Board 111: A Systematic Review of Instruments Used to Evaluate the Effectiveness of the Entering Mentoring Curriculum

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Abstract

Mentorship has been shown to significantly impact students' academic careers, research skills, productivity, mental health, and persistence in STEM fields. Recognizing this, many universities and research institutions offer faculty training programs to improve their mentoring skills and relationships. The *Entering Mentoring* training curriculum is a popular evidence-based approach used by many mentor programs. Determining the effectiveness of the *Entering Mentoring* training curriculum involves measuring a training program's results and determining whether intended outcomes have been achieved. Thus, it is essential to understand assessment tools and their appropriate usage when planning and evaluating mentorship programs. Since its introduction in 2005, the Entering Mentoring training curriculum has been evaluated using various assessment tools and approaches. This study aims to systematically review empirical studies conducted in STEM fields, including intervention and program evaluation studies using the *Entering Mentoring* training curriculum. The review seeks to identify the outcome variables that have been assessed to indicate the effectiveness of the Entering Mentoring training curriculum and the measurement instruments used to quantify those variables. Additionally, the study provides a discussion on selecting the appropriate tool based on research goals and resources. The findings of this study provide timely insights into research trends on the evaluation of the Entering Mentoring training curriculum in STEM fields.

Introduction

Effective mentorship has been linked to improving students' research skills and productivity [1-4], reducing the risk of anxiety and depression [5-7], and maintaining students' academic persistence in STEM fields [6, 8, 9]. Recognizing the enormous effect of mentoring on students' academic careers and confidence, many universities and research institutions provide training programs to faculty to enhance their mentoring skills and knowledge and strengthen mentoring relationships [10-13]. Created by a team of mentoring researchers and practitioners at the University of Wisconsin Madison, *Entering Mentoring* (EM) has been one of the widely used [14-18] mentor training curricula since 2005. It is designed to enhance the effectiveness of research mentors working with mentees in STEM disciplines. As many academic and research institutions implemented the EM curriculum in their mentoring programs, several instruments to assess the effectiveness of EM have been developed and utilized for program evaluation purposes.

From an evaluation standpoint, assessing the effectiveness of a training program and determining whether it has achieved its intended outcomes (i.e., outcome evaluation) can help determine whether the program has met its goals. The evaluation results can also provide both summative data and formative feedback, allowing program organizers to identify areas that require improvement. It is, therefore, crucial to understand the criteria for using and accessing these assessment tools when planning and evaluating mentoring programs. This research aims to identify and summarize the existing assessment instruments that are used to evaluate the effectiveness of the EM program. By examining research trends on the evaluation of the Entering Mentoring training curriculum in STEM fields, this study has the potential to contribute to the current literature and guide evaluation professionals in identifying essential outcome variables and selecting appropriate instrument tools.

The Entering Mentoring Curriculum

The Development and Deployment of the Entering Mentoring Curriculum

In 2005, a team of researchers and practitioners at the University of Wisconsin Madison (UWM) met to discuss mentoring challenges, generate case studies, and conduct an experiential seminar where a facilitator engaged a small group of students in discussions of case studies on mentoring experience. This became the basis of the first edition of the EM, a training manual for research faculty in STEM disciplines [14]. This version of the seminar was replicated at another ten research universities. A total of 22 sessions were conducted [15]. Between 2007 to 2011, the UWM faculty continued to work on adaptations of EM into nine discipline-specific mentor-training curricula. The Center for the Integration of Research, Teaching, and Learning at UW conducted field-test on all developed training materials before they were subsequently used to train research mentors across the country [16].

A multidisciplinary team from the Clinical and Translational Science Award (CTSA) - funded institutions adapted EM to train mentors in clinical and translational research in 2010. The new curriculum was published as *Mentor Training for Clinical and Translational Researchers*. Its training activities addressed six research mentor competencies: (1) maintaining

effective communication; (2) aligning expectations; (3) assessing understanding; (4) addressing diversity; (5) fostering independence; and (6) promoting professional development. The training followed the original design, which was a process-based approach. Through facilitated discussions of case studies and activities, the small group of mentors learned the six mentoring competencies, tried out different mentoring strategies, and solved mentoring challenges. The typical training format was four sessions of one to two hours of interactive discussion with facilitation over two months. The curriculum was used in mentoring training at 16 U.S. institutions between 2010 and 2011 [16].

By 2015, EM was adopted and used as a primary training curriculum at the National Research Mentoring Network (NRMN), a cooperative agreement between the National Institutes of General Medical Sciences and academic institutions. The adapted curriculum still focused on training participants in the six research mentor competencies. The training format followed the facilitated discussion approach for the in-person implementation. A typical training dose was six hours for the entire curriculum. Within two years, the NRMN implemented 72 training events for 1,427 mentors [17].

The EM curriculum was originally built to deliver in-person mode, which is still the most common implementation [18]. However, as the EM training capacity was needed to expand to a more extensive network of universities around the country, the MTC developed and tested the online implementation of EM training. In 2015, asynchronous online mentor training – *Optimizing the Practice of Mentoring* (OPM) was created as a self-paced online course for senior faculty mentors in biomedical, clinical, and translational science disciplines. EM contents were organized into five modules. It took an average of 90 minutes to complete the course. NRMN also offered synchronous online training using the EM curriculum. Mentors and the facilitator met weekly via audio and video conferencing in six sessions of a two-hour meeting. Online tools, including electronic whiteboards, chat rooms, and breakout rooms, were employed to maintain interactive learning environments [17].

The NRMN Mentor Training Core (MTC) piloted a new training to address the need to build cultural awareness of research mentors in early 2016. Cultural Awareness Mentoring (CAM) was “a six-hour training focused on enhancing both intrapersonal and interpersonal culture awareness and cultural skills acquisition” [10, 18]. The research and practices from the pilot study became the basis of a new component of the EM curriculum, Enhanced Culturally Awareness (ECA). The module aims to deliver four learning objectives: (1) expand the understanding of cultural diversity in mentoring relationships, (2) recognize the impact of biases and assumptions on mentoring relationships and generate strategies to manage them, (3) increase awareness of cultural diversity in oneself and others, and (4) communicate effectively across dimensions of cultural diversity and consider power dynamics. For the implementation, the ECA was delivered using the combination of an online self-paced module and a two-hour in-person discussion session. The self-directed portion, iCAM, served as a primer to prepare mentors for the later discussion session led by a facilitator [19]. Also, in 2016, the scope of the EM curriculum was broadened to include another new training module, Promoting Trainee Research Self-efficacy. The pilot test was conducted at the NRMN Master Facilitator. Later, it was offered in three different formats: (1) a standalone in-person 90-minute workshop, (2) a 60- to 90-minute module of a full EM training seminar, and (3) synchronous online EM training [20].

To help prepare program leaders and administrators in the research community to implement the EM training at their institutions, the MTC developed, tested, and conducted train-the-trainer workshops for EM training facilitators [18]. By 2020, the EM curriculum encompassed ten mentoring competencies, which are (1) align expectations, (2) address equity and inclusion, (3) articulate a mentoring philosophy and plan, (4) assess understanding, (5) cultivate ethical behavior, (6) Enhancing work-life balance, (7) foster independence, (8) maintain effective communication, (9) promote mentee professional development, and (10) promote mentee research self-efficacy. In addition, the MTC organized the EM training manual into modules by the competencies. By modulation the curriculum, facilitators can customize their training intervention by mixing and matching modules and activities based on the specific need of the organization [21].

The Assessment of the Entering Mentoring Curriculum

Alongside developing and expanding the EM curriculum, the EM's original design team and the NRMN Mentor Training Core put enormous efforts into assessing the curriculum's effectiveness. Quantitative evaluation data such as mentoring skills rated by both mentor and mentees and skills gained assessed by comparing mentors with and without EM training were collected at every EM implementation since its inception. The evaluation data have been used for reporting the outcome of the EM training [16, 20, 21, 23-30] and assessing different delivery modes and methods of the curriculum [22, 23]. This study systematically and thoroughly reviews the extant empirical studies in STEM fields that have used the EM training curriculum since it was first introduced (2005 to 2023). The goal is to examine: (1) what outcome variables have been assessed to indicate the effectiveness of the Entering Mentoring training curriculum, and (2) what measurement instruments have been used to quantify the outcome variables? Finally, further discussion is provided, particularly on selecting the appropriate tool based on research goals and resources.

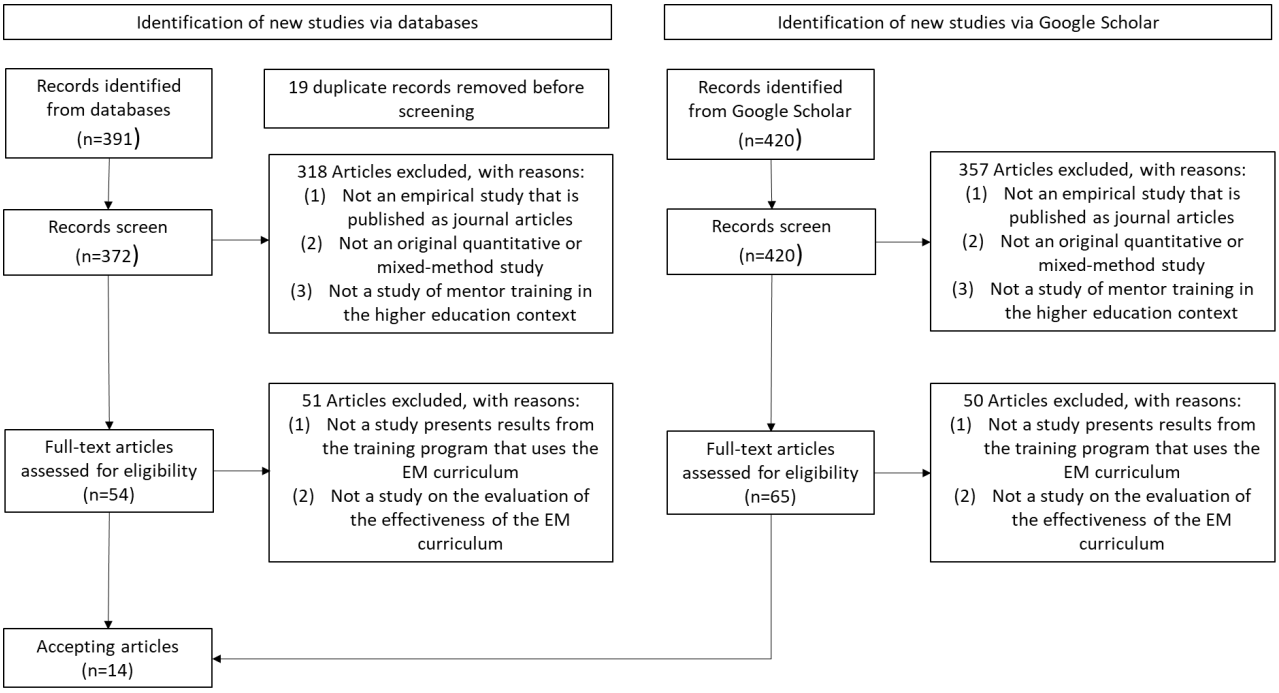
Methods

This study conducts a systematic review of measurement tools for assessing the effectiveness of the EM training curriculum based on the guideline provided by Preferred Reporting Items for systematic reviews and Meta-Analysis (www.prisma-statment.org). To ensure that all literature on EM was selected, we used "Entering Mentoring" as the search keyword and set the search period from 2005 to 2023, as the EM curriculum was first introduced in 2005. The authors conducted a primary search in Educational Research Information Clearinghouse (ERIC), ProQuest, ScienceDirect, and PubMed and a secondary search in Google Scholar.

There were 391 records obtained from the primary search. Once all the duplicate records were removed, the remaining 372 articles' titles and abstracts were screened using the three inclusion criteria. (1) Only empirical studies published as journal articles were selected since conference abstracts or presentations, editorial materials, dissertations, and news did not provide detailed development of the instrument. (2) Only original quantitative or mixed-method studies were accepted, as the qualitative research did not provide quantitative data that could be

statistically analyzed. (3) Only articles conducted research or evaluation of mentor training in the higher education context. Those articles whose titles and abstracts did not indicate they matched inclusion criteria were read in full. At this stage, the screening yielded 54 articles that went through full-text analysis based on the two exclusion criteria: (1) if the articles did not present results from the training program that used the Entering Mentoring curriculum; (2) the evaluation of the effectiveness of the EM curriculum was not part of the study. The secondary database search for additional literature yielded 420 records. Very few articles were duplicates of those in the primary search. Inclusion and exclusion criteria procedures were followed to screen out 406 articles. From the primary and secondary database search, the final selection for the systematic review included 14 articles. Figure 1 shows the complete retrieval and selection process.

Figure 1
PRISMA Flow Diagram for Systematic Reviews



Results

Fourteen reviewed articles were published between 2006 to 2022. Most (12 articles, 85.7%) were recently published from 2018 onward. Over half of the articles reported the accumulated assessment data from multi-training sites nationwide. The studied sample sizes varied widely from 18 to 875 participants (Appendix 1). The largest sample size study compared assessment outcomes between multi-year face-to-face and synchronous online training across multi-sites [23]. The participants were mostly faculty, including clinical instructors, assistant professors, associate professors, and full professors. In addition, some studies focus on graduate students, as they served as mentors to undergraduate students and participated in mentor training. The trained mentors' disciplines included clinical translational research, biomedical sciences, medical, and engineering (Appendix 1). From the 14 reviewed articles, eight instruments were identified as tools to measure the effectiveness of the EM training manual. It appears that there

are two distinct categories (1) the Mentoring Competency Assessment (MCA) and revised MCAs, and (2) newly developed instrument indented for newly added models in EM. (Table 1).

MCA and Revised MCAs

The first instrument was designed in 2005 as a part of the evaluation protocol (table 1), which accompanied the original EM manual [30]. In addition to surveying participants' mentoring practice and behavior, the instrument includes 12 survey items assessing skill gains from the training. The measured outcomes included effective communication, establishing expectations, assessing mentees' understanding, building mentees' independence, addressing diversity issues, and dealing with mentoring challenges. Using the evaluation protocol, Pfund et al. (2006) conducted a training assessment and reported results from 22 mentoring seminars piloting the EM curriculum. However, the research did not undertake any testing to validate the instrument [21]. Brace et al. (2018) used this same instrument to assess the effectiveness of a non-credit, year-long mentor professional development program where 64 graduate students, postdocs, and research staff attended six mentoring workshops using the EM curriculum from 2011 to 2014. Unfortunately, the article also did not report information on instrument reliability testing [24].

The Mentoring Competency Assessment (MCA) scales were developed in 2009 alongside the adaptation of EM to create *Mentor Training for Clinical and Translational Researchers* curriculum. The goal was to use the new tool to measure the training outcomes of the national trial for the curriculum in 16 U.S. universities in 2010. Another goal was to use the trial results to determine skills norms for research mentors in clinical and translational science [25]. The MCA developers started the scale development by reviewing existing mentoring assessment instruments, such as the original EM curriculum evaluation protocol [26] and other survey tools and scales [27, 28]. The working group then aligned the scale items with the six mentoring competencies that were the curriculum's learning objectives. Finally, they assessed the instrument's reliability by conducting cognitive interviews with six mentors and six mentees. As a result, the newly created instrument is a 26-item skills inventory that researchers can measure skill gains in six mentor competencies of mentors.

The developers validated the MCA scales using the assessment data from the 2010 national trial at 16 training sites. A team of 24 researchers administered the MCA via face-to-face interviews with 283 mentor-mentee pairs in the summer and fall of 2010 before the training intervention. Data on the instrument used by mentors and mentees was collected. The coefficient alpha calculated for the mentor group (0.91) and the mentee group (0.95) showed a solid internal consistency. A confirmatory factor analysis was conducted on the hypothesized-6 factor structure aligning with the mentor competencies to measure the instrument's construct validity. The correlations among the six competencies were high, ranging from 0.49 to 0.87 for the mentor instrument and 0.58 to 0.92 for the mentee instrument [29].

Table 1

Assessment Instruments for the Effectiveness of the Entering Mentoring Curriculum

Year of creation	Instrument Name/Description	Instrument Characteristics	Measured Skill Areas	Assessing Training Modules	Validation
2005	EM curriculum's evaluation protocol	12 items 6-point Likert scale	• Effective communication • Establishing expectations • Assessing mentees' understanding • Building mentees' independence • Addressing diversity issues • Dealing with mentoring challenges	• Learning to communicate • Goal and expectation • Identifying challenges and Issues • Resolving Challenges and Issues • Evaluating Our Progress as Mentors • The Element of Good Mentoring • Developing Mentoring Philosophy	N/A
2010	Mentoring Competency Assessment (MCA-26)	26 items 7-point Likert scale	• Maintaining effective communication • Aligning expectations • Assessing Understanding • Fostering independence • Addressing diversity issues • Promoting Professional Development	• Maintaining effective communication • Aligning expectations • Assessing Understanding • Fostering independence • Addressing diversity issues • Promoting Professional Development	Mentor's Cronbach Alpha = 0.91 Mentee's Cronbach Alpha = 0.95
2015	2015 Modified MCA	12 items 5-point Likert scale	• Maintaining effective communication • Establishing and aligning expectations • Fostering independence • Addressing equity and diversity • Promoting Professional Development	• Maintaining effective communication • Aligning expectations • Fostering independence • Addressing diversity issues • Promoting Professional Development	N/A
2016	Promoting Mentees' Research Self-Efficacy	5 items 7-point Likert scale	• Defining the source of self-efficacy • Building mentees' confidence in research • Employing strategies for building mentees' confidence in research • Assessing mentees' confidence in research • Recognizing deficits in mentees' confidence in research	• Promoting mentees' research self-efficacy	N/A
2016	Cultural Awareness Mentoring (CAM)	4 items	• Creating opportunities for the mentee to bring up the issue of race/ethnicity	• Cultural Awareness Mentoring	N/A

		7-point Likert scale	• Encouraging mentees to think about how the research relates to their own lived experience • Going outside of my comfort zone to help mentees feel included in the lab • Respectfully broaching the topic of race/ethnicity in my mentoring relationship		
2017	Enhanced Cultural Awareness (ECA)	5 items 7-point Likert scale	• Creating opportunities for the mentee to bring up the issue of race/ethnicity • Encouraging mentees to think about how the research relates to their own lived experience • Going outside of my comfort zone to help mentees feel included in the lab • Respectfully broaching the topic of race/ethnicity in my mentoring relationship • Making a plan to increase my culturally aware mentoring practice	• Cultural Awareness Mentoring	N/A
2017	2017 Modified MCA	11 items 7-point Likert scale	• Maintaining effective communication • Aligning expectations • Fostering independence • Addressing diversity	• Maintaining effective communication • Aligning expectations • Assessing Understanding • Fostering independence • Addressing diversity issues • Promoting Professional Development • Developing Mentoring Philosophy • Cultivate Ethical Behavior • Creating a Mentoring Plan	N/A
2019	Revalidated MCA (MCA-21)	21 items 7-point Likert scale	• Maintaining effective communication • Assessing Understanding • Fostering independence • Addressing diversity • Promoting Professional Development	• Maintaining effective communication • Assessing Understanding • Fostering independence • Addressing diversity • Promoting Professional Development	Cronbach alphas > .70 PCA, CFA

The validated Mentoring Competency Assessment Scales (MCA-26 – table 1) consist of 26 items on a 7-point Likert scale (from not at all skilled to extremely skilled). Its six subscales are: (1) Maintaining Effective Communication (six items), (2) Aligning Expectation (five items), (3) Assessing Understanding (three items), (4) Fostering Independence (five items), (5) Addressing Diversity (two items), (6) Promoting Professional Development (five items). The developers recommended using MCA to assess mentor performance by mentors and mentees, evaluate the efficacy of EM training, and identify the gap in the assessment by mentors and mentees for further discussion. The two articles published in 2013 and 2014 reported the procedures and results of the randomized control trial study on the effectiveness of the EM curriculum where mentors self-assessed their skills and students rated mentors' skills using MCA before and after training [25, 30].

The MCA scales continue to be used in assessing the effectiveness of EM training, at least within NRMN, as recently as 2020. Three reviewed articles reported assessment procedures and evaluation results on the EM training at three institutions using MCA [31-33]. Other researchers used aggregated MCA data to investigate the effectiveness of EM training on various implementation approaches. Roger et al. (2020) attempted to compare different EM training doses by analyzing the MCA results on 410 participants from 31 EM training events at 26 sites across the country over one year. The researcher created two dosage categories from the 31 training events. The low-dosage training (1-3 hours) often consisted of one-day, one-time workshops at conferences. In comparison, high-dosage training (4 or more hours) included full-day to multi-day seminars at training institutions. Mentoring skill gains measured by MCA were one of the key variables for comparing the training doses in terms of the effectiveness of different interventions [22]. Roger et al. (2022) conducted propensity score matching to examine differences in the efficacy of EM training between face-to-face and synchronous online modes. The study used aggregate data from 678 survey respondents who attended in-person EM training between 2015 and 2018 and 197 survey respondents who were trained via online platforms in 2017. One of the outcome variables analyzed was respondents' self-reported mentoring skill gains which MCA measured in both training modes [23].

Meanwhile, some institutions that implemented complete or selected modules of the EM curriculum at their sites chose to adapt the MCA to assess the specific learning objectives and established outcomes of their mentoring program. These adaptations resulted in new instruments from different modifications of the original MCA scales. Weber-Main et al. (2019) created an instrument by selecting nine out of MCA's 26 items. They then slightly rephrased the item statement and changed the rating scale from a 7-point to a 5-point Likert scale. The researchers further created three additional items to assess the added training activities. The combined 12-item instrument attempted to measure only five of the six mentoring competencies: (1) maintaining effective communication, (2) establishing and aligning expectations, (3) addressing equity and diversity, (4) fostering independence, and (5) promoting professional development. The researchers did not provide information on the validity and reliability analysis of the instrument. This new instrument (2015 Modified MCA – Table 1) assessed skill gain in a randomized control trial study of 59 faculty mentors who participated in the University of Minnesota's mentoring program from April to May 2015. One of the program components was two 2 ½ hour in-person training sessions adapted from the 8-hour EM curriculum [34].

Young and Stormes (2020) developed two instruments to assess the skills of the mentors who participated in the two-semester mentoring program at California State University Long Beach (CSULB) between 2015 and 2019. The first instrument was a survey tool with seven items on a 7-point Likert scale. Each of the first six items was stated as each of the EM mentoring competencies. The last item was the ability to articulate mentor/mentee compacts. In the first half of the mentoring program, 93 faculty mentors used the instrument to self-assess their skills gains after attending a tailored EM training. The second instrument was an 11-item survey adapted from MCA (2017 Modified MCA – Table 1). When closely examining the individual items of the second instrument, it seems only to measure four out of six competencies: (1) maintaining effective communication, (2) aligning expectations, (3) fostering independence, (4) and addressing diversity. Ninety-three students, of whom 54 had mentors who participated in the training and 39 who did not, used the second instrument to rate their mentors' skills after working with faculty on mentoring-related projects. Unfortunately, the researchers did not discuss the validity testing of both survey instruments [35].

Finally, the original MCA was revalidated using a larger and more diverse sample of mentors who participated in at least eight hours of face-to-face EM training between 2010 and 2019. In this study, 1,626 mentors completed the MCA scales after 166 training events at 54 institutions across the U.S. The researchers conducted principle component analysis and confirmatory analysis to reassess the internal structure and Cronbach's alpha analysis to measure the reliability of newly loaded components of the MCA. The original 26 items were loaded into eight components with factor loading ranging from 0.61 to 1.00 and Cronbach's alpha from 0.79 to 0.86 within each component. The analysis showed that the new MCA achieved strong internal validity and reliability. Based on the analysis, the researchers recommended dropping five items from the original scales. The condensed MCA (MCA-21 – table 1) now has 21 items with six subscales measuring six competencies: Maintaining Effective Communication (4 items), Aligning Expectation (4 items), Assessing Understanding (3 items), Fostering Independence (3 items), Addressing Diversity (3 items), Promoting Professional Development (4 items). The revalidated scale is called MCA-21 to distinguish it from the original MCA-26 [36].

Newly Developed Instruments for Added Modules in EM

As the NRMN Mentor Training Core expanded the EM curriculum by adding additional training modules, they developed scale items to assess the training outcomes of these modules. For the self-efficacy training module, the instrument (Promoting Mentees' Self-Efficacy – table 1), which consisted of five items on a 7-point Likert scale, aims to measure mentors' skills in building and assessing mentees' research self-efficacy. The items included (1) defining the source of self-efficacy, (2) building mentees' confidence for research, (3) employing strategies for building mentees' confidence in research, (4) assessing mentees' confidence for research, and (5) recognizing deficits in mentees' confidence for research. Butz et al. (2018) reported the assessment data using the self-efficacy scales on 245 mentors from 11 implementations at seven sites across the country in the Spring, Summer, and Fall of 2016 [20].

In 2016, a team of researchers at NRMN developed a new assessment scale to accompany a training program on cultural awareness mentoring skills for research mentors. Seventy faculty mentors used the scales in a pilot study at three implementation sites. The scale

(CAM – Table 1) consisted of four items on a 7-point Likert scale to assess four skill areas: (1) creating opportunities for the mentee to bring up the issue of race/ethnicity, (2) encouraging mentees to think about how the research relates to their own lived experience, (3) going outside of my comfort zone to help mentees feel included in the lab, and (4) respectfully broaching the topic of race/ethnicity in my mentoring relationship [10]. In 2017, the NRMN Mentor Training Core adapted this instrument to create Enhancement Cultural Awareness scales (ECA – Table 1) by adding one more item – making a plan to increase my culturally aware mentoring practice – to the CAM scales. The ECA scales were then used to assess the ECA training module of the EM curriculum on 94 faculty mentors at 16 training events in the summer of 2017 [19]. Unfortunately, no information was available on validity and reliability analysis for these assessment instruments of newly added training components.

Discussion

This study followed the PRISMA guideline to systematically review research articles that provide information on instruments for assessing the effectiveness of the EM training curriculum. Most reviewed studies (n=11) reported EM evaluation data from using the MCA or three modified MCA scales. Two studies presented data collected from the MCA's predecessor, the evaluation protocol of the original EM. Although there were some slight differences in the number of contained items, all instruments were designed to measure the six mentoring competencies of the core EM curriculum. The remaining three articles presented the evaluation data on two new EM training modules. Two instruments were created to assess the two mentoring competencies that were the training goals of the additional modules. Therefore, depending on which of the seven instruments is selected, program evaluators can be able to assess the effectiveness of their EM training by choosing the following outcome variables: effective communication, aligning expectations, assessing understanding, fostering independence, promoting research self-efficacy, addressing diversity, cultural awareness, and professional development.

Besides answering the main research questions, the study also found a variety of mentor programs incorporated in whole or parts of the EM curriculum. Since MCA is tightly aligned with the core training modules of EM, these programs often modify MCA to create new assessment tools to assess their unique training designs. Both articles, which reported evaluation data from modified MCA tools, discussed the procedure of tailoring the MCA to their specific needs. Weber-Main et al. (2019) described the hybrid mentor training approach at the University of Minnesota in which a 90-minutes, self-paced, online module called Optimizing the Practice of Mentoring was followed by workshops based on the EM curriculum. The researchers designed the assessment tool by selecting items from the MCA that aligned with targeted five out of six competencies and created additional items to reflect the content in the online module [17]. As mentioned earlier, Young and Stormes (2020) discussed a unique mentor program at CSULB as a two-semester operation. In the first semester, faculty mentors attended a 10-week hybrid-training format with one in-person meeting and 8-week online sessions focusing on the learning objectives of the EM curriculum. In the second semester, the mentors would practice their skills with students in mentor-related projects. Based on the learning goals of the tailored EM training and the critical aspects of the mentor-mentee compacts from the projects, the researchers selected and modified items in each subscale of MCA to design scales that allowed students to rate their

mentors' skills. These customized scales only assessed four out of six mentoring competencies [15]. From this observation, it could be inferred that MCA has been used with great flexibility to match the customization of the EM curriculum.

One notable finding from the study is the strength of the key EM assessment instrument. MCA was validated twice using large sets of evaluation data on many EM training implementations from multi-sites nationwide. Each validation procedure relied on different data sets to ensure the accuracy of the instrument's performance [29, 36]. Furthermore, as the authors investigated further into the application of MCA, some mentoring programs which did not implement the EM curriculum modified MCA to assess the skills of their mentors in the six mentoring competencies [37, 38]. Mickel et al. (2018) described the new instrument, which consisted of 31 items. Five new items were added to the original 26 items of the MCA. Two items were added to the Assessing Understanding subscale and three to the Addressing Diversity subscale. The researchers independently validated the instrument using the self-assessment data of 135 faculty mentors at the University of Oklahoma Health Science Center. The obtained coefficient alphas were greater than 0.70 at each MCA subscale, including the modified ones. Therefore, the modification did not reduce the effectiveness of the scale [38].

The core MCA was validated multiple times, but the assessment scales for the EM's additional training components, such as research self-efficacy and cultural awareness, were deployed without validation testing [10, 19, 20]. A full suite of EM curriculum allows leaders of mentor programs to conduct expanded training beyond the six mentoring competencies. In turn, they would need a comprehensive assessment tool to complete the evaluation of their mentor training operations. The comprehensive instrument can be created by adding ECA and Research Self-efficacy scales to the MCA's six subscales. There may be a need to conduct a validation of the comprehensive instrument.

More importantly, although the previous MCA validation testing was based on large samples of evaluation data, the sample population is predominantly composed of individuals who identify as white (90.8% are white in the MCA's original validation, 67% in the MCA's revalidation, and 76.9% in the modified MCA's validation). The same skewness toward white participants is also observed in the evaluation samples of nine reviewed articles, where the rest did not provide demographic data for their samples. As more and more institutions use EM for their mentoring program to target its support for minority and historically underrepresented students, no current studies are using the reviewed tools to investigate the impact of EM on these mentor and student groups. Therefore, future studies should focus on evaluation data from minority populations to assess the EM program.

This study has limitations. The results from the article review show that several studies reported combined evaluation data from multi-site and multi-year training events. The authors cannot verify whether any shared data happened across these studies. However, at least reviewed articles reported similar evaluation results using MCA at six individual institutions where assessment data is independently collected and used [24, 31-33]. Finally, the study can conclude that MCA has been used as the standard tool for any training based on the EM manual, thanks to its alignment with the learning outcomes of the curriculum and its rigorous testing for reliability and validity.

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Appendix 1

Publication Information, Demographic Information, Research Instrument of the Included Studies

	Article	**Training Site**	**Sample Size**	**Participant**	**Mentors' Discipline**	**Instrument**
1	The Merits of Training Mentors [15] **2006**	11 U.S. universities	• 85 mentors • 12 facilitators	• Graduate students • Postdocs • Research scientists		• 12 survey items as a part of the evaluation protocol of the EM original training manual measure mentoring skills
2	A Research Mentor Training Curriculum for Clinical and Translational Researchers [25] **2013**	16 U.S. universities	• 144 mentors • 35 facilitators	• Assistant professors • Associate professors • Full professors	• Clinical Translational Research	• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skills
3	Training Mentors of Clinical and Translational Research Scholars: A Randomized Controlled Trial [30] **2014**	16 U.S. universities	• 144 mentors	• Assistant professors • Associate professors • Full professors	• Clinical Translational Research	• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skills
4	Promoting STEM Trainee Research Self-efficacy: A Mentor Training Intervention [20] **2018**	7 U.S. sites	• 254 Mentors • 17 facilitators	• Graduate students • Postdocs • Research scientists • Faculty/Instructors	• STEM disciplines	• 5 survey items were developed to measure skills to promote the mentee's self-efficacy
5	Design, implementation, and evaluation of a multi-disciplinary professional development program for research mentors [24] **2018**	1 U.S. university	• 82 mentors	• Graduate students • Postdocs • Research scientists	• Biology • Chemistry • Communication • Engineering • Medicine • Psychology	• 12 survey items as a part of the evaluation protocol of the EM original training manual measure mentoring skills
6	Pilot study of an intervention to increase cultural awareness in research mentoring: Implications for diversifying the scientific workforce [10]	2 U.S. universities 1 U.S. Institution	• 70 mentors	•	• STEM disciplines	• 4 survey items were developed to measure the cultural awareness mentoring skills

	Article	Training Site	Sample Size	Participant	Mentors' Discipline	Instrument
	2018					
7	A randomized controlled pilot study of the University of Minnesota mentoring excellence training academy: A hybrid learning approach to research mentor training [34] **2019**	1 U.S. university	• 59 mentors	• Assistant professors • Associate professors • Full professors	• Dentistry • Medicine • Nursing • Pharmacy • Public Health • Veterinary Medicine	• 9 survey items were adapted from Mentoring Competency Assessment scale and 3 newly developed items to measure mentoring skills
8	Assessing mentor academy program effectiveness using mixed methods [31] **2019**	1 U.S. university	• 20 mentors	• Assistant professors • Associate professors • Full professors	• Biomedical Sciences	• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skill
9	The BUILD Mentor Community at CSULB: A Mentor Training Program Designed to Enhance Mentoring Skills in Experienced Mentors [35] **2020**	1 U.S. university	• 93 mentors	• Assistant professors • Associate professors • Full professors	• Engineering • Liberal Arts • Health and Human Services • Science	• 11 survey items were adapted from Mentoring Competency Assessment scale
10	STEM Ambassadors: Developing Communications, Teamwork and leadership skills for Graduate students [32] **2020**	1 U.S. university	• 18 mentors	• Graduate students	• Engineering	• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skills
11	How much is enough? The impact of training dosage and previous mentoring experience on the effectiveness of research mentor training intervention [22] **2020**	26 sites	• 410 mentors	• Administrators • Graduate students • Clinical instructors • Assistant scientist • Associate scientists • Assistant professors • Full professors		• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skills

	Article	Training Site	Sample Size	Participant	Mentors' Discipline	Instrument
				• Deans		
12	A system-wide health sciences faculty mentor training program is associated with improved effective mentoring and institutional climate [33] **2021**	1 U.S. university	• 391 mentors	• Assistant professors • Associate professors • Full professors • Other faculty	• Health Sciences	• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skills
13	Enhancing Research Mentors' Cultural Awareness in STEM: a Mentor Training Intervention [19] **2022**	16 sites	• 62 mentors	• Administrators • Graduate students • Clinical instructors • Assistant professors • Associate professors • Full professors • Academic leaders		• 5 survey items were developed to measure the cultural awareness mentoring skills
14	Comparing the outcomes of face-to-face and synchronous online research mentor training using propensity score matching [23] **2022**	Multiple sites and multiple institutions	• 678 mentors (face-to-face implementation) • 197 mentors (online implementation)	• Graduate students • Postdocs • Research scientists • Faculty/Instructors		• 26 survey items of the Mentoring Competency Assessment scale measure mentoring skills