 < 0.001); increase from 39% to 57% who strongly believed these workshops should be required (p < 0.001); increase from 31% to 64% who strongly believed that health professional schools should offer workshops in which healthcare professionals work together (p < 0.001); 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 < 0.001); 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 A et al. (2013)

Online pre- and post-APPE survey instrument examining perceptions of interprofessional roles, communication, and teamwork

Student

Ottis E and Gregory G (2016)

Pre- and post-simulation survey that contained questions addressing interprofessional teamwork during the simulation

Student

Peeters M et al. (2017)

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

Pittenger A et al. (2013)\textsuperscript{30} IEPS and RIPLS were administered at baseline and the end of the course

Rotz M et al. (2016)\textsuperscript{9} Students evaluated using the PACT and SPICE Instrument

Saini B et al. (2011)\textsuperscript{31} Completion of the Asthma Knowledge for HealthProfessionals Scale, Attitudes Toward Health Care Teams Scale and RIPLS

Sevin A et al. (2016)\textsuperscript{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

Snyder Franklin A et al. (2016)\textsuperscript{33} Survey to assess the learners' perceptions of their teamwork competencies, team interdependence, and perceived understanding of phenytoin PK

Vyas D et al. (2012)\textsuperscript{34} 30-item survey of knowledge, skills, and attitudes administered pre- and post-intervention

Zakaria SF and Awaisu A (2011)\textsuperscript{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

some professions, enhanced clarification of roles of professions); Course evaluations demonstrated overall satisfaction with the course

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

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

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).

Students' self-assessment of IPEC competencies significantly improved in all four domains after completion of the course (p < 0.0001)

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 < 0.01)

K: No difference seen in items related to PK principles understanding between face-to-face cohort and online cohort

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

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 J 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 < 0.05); medicine responses less favorable for Teamwork and Professional Identity than nursing and pharmacy.

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.