

Short title: E-mentoring in Medicine

Title: Enhancing mentoring experiences through e-mentoring; a systematic scoping review of e-mentoring programs between 2000 and 2017.

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Abstract

Introduction

Mentoring is suffering from a shortage of trained mentors which compromise the efficacy of novice mentoring or mentoring between a senior clinician and a junior clinician. E-mentoring is proposed as a means of supplementing this dominant form of mentoring in medicine by providing accessible, timely and longitudinal support for mentees. However, with little is known about e-mentoring nor its role in a blended mentoring approach, a systematic scoping review is proposed to evaluate these gaps in understanding in order to better understand e-mentoring and assess the viability of employing e-mentoring practice to support novice mentoring.

Methods

Using Arksey and O'Malley's (2005) approach, 5 reviewers carried out independent literature reviews of e-mentoring as an adjuvant to novice mentoring in PubMed, Embase, PsycINFO, ERIC, Cochrane Database of Systematic Reviews, Google Scholar, Scopus, GreyLit, OpenGrey, and Web of Science databases. Braun and Clarke's (2006) thematic analysis approach was used to thematically analyse accounts of e-mentoring across different settings.

Results

6557 abstracts were identified, 109 full text articles were reviewed, and 18 articles were included and thematically analysed. The themes identified include definitions, role, stages, processes, platforms, evaluation, and relationships in e-mentoring.

Discussion & Conclusion

The themes identified provide a clinically relevant definition of e-mentoring, and in highlighting the similarities in the phases of novice and e-mentoring reaffirms the validity of a blended approach as a means of addressing shortfalls in mentoring in medicine.

Word count 231

Keywords: blended mentoring; e-mentoring; mentoring; medical education; mentoring framework; mentoring relationship; online mentoring

Introduction

Mentoring enhances the professional, academic, research, and personal development of mentors and mentees, improves patient outcomes, and boosts the reputations of the organizations that host these programs (Alleyne et al., 2009; Andre et al., 2017; Buddeberg-Fischer et al., 2004; Bussey-Jones et al., 2006; Chen et al., 2016a; Files et al., 2008; Fleming et al., 2015; Kashiwagi et al., 2013; Lewellen-Williams et al., 2006; Loo, 2017; Lord et al., 2012; Pololi et al., 2015; Pololi et al., 2002; Singh et al., 2014; Sng et al., 2017; Tan et al., 2017; Toh, 2017; Wahab et al., 2017; Welch et al., 2012; Wu et al., 2016; Yeam, 2016). However shortages of trained and experienced mentors (Bussey-Jones et al., 2006; Pololi et al., 2015; Tan et al., 2017), limited resources and competing demands upon mentors jeopardize mentoring's role in medical education (Alleyne et al., 2009; Andre et al., 2017; Chen et al., 2016b; Files et al., 2008; Pololi et al., 2015). Particularly sensitive to these limitations has been novice mentoring, the dominant form of mentoring in medicine (Low et al., 2018; Sng et al., 2017; Tan et al., 2018b). Defined as a *'dynamic, context-dependent, goal-sensitive, mutually beneficial relationship between an experienced clinician and junior clinicians and/or undergraduates focused upon advancing the development of the mentee'* (Hauer et al., 2005; Kashiwagi et al., 2013; Sheri et al., 2019; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018a; Toh, 2017; White et al., 2009; Wu et al., 2016) novice mentoring pivots upon the development of personable and enduring relationships which in turn is reliant upon holistic, accessible, longitudinal interactions with the mentor that are nurtured through personalised, appropriate, specific, timely and holistic mentoring support (Sng et al., 2017).

With mentoring interactions restricted and mentoring support limited, e-mentoring is increasingly proposed as a means of circumventing some of obstacles faced by novice mentoring (Aronoff et al., 2010; Jaffer et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010). Though defined as *'a computer mediated, mutually beneficial relationship*

between a mentor and a protege´ which provides learning, advising, encouraging, promoting, and modelling, that is often boundaryless, egalitarian, and qualitatively different than face-to-face mentoring´, e-mentoring remains poorly understood (Bierema & Merriam, 2002). These gaps have been attributed to three considerations. Continued conflation of distinct mentoring approaches such as peer, near-peer, novice, mosaic, leadership and group mentoring and the mistaken intermixing of mentoring with role modelling, supervision, coaching, networking, advising and tutoring has clouded understanding of e-mentoring (Sng et al. 2017). A failure of regnant studies to account for mentoring’s evolving, entwined, context-specific, goal-sensitive, mentee-, mentor-, relationship- and host organization-dependent nature (Hauer et al., 2005; Kashiwagi et al., 2013; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018b; Toh, 2017; Wahab et al., 2017; White et al., 2009) which restricts studies of e-mentoring to programs with similar mentee and mentor populations, mentoring approaches and host organization, education and clinical systems has resulted in scant e-mentoring data (Hauer et al., 2005; Kashiwagi et al., 2013; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018b; Toh, 2017; Wahab et al., 2017; White et al., 2009). Concurrently, continued reliance upon self-rated scales (Pfund et al., 2014) and tools that remain rooted in “*Cartesian reductionism and Newtonian principles of linearity*” (Mennin, 2010) neglect the diverse influences of the mentee, the mentor, the host organization and the wider stakeholders upon the wider mentoring process. The lack of holistic and longitudinal assessment tools (Mennin, 2010) further compounds prevailing failures to consider mentoring’s entwined nature, limits available data on e-mentoring and underscores the need for holistic and longitudinal e-mentoring studies (Sheri et al, 2019).

The need for this review

In the absence of clear definitions of e-mentoring (Griffiths & Miller, 2005; Hunter et al., 2008; Schichtel, 2010) or effective characterizations of the various stages of the e-mentoring approach and relationships that underpins its success it is evident that scrutiny of e-mentoring is warranted (Butterworth et al., 2011; Weiner et al., 2014) particularly in light of increasing concerns over the potential abuse of mentoring relationships (Byerley, 2018; Chopra et al., 2016; Duck, 1994; Long, 1997; Pfund et al., 2015; Singh & Singh, 2018; Soklaridis et al., 2018; Walensky et al., 2018). This is especially so when assessments of e-mentoring relationships and oversight of e-mentoring programs remain poorly detailed (Sng et al., 2017; Tan et al., 2017; Tan et al., 2018b; Toh, 2017; Wahab et al., 2017). Gaps in understanding how e-mentoring circumnavigates the lack of nonverbal communication (Griffiths & Miller, 2005; Hunter et al., 2008; Pillon & Osmun, 2013; Schichtel, 2010) and the impact of its use of discontinuous interactions (Butterworth et al., 2011; Griffiths & Miller, 2005) to facilitate rapport between mentee and mentors (Griffiths & Miller, 2005; Pillon & Osmun, 2013), merely emphasises the need for a better understanding of e-mentoring as an adjunct to ‘traditional’ face-to-face mentoring (Luckhaupt et al., 2005).

A systematic scoping review of e-mentoring (Arksey & O'Malley, 2005; Grant & Booth, 2009; Lorenzetti & Powelson, 2015; Mays & Roberts, 2001; Thomas et al., 2014) is proposed to explore the potential size and scope of available literature on e-mentoring in published peer-reviewed and prevailing grey literature.

Methods

A systematic scoping review of undergraduate and postgraduate medical school training, and to postgraduate training in specialities that are a part of Internal Medicine as delineated by the

American College of Physicians (American College of Physicians, 2018) was carried out. A systematic scoping review was considered appropriate given the paucity of relevant literature and given the wide range of program designs, e-mentoring approaches, study designs and methodologies used to study and report on e-mentoring (Pham et al., 2014; Schwerdtle et al., 2017). A systematic scoping review was also useful to map “*the key concepts underpinning a research area and the main sources and types of evidence available*” (Mays et al., 2001) to “*produce a profile of the existing literature in a topic area, creating a rich database of literature that can serve as a foundation*” to inform practice and guide further research (Daudt et al., 2013; Gagliardi et al., 2014; Grant & Booth, 2009; Pham et al., 2014).

The research questions addressed in this scoping review were: 1) “What is known about e-mentoring in the context of novice mentoring?”. Focus upon e-mentoring in the context of novice mentoring was in acknowledgement of the diverse forms of e-mentoring available and acceptance that not all forms of e-mentoring would be applicable as an adjuvant to novice mentoring (blended approach). The other research questions include 2) How are blended mentoring programs structured and delivered?; 3) To what extent, and in what ways, have blended mentoring programs been evaluated?; 4) what are the research gaps in the context of blended mentoring?

Levac et al’s (2010) and Arksey and O’Malley’s (2005) framework is employed to guide the systematic scoping review (Arksey & O’Malley, 2005; Grant & Booth, 2009; Lorenzetti & Powelson, 2015; Mays & Roberts, 2001; Thomas et al., 2014). The six steps proposed by Levac et al (2010) and Arksey and O’Malley (2005) are used to organise the approach and results (Arksey & O’Malley, 2005; O’Brien, 2010; Mays & Roberts, 2001; Thomas et al., 2014).

Confining the focus of this review to specialities associated with Internal Medicine as delineated by the American College of Physicians (American College of Physicians, 2018) and to e-mentoring within the novice mentoring context helps circumnavigate the limitations posed by mentoring's nature (Sheri et al., 2019; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018a; Toh, 2017; Wahab et al., 2017; Wu et al., 2016).

Stage 1: Identifying the research question

Motivated by the wish to better understand the e-mentoring process and provide practical guidance to mentors, mentees, program designers and administrators, on the potential use of e-mentoring as an adjuvant for novice mentoring, the 7 member research team (CJY, CAH, YR, LWQ, YPT, SM, LK) discussed the prevailing concerns and gaps in e-mentoring with medical librarians from the medical library at the Yong Loo Lin School of Medicine (YLLSoM) at the National University of Singapore and at the National Cancer Centre Singapore (NCCS) and local educational experts and clinicians at the NCCS, the Palliative Care Institute Liverpool, YLLSoM and Duke-NUS Medical School. With their guidance the research team determined the research question. A PICOS format to study mentoring programs (Table 1).

The detailed search strategy for PubMed is included in Appendix 1.

[Insert Table 1]

Stage 2: Identifying relevant studies

Focusing upon Bierema and Merriam (2002)'s definition of e-mentoring as '*a computer mediated, mutually beneficial relationship between a mentor and a protege' which provides learning, advising, encouraging, promoting, and modelling, that is often boundaryless,*

egalitarian, and qualitatively different than face-to face mentoring' helps differentiate e-mentoring from novice, leadership, personal, mosaic, mixed, peer, near-peer, group, family, patient and research mentoring as well as supervision, coaching, preceptorship, advising, networking and role modelling which have specific goals and approaches in medical education.

This review confines itself to accounts of mentoring after the year 2000 given data suggesting articles published before 2000 tended to conflate mentoring approaches (Low et al., 2018; Sambunjak et al., 2010; Sheri et al., 2019; Wahab et al., 2017) with other approaches. Articles on mentoring published before 2000 were also unlikely to describe the mentoring approaches they studied and fail to account for mentoring's nature in their assessments and analysis (Low et al., 2018; Sambunjak et al., 2010; Sheri et al., 2019; Wahab et al., 2017). Only articles published in English, or had English translations, between 1 January 2000 and 31 December 2017 were included.

Guided by librarians at the Medical Libraries at YLLSoM and NCCS and by local educational experts and clinicians at NCCS, the Palliative Care Institute Liverpool, YLLSoM and Duke-NUS Medical School, the 7 members of the research team determined the inclusion and exclusion criteria of the review and carried out independent searches of ERIC, Embase, PubMed, Cochrane Database of Systematic Reviews, Google Scholar, Web of Science, Mednar, EBSCO, and OpenGrey databases. The searches were carried out using between 17th January 2018 and 24th April 2018. The broad scope of the research question meant that pilot searches were carried out on variations of the word 'e-mentoring' that appeared in the title or abstract of articles in specialities associated with Internal Medicine as delineated by the American College of Physicians (American College of Physicians, 2018).

Stage 3: Selecting studies to be included

Pilot searches of GreyLit and PubMed databases were carried out using variations of the word ‘e-mentor’ that appeared in the title or abstract of articles. Five members of the research team (CJY, CAH, YR, LWQ, YPT) led by the senior researcher (LK) independently read through the abstracts of all the articles identified in the pilot search and sought to identify those publications on ‘e-mentoring’ that were sited or involved novice mentoring. Whilst novice mentoring has been defined, the term is relatively new and acknowledging that this form of mentoring is frequently conflated with other forms of mentoring, the search terms were cast wide and the title searches were accompanied by an abstract search. This additional aspect to the search process was adopted to meet the specific inclusion criteria adopted given that conventional searches were fairly restricted (Sheri et al., 2019; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018a; Toh, 2017; Wahab et al., 2017; Wu et al., 2016). This consideration was included in tandem with the other inclusion and exclusion criteria to create an abstract screening tool.

This abstract screen tool was used on the results of the pilot searches. Having discussed the individual results of their pilot searches online and at face-to-face reviewers’ meetings, the seven members of the research team reviewed the search terms and the abstract screen tool. Sambunjak et al.’s (2010) “negotiated consensual validation” approach (Sambunjak et al., 2010) was applied to achieve consensus on the inclusion/exclusion criteria, the search terms and the abstract screening tool for the search. Aside from improving reliability between reviewers (Tricco et al., 2016), the process facilitated discussions and agreement that all research methodologies (quantitative and qualitative) would be included.

The finalised search strategy included the keywords: ‘e-mentor’, ‘blended mentoring’, AND ‘Internal Medicine’ and their combinations and used in all databases. The same keywords were used for all the databases. All allied health specialties (e.g. dietetics, nursing, psychology, chiropractic, midwifery, social work) and non-medical professions (e.g. science, veterinary,

dentistry) were excluded. E-mentoring in peer, near peer, group, patient, family, youth, leadership, mixed and mosaic mentoring, role modelling, coaching, supervision, networking and/or advising were excluded in acknowledgment of specificity of the e-mentoring approach within a novice mentoring process and in recognition of mentoring's nature.

Guided by the senior reviewers (SM and LK), 5 members of the research team adopted similar search strategies to carry out independent searches of the rest of the agreed upon databases. All searches were carried out between the 24th April 2018 and the 12th September 2018. Using the abstract screen tool, titles and abstracts of the papers were independently reviewed by each member of the research team. To ensure concordance and consistency in the search approach, each author examined the same 50 titles and abstracts using the same search terms, database and the abstract screening tool and compared their results in online discussions with all the team members. Having calibrated their identification of publications, the 5 reviewers proceeded to carry out their independent searches of the remaining databases. The 5 members of the research team used Sambunjak et al.'s (2010) "negotiated consensual validation" approach (Sambunjak et al., 2010) to achieve consensus on the final list of articles to be included in this systematic scoping review.

All the articles from the final list to be included articles were then downloaded and imported into EndNote to be reviewed independently by all the members of the review team. Each reviewer created individual lists of full-text articles to be studied. The individual lists were discussed at research team meetings which involved all seven members of the research team where Sambunjak et al.'s (2010) approach of 'negotiated consensual validation' (Sambunjak et al., 2010) was used to reach consensus on a final list of full-text articles to be studied.

Stage 4: Data characterization and analysis

In the absence of an *a priori* framework for mentoring, a prevailing lack of understanding of e-mentoring processes and in the presence of diverse research methodologies that prevent statistical pooling and analysis, the team members opted to use Braun & Clarke's (2006) approach to thematic analyses (Sheri et al., 2019; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018a; Toh, 2017; Wahab et al., 2017; Wu et al., 2016). Braun & Clarke's (2006) approach has been widely used in the study of mentoring processes and helps circumvent the restrictions posed by mentoring's nature that limits comparisons of research findings to mentoring programs with similar mentee and mentor populations and clinical, healthcare, educational, healthcare financing and cultural settings (Sheri et al., 2019; Sng et al., 2017; Tan et al., 2017; Tan et al., 2018a; Toh, 2017; Wahab et al., 2017; Wu et al., 2016).

Analysis of the transcripts

Three reviewers (CJY, CAH, YR) led by the senior mentor (LK) and near-peer mentor (YPT) who are experienced in the use of Braun and Clarke's approach to thematic analysis carried out independent analyses of the included articles.

In keeping with the first phase of Braun and Clarke's approach, an iterative step-by-step thematic analysis was carried out with the first 10 included articles. The five reviewers (CJY, CAH, YR, YPT and LK) 'actively' read the included articles to find meaning and patterns in the data.

Next, the reviewers constructed 'codes' which Braun and Clarke (2007) describe as a "*feature of the data (semantic content or latent) that appears interesting to the analyst, and refer to 'the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon'*" from the 'surface' meaning of the mentee's

responses contained within first 10 included articles (Boyatzis, 1998; Braun et al., 2006; Sawatsky et al., 2016; Voloch et al., 2007). An Excel form was used to capture the initial codes and notes that explained what the codes were and the reviewers' thoughts about them. The initial codes from 'open coding' were then grouped into categories according to their similarities.

In the third phase categories were organised into themes which Braun and Clarke (2007) describe as "*something important about the data... and represents some level of patterned response or meaning within the data set*". Mind maps were used to illustrate the links between the various codes and to help delineate themes. An inductive approach allowed themes to be "*defined from the raw data without any predetermined classification*" (Cassol et al., 2018).

Each reviewer reviewed and refined their themes between 3 to 5 times to ensure they were coherent and representative of the whole data set. In the fifth phase of Braun and Clarke's (2007) approach, the reviewers continued to work independently naming and delineating the specific characteristics of each theme. Once the themes were established, they were discussed online and at face-to-face meetings to agree upon a common coding framework and code book. The code book (Chesang et al., 2017) consisted of the codes, sub-themes, definitions, descriptions of terms and guidelines on when to use and when not to apply.

In using the code book to code and analyses the rest of the transcripts, the reviewers maintained an iterative approach to the analysis and grouped the 'detail rich' codes together to identify larger inclusive concepts. As new codes emerged (Price & Schofield, 2015), the codes and the larger inclusive concepts were collapsed into themes and subthemes (Ordons et al., 2016). The reviewers reported no new themes after review of 15 full text articles. The coding framework and code book were reviewed as part of the iterative process employed by this study.

The senior reviewer (SM) analyzed each code for consistency and accuracy (Ordons et al., 2016).

The themes identified by each reviewer were discussed online and at face-to-face meetings to ensure that the themes accurately reflected accounts of e-mentoring (Braun et al., 2006; Stenfors-Hayes et al., 2010). A final list of themes and subthemes was achieved using the “negotiated consensual validation” approach. The final list of themes and subthemes were reviewed once more by the senior reviewer (SM).

Validity and reliability of the analysis

For the purposes of triangulation, the analysis was carried out by 7 independent reviewers and their coding and thematic analysis was discussed in online and face-to-face meetings and independently reviewed by an experienced senior reviewer (SM) well versed in the topic at hand and in the use of Braun and Clark’s approach to thematic analysis. To further ensure theoretical validation the results of the analysis was compared with prevailing data. An iterative process was employed which meant that any new codes identified meant that all the transcripts were reviewed to verify the classification and ensure complete data extraction.

Stage 5: Collating, summarizing and reporting results

6557 abstracts were identified, 109 full text articles were reviewed, 18 full text were included (Figure 1).

[Insert Figure 1]

The review narrative follows the Best Evidence Medical Education (BEME) Collaboration guide (Haig & Dozier, 2003) and STORIES (Structured approach to the Reporting In healthcare education of Evidence Synthesis) statement (Gordon & Gibbs, 2014).

Quality Assessment of Studies

Although not commonly associated with systematic scoping reviews, all included articles underwent quality assessment using Consolidated Criteria for Reporting Qualitative Research (COREQ) for qualitative articles and Medical Education Research Quality Instrument (MERSQI) for quantitative studies (Appendix 2).

Results

Thematic analysis of the 11 program reviews, 4 commentaries and 2 systematic reviews and 1 survey analysis included revealed 5 themes including characterization, role, process, platform, evaluation and relationships and blended approach. We will discuss each theme in turn.

A. Characterization of e-mentoring within a blended approach

Only 4 out of 18 papers defined e-mentoring (Griffiths & Miller, 2005; Obura et al., 2011; Pillon & Osmun, 2013; Schichtel, 2010). Three papers (Griffiths & Miller, 2005; Pillon & Osmun, 2013; Schichtel, 2010) adopted Bierema and Merriam's (2002) definition of e-mentoring whilst 12 articles described the e-mentoring approach that had been employed (Anshu et al., 2010; Aronoff et al., 2010; Butterworth et al., 2011; Chang et al., 2012; Chu et al., 2013; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Obura et al., 2011; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al.,

2014). Thematic analysis of prevailing definitions and descriptions of e-mentoring revealed a number of consistent elements within prevailing practices (Table 2). These features suggest that e-mentoring is an adaptable electronically mediated process that can be scaled to fit the needs of the mentees, mentors and host organizations and is unencumbered by time and geographical restrictions (Pillon & Osmun, 2013; Schichtel, 2010; Walsh, 2016). The process is personalised, mutually beneficial and asynchronous nurturing mentoring relationships and complementing face-to-face mentoring approaches (Aronoff et al., 2010; Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Kim et al., 2013; Luckhaupt et al., 2005; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al., 2014).

[Insert Table 2]

B. *The role of e-mentoring*

E-mentoring reduces costs (Jaffer et al., 2013; Pillon & Osmun, 2013; Schichtel, 2010; Walsh, 2016), provides additional (Jaffer et al., 2013; Perlman et al., 2014; Walsh, 2016), and timely support (Aronoff et al., 2010; Chang et al., 2012; Griffiths & Miller, 2005; Jaffer et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al., 2014) and the opportunity for privacy and honest discussions on sensitive issues (Schichtel, 2010). E-mentoring also enhance knowledge assimilation, facilitate the formation of social support and nurture bonds and collaborative learning (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010)

C. *Goals of e-mentoring*

Eleven articles used e-mentoring to support clinical skills training (Butterworth et al., 2011; Chang et al., 2012; Chu et al., 2013; Griffiths & Miller, 2005; Guse et al., 2016; Hunter et al., 2008; Jaffer et al., 2013; Obura et al., 2011; Pillon & Osmun, 2013; Schichtel, 2010; Spickard et al., 2016), 5 articles employed e-mentoring for personal and academic support (Anshu et al., 2010; Aronoff et al., 2010; Guse et al., 2016; Perlman et al., 2014; Spickard et al., 2016) and in 4 articles e-mentoring provided career support and networking opportunities (Griffiths & Miller, 2005; Guse et al., 2016; Kim et al., 2013; Weiner et al., 2014) (Table 3). Most programs had more than one goal.

[Insert Table 3]

D. Preparation for e-mentoring

Preparation for e-mentoring entails the selection and preparatory phases

i. Selection

E-mentee selection: Eligibility for e-mentoring programs depends upon the goals of the e-mentoring process and the mentee's goals (Butterworth et al., 2011; Chang et al., 2012; Chu et al., 2013; Hunter et al., 2008; Obura et al., 2011; Pillon & Osmun, 2013; Schichtel, 2010). Motivation is a significant consideration for recruitment given that motivated mentees are more likely to invest and produce successful mentoring relationships (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010).

E-mentors selection: E-mentors were senior and experienced faculty members (Aronoff et al., 2010; Butterworth et al., 2011; Chu et al., 2013; Griffiths & Miller, 2005; Hunter et al.,

2008; Jaffer et al., 2013; Kim et al., 2013; Obura et al., 2011; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al., 2014).

ii. Preparatory phase

The preparatory phase consists of mentor training and selection of the e-mentoring platform.

Mentor training: E-mentor training provides preparation on the use of the electronic platforms used in the program (Griffiths & Miller, 2005; Perlman et al., 2014; Schichtel, 2010; Walsh, 2016), how to align mentee expectations (Anshu et al., 2010; Jaffer et al., 2013; Schichtel, 2010), and supplement other educational programs and training initiatives (Aronoff et al., 2010; Chu et al., 2013; Perlman et al., 2014), provide feedback (Jaffer et al., 2013) and use of reflective practice (Perlman et al., 2014). The content of structured mentoring training varies depending upon the mentoring goals (Aronoff et al., 2010; Pillon & Osmun, 2013). Flexibility within mentor training programs allows mentors to determine the training topics to better meet their training needs. Amongst these topics include online skills and competencies (Griffiths & Miller, 2005; Perlman et al., 2014; Schichtel, 2010; Walsh, 2016), communication and cognitive training, social and cultural teaching and leadership and managerial skills (Aronoff et al., 2010; Chu et al., 2013; Perlman et al., 2014; Schichtel, 2010). The duration and frequency of these programs are unclear.

E-mentoring platforms: E-mentoring maybe carried out via email, telephone calls (Hunter et al., 2008; Kim et al., 2013), learning management server (Spickard et al., 2016), video conferencing (Griffiths & Miller, 2005; Jaffer et al., 2013; Kim et al., 2013; Pillon & Osmun, 2013; Schichtel, 2010; Walsh, 2016), point of care tools (Butterworth et al., 2011; Chang et al., 2012) and 3D virtual world (Jaffer et al., 2013). In some cases e-mentoring may

involve more than one platform (Griffiths & Miller, 2005; Jaffer et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010).

[Insert Table 4]

- (1) Learning Management server: Learning management server (LMS) is an online, comprehensive (Chu et al., 2013), software platform that contains preloaded videos, lecture series, simulation, demonstrations, video conferencing capabilities (Chu et al., 2013), quizzes (Chu et al., 2013; Perlman et al., 2014) and both group (Anshu et al., 2010; Chu et al., 2013; Jaffer et al., 2013) and individual messaging platforms designed for use in e-mentoring programs. The LMS can be customised or adapted to suit individual or program requirements (Spickard et al., 2016) and allows curriculum material to be referenced.
- (2) Multi-media: All 5 programs that use email (Griffiths & Miller, 2005; Hunter et al., 2008; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013) do so in tandem with other forms of communication including phone (Hunter et al., 2008; Kim et al., 2013) and video conferencing (Griffiths & Miller, 2005; Pillon & Osmun, 2013; Walsh, 2016). All programs that utilised multiple communication platforms involved e-mentoring relationships between one mentor and one mentee.

Increasing access to computers, internet connections, software such as Skype and learning management systems e-mentoring has been found to be cheaper than other forms of mentoring (Chang et al., 2012; Jaffer et al., 2013; Obura et al., 2011; Pillon & Osmun, 2013). However this leaves e-mentoring programs heavily reliant upon host organizations for technical and administrative support (Weiner et al., 2014).

E. Matching

Three programs discussed pairing mentors to mentees (matching) (Guse et al., 2016; Kim et al., 2013; Weiner et al., 2014). In an undergraduate context, matching involved online databases where students could search for mentors based on specialty, type of work, mentoring preferences and personal interests (Weiner et al., 2014). In a postgraduate setting, mentees sought out mentors by accessing social networks (Kim et al., 2013). In mentee initiated e-mentoring relationships focus was upon building rapport with a mentor with shared opinions and complementary characteristics (Butterworth et al., 2011; Guse et al., 2016; Kim et al., 2013; Weiner et al., 2014). Mentee initiated mentoring relationships tend to be guided by recommendations from colleagues and friends or previous interactions with the mentor (Kim et al., 2013; Schichtel, 2010).

Matching in formal e-mentoring programs where the host organization matches the mentor to the mentee, (Aronoff et al., 2010; Perlman et al., 2014; Pillon & Osmun, 2013), was based on similar goals, shared values, interests and beliefs (Guse et al., 2016; Kim et al., 2013; Schichtel, 2010; Weiner et al., 2014) and the mentor's availability and commitment (Guse et al., 2016; Kim et al., 2013; Weiner et al., 2014).

Whilst shared online profiles and matching preferences that take into account mentee and mentor interests and expertise are seen to be helpful, face-to-face meetings are still preferred (Guse et al., 2016). Guse et al. (2016) suggests that face-to-face meetings provide a chance to build rapport and successful matches.

F. E-mentoring Relationships

Mentoring relationships are critical to the success of an e-mentoring programs (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Schichtel, 2010). E-mentoring relationships evolve over the course of the mentoring program (Kim et al., 2013) and are

dependent upon the nature and frequency of interactions between mentee and mentor (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Schichtel, 2010).

a. Frequency of meetings

The frequency of meetings vary, from weekly (Butterworth et al., 2011) to monthly (Chu et al., 2013; Kim et al., 2013; Obura et al., 2011) depending on the goals and stage of the mentoring process and the state of mentoring relations. In the initial stages, e-mentoring meetings were more frequent in order to build trust and rapport (Obura et al., 2011). Once established, meetings became less frequent (Schichtel, 2010). The optimum frequency, format and duration of these meetings were not stipulated.

b. Nature of interactions

The nature of interactions affects e-mentoring relationships and is determined by the mentoring approach and environment (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Kim et al., 2013; Schichtel, 2010). Building effective relationships is dependent upon open and frank discussions, active listening, holistic appreciation of the mentee's issues, goals and situation and the provision of timely and appropriate support (Kim et al., 2013). Increased engagement builds personal ties, motivates mentees and enhances cooperation (Butterworth et al., 2011).

The mentor's role is to support and moderate discussions and interactions (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010). Mentors also advance mentoring goals such as the provision of academic support and knowledge transfer (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010) which in turn help motivate mentees (Pillon & Osmun, 2013).

Successful e-mentoring relationships pivot on trust developed in a supportive e-mentoring environment (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Kim et al., 2013; Schichtel, 2010). This trusting environment promotes learning and bonding (Schichtel, 2010) and facilitates sharing and open discussions without fear of judgement (Hunter et al., 2008; Kim et al., 2013) and helps motivate both parties (Kim et al., 2013).

Influencing the e-mentoring environment and the e-mentoring relationship is the mentoring approach, which may be formal or informal and the roles of mentees and mentors (Hunter et al., 2008; Pillon & Osmun, 2013; Schichtel, 2010). Communications between mentees and mentors in a formal program tend to be more instructional and reflect a hierarchical setting (Pillon & Osmun, 2013; Schichtel, 2010). Interactions in informal mentoring that takes place outside the formal curriculum (Pillon & Osmun, 2013; Schichtel, 2010) tend to include humour through emojis (Chang et al., 2012), an attenuation in the sense of hierarchy, facilitation of more conversational and multidirectional interactions and setting the tone for the discussions and promoting social bonding and participation (Hunter et al., 2008).

G. Blended approach

Concerned over the lack of nonverbal communication (Griffiths & Miller, 2005; Hunter et al., 2008; Luckhaupt et al., 2005; Pillon & Osmun, 2013; Schichtel, 2010; Walsh, 2016), discontinuous interactions (Butterworth et al., 2011; Griffiths & Miller, 2005; Luckhaupt et al., 2005) and apparent difficulties in building rapport online (Griffiths & Miller, 2005; Pillon & Osmun, 2013; Walsh, 2016) associated with *purely* e-mentoring approaches, e-mentoring is increasingly used in tandem with other forms of mentoring (Kim et al., 2013; Luckhaupt et al., 2005; Schichtel, 2010). However these blended approaches pivot upon complementing each

other's approaches and mitigating each other's shortcomings in order to enhance the overall mentoring experience (Aronoff et al., 2010; Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Kim et al., 2013; Luckhaupt et al., 2005; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al., 2014). With each mentoring approach having its particular strengths and weaknesses, not all mentoring approaches can be used in tandem with e-mentoring (Kim et al., 2013; Luckhaupt et al., 2005; Schichtel, 2010). In addition a blended approach may only be used at certain stages of the mentoring process, or to meet specific goals and roles (Kim et al., 2013; Luckhaupt et al., 2005; Schichtel, 2010).

Twelve articles used e-mentoring to complement novice mentoring (blended approach) (Aronoff et al., 2010; Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Kim et al., 2013; Luckhaupt et al., 2005; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Spickard et al., 2016; Walsh, 2016; Weiner et al., 2014) and improve competency (Griffiths & Miller, 2005; Schichtel, 2010), sustain longer-term relationships, overcome geographical obstacles and provide access to mentoring support (Pillon & Osmun, 2013; Schichtel, 2010; Walsh, 2016), promote asynchronous learning, facilitate time for reflections and boost confidentiality, anonymity and timely support (Griffiths & Miller, 2005).

Blended mentoring programs can last between six months to more than a year, with meetings occurring on a weekly or monthly basis depending upon individual preferences (Butterworth et al., 2011; Chu et al., 2013; Kim et al., 2013). Each session lasting between 30 minutes to four hours (Butterworth et al., 2011; Chu et al., 2013; Kim et al., 2013).

There are different ways in which blended mentoring is carried out. The electronic platform can be utilized as the main mentoring platform where discussions are held or assignments are submitted. Here face-to-face meetings complement the process by fostering better rapport in the introductory phase (Aronoff et al., 2010; Pillon & Osmun, 2013) or share

feedback or tie up loose ends (Aronoff et al., 2010; Hunter et al., 2008; Perlman et al., 2014). Alternatively, mentoring programmes can make use of the electronic platforms to supplement its processes (Weiner et al., 2014).

Five articles (Chang et al., 2012; Griffiths & Miller, 2005; Jaffer et al., 2013; Schichtel, 2010; Spickard et al., 2016) discussed a combination of group e-mentoring and novice mentoring. Anshu et al. (2010), Griffiths & Miller (2005) and Obura et al. (2011) describe blended group e-mentoring as an e-mentoring approach where peer and/or near-peer mentees collaborate and support each other through e-mentoring.

H. *Evaluating e-mentoring*

Evaluations of e-mentoring programs take the form of surveys (Weiner et al., 2014), and studies that compare outcomes with peers who did not attend e-mentoring programs (Chang et al., 2012; Chu et al., 2013). The outcome measures adopted include the frequency of interaction between mentor and mentee (Anshu et al., 2010; Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Schichtel, 2010), the utility of the platform (Chang et al., 2012), mentee satisfaction, self-rated improvements in confidence (Chu et al., 2013; Hunter et al., 2008), motivation (Chu et al., 2013; Hunter et al., 2008), connectedness (Chu et al., 2013; Obura et al., 2011), and content knowledge (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010). Some programs evaluated increased content knowledge (Aronoff et al., 2010; Butterworth et al., 2011), clinical performance and competency (Hunter et al., 2008), readiness for residency (Chu et al., 2013) and change in practice (Obura et al., 2011). Also appraised is the presence of open and frank discussions, active listening, holistic appreciation of the mentee's issues, goals and situation and the provision of timely and appropriate support

(Kim et al., 2013). However despite being multi-faceted and evolving over the course of the mentoring program (Kim et al., 2013) e-mentoring relationships are often assessed at single time points and rarely holistically.

Discussion

This offers a clinically relevant sketch of blended mentoring approaches that will be of interests to program designers and administrators and mentors and mentees alike. Evidence presented by this systematic scoping review not only suggests that an e-mentoring approach is a distinct mentoring approach but one that is sufficiently complementary to novice mentoring to be used effectively within a blended approach. Overall data from this systematic scoping review suggests that an e-mentoring approach can enhance the mentoring experiences, support and outcomes of a novice mentoring program. Increased interactions provided by e-mentoring also help nurture better oversight of mentees and provide an additional means of overseeing individual mentoring relationships at a time when mentoring is increasingly under the microscope for potential abuse of mentoring processes and relationships (Byerley, 2018; Chopra et al., 2016; Duck, 1994; Long, 1997; Singh & Singh, 2018; Soklaridis et al., 2018; Walensky et al., 2018).

The definition of e-mentoring forwarded here and the new insights into the goals, roles, stages of the e-mentoring process including the preparatory and matching phases and the development and evaluation of blended program will also help the design of similar programs.

A. Definition

As an adjuvant to novice mentoring a blended e-mentoring approach may be defined as a

personalised, internet or electronically mediated approach that is largely used to complement face-to-face mentoring to provide personalised, appropriate, specific, timely, holistic, accessible and longitudinal mentoring support to build mutually beneficial mentoring relationships between the host organization, a senior mentor and an individual mentee. Working within the confines of prevailing professional codes of conduct and standards of practice this approach is focused upon realizing the goals and needs of the mentee, the mentor, the host organization that supports and oversees the program and their relationships. Its asynchronous nature also nurtures reflective practices that helps develop deeper mentoring relationships.

Building upon Bierema and Merriam's (2002) definition, this characterization of e-mentoring is not confined to computer mediated options but embraces the use of hand-held devices, other electronic or internet mediated platforms and email and text messaging albeit under the aegis and oversight of prevailing guidelines and codes of conduct. It also underscores the importance of host organization in overseeing and supporting an e-mentoring approach.

B. The nature of e-mentoring relationships

E-mentoring relationships change over time as evidenced by increased frequency of communications between mentees and mentors (Butterworth et al., 2011; Chu et al., 2013; Kim et al., 2013; Obura et al., 2011). This highlights the evolving nature of mentoring relationships and also underlines the influence of the mentee, mentor and the relationship upon the e-mentoring process within a novice mentoring program (Aronoff et al., 2010; Butterworth et al., 2011; Chu et al., 2013; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Obura et al., 2011; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al., 2014). E-mentoring relationships are also guided by the goals and needs of the

host organization highlighting the influence of the host organization and curricula upon the mentoring process (Aronoff et al., 2010; Butterworth et al., 2011; Chu et al., 2013; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Obura et al., 2011; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010; Weiner et al., 2014). The pivotal role of the host organization is also evident from its role in providing technical and IT support for the mentoring platform used, its influence upon the selection, matching and training of mentees and mentors, its oversight of the mentoring process and its evaluation and auditing of the mentoring program itself (Perlman et al., 2014; Schichtel, 2010). The culture of the host organization also influences the nurturing of an e-mentoring environment and the development of e-mentoring relationships (Chang et al., 2012; Jaffer et al., 2013; Obura et al., 2011; Pillon & Osmun, 2013).

The presence of these diverse influences upon the e-mentoring process reaffirms e-mentoring's context-specific, goal-sensitive, mentee-, mentor-, host organization, relationship-dependent nature. Understanding e-mentoring's nature also serves to validate the decision to focus upon novice mentoring approach as a partner to e-mentoring approach in a blended mentoring program. It is reassuring that the similarities between the nature of e-mentoring and that of novice mentoring suggest that a blended approach involving e-mentoring and novice mentoring would be viable (Sng et al., 2017; Tan et al., 2018b).

[Insert Table 5]

C. Implementing a blended approach

Commonalities in the preparatory and matching phases, mentoring relationships and oversight of an e-mentoring suggest a basis for an effective blended approach. The benefits of a blended approach will be especially timely as novice mentoring programs struggle in rapidly evolving medical education, academic, research and clinical fields.

Data from this review suggests that an effective blended approach pivots upon the host organization meeting five critical roles. One, it is suggested that the host organization must establish clear guidelines, standards of practice, codes of conduct and well delineated roles, responsibilities and expectations upon host organizations, mentees and mentors (Butterworth et al., 2011; Griffiths & Miller, 2005; Hunter et al., 2008; Jaffer et al., 2013; Kim et al., 2013; Perlman et al., 2014; Pillon & Osmun, 2013; Schichtel, 2010). In the absence of such frameworks in e-mentoring programs and based on the similarities with novice mentoring it ought to be feasible to extrapolate frameworks, guidelines and codes of conduct from the better established novice mentoring setting (Sng et al 2018; Tan et al 2018; Sheri et al., 2019). Practically however limited oversight of mentoring interactions in ‘real time’ and poor general oversight of the mentoring process primarily as a result of a lack of effective assessment methods gives reason for worry (Sheri et al., 2019).

Whilst host organizations are charged with the design a longitudinal and holistic assessment approach that will better inform the program designers and administrators of the needs of the mentees, the mentors and their relationships (Kim et al., 2013), such tools have not been validated (Sheri et al., 2019). This gap may be a cause to pause efforts to roll out a blended mentoring approach particularly at a time when mentoring as a whole is subject to concerns over abuse of mentoring relationships (Byerley, 2018; Chopra et al., 2016; Duck, 1994; Long, 1997; Singh & Singh, 2018; Soklaridis et al., 2018; Walensky et al., 2018). Gaps in the assessment of mentoring processes and relationships and in recruiting, guiding, vetting, matching and training mentees and mentors (Guse et al., 2016; Kim et al., 2013; Weiner et al., 2014) also raise questions as to the ability of the host organization to meet its goals of auditing mentoring programs as a whole (Sheri et al., 2019).

Five, the host organization guided by IT experts, curriculum planners, content experts and program designer as well as mentors and mentees should establish effective, accessible,

and robust mentoring, communication, assessment and feedback mechanisms and platforms (Aronoff et al., 2010; Chu et al., 2013; Perlman et al., 2014; Schichtel, 2010). Mentor and mentee training to prepare them for a blended approach, software, technical and administrative support and codes of conduct and reporting structures should also be overseen by the host organization. Here access to infrastructure and hardware raise questions of cost and the sustainability of the program particularly when the long term benefits remain unproven and poorly assessed.

Based upon this background data, we suggest an e-mentoring framework (Figure 2.) which may be used to guide the roll out of the e-mentoring programs. The e-mentoring framework requires validation however used in this sequence, this process is likely to be easily applied in various settings and context.

(Insert Figure 2 here)

Limitations

Whilst this systematic scoping review does provide the first sketch of e-mentoring's growing role in medical education, significant gaps in our understanding of e-mentoring remain which give ample reason to reconsider the viability of the blended approach. Whilst a comprehensive approach to studying prevailing accounts of e-mentoring has been carried out involving key databases, it does not fully capture the breadth of opinion and practice present as a result of omissions of articles not published in English. The continued conflation of e-mentoring with other forms of mentoring and practices such as supervision, tutoring and coaching means that significant data would have been lost as a result of our strict inclusion and exclusion criteria. Much is also lost by focus upon e-mentoring in medicine and the exclusion of other clinical practices.

As a result, it is unsurprising that the nature and development of e-mentoring relationships and how they impact one another remain poorly delineated. There is also a possibility that poor conceptions of e-mentoring and a failure to effectively study the e-mentoring relationship have led some authors to liken it, rather prematurely, to novice mentoring. Influenced by these misconceptions study findings and descriptions lead reports, descriptions and study findings to take more than a passing likeness to novice mentoring. These erroneous beliefs and prevailing gaps in effective assessment methods limit the findings of this systematic scoping review to a mere sketch of prevailing practices that provides only limited guidance to program designers, administrators, host organizations, mentees and mentors on the design, support and oversight of e-mentoring and mentoring relationships in a blended approach.

Many of the purported reasons for the use of e-mentoring remain untested and the efficacy of a potential blending with novice mentoring remains unproven. Many of the terms used in the literature search such as e-mentoring and novice mentoring, a blended approach, mentoring nature and the practices that the initial analysis focused upon are new and poorly described in the extant literature. This in turn raises further questions about the viability, potential, oversight and effectiveness of e-mentoring programs that include novice mentoring. Similarly, the purported savings in time and money by the organization has little traction when effort, time and money need to be invested in training, overseeing and mentoring e-mentors and mentees. Overlap of terms and diverse practices colour the conclusions reached as do the limited number of papers and their focus upon largely US data and practice, which may limit the applicability of these findings beyond the American setting.

Future Research

Consistencies in the mentoring approach, structure and relationships of novice mentoring and e-mentoring and well documented issues with purely e-mentoring approaches suggests a blended approach involving novice and e-mentoring would be viable so long as the prevailing gaps in understanding and assessment are addressed. To effectively operationalize such a program, there are three significant gaps to be addressed. Notwithstanding the insights provided here the nature of a blended approach, assessments of the program and nurturing and supporting mentoring relationships in blended programs and should be the focus of future studies. Much more data is needed to understand the mentoring environment within a blended approach, oversight of these programs and to anticipate the impact of interventions such as FaceTime, Google Hangouts and Skype in supplementing face-to-face mentoring.

Development of robust, holistic and longitudinal assessment tool are critical to effective and sustainable mentoring and personalized medical education and serves to improve oft-neglected issue of oversight of mentoring programs and relationships at a time when concerns about potential abuse of mentoring relationship (Byerley, 2018; Chopra et al., 2016; Duck, 1994; Long, 1997; Singh & Singh, 2018; Soklaridis et al., 2018; Walensky et al., 2018) are becoming common place.

It is only in addressing these gaps under the aegis of well-structured host organization that a blended approach can truly take its place in mainstream mentoring and advance personalized medical education.

Conflict of interest

The authors (CJY, CAH, YR, YPT, LK, SM) report no conflict of interest.

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Appendix 1

The search strategy for PubMed employed is as follows:

((("Mentors"[Mesh] OR "Mentoring"[Mesh] OR Mentor[tiab] OR mentors[tiab] OR mentorship[tiab] OR mentorships[tiab] OR mentee[tiab] OR mentees[tiab] OR mentoring[tiab] OR mentor-mentee[tiab] OR mentee-mentor[tiab] OR mentored[tiab]) AND (virtual[tiab] OR online[tiab] OR cyber[tiab] OR distance[tiab] OR "long-distance"[tiab] OR electronic[tiab] OR internet[tiab] OR web[tiab] OR blend[tiab] OR blended[tiab] OR skype[tiab] OR video[tiab] OR "Computer-assisted instruction"[MeSH] OR "Education, Distance"[MeSH] OR "Electronic mail"[MeSH] OR "Text Messaging"[MeSH] OR "social media"[MeSH] OR "Social Networking"[MeSH] or "Internet"[Mesh])) OR (e-mentor*[tiab] or ementor*[tiab] OR cybermentor*[tiab] OR telementor*[tiab] OR tele-mentor*[tiab]))

Appendix 2

References	Study Details	Intervention	MERSQI Score	COREQ Score
Anshu et al. (2010)	Qualitative Analysis, Intervention study	Participants of a medical education fellowship program conducted by the Foundation for Advancement of International Medical Education and Research (FAIMER) Regional Institute at Christian Medical College, Ludhiana (CMCL) in India interact on a listserv called the Mentoring-Learning Web (ML- Web). Monthly topics for online discussion are chosen by fellows through a standard tool called “multi-voting”. Fellows moderate sessions and direct the pace of the discussion, in which the content and process was analysed.	N.A	12

Aronoff et al. (2010)	Quantitative analysis, intervention study	3rd year medical students completed 6 online, didactic modules over the first 18 weeks, and developed questions independently from patients seen during clerkships and then retrieved and appraised relevant evidence over the next 24 weeks. Online, faculty mentors reviewed student assignments to monitor progress. Mastery of the skills of EBM was assessed prior to and at the conclusion of the course.	15.5	NA
Butterworth et al. (2011)	Quantitative and qualitative analysis, intervention study	Project participants could choose four CME modules out of seven. Eight general practitioners acted as mentors. There was a short one-half-day workshop on mentoring for those with no previous mentoring experience. Each mentor was assigned four mentees, two urban and two rural. After six months, a structured questionnaire was also sent to mentees regarding	10	11

		their experiences during the mentoring process.		
Chang et al. (2012)	Quantitative analysis, intervention study	A smartphone-based mLearning pilot project was implemented to help residents train and care for patients by providing access to medical resources and remote mentoring. Residents were provided with myTouch 3G smartphones, equipped with Android-based medical information applications, built-in camera, and data-enabled SIM card. The phones contained locally loaded point-of-care applications, including Medscape, UCentral, Skyscape, and ePocrates Rx.	13	NA
Chu et al. (2013)	Quantitative and qualitative analysis, intervention study	A 10-month e-learning program, Successful Transition to Anesthesia Residency Training (START), used as a longitudinal intervention to increase interns' self-perceived preparedness to begin anesthesiology residency training. We administered the	8	14.5

START modules to 22 interns, once a month, using an integrated learning management and lecture-capture system. We surveyed interns' self-assessed preparedness to begin anesthesiology residency before and after completing the START modules.

Griffiths & Miller (2005)	Personal view	N.A	N.A	N.A
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Guse et al. (2016)	Quantitative and qualitative analysis, intervention study	Four focus groups with mentees and mentors who participated in a mentoring speed dating event. The matching process was carried out in two stages. First, students were asked to complete an application form stating preferred main areas of research, a self-assessment of their current interest in research, and two open-ended questions about goals and mentorship expectations. Second, students met all mentors associated with their preferred area of research during a MSD session.	13	20
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			Students spent 5 minutes with each mentor and both had the chance for specific questions relevant to mentorship and their ideas of research.	
Hunter et al. (2008)	Descriptive study, qualitative analysis	N.A		N.A 14
Jaffer et al. (2013)	Systematic review	N.A		N.A N.A
Kim et al. (2012)	Commentary	N.A		N.A N.A
Luckhaupt et al. (2005)	Survey analysis	N.A		N.A 15
Obura et al. (2011)	Qualitative analysis, intervention study		A six-month e-mentoring pilot was offered to 10 Radiology residents in the Aga Khan University Postgraduate Medical Education Program in Nairobi, Kenya (AKUHN) with a Professor of Radiology, located at University of Virginia, USA, acting as the e-mentor. Monthly Internet	N.A 20

case-based teaching sessions were facilitated by the e-mentor. Residents were coached by a community facilitator to form CoL and collectively work through clinical cases at weekly face-to-face CoL sessions.

Perlman et al. (2014)	Qualitative analysis, intervention study	Three faculty development workshops in the initial pilot year of the SePAT, and one workshop in preparation for the second year. The initial workshops were designed to familiarize faculty members with ePortfolios and give them practice providing feedback, or mentoring, on the students' reflective essays. The final workshop was structured to elicit faculty perspectives on their experiences with the entire process.	N.A	15
Pillon & Osmun (2013)	Perspective paper		N.A	N.A
Schichtel (2010)	Systematic review		N.A	N.A

Spickard et al. (2016)	Qualitative analysis, intervention study	The VUSM embarked on a major curriculum reform, entitled Curriculum 2.0. In the Curriculum 2.0 model, medical students advance through the healthcare system of learning based on achievement of dynamically integrated curricular and personal goals. Mentoring program in which trained faculty, called portfolio coaches, guide students in structured reviews of the performance evidence collected in their portfolios, determination of milestone progress, and the generation of personalized learning plans.	N.A	10
Walsh (2016)	Commentary	N.A	N.A	N.A
Weiner et al. (2014)	Quantitative analysis, intervention study	Novel web-based database of faculty members who expressed interest in mentoring students at the Icahn School of Medicine (SoM) at Mount Sinai. Students are able to access faculty	7.5	N.A

profiles through an online searchable platform which facilitates personalised mentoring opportunities based on individual academic and personal needs. This initiative also permits faculty members to specify their preferences for the type of mentoring they wish to provide to students.
