Volume 4 | Issue 4                                     Article 4

2020

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## Abstract

This scoping review examined outcomes of *capstones* in relation to entry-level doctoral education programs within the health professions. Aims of the study included mapping existing evidence related to capstone across entry-level clinical doctorates; investigating the purpose of capstones within health professions education; and identifying future research initiatives. Researchers applied and reported via the PRISMA Extension for Scoping Reviews systematic approach, and Best Evidence Medical Education global scale. The study indicated a gap in existing literature. Few health professions described requirements for capstones as part of an entry-level doctorate. Reviewed articles offered no consistent definition, intent, process, or outcome for capstones. The majority of publications documented Kirkpatrick Level 2a educational outcomes, modification of learner attitudes and perceptions. No publications documented Level 3, 4a, or 4b educational outcomes reporting student behavioral change, change in organizational practice, or direct improvement to the health and well-being of patients or clients. The researchers recommend additional evidence-based educational research to expand the body of evidence related to the capstone.

## Keywords

Capstone, scoping review, clinical doctorate

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# The Purpose of Capstone in an Entry-Level Clinical Doctorate: A Scoping Review

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## ABSTRACT

This scoping review examined outcomes of *capstones* in relation to entry-level doctoral education programs within the health professions. Aims of the study included mapping existing evidence related to capstone across entry-level clinical doctorates; investigating the purpose of capstones within health professions education; and identifying future research initiatives. Researchers applied and reported via the PRISMA Extension for Scoping Reviews systematic approach, and Best Evidence Medical Education global scale. The study indicated a gap in existing literature. Few health professions described requirements for capstones as part of an entry-level doctorate. Reviewed articles offered no consistent definition, intent, process, or outcome for capstones. The majority of publications documented Kirkpatrick Level 2a educational outcomes, modification of learner attitudes and perceptions. No publications documented Level 3, 4a, or 4b educational outcomes reporting student behavioral change, change in organizational practice, or direct improvement to the health and well-being of patients or clients. The researchers recommend additional evidence-based educational research to expand the body of evidence related to the capstone.

## Introduction

There has been an increase in entry-level doctoral educational programs across health professions within the last several years. While some programs include a culminating activity, experience*,* course, or project, the purpose of *capstone* within an entry-level clinical doctorate is unclear. There is no consistency of definition, intent, process, or outcome. The research team conducted a scoping review to systematically map existing evidence related to capstone across entry-level clinical doctorates; clarify the purpose of capstone within health professions education; and identify possibilities for future inquiry. The primary research question asked *what is the purpose of capstone within entry-level health professions clinical doctoral education*?

## Background

The United States Department of Education National Center for Education Statistics (2019) glossary defined a professional doctorate as:

> [a] degree that is conferred upon completion of a program providing the knowledge and skills for the recognition, credential, or license required for professional practice. The degree is awarded after a period of study such that the total time to the degree, including both pre-professional and professional preparation, equals at least six full-time equivalent academic years (p. 10) .

Current entry-level doctoral degrees include chiropractic medicine, dentistry, medicine, optometry, osteopathy, pharmacy, podiatry, occupational therapy, and physical therapy. Non health-related professional doctorates were outside the scope of the study. The literature used *clinical doctorate, practice doctorate,* and *professional doctorate* interchangeably, referring to a degree required for entry into a health professions practice. Clement (2005) described the *practice doctorate* or *clinical doctorate* as a first professional degree or a degree serving as entry into practice. Phelps and Gerbasi (2009) described a rationale for an entry-level *practice doctorate*, citing a variety of accreditation and curricular requirements across health care professions. For the purpose of this scoping review, researchers used the term *clinical doctorate*, referring to a degree required for entry into a health professions practice.

The literature employed *capstone* and *scholarly project* interchangeably, as well as other terms for a culminating activity, experience, course, or project in health professions clinical doctoral degrees; however, there is currently no definition of *capstone* available from the United States Department of Education National Center for Education Statistics (2019) or other equivalent source addressing higher education. Phelps and Gerbasi (2009) examined accreditation requirements of 14 healthcare professions, excluding nursing. At that time, no professional accrediting body required a capstone or scholarly project. In their examination of educational trends, Seegmiller et al. (2015) reported only four professions required a culminating project: Doctor of Clinical Laboratory Science (DCLS), Doctor of Psychology (PsyD), Doctor of Nursing Practice (DNP), and Doctor of Occupational Therapy (OTD).

Researchers examined accreditation standards across professions offering entry-level clinical doctorate degrees (see Table 1). Documents from two professional accrediting bodies mentioned capstone or similar projects. Accrediting bodies for optometry, osteopathy, and chiropractic medicine noted required support for student opportunities in research and scholarly activity without describing a capstone experience, course, or culminating project. Pharmacy accreditation standards allowed but did not require capstone courses or activities as part of the Advanced Pharmacy Practice Experience (APPE) Curriculum, following completion of the Introductory Pharmacy Practice Experience (IPPE) portion of the curriculum (ACPE, 2015). Standard 13.5 stated, "Required capstone courses or activities that provide opportunity for additional professional growth and insight are allowed during or after completion of APPEs. These activities do not compromise the quality of the APPEs, nor count toward the required 1440 hours of APPE" (ACPE, 2015, p. 9). Pharmacy standards included no additional definition of capstone or culminating project. While some professions may allow or encourage scholarly work in a closing project, none of the accrediting bodies of dentists, psychologists, speech language pathologists or audiologists, physical therapists, podiatrists, osteopathic physicians, or medical physicians referred to a capstone experience, course, or culminating project as outlined in Table 1.

**Table 1**

*Accreditation Inclusion of Capstone*

| Professional organization, Accrediting body (current standards date) | Statement related to capstone, culminating project, or scholarly product |
| --- | --- |
| American Academy of Chiropractic Physicians/American Chiropractic Association, Council on Chiropractic Education (2018) | Capstone not addressed. |
| American Association of Colleges of Pharmacy/American College of Clinical Pharmacy/American Pharmacists Association, Accreditation Council for Pharmacy Education (2015) | Capstone courses/activities are allowed during or after Advanced Pharmacy Practice Experiences |
| American Dental Association, Commission on Dental Accreditation (2019) | Capstone not addressed. |
| American Psychological Association, Commission on Accreditation (2015) | Capstone not addressed. |
| American Speech-Language-Hearing Association, Council on Academic Accreditation in Audiology and Speech-Language Pathology (2019) | Capstone not addressed. |

| | |
|---|---|
| American Occupational Therapy Association, Accreditation Council for Occupational Therapy Education (2018) | Capstone experience and project required. |
| American Optometric Association, Accreditation Council on Optometric Education (2019) | Capstone not addressed. |
| American Physical Therapy Association, Commission on Accreditation in Physical Therapy Education (2016) | Capstone not addressed. |
| American Podiatric Medical Association, Council on Podiatric Medical Education (2014) | Capstone not addressed. |
| American Osteopathic Association, Commission on Osteopathic College Accreditation (2019) | Capstone not addressed. |
| Association of American Medical Colleges /American Medical Association, Liaison Committee on Medical Education, (2019) | Capstone not addressed. |

The Accreditation Council for Occupational Therapy Education (ACOTE) currently requires an experiential capstone of an occupational therapy clinical doctoral student (2018). The first accreditation standards addressing doctoral-level degree programs for the occupational therapist (ACOTE, 2006) referred to completion of a "… culminating project that relates theory to practice and demonstrates synthesis of advanced knowledge in a practice area" (ACOTE, 2006, p. 11). The 2011 ACOTE Standards defined *culminating project* as, "A project that is completed by a doctoral student that demonstrates the student's ability to relate theory to practice and to synthesize advanced knowledge in a practice area." (ACOTE, 2012, p. 40), analogous to the current definition of *capstone project*, "A project that is completed by a doctoral-level student that demonstrates the student's ability to relate theory to practice and to synthesize in-depth knowledge in a practice area that relates to the capstone experience." (ACOTE, 2018, p. 47). The current Standards and Interpretive Guide identify *capstone experience* and *capstone project* as a 'integral part of the program's curriculum design' (Standard D.1.) for entry-level clinical doctoral education (ACOTE, 2018, p. 44).

Familiarity with literature was useful to examine the influence of other health professions on occupational therapy. The development of the clinical doctorate in occupational therapy embraced the idea of a practice scholar, different from a traditional research doctorate. Articulated differences included distinctive curricular design of practice versus scholarship. Early in the discussion of entry-level degree changes, Pierce and Peyton (1999) described a PhD as requiring original research while a clinical doctorate in occupational therapy required mentored advanced clinical experiences. Jirikowic et al. (2015) described a process of preparation, planning, implementation, and dissemination for capstone projects. Several authors described opportunities including

capstone leadership projects (Copolillo et al 2010; Hinojosa & Howe, 2016) or program development and advocacy (Jirikowic et al., 2015). Smallfield et al. (2019) found no significant difference between job titles, salaries, and perception of readiness for interprofessional work among occupational therapy masters and doctoral graduates from the same program. They also reported all participants perceived capstone as a positive influence to consider an academic career (Smallfield et al., 2019).

## Methods

The researchers selected a scoping review as a means to systematically map existing literature; explore the purpose of the capstone across scholarly experience, course, or culminating project; and identify implications for future research about capstone within entry level clinical doctorate degrees. Scoping reviews: (a) summarize evidence on a topic, particularly one involving divergent disciplines or methods, (b) map the existing literature to identify gaps, and (c) articulate the need for future research (Arksey & O'Malley, 2005; Munn et al., 2018; Peterson et al., 2017; Tricco et al., 2016; Tricco et al., 2018). Scoping reviews include a wide range of literature and, may or may not include critical appraisal of individual sources. The team selected critical review as valuable to answer the aims of the study. The research team included a non-traditional entry-level OTD student completing a doctoral experiential capstone, a faculty member with 22 years of experience, and a faculty member with 40 years of experience.

### Protocol

This scoping review followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) protocol and reporting format (Tricco et al., 2018). The research team initially drafted a protocol using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach (Moher et al., 2009), updating to the PRISMA-ScR upon its release. The researchers retained an audit trail to introduce rigor and objectivity into the study. The protocol and complete audit trail are available from the corresponding author.

### Eligibility Criteria

Since the earliest writings on the OTD occurred in the early 1990s (Pierce & Peyton, 1999), the research team included articles published from January 1990 through June 2019. Pierce and Peyton (1999) proposed that implications for OTD education could be drawn from examining the history of professional doctorates in medicine, dentistry, psychology, pharmacy, nursing, and physical therapy. Researchers further limited the search to English language, as the OTD is currently exclusive to the United States.

### Information Sources

The team searched four electronic databases on the basis of relevance of professions covered, consistent coverage over time, and the types of material covered. These included MEDLINE, PsychInfo, CINAHL Plus, and Embase.

**Search**

To include a broad view of professions, the team used medical subject heading (MeSH) terms: *occupational therapy, occupational therapists, pharmacy students, pharmacists, physical therapists, nurse practitioners, dentists, medical students*. The team also used the terms *capstone*, *clinical doctorate*, and *project.* A full literature search strategy for Embase is available in the Appendix. The team included backward and forward hand searching within references of included articles.

**Selection of Sources of Evidence**

Researchers examined peer-reviewed journal articles, including qualitative, quantitative, and mixed methodologies. Excluded were articles describing undergraduate or post professional capstones or addressing doctoral programs other than entry-level. Researchers examined accreditation websites for each of the clinical doctorates to clarify capstone requirements as foundational information from gray literature. Eligible studies included retrospective cohorts with response biases and non-standard assessments.

**Data Charting**

The research team developed charting categories at the study's inception. Researchers abstracted data from included articles according to a variety of capstone characteristics. These included identified profession, capstone purpose, identified objectives (eg. student learning goals), and outcome of capstone (eg. product, attitudes, beliefs, knowledge, behaviors). Researchers also summarized Best Evidence Medical Education (BEME) strength of evidence scale and Kirkpatrick-based outcome levels. Data are presented in narrative and tabular form in Table 2.

Data charting is also referred to as data extraction (Arksey & O'Malley, 2005). All researchers assessed each publication during multiple stages: identification, screening, eligibility, and inclusion. Researchers were blinded from one another during each stage to increase reliability, independently assessing each publication while recording results on a spreadsheet. Researchers compared and discussed results for each stage, recording exclusions, differences, and rationales for decisions before advancing to the next. Researchers resolved disagreements through close review of criteria and purpose of the study, discussion, and consensus. During eligibility, two researchers (blinded to each other) reviewed each full-text article, extracting inclusion information using direct citations. The two abstracting team members discussed results, consulting the third team member to review for clarity and consistency or resolution of disagreement.

**Critical Appraisal**

Researchers critically appraised the individual sources of evidence addressing capstone in entry-level clinical doctoral education. Researchers believed critical appraisal supported the aim of the study to investigate gaps in the literature. Researchers used the BEME strength of evidence scale (Milota et al., 2019; Sullivan, 2011) to examine each included article. The BEME strength of evidence scale is applied for reviews of medical and health professions educational literature to support evidence-informed education. Researchers rated articles using the model described by Milota et al. (2019),

without modification. The Global Rating Scale (see Table 2) included the BEME strength of evidence scale ranging from a rating of Level 1, *no clear conclusions*, to the Level 5, *results are unequivocal*. The Global Rating Scale also included Kirkpatrick-based outcome levels. Revisions to the Kirkpatrick model of educational assessment (1976) now serve as a standard method of evaluating educational outcomes (Praslova, 2010). Kirkpatrick-based outcome levels range from Level 1, *Participation*, to Level 4b, *Benefits to Patients and Clients*.

**Table 2**

*Global Rating Scale: Best Evidence Medical Education (BEME) Strength of Evidence Scale and Kirkpatrick-based Outcome Levels (Milota et al, 2019)*

| BEME strength of evidence scale | |
| --- | --- |
| 1 | No clear conclusions can be drawn—results based on testimonial evidence of authors |
| 2 | Ambiguous results, there may be a trend—tool(s) for analysis exhibit insufficient power, small sample size, other intervening factors |
| 3 | Conclusions can probably be based on the results—tool(s) used for analysis have sufficient power to assess the outcome |
| 4 | Results are clear and very likely to be true—multiple tools for analysis with sufficient power and explicit triangulation of results |
| 5 | Results are unequivocal |

| Kirkpatrick-based outcome levels | |
| --- | --- |
| 1 | PARTICIPATION<br>Affective reactions and feedback by students (for example: learning experience, course organization, materials, quality of instruction, feelings of pleasure or enjoyment)<br>*Instruments*—surveys, questionnaires, comment forms |
| 2a | MODIFICATION OF ATTITUDES OR PERCEPTIONS<br>Changes in attitudes towards intervention (for example, sense of personal or professional growth, increase in empathy, new sense of affiliation or connectedness)<br>*Instruments*—observation, pre- and post-tests, interviews, focus groups |
| 2b | MODIFICATION OF KNOWLEDGE AND SKILLS<br>For knowledge: acquisition of concepts, procedures, or principles. For skills: acquisition of thinking and problem-solving.<br>*Instruments*—observation, pre- and post-tests, interviews, focus groups, course writing samples |

| 3 | BEHAVIORAL CHANGE |
|---|---|
| | Evidence that knowledge and skills learned in course have been applied in subsequent contexts |
| | *Instruments*—creative final product (papers, projects, portfolios), surveys, observation |

| 4a | CHANGE IN ORGANIZATIONAL PRACTICE |
|---|---|
| | Attributable changes in organization or delivery of care |
| | *Instruments*—alumni surveys, patient and/or employee feedback |

| 4b | BENEFITS TO PATIENTS AND CLIENTS |
|---|---|
| | Improvement in health and well-being of patients as a direct result of classroom intervention   *Instruments*—patient feedback |

**Synthesis of Results**

The researchers categorized the studies by the profession represented, articulated capstone purpose, and capstone outcomes. The synthesis describes the range of evidence to answer the research questions. The evidence is presented in narrative and tabular form.

**Results**

**Selection of Sources of Evidence**

The initial database search identified 371 records, with an additional 20 gathered through hand searching. After removing duplicates, 294 total records remained. Each of the three researchers individually screened the 294 titles and abstracts for relevance. Researchers compared screening results and agreed upon a list of 91 full-text records to be reviewed for eligibility, assessing full-texts of all 91 relevant records. Researchers were again blinded to one another's results while reviewing all full-text articles. Researchers compared results, excluding 47 of the 91 full-text records as ineligible, including 37 articles and 10 records from gray literature. Researchers retained 25 of the 91 full-text records excluded from the final scoping review to inform background literature. Background literature was valuable for framing the development of capstone in the introduction of this article. Researchers incorporated a total of 19 publications in the final scoping review, including 15 articles from database searching as well as 4 articles from hand searching. The flow diagram (see Figure 1) of study selection mirrored the current PRISMA-ScR flow chart (Tricco et al., 2018).

**Figure 1**

*Study Flow Diagram*
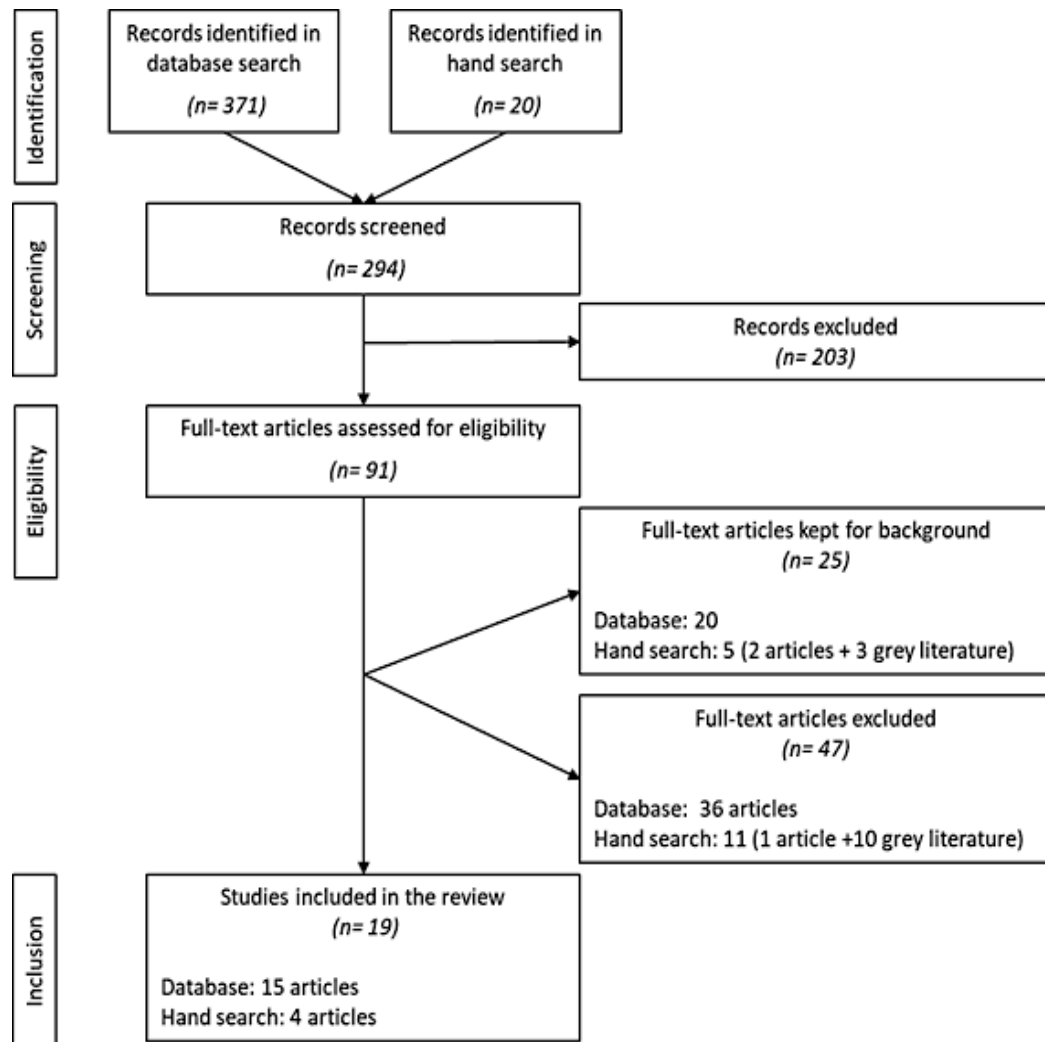


## Characteristics of Sources of Evidence

Of the 19 articles included in the scoping review, four professions were represented: 13 articles addressed capstone in pharmacy, four in medical doctorate, and one article each in occupational and physical therapy. Publication dates ranged from 2002 through 2019. Three were review articles (Barlow et al., 2018; Elnicki et al., 2015; Green et al., 2010), with the remainder (16) retrospective assessments of curricular capstone. Table 3 details design and results of the 19 publications eligible for the scoping review, as well as purpose and outcomes of capstone as specified in the articles.

Researchers categorized the purpose of capstone as varied across individual studies. Twelve articles described capstone applied as a course, with four as project-based (Donovan et al., 2011; Green et al., 2010; Vellurattil et al., 2014; Wuller, 2010). The three review articles did not specify capstone application style (Barlow et al., 2018; Elnicki et al., 2015; Green et al., 2010). While publications did not include specific learning objectives, most authors articulated more than one purpose or intent for capstone. Several authors described intent for capstone courses or experiences as integration of knowledge, problem-solving skills or critical thinking, student self-assessment, improved confidence, measuring specific practical competencies, preparation for required examinations, and scholarship. A few authors described a single intent of capstone, with three addressing scholarship as the intent (Donovan et al., 2011; Vellurattil et al., 2014; Wuller, 2010). Two of the review articles were not categorized because they specified no capstone purpose (Barlow et al., 2018; Elnicki et al., 2015).

Researchers also categorized capstone outcomes as related to Boyer's model of scholarship (1990). Within each article, researchers reviewed specific products, attitudes, beliefs, knowledge, behaviors, etc. for their connection to scholarship of discovery, integration, application, or teaching and learning identified. Some articles reflected more than one outcome of capstone. The majority of articles, 12 of 19, revealed capstone outcomes as a honing of entry-level practice skills (Beatty et al., 2014; Cheng et al., 2002; Conway & Ahmed, 2012; Donovan et al., 2011; Hanselin et al., 2016; Hirsch & Parihar, 2014; Hobson et al, 2015; Patel et al., 2015; Salzman et al., 2019; Saseen et al., 2017; Vellurattil et al., 2014; Wuller, 2010). Four articles identified professional development as an outcome of capstone (Clay et al., 2017; Doyle-Campbell et al., 2016; Lee et al., 2014; Smallfield & Wood, 2019). Neither of these categories were related to Boyer's discussion of scholarship. Four articles identified research, presentation, or projects as outcomes, representative of Scholarship of Discovery (Donovan et al., 2011; Green et al., 2010; Vellurattil et al., 2014; Wuller, 2010). One article identified capstone outcome as related to experience in academia, representing Scholarship of Teaching and Learning (Smallfield & Wood, 2019). Barlow et al. (2018) and Elnicki et al. (2015) were not categorized because they described no capstone outcome.

Articles detailing a course offering, such as Pharmacy, had the most thorough methods for assessing student outcomes as a result of the capstone. More often than not, capstone appeared to be used as a type of summary or integrated course review, designed with the intended outcome as a modification of knowledge, skills or attitudes. Metacognitive exercises in capstone experiences were more frequently limited to integration and application of knowledge within a controlled context (such as in an Objective Structured Clinical Examination [OSCE] or a written examination).

**Table 3**

*Implementation of Capstone*

| First author (date) Title | Profession | Design | Results | Capstone Purpose | Capstone Outcome & Boyer's Scholarship |
|---|---|---|---|---|---|
| Barlow (2018) A study of capstone courses utilized in United States DPT program curricula | DPT | Review article. Evaluated CAPTE web-accessible curricula for *capstone* in the course title or description. Described style of capstone reported. | Consensus opinion capstone may promote best-practice in entry-level professions. | Not specified. | Outcomes: not identified Boyer: NA |
| Beatty (2014) Measuring pre-advanced practice experience outcomes as part of a PharmD capstone experience | PharmD | Curricular assessment. Examined 4 capstone experiences over 4 years for student preparedness for Advanced Pharmacy Practice Experiences (APPE) and program-level assessment data. | Student feedback, focus groups, learning activity assessment data prompted curricular revisions. | Apply and integrate knowledge skills to prepare for APPE. Assignments and presentation. Self-assess strengths and weaknesses | Outcomes: Entry level practice Boyer NA  Outcomes: Professional development Boyer NA |
| Cheng (2002) Implementation of a capstone pharmaco-therapeutics course in the entry-level Doctor of Pharmacy program | PharmD | Curricular assessment. Implemented capstone course. Groups of students completed assigned projects. | Students course, average 84%. | Nurture problem solving skills and critical thinking. | Outcomes: Entry level practice Boyer NA |

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|---|---|---|---|---|---|
| Clay (2017) CaPOW! Using problem sets in a capstone course to improve fourth-year medical students' confidence in self-directed learning | MD | Curricular assessment. Students completed individual learning plans (ILP) for transition-to-residency capstone course through completion of problem sets/patient cases. | Individualized score reports of knowledge deficits from coaches for ILP and future learning. | Reports of knowledge deficits. Students self-assessed confidence. | Outcomes: Entry level practice Boyer NA  Outcomes: Professional Development Boyer NA |
| Conway (2012) A pharmaco-therapy capstone course to advance pharmacy students' clinical documentation skills | PharmD | Curricular assessment. Course to improve clinical documentation skills in preparation for APPEs. | Students perceived integration of course material (97%), improved clinical writing (80.5%). | Improve clinical documentation skills in preparation for APPEs. | Outcomes: Entry level practice Boyer NA |
| Donovan (2011) Assessment of center for the advancement of pharmaceutical education (CAPE) outcomes in a capstone course of an accelerated pharmacy program | PharmD | Curricular assessment. Graduation poster course to research and synthesize a response to a specific pharmacy-practice question using the medical and scientific literature to align with program student learning objectives (SLOs). | Faculty and student self-assessment. Faculty noted 85% completion of course evaluation items to meet SLOs. n=158 | Required professional poster presentation. | Outcome: Research poster presentation Boyer: Discovery |

| | | | | | |
|---|---|---|---|---|---|
| Doyle-Campbell (2016) A comprehensive capstone course focusing on simulation in community, ambulatory, and acute care | PharmD | Curricular assessment. Course with clinical and simulated patient experiences in preparation for APPEs. | Student and faculty assessment via Objective Structured Clinical Examinations (OSCEs). Overall student satisfaction. | To integrate the knowledge and experiences. Self-assessment | Outcomes: Entry level practice Boyer NA Outcomes: Professional development Boyer NA |
| Elnicki (2015) Course offerings in the fourth year of medical school: How US medical schools are preparing students for internship | MD | Review article. Fourth-year courses to fill curricular gaps. | Mixed results, not specified. | Not specified. | Outcomes: Not identified Boyer NA |
| Green (2010) Encouraging scholarship: Medical school programs to promote student inquiry beyond the traditional medical curriculum | MD | Review article. Described multiple programs' focus, participation, duration, capstone, faculty involvement, and areas of concentration. | Programs reviewed shared a common goal of producing physicians with improved analytic, creative, and critical-thinking skills | Scholarly work with multiple options for products. | Outcomes: multiple means dissemination of scholarship Boyer: Discovery |
| Hanselin (2016) Development of a capstone course to improve student confidence and pharmaco-therapy knowledge prior to advanced pharmacy practice experience | PharmD | Curricular assessment. Course evaluating complex cases and developing care plans in preparation for APPEs. Focus on Center for Advancement of Pharmacy | Increased student confidence for clinical skills, provided medication therapy, and documentation. Comprehensive written (average score 87.2%) and | Improve clinical skill and confidence. | Outcomes: entry-level practice Boyer: NA |

| | | Education educational outcomes. Improve student confidence with clinical skills. | verbal exam (score 79.1%). | | |
|---|---|---|---|---|---|
| Hirsch (2014) A capstone course with a comprehensive and integrated review of the pharmacy curriculum and student assessment as a preparation for advanced pharmacy practice experiences | PharmD | Curricular assessment. Course preparation for APPEs. End of course OSCE, simulated North America Pharmacy Licensure Examination (NAPLEX), and state Board of Pharmacy Practical Examination. | Written and verbal presentations, exams, standardized patient. 95% first attempt pass rate. Student satisfaction. | Practical, clinical, communication skills. Prep for APPEs. | Outcomes: entry-level practice Boyer: NA |
| Hobson (2015) Staging a reflective capstone course to transition PharmD graduates to professional life | PharmD | Curricular assessment. Project-based hybrid course during final semester for reflection-focused goals. | Measured student knowledge, skills, higher order thinking, presentation, and professional reflection on action via standardized rubrics and observation. | Demonstration of entry-level professional practice critical thinking, self-assessment, self-directed learning, written and oral communication, and professionalism. | Outcomes: Entry level practice Boyer NA Outcomes: Professional development Boyer NA |
| Lee (2014) Development of a pharmacy capstone course | PharmD | Curricular assessment. Capstone course | Statistically significant increases in mean total | Assess students' confidence and knowledge | Outcomes: entry-level practice Boyer: NA |

| | | | | | |
|---|---|---|---|---|---|
| from focus groups to advanced patient care | | addressing advanced patient care including cases, interactive exercises, and OSCEs. | confidence score and total mean knowledge score. | managing 8 common conditions. | |
| Patel (2015) Pharmacy students' experience with a capstone project | PharmD | Curricular assessment. Elective course focused on transitions of care using active learning tasks. Projects addressed therapeutic knowledge, patient counseling, and communication skills. | Positive feedback from students. | Prepare students for APPEs, members of healthcare team. | Outcomes: entry-level practice Boyer: NA |
| Salzman (2019) A mastery learning capstone course to teach and assess components of three entrustable professional activities to graduating medical students | MD | Curricular assessment. Course to improve student performance with pre-test, post-test design. | 97% completed all curricular requirements and assessments with statistically significant improvements. | Simulation-based mastery learning on components of three Entrustable Professional Activities (EPAs): informed consent, differential diagnosis, writing orders. | Outcomes: entry-level practice Boyer: NA |

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|---|---|---|---|---|---|
| Saseen (2017) A pharmacotherapy capstone course to target student learning and programmatic curricular assessment | PharmD | Curricular assessment. Longitudinal course analysis addressed knowledge, skills, and critical thinking. Assessed for active learning and curricular review. | Survey and self-evaluation data showed increased student confidence in critical thinking, problem-solving, decision-making, life-long learning. Prompted curricular changes. | Prepare students for APPEs, curricular development. | Outcomes: entry-level practice Boyer: NA |
| Smallfield (2019) Student perspectives of the occupational therapy doctoral experience in an academic setting | OTD | Curricular assessment. A retrospective qualitative study of doctoral experiential component in an occupational therapy academic settings. | Four major themes: 1) learning experiences; 2) purposeful ambiguity; 3) knowledge and skill development; 4) newfound appreciation. | Capstone prepared students to become more confident and gain experience in academia. Outcomes are varied based upon individualized learning objectives. | Outcome: Create educators Boyer: Scholarship of Teaching of Learning |
| Vellurattil (2014) Introduction of a capstone research program in a new college of pharmacy: Student perceptions | PharmD | Curricular assessment. Evaluated students' perceived value of research, level of preparedness during research, and perceived impact of research on student abilities. | 69.2% students felt prepared to present poster, 72.3% students felt prepared to write a manuscript. | Apply and integrate knowledge learned through the synthesis of a research project. External submission encouraged, not required. | Outcomes: multiple means dissemination of scholarship Boyer: Discovery |

| | | | | | |
|---|---|---|---|---|---|
| Wuller (2010) A capstone advanced pharmacy practice experience in research | PharmD | Curricular assessment. Course with mentored research project and capstone experience. | Student and faculty perceived positive learning, and useful to practice sites. | Required students to apply knowledge and skills from curriculum to research project using higher-order thinking skills. | Outcomes: multiple means dissemination of scholarship Boyer: Discovery |

Note: DPT – Doctorate of Physical Therapy, PharmD – Doctorate of Pharmacy, MD – Medical Doctorate, OTD – Occupational Therapy Doctorate

**Critical Appraisal within Sources of Evidence**
Two researchers independently rated each of 19 articles on BEME strength of evidence scale and Kirkpatrick-based outcome levels (see Table 4). All researchers discussed ratings for agreement, with the third researcher scrutinizing article details for concurrence.

**Results of Individual Sources of Evidence**
Appraisal of BEME strength of evidence scale revealed no clear conclusion (Level 1) from 1 article. Six articles described ambiguous results (Level 2) and three articles appeared to have conclusions which are probable, based on reported results (Level 3). Six articles had clear results (Level 4). No articles results appeared unequivocal (Level 5). The BEME strength of evidence scale was not applicable for three overview articles.

Applying Kirkpatrick-based outcome levels to evaluate reported educational outcomes, five articles described student responses to participation in a learning activity or experience (Level 1). Modification of attitudes (Level 2a), and modification of knowledge or skill (Level 2b) were indicated in two and nine articles respectively. No articles reported direct evidence of behavioral change applied across different contexts (Level 3), change in organizational practice (Level 4a), or revealed a direct improvement to the health and well-being of patients or clients (Level 4b) as an education outcome of capstone. Of the 19 articles meeting inclusion criteria, Kirkpatrick-based outcome levels were not relevant to the three review articles.

**Table 4**

*Critical Appraisal within Sources of Evidence*

| First author (date) | BEME strength of evidence scale | Kirkpatrick-based outcome levels |
|---|---|---|
| Barlow (2018) | NA | NA |
| Beatty (2014) | 4 Results are clear | 2b Modification of knowledge & skills |
| Cheng (2002) | 2 Ambiguous results | 1 Participation |
| Clay (2017) | 2 Ambiguous results | 2b Modification of knowledge & skills |
| Conway (2012) | 3 Conclusions probable | 2b Modification of knowledge & skills |
| Donovan (2011) | 4 Results are clear | 2b Modification of knowledge & skills |
| Doyle-Campbell (2016) | 2 Ambiguous results | 1 Participation |
| Elnicki (2015) | NA | NA |
| Green (2010) | NA | NA |
| Hanselin (2016) | 4 Results are clear | 2a Modification of attitudes or perceptions |
| Hirsch (2014) | 2 Ambiguous results | 2b Modification of knowledge & skills |
| Hobson (2015) | 4 Results are clear | 2b Modification of knowledge & skills |
| Lee (2014) | 4 Results are clear | 2b Modification of knowledge & skills |
| Patel (2015) | 1 No clear conclusions | 1 Participation |
| Salzman (2019) | 4 Results are clear | 2b Modification of knowledge & skills |
| Saseen (2017) | 2 Ambiguous results | 2b Modification of knowledge & skills |
| Smallfield (2019) | 2 Ambiguous results | 2a Modification of attitudes & perceptions |
| Vellurattil (2014) | 3 Conclusions probable | 1 Participation |
| Wuller (2010) | 3 Conclusions probable | 1 Participation |

## Synthesis of Results

The majority of publications identified capstone as applied through a course, with a few project-based applications. The majority of articles described entry-level practice skills, with smaller numbers identifying professional development or a scholarly focus. Articles addressing entry-level skill were not able to be classified within a Boyer model of scholarship. Four of the articles were considered scholarship of discovery (Donovan et al., 2011; Green et al., 2010; Vellurattil et al., 2014; Wuller, 2010), and a single article was classified as scholarship of teaching and learning (Smallfield & Wood, 2019). Strength of evidence was inconsistent. Outcomes of capstone focused on participation and modification of learner knowledge and skills.

## Discussion

### Summary of Evidence

This scoping review mapped the current evidence related to the purpose of capstone experience, course, or culminating project in entry-level clinical doctoral programs in health professions, finding no consensus across profession, purpose, or outcome. The review indicated a paucity of research related to capstone in entry-level doctorates across professions. Reported capstone purposes included a broad variety of practice skills, critical thinking, confidence, and scholarship. There appeared to be no commonly accepted description of the term capstone, nor consensus in defining purpose, style, or means of assessment. Results suggested health professions capstones were applied through various means, without a common purpose or outcome.

This scoping review investigated the purpose of capstone within health professions education. Findings suggest a disconnect between clinical doctorate purpose and the application of capstone. While preparation for entry-level practice appears to have been affirmatively adopted by doctoral programs, the contribution of capstone to education and community remains unclear. Reported capstone outcomes were disparate. Critical appraisal of the literature through the Global Rating Scale (see Table 2) examined strength of evidence and reported educational outcomes. Eligible literature spanned a variety of levels of strength of evidence from no clear conclusions to clear results. None of the reviewed articles had unequivocal results. Levels of educational outcomes suggested studies primarily measured modification of attitudes and perceptions (2a), or of knowledge and skills (2b). A small percentage of studies measured educational outcomes based on participation alone (1). No studies reported changes in organizational practice (Level 4a), nor benefits to patients and clients (Level 4b).

### Limitations

There exists a paucity of information addressing purpose and outcome of capstone for entry-level clinical doctoral degrees across health professions. While the researchers explored four databases using the most current scoping review methodology, missing literature may be cataloged in alternative archives. Also, articles published between the review cut-off date and publication were not included in the study. Although researchers delimited the MeSH terms *capstone*, *clinical doctorate*, and *project* for inclusion,

additional terms for culminating projects could provide additional insight. Researchers believe the current findings to be representative of existing literature.

## Conclusions

The study indicated a substantial gap in the literature related to capstone as part of an entry-level clinical doctorate in a health profession. Reviewed articles offered no consistent definition, intent, process or outcome for capstone. Without clarity, each profession and program is allowed to interpret capstone as they see fit. There is an opportunity for robust evidence-based educational research to operationalize definitions, outline purposes, delineate programmatic expectations, and standardize processes and outcomes. Clarity would benefit support of program mission and vision, faculty mentorship of student capstone performance, and learner understanding of expectations. There also exists an opportunity to apply capstone experiences and projects as knowledge translation. While capstone experiences and courses are learner-centered, capstone projects could be community-centered, closing the knowledge to action gap. Researchers hope the paper will provide a resource for faculty, students, and educational programs in making decisions about the implementation of capstone. The findings of the study may direct researchers to scholarly inquiry, knowledge translation, and implementation of best practice in capstone education.

### Implications for Occupational Therapy Education

- Clarify capstone purpose, nomenclature, categories, etc. to provide a common language for all stakeholders.
- Delineate capstone programmatic expectations and processes to support clarity of outcomes for improved quality, level, and effectiveness of education.
- Implement and disseminate context-relevant capstone projects to narrow the research to practice gap, improving delivery, systems change, or quality of care.

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References included in the scoping process are marked with an asterisk.

**Appendix**

**Literature search strategy for Embase**

Embase search strategy (literature search performed: October 2, 2018). Limits: 1990-2018, English.

1. (Capstone) AND (Clinical AND Doctorate)
   a. Yield= 3 (2 duplicates)
2. ((Capstone) OR (Clinical AND Doctorate)) AND ((Occupational AND Therapy) OR (Occupational AND Therapist)
   a. Yield= 27 (16 duplicates)
3. ((Capstone) OR (Clinical AND Doctorate)) AND ((Pharmacy AND Students) OR (Pharmacist))
   a. Yield= 73 (28 duplicates)
4. ((Capstone) OR (Clinical AND Doctorate)) AND (Physical AND Therapist)
   a. 10 (4 duplicates)
5. (Capstone) OR (Clinical AND Doctorate)) AND ('Nurse Practitioner')
   a. 63 (32 duplicates)
6. ((Capstone) OR (Clinical AND Doctorate)) AND ('Medical Student')
   a. 61 (18 duplicates)
7. ((Capstone) OR (Clinical AND Doctorate)) AND ('Dentist')
   a. 5 (2 duplicates)

Note: Additional audit trail available from corresponding author.