Structure and impact of longitudinal Graduate Medical Education curricula designed to prepare future clinician-educators: A systematic scoping review: BEME Guide No. 74

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ABSTRACT

Background: Many Graduate Medical Education (GME) programs offer clinician-educator curricula. The specific instructional methods employed and current best practices for clinician-educator curricula are unknown. We aimed to characterize the structure, curriculum content, instructional methods, and outcomes of longitudinal GME clinician-educator curricula.

Methods: We conducted a scoping review, registered with BEME, by comprehensively searching health science databases and related grey literature from January 2008 to January 2021 for studies involving longitudinal GME curricula aimed to train future clinician-educators.

Results: From 9437 articles, 36 unique curricula were included in our review. Most curricula were designed for residents but were heterogeneous in structure, instructional methods, and content. Several curricular themes emerged, including: 1) duration >12 months, 2) application of theory-based didactics with experiential activities, 3) independent projects, 4) exposure to faculty mentorship and educator communities, 5) strengthening competencies beyond teaching and scholarship, and 6) protected time and funding. Most outcomes were positive and focused on learner satisfaction or behavior change related to scholarly output and career tracking.

Conclusions: Curricula in our review included important skills including experiential teaching, scholarly projects, and exposure to educator communities. Future curricula should build on these competencies and include more assessment of learner and program outcomes.

KEYWORDS

Clinician-educator; graduate medical education; curriculum; career development

Introduction

Clinician-educator faculty play a central role in the educational and clinical mission of academic medical centers (Levinson and Rubenstein 2000). With the advent of competency-based education and curriculum reform in both undergraduate and Graduate Medical Education (GME), the roles and competencies of today’s clinician-educators extend beyond providing clinical care and direct teaching of trainees. Clinician-educators are charged with leading curriculum development, learner and program assessment, program administration, and dissemination of education research (Branch et al. 1997; Atasoylu et al. 2003; Heflin et al. 2009; Hu et al. 2013; Sherbino et al. 2014). Academic medical centers need clinician-educators trained in these competencies to meet the challenges of medical education transformation.

These aforementioned skills and competencies have not traditionally been taught during training prior to clinician-educators entering the academic workforce. As a result, clinician-educators often feel underprepared for their dual roles upon entering academic medicine, report challenges with balancing clinical work and educational goals, and also face barriers to scholarly productivity and promotion not experienced by their clinician-investigator counterparts (Branch et al. 1997; Levinson and Rubenstein 2000; Atasoylu et al. 2003; Fleming et al. 2005; Hu et al. 2013). These challenges pose threats to the job efficacy and retention of today’s clinician-educators (Chang et al. 2021).

Skills development available to clinician-educators currently includes faculty development through workshops, longitudinal programming, education fellowships, or graduate degree training (Steinert et al. 2016; Knight et al. 2017;
Providing skills development to individuals during medical training prior to entering full-time academic careers may help augment the pipeline of competent clinician-educators. In the last decade, GME programs have started to offer formalized, in-depth, clinician-educator training curricula. These longitudinal curricula, often referred to as ‘tracks,’ ‘pathways,’ ‘concentrations,’ or ‘distinctions’ (Jibson et al. 2010; Naeg et al. 2011; Smith et al. 2014; Lin et al. 2016) typically span the course of 1–2 years and aim to provide skills development – beyond direct teaching skills – to trainees prior to entering full-time academic careers. Specific areas of focus include development of teaching portfolios, leadership skills, curriculum development, and training in education scholarship. Implementation of these longitudinal curricula requires faculty, trainee, and institutional investment (Chen et al. 2017). The opportunity to take part in such a curriculum may also affect GME applicant recruitment (Jibson et al. 2010).

GME programs seeking to develop or improve longitudinal clinician-educator curricula for their trainees may find several limitations in the current body of literature. Descriptions of longitudinal curricula are typically limited to the experience of a single institution or training program. Curricular content, instructional methods, and outcomes studied also vary between programs. These limitations make the identification of evidence-based interventions or assessment strategies for such curricula challenging.

Prior reviews of faculty development curricula for clinician-educators seem to indicate that longitudinal programming, multimodal methods of instruction, and access to a community of practice are important curricular components for the development of practicing clinician-educators (Steinert et al. 2012, 2016). It is unclear if these themes are generalizable to clinician-educator training within a GME population. Friedman et al recently published a scoping review on clinician-educator tracks in GME (Friedman et al. 2019). The review included 19 publications covering 18 unique tracks with a summary of each track’s administrative structure, time commitment, and outcomes. What is not known, however, are the specific instructional methods employed or current best practices for clinician-educator curricula at the GME level.

We conducted a systematic review based on Arksey and O’Malley’s framework for scoping reviews to synthesize the broader landscape of current longitudinal clinician-educator curricula in GME, with a focus on how these curricula approach education strategies, implementation, and evaluation (Arksey and O’Malley 2005).

Our review addresses the following question: What are the components of longitudinal curricula that prepare future clinician-educators during GME, and what is the impact of these curricula? The objectives of this review are to:

1. Characterize the structure and program content of GME-based longitudinal clinician-educator curricula.
2. Describe the instructional methods employed in GME clinician-educator curricula.
3. Assess reported outcomes of longitudinal clinician-educator curricula in GME.
4. Characterize challenges reported by programs/institutions in implementing clinician-educator curricula for GME trainees.
5. Review strengths and weaknesses of research on this topic and identify gaps that exist in the literature surrounding GME clinician-educator curricula.
6. Formulate recommendations for GME programs wishing to develop or enhance a longitudinal clinician-educator curriculum for trainees.

Methods

Inclusion/exclusion criteria

The following criteria were used to select articles for review:

Target population

Interventions aimed toward physician trainees in GME (residents or fellows) were selected. Due to challenges with indexing of medical education literature, curricula that involved medical students or faculty were included in the initial search to ensure a comprehensive search, but interventions designed solely for medical students or faculty were excluded during full-text review.

Intervention

Interventions were included if they met three additional criteria. First, those with the primary goal of developing clinician-educators were selected for review. As clinician-educators must demonstrate competencies beyond clinical teaching alone, we selected interventions that addressed at least two clinician-educator competencies as defined by Sherbino et al: teaching, curriculum development, assessment, education scholarship, and/or leadership (Sherbino et al. 2014). Second, the intervention must also have been delivered longitudinally which we defined as a series of experiences spanning over at least six months. Third, the intervention must have already been implemented.

Study design

Given the lack of randomized-control trials in medical education literature, this review did not make exclusions based upon study design. Descriptive and qualitative articles were included.

Language and geography

Only articles written in English were included. No exclusions were made based upon geographic location.
Search strategy

Due to the fragmented indexing of medical education literature (Maudsley 2011), we used multiple search approaches to reduce bias in the review process. Using three representative articles (Smith et al. 2014; Chen et al. 2017; Ahn et al. 2018), we performed a medical subject headings (MeSHs) analysis to develop a concept table of MEDLINE search terms (Figure 1) (Grossetta Nardini and Wang 2021). These controlled vocabulary terms served as the foundation of our search strategy. Together with synonymous free text words we searched the following databases: OVID MEDLINE, Embase, Scopus, Web of Science, ERIC, ProQuest Dissertations and Theses Global, CINAHL Complete, and the Cochrane Library from inception. The database searches were developed in conjunction with and conducted by a Yale health sciences librarian (JS) on 3 December 2019. We re-ran the database search to update our search on 25 January 2021.

Following the database search, we conducted hand searches of the reference section of retrieved articles and used Scopus to identify published articles that cited retrieved articles. We also conducted a hand search of the table of contents of the following medical education journals beginning in 2008 until present: Academic Medicine, Teaching and Learning in Medicine, Medical Education, Medical Teacher, and Journal of Graduate Medical Education. Additionally, we attempted to contact the corresponding authors of references that were short abstracts to obtain additional details regarding the referenced curricula.

Selection methods

All search results were imported into an online application (Covidence, https://www.covidence.org/home). A total of 9437 references were identified from the search, yielding 7980 titles after 1457 duplicates were removed. Each title and abstract were independently screened by two of three reviewers (YY, KG, or BB) to determine whether the article was related to clinician-educator training. Discrepancies in full-text review were discussed by all three reviewers and differences were resolved by consensus, resulting in 35 articles. A subsequent hand search of reference lists and table of contents generated an additional four articles that had not appeared in the database search, yielding a total
of 39 articles for inclusion in the review. See Figure 2 for the full PRISMA diagram of this review’s search screening process.

Data extraction and analysis

We developed a preliminary extraction coding form modeled after previously-published BEME systematic reviews on faculty development programs (Steinert et al. 2012, 2016). This preliminary extraction form was piloted against exemplar papers from our initial search to improve clarity of items (Smith et al. 2014; Chen et al. 2017; Ahn et al. 2018) calibrate reviewers, and generate a final coding form (Supplementary Appendix) using an electronic survey platform (Qualtrics, Provo, UT). Data from each article were collected on the following items:

- Setting and participants (e.g. location, learner type, learner specialty).
- Curriculum structure of the intervention (e.g. duration, admission, requirements for completion, funding).
- Instructional methods of intervention.
- Curricular content of intervention.
- Outcomes of the intervention.
- Challenges and lessons learned from the intervention.
- Study design and quality.

Once the extraction form was finalized, three members of the research team participated in a two-step data extraction. Each article was first extracted using the electronic coding form by one of two reviewers (KG or BB). The primary author (YY) then reviewed all articles independently to ensure completeness and accuracy of the first round of coding. The extraction team met regularly to discuss differences that arose between reviewers, which were then resolved by consensus.

Extracted data were exported into Microsoft Excel spreadsheets. The spreadsheets provided a means for data storage and tabulation, as well as further data analysis based upon the framework by Arksey and O’Malley (Arksey and O’Malley 2005).

Outcomes were appraised using a modified Kirkpatrick’s model for evaluating training programs that include four outcome levels (Yardley and Dornan 2012). The first level reflects learner reactions to the intervention. The second level reflects learning, divided into modification of attitudes or perceptions (2a) and acquisition of knowledge and skills (2b). The third level reflects changes in behavior, divided into self-reported changes (3a) and observed changes in behavior (3b). The fourth level reflects changes at the level of the institution or organization (4a) and of the participants’ learners (4b).

We appraised the methodologic quality of primary studies with quantitative data using the Medical Education Research Quality Instrument (MERSQI) score (Cook and Reed 2015). Two reviewers independently calculated the MERSQI score for included studies during data extraction. Qualitative studies were appraised based upon criteria as described by Mays and Pope (2000). Differences in quality appraisal were discussed and resolved with the three-member extraction team by consensus.

Results

We retrieved 39 articles on longitudinal curricular interventions that provided training in educator skills to participants
in GME (Supplemental Table 1). Publication dates ranged from 2006 to 2020, with 36 (92.3%) of the 39 articles published in or after 2010. These articles represented a total of 36 unique curricula (Supplemental Table 2). Two articles by Santini referenced the same ‘Resident as Comprehensive Educators’ program; (Santini and Hohler 2014; Santini et al. 2018); Lin and Celebi referenced the same ‘O’Connor Stanford Leaders in Education Residency (OSLER) Track’; (Celebi et al. 2016; Lin et al. 2016) Penner and Jacobson referenced the same ‘Academic Administrator, Clinician-Educator (AACE) Track’ (Jacobson et al. 2010; Penner et al. 2017); two articles by Kohlwees referenced the same ‘Area of Distinction’ program; (Kohlwees et al. 2010, 2011) and two articles by Darbyshire referenced the ‘Academic Foundations Programme’ (Darbyshire and Baker 2013; Darbyshire et al. 2019). One article by Jibson described curricula at three separate institutions (Jibson et al. 2010).

Curriculum setting and participants

The 36 unique curricula included 34 (94.4%) based in the United States, one in the United Kingdom (Darbyshire and Baker 2013; Darbyshire et al. 2019) and one in Australia (Supplemental Table 2) (Bartle and Thistlethwaite 2014). All curricula were set in university or academic-affiliated hospitals. Four curricula (11.1%) included participants from more than one institution (Bartle and Thistlethwaite 2014; Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017; Gisondi et al. 2018). Residents were the target participants for most of the curricula (n = 26, 72.2%). Fellows were target participants in six curricula (13.9%) (Medina-Walpole et al. 2007; Adamson et al. 2015; Moore and Pinsky 2015; Rama et al. 2015; Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017; Dilly et al. 2018). Four curricula (11.4%) included participants from a mix of training levels, and some included faculty (Muller and Irby 2006; Petinaux et al. 2012; Chen et al. 2017; Kraemer et al. 2018). Four curricula (11.4%) included participants from multiple specialties (Muller and Irby 2006; Chen et al. 2017; Ahn et al. 2018; Kraemer et al. 2018) and the two curricula outside of the United States included participants during post-graduate foundations training prior to specialization (Darbyshire and Baker 2013; Bartle and Thistlethwaite 2014; Darbyshire et al. 2019). All others were specific to one specialty, including six (16.7%) in psychiatry (Ning et al. 2009; Jacobson et al. 2010; Jibson et al. 2010; Wasser and Ross 2016; Penner et al. 2017), five (13.9%) in pediatrics (Paradise Black et al. 2014; Moza et al. 2015; Rama et al. 2015; Toto et al. 2017; Winn et al. 2018), five (13.9%) in emergency medicine (Petinaux et al. 2012; Gorgas et al. 2013; Craddock and Krzyzaniak 2017; Gisondi et al. 2018; Caretta-Weyer 2020), four in radiology (11.1%) (Naeger et al. 2011; Matalon et al. 2018; Mendoza et al. 2018; Snyder et al. 2018), three (8.3%) in internal medicine (Kohlwees et al. 2010, 2011; Smith et al. 2014; Pesseguiero et al. 2018), two (5.6%) in pulmonary/critical care (Adamson et al. 2015; Moore and Pinsky 2015), two (5.6%) in neurology (Santini and Hohler 2014; Dilly et al. 2018; Santini et al. 2018), one (2.8%) in family medicine (Celebi et al. 2016; Lin et al. 2016), one (2.8%) in geriatrics (Medina-Walpole et al. 2007), and one (2.8%) in gastroenterology (Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017).

The number of participants included in each cohort cycle of the intervention was variable across curricula, from one fellow per cycle, to 10–12 participants across multiple GME specialties per cycle, to all 18 neurology residents within a post-graduate year per cycle. A large variation was also seen in the number of participants who had completed the curricula at the time of study publication. Of the 22 studies that reported the number of participants who had completed their curricula, the median number of participants was 12. Two curricula with mixed GME and faculty participants reported the highest number of participants at 64 and 71 (Muller and Irby 2006; Chen et al. 2017). Three curricula were in the early stages of piloting at the time of publication and had no participants who completed the intervention (Jibson et al. 2010; Mendoza et al. 2018; Caretta-Weyer 2020).

Curriculum structure

Twenty-five of the 36 curricula (69.4%) were described as educator ‘tracks,’ ‘pathways,’ ‘concentrations,’ or ‘distinctions,’ in which residents or fellows interested in developing educator skills could choose to participate as a supplement to their core GME training requirements (Supplemental Table 3). Seven (19.4%) curricula appeared to be longitudinal professional development programs, five of which were incorporated into the formal curriculum for all residents or fellows within their GME programs. Three (8.3%) curricula were described as teaching scholars’ programs or academic medicine training placements.

Sixteen (44.4%) curricula reported providing or requiring participants to have some protected time to complete curricular programming, most often in the form of dedicated time to attend core didactic sessions or workshops. The median longitudinal curriculum duration was 24 months, with most curricula spanning between 12 and 36 months. Only three curricula were shorter than 12 months, all at nine to ten months in duration (Muller and Irby 2006; Santini and Hohler 2014; Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017; Santini et al. 2018). Six of the 36 curricula (16.7%) specified providing participants with a certificate after completion.

Curriculum admission

Out of the 36 unique curricula described, 21 (58%) required an application to participate (Table 3). The most common application component was submission of a curriculum vitae which was required by 11 of the 16 curricula (68.8%). A letter of intent or statement of goals, a project proposal, and/or program director approval were each required by nine curricula (56.3%). One pulmonary-critical care fellowship-based track required an in-person interview prior to acceptance into the track (Adamson et al. 2015). Nine curricula did not require an application and had content open to all interested residents or fellows within the sponsoring program (Petinaux et al. 2012; Santini and Hohler 2014; Moore and Pinsky 2015; Moza et al. 2015; Rama et al. 2015;
Wasser and Ross 2016; Craddick and Krzyzaniak 2017; Kraemer et al. 2018; Santini et al. 2018; Snyder et al. 2018).

**Instructional methods**

Descriptions of instructional methods were available for 33 of the 36 (91.7%) unique curricula included in the review (Supplemental Table 4). Of these, 31 (96.8%) included content that was delivered synchronously to participants. Fourteen (38.9%) curricula delivered content asynchronously, allowing learners to review material at their own time, often through online coursework, video-recorded sessions, or independent readings.

Table 1 summarizes the instructional methods used, ranked from the highest to lowest frequency. Nearly all curricula (n = 29, 87.9%) used didactic meetings or conferences to deliver curricular content. Most curricula also included coaching and mentorship (n = 24, 72.7%) and independent projects (n = 22, 66.7%). Nearly half of curricula (n = 15, 45.5%) involved the use of small-group learning and skills workshops (n = 14, 42.4%). Only half of curricula provided direct observation with feedback from a supervisor on curriculum participants’ teaching. Less than a third of curricula reported the use of journal clubs (n = 10, 30.3%) or research in progress sessions (n = 7, 21.2%). Career panels were reported in seven curricula (21.2%).

The availability of virtual coursework was described in eight curricula (24.2%). Two curricula included web-based modules on curriculum development (Ahn et al. 2018; Dilly et al. 2018) and one included an online leadership course (Lin et al. 2016). Notably, one curriculum, the Emergency Medicine Chief Resident Incubator, delivered nearly all of its content virtually (Gisondi et al. 2018).

**Curricular content**

The curricula in this review incorporated a range of content spanning across the five clinician-educator competencies of teaching, scholarship, curriculum development, assessment, and leadership. Additionally, many curricula also provided content related to clinician-educator career development skills (Supplemental Table 5). Only five of the unique curricula addressed topics falling into all six of these core content domains. The curricula in this review addressed a mean of four of the six educator competency and career development content domains.

**Curricular content: Teaching skills**

Thirty-three of the 36 unique curricula (91.6%) reported curricular content aimed to improve teaching skills (Supplemental Table 6). However, only 28 curricula (77.8%) provided additional details on topics related to teaching (Table 2). From these 28 curricula, the most frequently included topics were adult learning theory and small group teaching (both n = 15, 53.6%), giving feedback (n = 14, 50%), followed by bedside teaching and large group teaching (both n = 12, 42.9%). Technology in teaching (n = 3, 10.7%) and chalk talks (n = 1, 3.6%) were two of the least frequently reported topics.

**Curricular content: Curriculum development**

Thirty-three of the 36 unique curricula (91.6%) reported including medical education scholarship skills development content (Supplemental Table 7). Twenty-nine of these curricula provided additional details regarding their scholarship content (Table 3). Mentored research projects were described in 21 of 29 (72%) curricula as a core, experiential component of medical education scholarship skills content. Scholarly writing was the most frequently cited didactic topic related to education scholarship, included in 17 curricula (68.6%), followed by research methods and statistics (n = 14, 48.3%). Thirteen curricula (44.8%) taught learners strategies to present scholarly work, either in the form of posters, oral presentations, or workshops. Navigating the IRB process was one of the least reported topics, discussed in only four curricula (13.8%). Only one curriculum described addressing all seven education scholarship topics in their curriculum (Chen et al. 2017).

**Curricular content: Medical education scholarship**

Twenty-two of the 36 unique curricula specified teaching curriculum development concepts (Supplemental Table 8); however, only 10 described curriculum development
components taught to participants in more detail. Five of these curricula addressed needs assessment, six included creating goals and objectives, seven addressed educational strategies, eight addressed implementation, and seven addressed curriculum evaluation. Four curricula addressed all five curriculum development concepts (Muller and Irby 2006; Chen et al. 2017; Ahn et al. 2018; Dilly et al. 2018).

Curricular content: Assessment
Fifteen of the 36 curricula (41.7%) described providing participants with assessment skills (Supplemental Table 8). Of these 15, 100% reported addressing skills to assess learners. Only three curricula reported addressing skills for programmatic assessment.

Curricular content: Leadership/administration skills
Nineteen of the 36 unique curricula (52.8%) incorporated content related to leadership or administration skills (Supplemental Table 9). However, details regarding the leadership training were not well described in the articles. Some curricula included experiential, ‘on-the-job’ leadership opportunities by offering interested participants administrative oversight of a didactic series within the residency program or with a component of the curriculum itself (Jibson et al. 2010; Paradise Black et al. 2014; Wasser and Ross 2016; Penner et al. 2017). Others offered didactic sessions on specific leadership concepts, such as middle management, lobbying and legislation, risk management, and developing teams and coalitions (Muller and Irby 2006; Petinaux et al. 2012; Gisondi et al. 2018). One curriculum offered online modules on change leadership (Lin et al. 2016), and two provided opportunities to take part in administration coursework at the medical center or university-affiliated business school (Jibson et al. 2010; Penner et al. 2017). Seven curricula offered participants training on mentorship.

Curricular content: Career development
Twenty-three of the 36 unique curricula (63.9%) broadly described programming dedicated to career development, of which 21 (58.3%) provided additional topic details (Supplemental Table 9). Developing an educator portfolio or curriculum vitae was the most common topic, reported in just over half of the 21 curricula (n = 11, 52.4%) (Table 4). Sessions on clinician-educator promotion criteria in academics were included in eight curricula (38.1%). Only 6 (28.6%) specified including sessions introducing learners to different clinician-educator careers, most commonly in the format of a career panel. Fewer curricula (4, 19%) described content aimed to help learners during the job search process, such as how to approach job interviews and employment contracts. Three curricula (14.3%) described content promoting future clinician-educator well-being, such as work-life balance, physician wellness, and managing stress.

Completion requirements
The requirements that participants must fulfill to successfully complete the curriculum were described in 24 of the 36 (66.7%) unique curricula (Supplemental Table 10) and were heterogeneous in nature.

Three curricula used credit or activity hours to track participant progress. One curriculum in emergency medicine required 40 credits spread across an assortment of activities, each with a different credit weight (Craddock and Krzyzaniak 2017). Two curricula required a minimum number of education-related activity hours, ranging from 50 to 70 h, spread across a variety of didactic, teaching, curriculum development, scholarly project, and/or career development activities (Moza et al. 2015; Chen et al. 2017).

Nearly all curricula with completion requirements (n = 23, 95.8%) mandated participants attend at least a portion of the curriculum’s core didactic or seminar series. However, the frequency of these seminars varied widely, from a 2-d teaching workshop (Snyder et al. 2018) to weekly 3-h seminars spread over 10 months (Muller and Irby 2006) to a percentage of monthly sessions for the duration of the curriculum (Adamson et al. 2015). Core curriculum attendance seemed to be the sole requirement for curriculum completion in three programs (Petinaux et al. 2012; Santini and Hohler 2014; Santini et al. 2018; Winn et al. 2018).

Teaching experience was required to successfully complete 18 of the 24 curricula (75%). The extent of the teaching requirements was variable throughout the curriculum descriptions. Several simply stated the curriculum required completion of ‘teaching activities’ that were otherwise unspecified. A curriculum within emergency medicine required participants to give one medical student lecture and lead one medical student simulation activity (Craddock and Krzyzaniak 2017). Other curricula had more extensive teaching requirements. For example, the Academy of Resident Educators required at least 25 out of 50 h of the curriculum to be spent on ‘direct teaching’ (Moza et al. 2015). Lin et al. required participants to teach 18 half days of a ‘Practice of Medicine’ medical student course, proctor an OSCE exam, and lead one journal club and one case conference for residents and medical students (Lin et al. 2016). Six programs (25%) specified teaching medical students, four programs (16.67%) specified teaching at the GME level, and four programs (16.67%) required teaching of both medical students and residents or fellows.

An independent scholarly project was required in 18 of the 24 curricula (75%). Only six curricula (25%) specifically required scholarly work to be disseminated in the form of publications or presentations at local, regional, or national conferences.

Three curricula required documentation of mentorship meetings. Only two of the 24 curricula (8.3%) specified requiring participants to submit an educator portfolio.
curricula (8.3%) required the observation of masters or peers.

**Program funding and support**

Twenty-one of the 36 curricula (58.3%) reported receiving some type of funding in the form of administrator support, monetary support for meals during meetings, or funding for participant scholarship. The amount of funding was typically unspecified. Two curricula reported receiving $2500–$3000 a year to support curricular activities and meetings (Moza et al. 2015; Kraemer et al. 2018). An internal medicine-based Areas of Distinction program reported that each area of distinction received 20–40% time support from an administrator (Kohlwes et al. 2010, 2011). A mixed GME and faculty curriculum reported receiving $50,000 of support yearly, which included salary support for faculty (Muller and Irby 2006). One curriculum paid its education fellow for face-to-face teaching time during a 2.5-week medical student teaching block (Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017).

Only eight of the 36 unique curricula (22.2%) reported support for the faculty overseeing the curriculum. Kohlwes reported faculty received 5–10% salary support (Kohlwes et al. 2010, 2011). Similarly, Kraemer reported 8% salary support for the faculty leader (Kraemer et al. 2018). Paradise reported 0.1 FTE support for faculty leaders (Paradise Black et al. 2014). Ahn also reported FTE support for faculty leaders, equating to 2–5 h per week (Ahn et al. 2018). Gisondi reported providing faculty with a ‘small honoraria’ (Gisondi et al. 2018). One psychiatry-based program allowed faculty to count their leadership toward ‘education credit units’ which resulted in a year-end bonus (Penner et al. 2017).

Programmatic and faculty support was typically provided by funds from the sponsoring department, or from an institution-based medical education office or academy. One residency-based curriculum and one fellowship-based curriculum received stipend support from their university-affiliated Veterans Health Affairs hospital (Adamson et al. 2015; Wasser and Ross 2016).

**Outcomes**

Kirkpatrick level 1 outcomes were most commonly reported in the 39 studies, present in 71.8% of the articles (n = 28) (Supplemental Table 1). Kirkpatrick level 2a, self-reported changes in perceptions and attitudes, were reported in 38.5% of articles (n = 15); and changes in skills and knowledge were reported in 30.8% (n = 12) of articles. Over half of the articles (n = 21, 53.8%) noted level 3a self-reported changes in behavior; with level 3b objective changes in behavior reported by 35.9% of articles (n = 14). Only six articles (15.4%) reported changes at the level of the program or institution (level 4a), and none at the level of participants’ learners (level 4b).

**Level 1 – participant reaction**

In general, the clinician-educator curricula were well received by participants. When collected, Likert scores related to curriculum satisfaction, achievement of objectives, value of sessions, likelihood to recommend the curriculum to others, et cetera, were high. Qualitative and mixed methods data indicate that residents appreciated small group experiences (Kohlwes et al. 2010, 2011) the ability to apply theory from didactics to relevant real-world experiences, and that sessions allowed members to be part of a community (Dilly et al. 2018). Participants also highlighted the importance of mentorship to the perceived success of the curriculum (Kohlwes et al. 2010, 2011; Darbyshire and Baker 2013); one program’s participants cited the lack of mentors with medical education research skills as a programmatic barrier (Bartle and Thistlethwaite 2014). Only one study included qualitative data from curriculum faculty mentors: mentors from the Academic Foundation Programme in the UK generally reported a positive experience from participating in the program and that the creation of an ‘authentic academic environment’ was particularly effective, but some felt a lack of preparation when it came to advising trainees on selecting a suitable research project (Darbyshire et al. 2019).

**Level 2a – changes in attitudes or perceptions**

Most studies with level 2a outcomes reported that participants experienced gains in self-efficacy and confidence related to teaching, scholarship, and/or leadership. Efficacy in scholarship was somewhat mixed, with a few curricula reporting low gains in participant confidence related to curriculum development and scholarship dissemination (Smith et al. 2014; Penner et al. 2017). Others noted that research was still perceived as a potential barrier to an academic career (Bartle and Thistlethwaite 2014). Several studies reported that their curriculum affirmed participants’ interest in educator careers (Medina-Walpole et al. 2007; Chen et al. 2017; Ahn et al. 2018). For example, 82% of participants in the GMEST program stated they wished to pursue clinician-educator careers (Ahn et al. 2018). Several curricula noted that participants reported a better understanding of academic career pathways, or that participation contributed to their career development (Muller and Irby 2006; Ning et al. 2009; Rama et al. 2015; Dilly et al. 2018; Kraemer et al. 2018; Pesssegueiro et al. 2018).

**Level 2b – changes in knowledge or skills**

All curricula with level 2b outcomes used self-reported changes in knowledge or skills. Improvement in teaching skills was most frequently reported. Specific teaching-related skills that were commonly cited included improved ability to apply adult learning theory, give feedback, assess learners, teach in small groups, and give effective presentations (Moore and Pinsky 2015; Pesssegueiro et al. 2018; V. E. Santini et al. 2018; Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017; Smith et al. 2014). No curriculum included objective evidence of knowledge or skills acquisition as a result of participation in the educator curriculum. Naeger et al. briefly describe that their two resident participants had teaching sessions that were rated in the 68th and 80th percentile of all resident lectures delivered by faculty, although no
scores prior to curriculum participation were available for comparison (Naeger et al. 2011).

**Level 3a – self-reported changes in behavior**

Most curricula with level 3a outcomes chose to track self-reported medical education scholarship output. For example, one curriculum had nine of 32 graduates (28%) report completing a medical education-related project compared to eight in the prior four years combined (Toto et al. 2017). Another curriculum had nine senior residents report a total of 66 scholarly activities in the first three years of the program (Mendoza et al. 2018). Several curricula listed the frequencies of publications, workshops, abstracts, posters, grand rounds reported by their participants. Participants at one pediatric fellowship-based curriculum reported that their experience in the curriculum changed the way they approached preparing for their job search and career advancement, as well as their choice of scholarly projects (Rama et al. 2015). A survey of trainees within the multi-institutional Academic Foundations Programme based in the UK found that only 26% of respondents had applied for an academic position post-graduation, although they note that this percentage is higher than the 9.5% of graduates from non-academic Foundations Programmes (Darbyshire et al. 2019).

**Level 3b – observed changes in behavior**

Similarly, objective tracking of medical education scholarship outputs and academic career outcomes were the most commonly-reported level 3b outcomes. Graduates objectively appeared productive. For example, a curriculum with 10 participants documented eight new curricular innovations for the residency program, four national conferences, three publications, and three leadership roles on regional or national committees (Wasser and Ross 2016). The percentage of graduates in teaching-predominant or academic institutions reported by six studies ranged from 67% (of nine graduates) (Medina-Walpole et al. 2007) to 100% (of three graduates) (Lin et al. 2016), with a mean of 80% (Jibson et al. 2010; Adamson et al. 2015; Wasser and Ross 2016; Penner et al. 2017; Shields and Teaching and Academic Gastrointestinal Pathophysiology Course Fellows 2017). Other curricula showed that graduates were able to attain leadership roles such as director of simulation, residency program director, and director of clinical skills (Muller and Irby 2006; Moore and Pinsky 2015).

**Level 4a – changes in program or organization**

While not always formally measured, a few curricula noted a positive impact of their clinician-educator curriculum on recruitment. For example, Celebi and Lin report that their program saw an increase in number of applicants (41%) that was beyond the increase in national average (29%) after implementation of the OSLER track (Celebi et al. 2016) and that 69% of surveyed applicants indicated that the opportunity to participate in the track increased their interest in the program (Lin et al. 2016). Wasser and Ross commented that their curriculum track was often a focus of discussion during interviews for their psychiatry residency (Wasser and Ross 2016). Likert-scale and qualitative data suggested that the presence of an educator track at one institution influenced some applicants to choose to train there for residency (Kohlwes et al. 2011; Chen et al. 2017).

**Level 4b – changes in participants’ learners**

No curricula reported outcomes related to changes in participants’ learners.

**Program challenges**

The authors of the articles included in this review cited programmatic challenges that shared several common themes: scheduling, protected time and funding, and mentorship.

First, scheduling events for synchronous core curricular sessions was a challenge given the varying clinical schedules of the intervention participants. This was particularly the case for interventions that were open to participants across multiple GME specialties. Studies reported different strategies to address scheduling challenges, including re-organizing ambulatory block times or academic half days (Kohlwes et al. 2010, 2011; Smith et al. 2014) consolidating core curricular content to be delivered over a month with ‘elective’ content and asynchronous learning opportunities following throughout the remainder of the program (Chen et al. 2017; Ahn et al. 2018), repurposing prior research time, and utilizing evening or weekend time.

Insufficient funding and protected time for participants were also often cited as programmatic challenges, even among interventions where protected time was offered. Authors felt that funding and protected time would enhance participant’s completion and dissemination of scholarly projects, ease scheduling of curricular activities, and contribute to programmatic expansion and sustainability.

Finding sufficient mentorship from faculty was also a common challenge. For curricula that had a larger number of participants, faculties were needed to: 1) help participants navigate curricular requirements, 2) provide mentorship on education projects, and 3) deliver content for core curricula sessions. Several studies noted that their curricula needed more formal mentorship structure and had difficulty identifying or recruiting faculty with expertise in medical education (even if based within large academic medical centers). Several studies commented on the use of intra-track near-peer mentorship between senior and junior curricula participants (Smith et al. 2014; Wasser and Ross 2016; Chen et al. 2017; Ahn et al. 2018), recruiting recent program graduates (Muller and Irby 2006) and combining resources with other scholarship tracks or academic academies as a means of overcoming mentorship challenges (Jacobson et al. 2010; Paradise Black et al. 2014; Matalon et al. 2018).

**Study design and quality**

Nearly half of the 39 included articles (n = 17, 43.6%) were mixed methods in design, of which five included quasi-experimental single group pre/post or non-equivalent control groups, and the remainder were cross-sectional. Thirteen articles (33.3%) were cross-sectional, non-experimental only. Three articles (7.7%) were quasi-experimental only without qualitative components. One article (2.5%) was purely
qualitative in design. Five articles were purely descriptive (Supplemental Table 1).

Articles in this review typically included multiple methods of data collection. Questionnaires were the most frequently used data collection method, reported in 22 of the articles (56.4%). Design, implementation, as well as validation of questionnaires were often not addressed in the study methods. While many articles tracked career outcomes and scholarly output of its participants, the collection strategies to obtain this data were not well described – six articles specifically reviewed the curriculum vitae or educator portfolio of participants, and a few used questionnaires. The remainder of articles did not explicitly state whether authors tracked career and scholarship outcomes observationally while participants were completing the curriculum or through another method. Qualitative components of the mixed-method studies were limited and mostly derived from short free response questions on questionnaires; six of the 17 mixed-method studies reported using focus groups or interviews for qualitative data collection.

The MERSQI score was calculated for 31 of the 39 articles. The median MERSQI score was 8, with a range of 4.5–11.5 (max score of 18). The MERSQI score did not apply to the four descriptive or one qualitative article, and three articles were short abstracts without sufficient information for the MERSQI to be applied.

Discussion

Synthesis of findings

This review aimed to identify and describe the structure and impact of longitudinal curricular interventions within GME designed to train future clinician-educators. Our findings indicate that experiential teaching activities, independent scholarly projects, and exposure to educator communities are key components included in longitudinal clinician-educator curricula. Despite this training, the educational curricula in our review often lacked strong outcome measures including objective changes in learner outcomes, program or institutional impact, and career progression of participants. This dearth of evaluation may limit our understanding of the true outcomes of these initiatives.

Development of teaching and education scholarship skills were part of the curricular content in the educational initiatives we reviewed. Nevertheless, there did not appear to be a shared set of educator competencies across programs. While adult learning theory, facilitating small groups, and giving feedback were the most frequently reported teaching skills topics, each topic was only reported by half of the curricula. Using experiential learning techniques with feedback are key elements to teaching and can help develop individuals as independent learners, thinkers, and teachers (Kauffman 2003). While career development content was included in nearly two-thirds of the articles, the nature of how this was delivered varied between programs. Additionally, interventions tended to only briefly reference curriculum development, assessment, and leadership skills content and were not well reported or described. Providing clear educational strategies and assessment as defined in standard curriculum development resources (Thomas et al. 2016) are important to disseminating curricula so that others may learn from their successes and failures.

Nearly all curricula in our review used synchronous didactic meetings or conferences. It should be noted however that all studies in this review were conducted prior to the COVID-19 pandemic. Therefore, while only a minority of programs employed asynchronous or virtual techniques, these approaches may be more useful today to help trainees develop appropriate skills when social distancing is needed.

Most studies in this review did report some curricular outcomes, although there was heterogeneity in the type of outcomes that were measured. Participant reaction (Kirkpatrick level 1 outcome) was the most-frequently measured outcome in our review. Nearly half of articles reported on changes in attitudes, perceptions, and knowledge (level 2 outcomes) – all based upon participant report rather than objective measurements. Less curricula reported changes in participant behavior (level 3 outcomes) and few reported program/organization outcomes (level 4 outcomes). In addition to lack of outcomes reporting, the overall quality of articles in this review was low. While over half of the studies were technically mixed methods, most quantitative measures were non-experimental and cross-sectional. The lack of strong outcome measurements and low study quality leaves one to question the true longitudinal effects of the curricula on trainees and their programs.

Synthesis of themes of longitudinal clinician-educator curricula in GME

Though the tracks or pathways described above demonstrated significant heterogeneity in makeup, we identified several themes that may represent central elements to longitudinal educational curricula.

Duration

While no articles compared the effect of shorter versus longer duration curricula, the review suggests a range of 12–36 months was most common. This is in line with prior reviews of faculty development interventions for teaching, leadership, and scholarship (Steinert et al. 2012, 2016). Longitudinal programming allows for time to complete scholarly projects, establish a sense of community with peers and mentors, pursue opportunities for practice, and feedback over time. This coupled with flexibility in requirements provided residents and fellows in training the opportunity to engage with the curricula at their own pace.

Incorporation of multiple instructional methods and experiential learning

Curricula in this review employed a combination of instructional methods to address the various educator skills objectives, with most using several techniques within a single program. Core didactics often included small group discussions or seminars, workshops, and joint reflection to promote active learner engagement. The use of experiential activities was prominent throughout many of the curricula and included independent projects as an application of medical education research or curriculum development
skills, directly observed teaching with feedback, teaching electives, as well as leadership or administrative roles within the curricula or GME program. These findings align with prior studies on faculty development curricula for educators in which multi-modal approaches were deemed more effective (Steinert et al. 2012, 2016).

Focus on teaching and medical education scholarship competencies

Teaching and scholarship skills were the educator competencies most frequently addressed by longitudinal educator curricula in this review. This does not come as a surprise, as several studies show institutional promotional criteria for clinician-educators focused on teaching, education scholarship, and clinical service. Despite over 90% of curricula addressing education scholarship as a competency, qualitative outcomes across several programs show that participants often struggled with conducting education scholarship or wished for additional mentorship and support with education scholarship methods. This was particularly notable among curricula that required independent research projects but lacked descriptions of theory-based sessions focusing on research methods or curriculum development. Curriculum development, leadership, and administration, as well as assessment are key competencies for clinician-educators, but most studies in this review provided little detail on if and how these competencies were addressed.

Need for faculty champion and mentorship

Faculties were needed to administer longitudinal curricula and track progress, and to lead didactics. However, multiple articles cited the need for faculty to assist with mentorship for scholarly projects, and for structured teaching observation activities. Several articles reported needing to identify and train a wider network of faculty mentors earlier on in their curricula as a challenge/lesson learned.

Utilization of existing, local educator resources

Several education curricula were part of a broader career ‘pathways’ programming. Others initially built curricula on existing ‘resident as teacher’ content. Additional interventions partnered with institutional organizations, such as a medical education academy or department of medical education, existing local teaching scholars programs, or medical education faculty development seminars, electives, workshops, and teaching opportunities. Multiple benefits were cited regarding the sharing of resources rather than ‘reinventing the wheel.’

Clarifying efficacy of longitudinal clinician-educator curricula in GME using concepts in educator identity formation

Prior work has shown that many of the above approaches help learners early in their careers develop self-image and professional identity, and align with prior conceptual models of educator identity formation, in which learners interested in pursuing an educator career path are intrinsically and extrinsically motivated to engage with learning material with an intended outcome – in this case developing a career in medical education (Sethi et al. 2018). Using these frameworks provide better insight into why learners might choose to engage with content focused on clinician-educator skills, and motivation for learners to engage in a newly formed clinician-educator track.

Motivation to engage in clinician-educator training curricula, and to pursue a clinician-educator career, may derive from both extrinsic and intrinsic factors, as well as an individual’s beliefs about their competence (Bandura 1986; Cook and Artino 2016). In terms of extrinsic factors, the presence and availability of a longitudinal educator curriculum may influence learners to engage in material, even if they are not motivated by a specific end goal. The development of an educator curriculum may also provide messaging to potential learners about institutional priorities, which in prior work has informed intrinsic motivations at the individual level (Blackburn et al. 1991). For example, offering a certificate or credentials (e.g. MedEd) as a curricular outcome provides messaging to learners that additional education may be necessary to further a career in medical education. Prior work indicates that providing such credentialing supported with a work environment that encourages ongoing professional identity formation through scholarship and mentorship may provide powerful extrinsic motivation for learners early in their career (Sethi et al. 2016). Other efforts, such as emphasis on contextualizing educator curricula within a medical education milieu including faculty educators, education-focused roles (e.g. chief residents for medical education and medical education fellows) could also further extrinsic motivators for participation by allowing learners early in their career to ‘visualize’ their own pathway toward those roles.

Internal motivators were also important for engagement in educator curricula activities. Indeed, an intent of many of the career development tracks or pathways discussed in this review was the fostering of professional self-efficacy. Self-efficacy is defined as an individual’s belief in their own ability to affect events in their life, and is foundational to motivation and personal accomplishment (Bandura 1986; Cook and Artino 2016). In addition to motivating actions, self-efficacy also determines how much effort one puts forth and how one persists in the setting of challenge (Kaufman 2003). Prior studies show that self-efficacy can be encouraged in medical learners through mastery experiences, observation of others, and one’s own emotional feedback during performance (Artino 2012). Of these, mastery experiences are thought to have the most potent effect on self-efficacy (Bandura 1997). In this review, we observed that nearly all programs provided a mechanism for development of self-efficacy in medical education, including experiential learning to build mastery, direct observation and feedback activities, and structured reflection. We suggest that programs interested in developing a longitudinal educator curriculum consider how the curriculum supports this framework of self-efficacy.

As mentioned above, multiple articles in this review discuss the importance of developing committed core faculty to support educator curriculum efforts. Whether explicitly stated or implicit, these represent communities of practice (COP), a persistent, sustaining social network of individuals who share and develop an overlapping knowledge base,
set of beliefs, values, history and experiences focused on a common practice and/or mutual enterprise (Barab et al. 2002). COPs are thought to be useful as they are thoroughly grounded in the ‘reality of practice,’ connect individuals, promote a shared identity, and provide forums for mentoring relationships (Wenger 2002; Steinert 2010). Therefore, we postulate that many longitudinal education curricula that established medical education COPs further influenced learners to engage in the material by providing role modeling.

**Strengths of the review**

A strength of this review is its utilization of a rigorous systematic review methodology that was prospectively peer-reviewed and registered, and utilized predetermined inclusion and exclusion criteria, as well as methods to reduce bias by the authors throughout the review process by the use of at least two reviewers for all stages of screening and data extraction. This review incorporated a broad search strategy, including a search update, to identify relevant studies, and was able to include twenty studies not reviewed by Friedman et al. (2019). Additionally, the review was able to provide detailed summaries of the administrative components, curricular contents, and instructional methods utilized by the included interventions at a granular level that has not previously been described.

**Limitations of the review**

This review has limitations. First, due to the inconsistent indexing of medical education research, and the heterogeneity that existed in the interventions of interest, the MESH terms utilized in our search were quite broad; while this resulted in a large number of results, we believe this helped our review identify references not captured by the previous review. Second, most interventions were based in academic medical centers in North America. Third, many references only briefly or incompletely described the administrative structure, curriculum content, and instructional methods of their intervention. Therefore, it was difficult to conclude whether certain aspects of these interventions were simply not specified or truly not included as a component of the intervention and may have led to under-reporting of curricular content and instructional methods in our review. Similarly, this review is limited by low-quality study methods of the included references. Most studies used non-experimental cross-sectional methods, relying on surveys without addressing validation; others lacked clear description of how outcomes were measured, reported anecdotal findings, or included outcomes that were self-reported. Furthermore, many references reported early outcomes from a pilot or the first few years of implementation. These characteristics of the included articles are a challenge, given that the intended outcomes of these programs are often longer term, such as trends of job opportunities and career advancement for clinician-educators. Additionally, for the outcomes that were measured, there was a lack of comparison groups in many of the references.

Overall, the above limitations related to quality of included studies reduce this review’s ability to confidently attribute observed outcomes directly to the educator tracks themselves, rather than to participant or broader institutional factors. However, despite the heterogeneity among the interventions in terms of administrative structure, instructional methods, and curricular contents, the interventions reported similar trends in outcomes, including learner satisfaction and increased efficacy, as well as early behavior change outcomes. This suggests that longitudinal educator curricula within GME is not ‘one size fits all,’ rather there may be a degree of customizability at the level of the GME program or institution, which may contribute to generalizability.

**Implications for practice**

We suggest the following ‘tool belt’ (Figure 3) of practices to those who may be interested in creating a longitudinal GME curricula to train future clinician educators. Items from the tool belt were selected based upon: 1) common themes regarding structure, curricular content, instructional methods, results, and challenges of longitudinal clinician-educator curricula in GME collated from this review, 2) existing literature on best practices for clinician-educator development programs (McCullough et al. 2015; Steinert et al. 2016; Alexandraki et al. 2021; Ramani et al. 2021), and 3) practice experience of several of the authors who have

![Figure 3. Tool belt for longitudinal clinician-educator curricula in Graduate Medical Education. This review identified several key elements common to longitudinal GME clinician-educator training curricula. Clinician-educator competencies including teaching, curriculum development, scholarship, leadership, and administration, as well as career development skills comprise the core curricular content, as noted by the tools on the toolbelt. Programmatic attributes supporting the success of these curricula are noted on the belt itself, including: 1) protected time for participants, funding, as well as institutional and programmatic support; 2) the availability of a network of mentors; 3) clear and defined goals and objectives, as well as criteria for completion of the training curricula; 4) incorporation of multiple instructional methods with a focus on experiential learning; 5) exposure to a community of clinician-educators. See text for additional details.](image-url)
Identify a cohort of faculty who can serve as mentors and role models for curriculum participants. It may be beneficial to include faculty who excel in clinical teaching, as well as those with expertise in curriculum development, assessment, and scholarship methods.

Assess local resources that may already be available that could be incorporated into or partner with your program. This may include educator development workshops sponsored by another program or department, a resident-as-teacher elective already in existence, ‘research in residency’ time that could be repurposed for medical education projects.

Identify available timing and space (could potentially be virtual) that will be required to deliver curricular contents. Can participants be given protected time to complete elements of the pathway (e.g. elective time, academic half days, research time, noon conference time, etc.)? We suggest programs span at least 12–24 months to allow for completion of projects, participation in experiential learning activities, and exposure to role models.

Incorporate curricular content that addresses core skills and competencies for clinician-educators, including: teaching skills, education scholarship, curriculum development, leadership and administration, and assessment, and career development. We particularly encourage programs consider the concrete skills relate to curriculum development, leadership and administration, and assessment.

Incorporate opportunities to apply theory-based didactics to experiential, situated learning for core educator skills. This includes opportunities for practice, shared reflection, venues for observed teaching with feedback, mentored independent or group education projects, and leadership or administrative experiences.

Incorporate an application when recruiting participants, which could include a letter of interest, potential project ideas, and GME program director support.

Determine which components of the curriculum are required for all learners and which components may be elective. Consider opportunities to allow participants flexibility to form individualized goals and pursue asynchronous learning.

Have a clear method for communicating curriculum requirements, and for faculty leaders and pathway participants to track progress in the curriculum.

Expose participants to clinician-educator COP. Example strategies include holding educator career panels, inviting a variety of educator faculty to facilitate didactic sessions, participation in education committees, attendance at institutional/local/national conferences highlighting the work of clinician-educators, frequent interactive discussions with peers (joint reflection, journal club, research in progress), etc.

Seek opportunities for funding to support the curriculum. While not all faculty leaders for these programs received FTE or salary compensation in our review, many programs received modest departmental support in the form of funding for meals and supplies, or assistance from an administrator.

Implications for future research

There remains an ongoing need for standardized reporting of curricular interventions in medical education. Future studies should provide detailed descriptions of intervention aims and objectives, administrative structure, instructional methods, curricular content, and methods of assessment.

The COVID-19 pandemic has significantly altered medical education across the spectrum of trainees, moving a large portion of non-clinical education into the virtual arena. Only a few of the included interventions specifically address the effective use of technology for teaching, and only one intervention utilized a completely virtual format. Additional research is needed to better understand the role of incorporating technology in teaching and the use of virtual learning spaces in longitudinal educator curricula.

These longitudinal curricular interventions require significant faculty and programmatic investment. Long-term follow-up is needed to ascertain the sustainability of these curricula over time. Additionally, long-term follow-up of intervention participants is needed to provide further insight into the durability of impact that these curricula have on educator career development and advancement.

Educator development is a complex process that takes place over time, and subject to many individual and environmental factors and variables. Future clarification studies would help discern which aspects of these curricular interventions are particularly beneficial to aspiring educators at the GME level, and why.

Conclusion

The last decade has seen an increasing number of GME training programs offer longitudinal curricula to prepare future clinician-educators. Our review of the available literature related to longitudinal educator curricula in GME showed positive outcomes related to participant satisfaction, participant-reported gains in self-efficacy and educator skills, as well as positive trends in terms of behavior change as measured by scholarly productivity and attainment of academic careers, although the strength of evidence in this review is limited by weak study design in most studies included in our analysis.

Our review showed significant heterogeneity in structure and content between curricula. However, we identified several elements that may be key to these curricula, including typical duration of 12–36 months; requirement for an application prior to participation; interactive core didactic sessions with opportunities for real-world, experiential application of skills; independent scholarship projects; exposure to a community of educators; emphasis on the need for faculty mentorship, protected time, and institutional support. While most curricula addressed teaching and scholarship skills, improving support...
and mentorship for medical education research was a common theme in qualitative components of the study. Additionally, we found that many curricula lacked well-described content related to the other educator competencies of curriculum development, assessment, and leadership.

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