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The Effect of Mentoring for Undergraduate Mentors: A Systematic Review of the Literature

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TITLE PAGE

**The Effect of Mentoring for Undergraduate Mentors:
A Systematic Review of the Literature**

University Honors Program Thesis/Capstone/Creative Project

University of Nebraska at Omaha

Submitted by

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Abstract

Multiple meta-analyses and systematic reviews have been conducted to evaluate methodological rigor in research on the effect that mentoring has on the mentee. However, a dearth of information exists regarding the effect of mentoring on the mentor. As such, I conducted a systematic review of the literature focused on such an effect (if any) within the fields of science, technology, engineering, and mathematics (STEM), aiming to bolster the literature surrounding this affect. In the case of this work, my focus is on undergraduate or post-secondary students as mentors for near-peers and/or youth. This review functions to identify commonalities of affective outcomes and benefits or challenges for undergraduate mentors, and further to promote methodological rigor on the subject by providing a more consistent description of the metrics utilized across studies. Herein articles from 2013-2021 are analyzed to determine characteristics of UG mentor programs, the functionality of mentors within the programs, and the methodological rigor of research applied. Overall, the following best practice suggestions are made for future research on the effect of mentoring on mentors; the employment of longitudinal and exploratory mixed methods designs utilizing sequential collection of qualitative then quantitative measurements, and experimental descriptions nested within a theoretical framework.

Keywords: STEM education, UG mentoring, rigor, methods, theoretical/conceptual framework, systematic review

Introduction

Programs focusing on undergraduates (UGs) providing mentoring are widespread within and outside of science, technology, engineering, and mathematics (STEM) disciplines. The effects of these programs are not beyond empirical analysis, with much of the existing research on mentoring focusing only on the impact of mentoring on mentees, objective data (e.g., exam scores, course grades, grade point average, etc.), or quantitative data (Crisp & Cruz, 2009; Gershenfeld, 2014), which ultimately limits the scope of understanding and application. The present study is a systematic review to determine methodological rigor of research measuring outcomes for UG mentors (i.e., the individuals doing the mentoring, as opposed to those benefiting from the mentoring, as is commonly reported in the literature). I reviewed studies between 2013 and 2020, since 2014 (Gershenfeld) was the last publication in the area and would not have included articles in press (i.e., during 2012 and published in 2013) at time of its writing. In all, I identified 80 studies containing quantitative and/or qualitative insight from UG mentors.

Jacobi's (1991) review of a decade (1980-1990) of mentoring research on mentor and mentee perspectives proposed a need for improved methodology and reasoned for the importance of situating mentoring programs and research within a theoretical base. Consequently, Jacobi (1991) put forward four major theoretical frameworks of mentoring programs: 1) Involvement with learning, 2) Academic and social integration, 3), Social support, and 4) Developmental support. Hannafin *et al.* (1997) indirectly extended, and expounded upon this, reasoning for use of grounded theory design: Namely, that alignment of methods, theoretical or conceptual framework, and research are essential in understanding learning environments.

Nora and Crisp's (2007) report on a survey of UG mentor perspectives and a corresponding literature review detailed the functional roles of mentors, and prompted their assertion that mentoring programs and research continued to lack theoretical/conceptual bases. Nora and Crisp (2007) identified four major components that mentoring programs can utilize to provide a strong conceptual base: Namely, 1) Education/career goal establishment and evaluation, 2) Emotional and psychological support, 3) Academic content knowledge support, and 4) Presence of a role model. Two years later, Crisp and Cruz's (2009) update of Jacobi's (1991) review discussed a continued lack of methodological rigor in a wider body of mentoring research between 1990 and 2007.

The last major review prior to this was conducted by Gershenfeld (2014) with the intention of extending the analysis of mentoring research to include published works between 2008 and 2012. Gershenfeld (2014) ultimately reported some improvement in the application of theoretical or conceptual frameworks, but similarly outlined persistent methodological shortcomings. Of particular note, Gershenfeld (2014) identified some of what is termed "key mentoring program components" (**Table 1** and **Table 2**) and innovatively applied the Levels of Evidence-Based Intervention Effectiveness (LEBIE; shown in **Table 3**; Jackson, 2009) scale to evaluate methodological rigor.

However, Gershenfeld (2014) identified a skew in article rankings by the LEBIE scale, assigning only 3's, 4's, and 5's (low scores, as 5 = concerning). They attributed this skew to the scale's rankings tending toward typical quantitative studies, in which the presence of equivalent controls and randomization are more common. In isolation, this issue would be significant, but Gershenfeld (2014) employed other forms of evaluation to ensure appropriate analysis of qualitative and mixed-method study designs; a strategy which the present study adopts as well.

As a consequence of the prior literature reviews completed to-date, namely those preceding 2014, I included in this study a date range that included any articles published while the Gershenfeld paper would have been under review (i.e., 2013) and through the final full year prior to submission (i.e., 2020). Therefore, this systematic review includes studies from 2013-2020, covering the entire ERIC database and multiple databases within EBSCO, and yielding 1,231 positive hits. The aim of this study is to extend the analysis of research on the effect of mentoring on mentors, from the last review of such literature (i.e., the period covering 2013-2020). **I aimed to address two key research questions:**

- 1) Does the application of the LEBIE scale (Jackson, 2009) to evaluate mentoring research that contains mentor perspectives published between 2013 and 2020 mirror that shared by Gershenfeld (2014)? Or, did the field respond with more expansive mentoring evaluation practices after that publication?
- 2) Identify “key mentoring program components” (Gershenfeld, 2014), theoretical or conceptual frameworks (if provided), methods, and general findings. I sought to determine what these components are, based upon the frameworks of Jacobi (1991), Hannafin *et al.* (1997), Nora and Crisp (2007), Crisp and Cruz (2009), and Gershenfeld (2014).

Ultimately, these results will allow for recommendations for future researchers to improve upon methodological rigor in research that studies the effectiveness of mentoring on mentors.

Methods

The methods employed for this systematic review are consistent with the practices within the literature, namely of Cronbach and Shapiro (1982) and Moher *et al.* (2009), using the

following Cronbach's Units, Treatments, Outcomes, and Study Designs (UTOS) framework. The population of interest (**Units**) is UG mentors within STEM and peripheral fields. I have focused on the provision of mentoring by UGs (**Treatments**) as an intervention, including but not limited to mentoring within peer-mentoring, service-learning, course related, internship, and research programs. The **Outcomes** of interest are those reported openly by or requiring insight from UG mentors on what effect the experience had on them. Due to the exploratory nature of this study and the widely variable outcomes measured, this parameter is not further constricted. However, I did also identify and report on other subjective components (e.g., demographics, compensation, support, frequency, etc.). As one of the major goals of the present study is to identify methods employed, all **Study Designs** are eligible for review herein so long as outcomes are reported and are in line with the above parameter.

I completed a literature search within the Education Resources Information Center's database (ERIC) and multiple databases within EBSCO (namely: Academic Search Complete, Education Source, E-Journals, PsycARTICLES, PsychINFO, Psychology and Behavioral Sciences Collection, and Teacher Reference Center) using the respective search terms "mentor and undergraduate" in ERIC and "mentor and UG" in EBSCO. One set of search terms could not be used exclusively within both databases due to an issue with ERIC producing only two search results with the latter and EBSCO producing thousands of unrelated results with the former. Other search criteria included scholarly articles, written in English, peer reviewed, and published between 2013 and 2020 (see **Figure 1** below for stepwise exclusion). After the removal of duplicates, the article titles and abstracts were screened for any indication of findings related UG mentors (e.g., title and/or abstract explicitly contain the words undergraduate/UG mentors and suggest or explicitly state something about mentor perspectives/insight) which would fulfill the

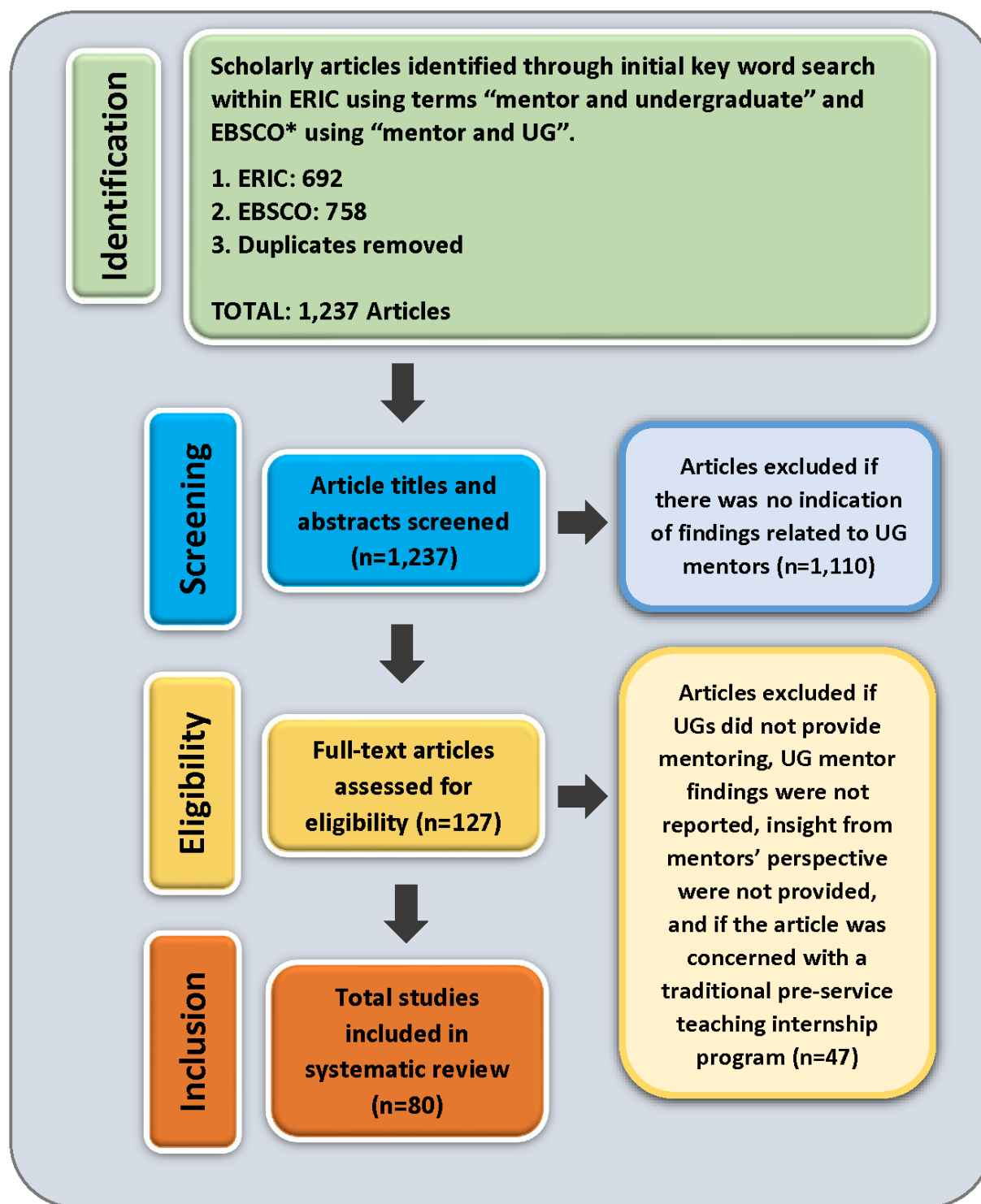


Figure 1. Prisma Flow Diagram (Moher et al., 2009) for record identification, inclusion, and exclusion. *Databases included within EBSCO search: Academic Search Complete, Education Source, E-Journals, PsycARTICLES, PsychINFO, Psychology and Behavioral Sciences Collection, and Teacher Reference Center.

Units parameter. Those included through this initial screening were reviewed in full for eligibility if the focus was on the provision of mentoring by UGs, findings were reported, and insight from the mentors' perspective were provided (i.e., explicit statements and data were provided to demonstrate each), therefore fulfilling the **Outcomes** and **Treatment** parameters. Articles or programs pertaining to service-learning were included only if the service-learning involved provision of mentoring by UGs, and any articles or programs concerning traditional pre-service teaching internship programs (e.g., co-teaching within a classroom setting under the supervision of a certified teacher) were excluded, as such positions do not revolve around the adoption of a mentor role. While mentors may certainly serve as teachers and teachers may certainly serve as mentors, they are generally observed and/or measured as separate roles albeit closely related (Crisp & Cruz, 2009; Gershenfeld, 2014; Jacobi, 1991; Nelson & Cutucache, 2017; Nora & Crisp, 2007), prompting my decision to exclude pre-service programs in order to maintain focus on mentoring in alignment with the **Treatment** parameter.

In total, there were 1,231 positive hits through the database query after duplicate removal. Of these, $n = 80$ met all of the inclusion criteria and were analyzed by the following evaluative tools. I used the LEBIE scale (Jackson, 2009) to examine methodological rigor (see results **Table 3**) in terms of study design (e.g., presence of equivalent vs non-equivalent vs no control group) and evidence of effectiveness (e.g., evidence that intervention results in some positive change over time or is better than or comparable to a control/placebo). To examine program and research functionality and qualities I used Nora and Crisp's (2007) conceptualization of core functional roles (e.g., assist with a course, provide peer-mentoring, service-learning, etc.) and Gershenfeld's (2014) key mentoring program and research components (namely: mentor and mentee demographics, compensation, frequency of mentoring, support, $N =$ number of mentors,

quantitative vs qualitative vs mixed methods, how data are collected, and major findings). In line with prior researchers from Jacobi (1991) and Hannafin *et al.* (1997) to Nora and Crisp (2007) and Gershenfeld (2014), I also identified theoretical/conceptual frameworks (if stated by authors).

Finally, for relevant studies I examined characteristics deemed essential within the literature to mixed methods designs (**Table 4**), including an explicit statement that mixed methods research is being utilized, rationale for using mixed methods research, integration of quantitative and qualitative data (merging, connecting or building), analytic logic (independent or dependent), sequencing/timing (concurrent or sequential), and/or priority (quantitative, qualitative or both; Creswell, 2013; Creswell & Plano Clark, 2017; Harrison *et al.*, 2020; O’Cathain *et al.*, 2008; Plano Clark & Ivankova, 2016). The former three were taken from eligible studies (i.e., stated or not, and what was stated), while the latter three are interpreted for all but one. Ultimately, my results will consist of LEBIE scale ratings, compiled qualitative data on program and research qualities, and reporting of relative proportions of qualities where possible. Of note, where I discuss proportions/percentages, the sample size (n) may not equal the total number of eligible studies (n = 80) due to some qualities not being reported or present in certain studies (e.g., mixed methods design), and percentages may add up to be greater than 100% due to certain studies reporting multiple elements within a given quality (e.g., different types of compensation given to different participants).

Results and Discussion

Consistent with prior research, I have included many components of the articles I reviewed and the mentoring programs they analyzed (contained within tables 1 through 4). It is

and always was my intention to compile this large amount of data in order to provide easy access to overviews of these studies for other mentoring researchers (I have grouped similar data together for this reason). However, my primary goal is to identify trends within mentoring program and research functionality and to analyze methodological rigor in studies on the subject in order to provide suggestions for improvement of future research. To this end, the results and discussion will be focused on my research questions to determine rigor (i.e., **Table 3**, **Table 1**'s function column, **Table 2**'s theoretical/conceptual framework, and some discussion on general component description) and methodology (i.e., **Table 2**'s methods and N and data collection columns, and mixed methods criteria in Table 4) of this article sample.

Rigor in Experimental Design for Mentoring Articles

As within Gershenfeld's (2014) review, I am analyzing rigor by the LEBIE scale and components deemed essential to mentoring and mentoring research within the literature (Crisp and Cruz; 2009; Hannafin *et al.*, 1997; Jacobi, 1991; Nora and Crisp, 2007). My rankings by use of the LEBIE scale (see **Table 3** below) were consistent with Gershenfeld's (2014) review (only Level 5's, 4's, and 3's are given), but with considerable regression onto Level 4 (Gershenfeld assigned eleven Level 5's, four Level 4's, and three Level 3's). Of note, I only ranked one article as efficacious (Level 3) and one other as concerning (Level 5). For all remaining articles (78 of n = 80) included in this review I assigned the rank of emerging (Level 4), with 11 containing some form of pre- and post-intervention measurement. While reviewing articles for theoretical/conceptual frameworks (see **Table 2**; placed at the end of the document for readability) I recorded any that were explicitly stated (61.25%, n = 49) and also identified those that relate to at least one of one of the four major theoretical frameworks of mentoring programs put forward by Jacobi (1991; 45%, n = 36).

Table 3. Levels of evidence-based institutional effectiveness scale (LEBIE).

Evidence-based intervention Level	Study Design	Evidence of Effectiveness	*Articles Meeting Criteria
Level 1: Superior	ED: Randomization with equivalent control & comparison group	Intervention is superior to an appropriate comparison program. Sustained effect reported at follow-up	0
Level 2: Effective	ED: Randomization with equivalent control & comparison group	Intervention is proven to be significantly better than a placebo control group, or evidence supporting that the intervention is better than an appropriate comparison intervention	0
Level 3: Efficacious	QED: non-equivalent control group/non-randomization	Intervention efficacy over the placebo control group, or evidence supporting that the intervention is comparable to or better than an appropriate comparison intervention	1
Level 4: Emerging	NED: single group (may include pre-/post-test)	Intervention demonstrates some degree of positive change over time	78
Level 5: Concerning	Any	No evidence of change or change in the opposite direction, putting participants at risk	1

*LEBIE scale taken from Jackson (2009) and used by Gershenfeld (2014). ED: Experimental design; QED: Quasi-experimental design; NED: Non-experimental design. *Count of articles meeting the criteria of each level from the current review (2013 - 2021).

For program functionality (see **Table 1**; placed at the end of the document for readability) my concern was with the type of mentoring (i.e., peer, near-peer, and youth), whether the authors considered other core functions (i.e., internship and service-learning), and which of Nora and Crisp's (2007) four major components were present. I found that 65% (n = 52) of articles contained programs for peer mentoring, 22.5% (n = 18) for near-peer mentoring, 32.5% (n = 26) for youth mentoring, 22.5% (n = 18) for service-learning, and 2.5% (n = 2) for internships. Concerning Nora and Crisp's (2007) four major components, my analysis found 45% (n = 36) of programs to be solely or primarily focused on academic content and knowledge support, 8.75% (n = 7) to include discussion and focus on all four components, and the remainder to be focused on other single components or combinations of at least two of the four.

In general, I was able to discern other functional components (**Table 1**) of mentoring programs, but many details were not overtly shared (e.g., mentioned in passing through mentor or facilitator commentary) or were internally inconsistent. There were a number of studies that made no mention of compensation and a fair portion detailed or mentioned multiple different forms, combinations, or lack of compensation to different participants. Support available for mentors and frequency of mentor meetings with mentees each varied considerably (**Table 1**) and were not always specifically discussed. Mentees were either some pool of K-12 students (e.g., middle school, high school, grades 4-6, etc.), other UGs (e.g., underclassmen or near-peers), or a combination of these groups, and most articles provided little or no separation of data by this component. Finally, while UG mentors (**Table 1**) were the focus the present study, some articles included graduate student mentors, PhD candidate mentors, and faculty mentors, but did not always separate data by this component either.

Methodology

The majority (70%, n = 56; methods; **Table 2**) of articles I reviewed employed qualitative methodology and a small minority employed quantitative methodology (6.25%, n = 5) or were systematic reviews (3.75%, n = 3). My inspection shows that the number of mentors or sample sizes (N; **Table 2**) within the included studies are considerably variable, ranging from 1 to 1,972. Additionally, some articles did not report N at all or reported it vaguely (e.g., greater than 150). I found that a large portion of studies collected data (data collection; **Table 2**) through self-report surveys (38.75%, n = 31) and of these many were Likert scale based (18.75%, n = 15). Twelve articles (15%) used priorly developed tools for quantitative measurements and remaining data collection methods were made up by a spread and/or variable combinations of interviews, document analysis, focus groups, observation, demographic information, general

feedback or commentary, and questionnaires. While 9 studies (methods; **Table 2**) did explicitly state use of mixed methods design, I analyzed another 7 that contained both quantitative and qualitative data collection as employing mixed methods design (20%, n = 16 employed mixed methods design).

Qualities of Mixed Methods Research in Relevant Articles

All of the articles I identify as utilizing mixed methods designs explicitly state a use of qualitative and quantitative measures and just over half of these (56.25%, n = 9; see **Table 4**; placed at the end of the document for readability) also explicitly state the utilization of mixed methods design. Less than half of these (37.5%, n = 6) articles state a mode of integration (all but one report integration by triangulation) and seven (43.75%) studies provide no evidence of combining quantitative and qualitative data sets. The outlier (Hastings & Sunderman, 2019) reports integration by using qualitative data to build on and support quantitative data, and is the only article to include explicit details on analytic logic (dependent), sequencing/timing (quantitative prior to qualitative), and priority (quantitative, the only article with this priority). For the remaining articles I interpreted 68.75% (n = 11) to have even priority between quantitative and qualitative data, 25% (n = 4) to prioritize qualitative data, and all but one study (87.5%, n = 14) to have independent analytic logic and concurrent sequencing/timing (McIntosh, 2019; could not be interpreted due to a lack of methodological description). Of the studies that did not explicitly state integration (62.5%, n = 10), one provided some discussion of using qualitative and quantitative data to build on each other (Pica & Fripp, 2020), and two discussed looking for common patterns in each (Bonner et al., 2019; Köse & Johnson, 2016).

Present State of Research According to This Review

My LEBIE scale rankings are consistent with but do not directly mirror that shared by Gershenfeld (2014), suggesting that mentoring research between 2013 and 2020 has in general responded with at least some more expansive mentoring evaluation practices after its publication. However, the proportion of articles explicitly stating adoption of a theoretical or conceptual framework in this systematic review is smaller than previously reported and the most common and predominating function from Nora and Crisp's (2007) four major components remains academic content and knowledge support (Gershenfeld, 2014). Considering best practice in mentoring programs and research (Crisp and Cruz; 2009; Hannafin *et al.*, 1997; Jacobi, 1991; Nora and Crisp, 2007), I reason that a decrease in theoretical bases and lack of change in functional grounding suggests a general decrease in methodological rigor that is not measured by the LEBIE scale.

My analysis of article methodology is meant to augment these findings, as LEBIE scale rankings and functional component identification, while important do not evaluate the full spectrum of methodological designs within the field. The vast majority of studies identified through this systematic review employ qualitative only designs over singular and relatively short time period, and most utilize self-report surveys (Likert scale or otherwise) developed for the sole purpose of evaluating the program of interest. Additionally, I examined that qualitative or quantitative measurements generally were not taken pre-/mid- and post-intervention.

In programs that have employed mixed methods research, I found that evidence of quantitative and qualitative data integration was lacking and that methodological description was often limited or not present. Curiously, the article (Hastings & Sunderman, 2019) I identified as providing the most detailed methodological description employed an exploratory mixed methods

design, but used quantitative measurement for exploration and qualitative data for support. This is in opposition to recommendations in the literature for exploratory mixed methods studies (Creswell & Plano Clark, 2017, Harrison et al., 2020), in which qualitative then quantitative data are sequentially collected, and the latter depends on the former. This systematic review suggests that there remains a lack of valid and reliable tools for quantitative measurement of the effect of mentoring on UG mentors, and leading exploration with qualitative measurements is more likely to provide progress toward development of such tools (Creswell & Plano Clark, 2017, Harrison et al., 2020).

Conclusion

Ultimately, my analyses of UG mentor program components and function (**Table 1** and **Table 2**) demonstrates even more variability than priorly identified (Gershenfeld, 2014). Alongside the invariability of LEBIE scale (**Table 3**) rankings presently and previously (Gershenfeld, 2014), this reinforces the need for methodological rigor and evaluation appropriate to such a complex subject. Accordingly, my suggestions for future researchers on the effect of mentoring on UG mentors are that there is a need for studies of longitudinal design (Plano Clark et al., 2015), of an exploratory nature (Gershenfeld, 2014), and utilizing sequential collection of qualitative and then quantitative data (Creswell & Plano Clark, 2017, Harrison et al., 2020). I recognize that research completed to analyze mentoring programs is often constricted by the variable nature of its components and participant characteristics. None of these suggestions should necessitate the application of all others, as employment of even a single one would be beneficial to methodological rigor (e.g., well-established qualitative exploration to understand where quantitative measurements are most beneficial and appropriate).

Collecting data over longer and multiple periods of time should provide more information on whether and/or what long term effects of mentoring can realistically be expected (Nelson & Cutucache, 2017; Plano Clark et al., 2015), while quantitative data collection and analysis would provide studies more generalizability (Kruger, 2003) and increased objectivity (Linn et al., 2015; Owen, 2017). Moreover, by employing exploratory and longitudinal mixed-method designs, methodological rigor can be improved (Creswell & Plano Clark, 2017, Harrison et al., 2020) and progress can be made toward development of tools for valid and reliable quantitative measurement, hopefully creating a cycle of reciprocity.

I further assert that it is vital for studies on this topic to provide exceptional description and explicit statements of their methodology, program, and participants. Many of the studies I have identified within this systematic review did not overtly share important details, requiring interpretation and a lot of time to properly analyze them. Providing information explicitly not only improves the ease of access for future researchers, but is also valuable to methodological rigor by encouraging the adoption of theoretical/conceptual frameworks (Gershenfeld, 2014; Jacobi, 1991) and fleshing out mentor and program functionality (Gershenfeld, 2014; Nora & Crisp, 2007).

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Table 1. Key mentoring components* in mentoring programs.

Author & year	Mentors	Mentees	**Function	Compensation	Frequency	Support
Douglass et al., 2013	UGs	UGs	Peer mentoring: AKS	S	10 h/wk for duration of course	Faculty and GTA
Yilmaz et al., 2013	Senior level UGs	K - 12 youths	Service-learning: AKS	S, C	6 mtgs, 1-3 hrs each	Faculty & K - 12 team coaches
Burton et al., 2013	Exp UGs 3 rd year	1 st year UGs	Near-peer mentoring: AKS	C	N.S.	N.S.
Cushing & Love, 2013	UGs	Highschool youth (predominantly Latin/x)	Service-learning: AKS	C	1 semester, not further specified	Faculty
Karp & Maloney, 2013	UGs (predominantly freshman)	K - 8 youths	Service-learning: AKS	S (1 st yr) then C	15 h/semester	Faculty & K - 8 teachers
Hryciw et al., 2013	UGs 1 st & 2 nd year	1 st year UGs	Peer mentoring: AKS	-	1 hr/wk for 10 wks	Faculty
Afghani et al., 2013	UGs	Highschool youth	Near-peer mentoring: GEE, AKS	S	1 or more 2 wk sessions	Faculty & medical students
Karlin et al., 2013	Exp UGs	UGs	Service-learning: AKS	N.S.	2 mtgs/quarter, more as needed	Faculty & GTAs
Haddock et al., 2013	UGs	At-risk youth age 10-18	Service-learning, youth mentoring: GEE, EPS, AKS, PRM	C	6 hr mtg/wk for 12 wks	Faculty, clinical therapists, & peers
Ward et al., 2014	UGs	UGs	Peer mentoring: GEE	-	1.5hr/wk for 14 wks	Faculty & peers
Packard et al., 2014	UGs junior & senior	Sophomore UGs	Peer mentoring: AKS	-	N.S.	Faculty

James, 2014	UGs 2 nd & 3 rd year	Highschool seniors	Near-peer mentoring: GEE	C	7 mtgs/semester	Faculty & high school teachers
Washburn & Zevallos, 2014	Exp UGs	1 st year UGs	Near-peer mentoring: GEE, AKS	N.S.	Summer orientation, fall readiness course, spring workshop series, not further specified	Faculty
Lamb & Aldous, 2014	UGs 2 nd year	Grades 8-10 youth	Youth mentoring: EPS, AKS, PRM	-	Wkly emails	Faculty & peers
Monk et al., 2014	Upper level UGs	Grades 7-12 youth	Youth mentoring: AKS	- or C	1 mtg/wk for 1 yr	Faculty & peers
Schuetze et al., 2014	UGs	Grades 3-8 youth	Youth mentoring: AKS	-	1-2 hrs per wk for 8 months	LEGO Robotics personnel and grade 3-8 teachers
Tenenbaum et al., 2014	UGs	Grades 5-12 youth	Near-peer mentoring, youth mentoring: AKS	S	12 wk summer program, no further specification	Program management, volunteer scientists, & peers
Wasburn-Moses et al., 2014	UGs	Grades 9 & 10 youth	Service-learning, youth mentoring: EPS	C	1 x 45–60-minute mtg/wk	Faculty
Thalluri et al., 2014	UGs 1 st year	1 st year UGS	Peer mentoring: AKS	-	1 x 2 hr mtg/wk for 8 wks	Faculty
Zentz et al., 2014	Exp Senior UGs	Sophomore UGs	Near-peer mentoring: AKS, PRM	C	Assist with 2 sessions (1 virtual, 1 clinical)	Faculty & peers
Ross & Bertucci, 2014	UGs	Highschool youth	Near-peer mentoring: AKS	N.S.	1hr/wk for 10 wks	Faculty
Anderson et al., 2015	UGs	Grades 9-12 youth	Internship, near-peer mentoring: AKS	S	Summer internship, not further specified	On-site subject matter experts, licensed teachers
Lian et al., 2015	UGs 2 nd year or higher	UGs	Peer mentoring: GEE, AKS, PRM	N.S.	1 mtg/month or 1 mtg/block, for 2 hrs or less	N.S.

Aderibigbe et al., 2015	UGs	UGs	Peer mentoring: AKS	-	N.S.	Faculty & guidance staff
de Oliveira et al., 2015	UGs	UGs	Peer mentoring: AKS	- or S	12 hrs/wk	Faculty
Walsh et al., 2015	UGs	Grades 9-10 high school youth	Service-learning, youth mentoring: GEE, EPS, AKS, PRM	C	2 x 75-minute mtgs/wk for 10-12 wks	N.S.
Nelson & Youngbull, 2015	UGs	Highschool and middle school youth	Service-learning, youth mentoring: AKS	C	1-3 hrs/semester	Faculty & peers
Hemmerich et al., 2015	UGs 3 rd & 4 th year	UGs	Internship, peer mentoring: AKS	N.S.	1 semester, not further specified	Faculty & peers
Everhard, 2015	Exp UGs 3 rd & 4 th year	UGs 1 st year	Near-peer mentoring: GEE, AKS	C	7- 8 mtgs/semester	Faculty
Grant et al., 2015	UGs	Grades 5-12 youth	Community based, youth mentoring: AKS	- or C	Typically, 1-2 mtgs/wk	Faculty & middle/high school teachers
Santiago et al., 2016	UGs	Disabled K-8 youth	Service-learning, youth mentoring: GEE, EPS, AKS	C	1 mtg/wk for 6 wks	Faculty & teacher
Menard & Rosen, 2016	UGs	Grades 4-5 youth	Service-learning, youth mentoring: AKS	-	12 x 2 hr mtgs over 4 wks	Faculty, peers, & general music teachers
Philipp et al., 2016	UGTAs	UGs	Peer mentoring: AKS	S, C	Variable: Included wkly mtgs, 15-minute mtgs/course session, mtgs every lab session, and pre-scheduled private mtgs	Faculty
Keup, 2016	UGs	UGs	**Peer mentoring: GEE, EPS, AKS	-, S & C, S, or C	N.S.	N.S.
Cutright & Evans, 2016	Exp UG seniors	Freshman UGs	Near-peer mentoring: AKS, PRM	S, C	1 mtg/wk and as needed by email over 2 semesters	Faculty

Roy & Brown, 2016	UGs 2 nd & 3 rd year	1 st year UGs	Peer mentoring: GEE, PRM	C	1-3 hrs in total over multiple 20-30-minute mtgs, not further specified	Faculty
Wong et al., 2016	UGs	UGs	**Peer mentoring: GEE, EPS, AKS, PRM	-, C, or S & C	1 mtg/wk, 2 mtgs/wk, or as needed over 1 semester	Faculty
Murphy, 2016	UGs	UGs	Peer mentoring: AKS	C	5 hrs/wk	Faculty, library staff, & peers
Köse & Johnson, 2016	UGs	Middle school youth	Youth mentoring: GEE, AKS, PRM	C	6 mtgs/semester	Faculty & peers
Fogg-Rogers et al., 2017	UGs 2 nd year	Youth age 8-11, 2 nd year UGs	Service-learning, peer mentoring: EPS, AKS	-	3 mtgs cumulating in 2.5 days	Faculty & peers
Lee et al., 2017	UGs	Middle school youth	Service-learning, youth mentoring: GEE, EPS, AKS, PRM	C	~ 20 hrs/semester	Faculty & peers
Bunting & Williams, 2017	UGs 2 nd year or higher (some Exp)	1 st year UGs	Peer/near-peer mentoring: AKS	N.S.	15-20 hrs/wk over 1 semester	Faculty & staff
Wallin et al., 2017	Exp UGs 3 rd & 4 th year	1 st & 2 nd year UGs	Near-peer mentoring: AKS, PRM	-	Wkly over 1 academic yr	Faculty & peers
Ryan et al., 2017	UGs	UGs	Peer mentoring: EPS, AKS, PRM	N.S.	7.5 hrs/wk for 30 wks/ yr	N.S.
Davis, 2017	UGs	UGs	Peer mentoring: AKS, PRM	N.S.	N.S.	Faculty, GTAs, & peers
Masehela & Mabika, 2017	UGs	UGs	Peer mentoring: EPS, AKS, PRM	S	N.S.	N.S.
Gunn et al., 2017	Exp UGs 4 th year	1 st year UGs	Near-peer mentoring: GEE, EPS, AKS, PRM	C	5 x 50-minute mtgs over 1 semester	Faculty & peers
Finkel, 2017	UGs	Highschool youth	Youth mentoring: AKS	S	Wkly over 1 academic yr, unspecified frequency	Faculty researchers & post-doctoral students

						during a 10 wk summer internship	
Rohatinsky et al., 2017	UGs	UGs	**Peer mentoring: EPS, AKS, PRM	- or S		Ranged from hrs to wks and 1 mtg to wkly mtgs	Faculty, nursing staff, & N.S.
Lim et al., 2017	UGs 2 nd year or higher (some Exp)	1 st year UGs	Peer/near-peer mentoring: EPS, AKS	-		N.S.	Peers
Draves, 2017	UGs	UGs	Peer mentoring: EPS, AKS	-		4 activities or mtgs over 1 semester	Peers
Abdolalizadeh et al., 2017	UGs 2 nd year	1 st year UGs	Peer mentoring: EPS, AKS, PRM	N.S.		1 phone call/wk to 1 phone call/3wks, other interactions not further specified	Faculty & peers
Won & Choi, 2017	UGs	UGs	Peer mentoring: AKS	-		2hr/wk for 1 semester	N.S.
Goodrich et al., 2018	UGs	UGs	Peer mentoring: AKS	C		1 semester, not further specified	Faculty & TA
Najmr et al., 2018	UGTAs 2 nd year or higher	Grades 6-12 youth	Service-learning, youth mentoring: AKS	C		2 semesters, not further specified	Faculty & peers
Fried et al., 2018	UGs 3 rd year or higher	1 st year UGs	Peer mentoring: EPS	C		At least 2 mtgs/wk over 1 yr	Faculty & peers
Sweeney, 2018	UGs 4 th year	3 rd year UGs	Peer mentoring: AKS	-		At least 2 open lab sessions/month over 1 semester	Faculty
Kramer et al., 2018	Exp UGs 4 th year	2 nd and 3 rd year UGs	Near peer mentoring: AKS, PRM	- then S		2 mtgs/wk for 2 hrs/mentee	Faculty
James, 2019	UGs 2 nd & 3 rd year	A-level pupils	Peer mentoring: GEE, AKS	C		~ 6 x 1hr mtgs over Spring term	Faculty & peers

Bonner et al., 2019	UGs	UGs	Peer mentoring: GEE	-		5 x 2hr workshops	Peers
Hastings & Sunderman, 2019	UGs	K - 12 youths	Youth mentoring: PRM	N.S.		N.S.	N.S.
Wheat et al., 2019	UGs	K - 12 youths	Service learning, youth mentoring: EPS	C		1 mtg/wk per mentee for 1 semester	Faculty & peers
McIntosh, 2019	UGs 2 nd & 3 rd year	1 st year UGs	Peer mentoring: AKS	N.S.		N.S.	Faculty, academic staff, & peers
Weiler et al., 2019	UGs	Youths age 11-18	Service-learning, youth mentoring: GEE, EPS, PRM	C		4 hrs/wk for 12 wks	Faculty, family therapists, & graduate trainees
Diaz et al., 2019	UGs	Grades 4 – 6 youth	Service-learning, youth mentoring: AKS	C		1 hr/wk for 6-7 wks	Faculty, grades 5 – 6 teachers, & peers
Moy et al., 2019	UGTAs	High school youth	Youth mentoring: AKS	C		9 x 2 hr mtgs over 10 wks	Faculty & peers
Huvar et al., 2020	UGs	UGs, grades K – 12 youth	Peer/near-peer mentoring, youth mentoring: AKS	C		N.S.	Faculty, grades K - 12 teachers, & peers
Dunn & Moore, 2020	UGs 2 nd year	1 st year UGs	Peer mentoring: AKS	N.S.		Wkly mtgs over 1 academic yr	Peers
Daley & Zeidan, 2020	UGs	Middle school youth	Youth mentoring: Not further specified	N.S.		N.S.	N.S.
Cruz & Diaz, 2020	UGs	UGs and high school youth	**Peer mentoring, youth mentoring: GEE, EPS	- or N.S.		Anywhere between 1-3 hrs/wk, lasting months to a year, not further specified	N.S.
Matheson et al., 2020	UGs	Youths age 11-17	Service learning, youth mentoring: GEE, EPS, AKS	C		4 hr/wk for 16 wks	Faculty, mentor coaches, & peers

Spaulding et al., 2020b	UGs	1 st year UGs	Peer mentoring: AKS	S & C	1 hr group session/wk and 2 x 1 hr mtgs/wk for 1 semester	Faculty & Office of Student Life staff
Spaulding et al., 2020a	UGs	1 st year UGs	Peer mentoring: AKS	S & C	1 hr group session/wk and 2 x 1 hr mtgs/wk for 1 semester	Faculty & Office of Student Life staff
Forrester et al., 2020	UGs	Grade 9 youth	Youth mentoring: EPS, PRM	-	1 academic yr, not further specified	ABCD facilitator, grade 9 teachers, & peers
Athamanah et al., 2020	UGs	High school youth with intellectual and developmental disabilities (IDD)	Near-peer mentoring: EPS	-	1 mtg for at least 30-minutes/wk and monthly social events for 1 yr	Faculty & peers
Baroudi & David, 2020	UGs	UGs	Peer mentoring: GEE, EPS, AKS, PRM	S	Multiple sessions/day depending on mentees needs, for at least 1 semester	Faculty & peers
Rompolski & Dallaire, 2020	UGTAs	UGs	Near-peer mentoring: AKS	C	10 hr/wk for 1 quarter	Faculty, GTAs, peers
Pica & Fripp, 2020	UGs	Juvenile offenders on diversion	Service-learning, youth mentoring: GEE, EPS, AKS	C	1 mtg/wk for 1 semester	Faculty & peers
Skjevik et al., 2020	UG medical students	Medical student UGs	Peer mentoring: GEE, EPS, AKS	- or N.S.	Anywhere between 2 mtgs/yr and 24 mtgs/yr, not further specified	Faculty & peers
Haqqee et al., 2020	UGs 3 rd & 4 th year	1 st year UGs	**Peer mentoring: GEE, EPS, AKS, PRM	- or C	1 mtg/wk for 10 wks or 2-3 50-minute-mtgs/wk for 1 semester	Faculty & peers

N.S., not specified; - indicates none provided; S, indicates stipend; C, indicates credit for class or toward graduation; GTA, graduate teaching assistant; UGTA, undergraduate teaching assistant; Exp, Experienced (to imply at least 1-prior year training and only junior or senior standing UGs); GEE, education/career goal establishment and evaluation; EPS, emotional and psychological support; AKS, academic content knowledge support; PRM, presence of a role model. Peer vs near-peer, near-peer = Exp UGs mentoring other UGs or UGs mentoring high school students transitioning into post-secondary education. *Adapted from Gershenfeld (2014). **Studies that encompass multiple programs (e.g., participant pools from multiple programs, systematic reviews, etc.).

Table 2*. Theoretical/conceptual frameworks, methods, and findings in UG mentoring studies.

Author & year	**Theoretical/conceptual framework	LEBIE	Methods and N	Data collection	Findings
Douglass <i>et al.</i> , 2013	**Zone of Proximal Development (ZPD) (Vygotsky, 1978) and Relational-Cultural Theory (RCT; Miller & Stiver, 1997)	4	MM, quan: Ranking of mentor characteristics via UG Peer mentor Ranking Survey (UPMRS) qual: Open-ended perception questions via UG Peer Mentors Survey (UPMS) N=12 mentors	SR ranking and mentors' perceptions	UG mentors ranked knowledge of writing process, good communication skills, and trustworthiness as the most important skills of mentors, and prior mentoring experience and mentor availability as least important. UG mentor perceptions of the experience were positive, citing influence on their instructional abilities, learning to become an educator, and a requirement that they "think like a teacher".
Yilmaz <i>et al.</i> , 2013	Theoretical concepts of robotic design, nothing specific to mentoring	4	Qual only: Survey, N = 21 in first year 2 semester course, N=18 in second year 2 semester course	UGs enrolled in a robotics course in conjunction with mentoring completed a survey on the course which provided limited feedback related to mentoring	UG mentors expressed an increase in robotics understanding and interest as well as an increased interest in associated careers.
Burton <i>et al.</i> , 2013	**Student lifecycle framework in context of transition in-transition out (TiTo) model of peer mentoring (Lizzio, 2012)	4	Qual only: Likert SR survey, N=34	UGs enrolled in a capstone mentoring course completed Likert scale SR survey on the effectiveness and effects of the program	UG mentors reported increased sense of belonging, enjoyment of the program, and a positive learning experience. UG mentors displayed a significant increase in psychological literacy.
Cushing & Love, 2013	**Participatory planning theory, cultural responsiveness, & critical consciousness (Freire, 1970)	4	Qual only: SR in focus group N=36	SR during semi-structured focus groups held by a researcher not involved in the course	UGs overall expressed increased cultural responsiveness and awareness, increased satisfaction with learning during the course, and improved interpersonal and communication skills.
Karp & Maloney, 2013	Principles of grounded theory (Glaser & Strauss 1967; Charmaz 2006) concerning data collection, nothing specific to mentoring	4	Qual only: Open-ended interview questions N=>150	UGs enrolled in the course/program were given open-ended questions by the faculty that instructed their course section	UGs reported enjoyment in the experience, enjoyment in applying skills learned at university, and/or solidification of higher-level concepts.
Hryciw <i>et al.</i> , 2013	**Collaborative learning, cooperative learning, PASS model (Topping & Winterhoff, 2001)	4	Qual only: Surveys, closed and open ended, N=4 1st year, N=4 2nd year	UG mentors given a survey consisting of 7 closed-ended questions using a 5-point Likert scale and another containing 10 open-ended questions at the end of each semester	UG mentors indicated the positive outcomes of the program to be helping first year students in coursework and improving their knowledge, development of leadership skills, increased comfort in teaching others, improved oral communication skills, understanding of bioscience, and general confidence.

Afghani <i>et al.</i> , 2013	**Peer-assisted mentorship (Topping, 1996; Ten Cate O, 2007), cascading model	4	MM, quan: Likert scale survey, qual: 2 open-ended questions N=34 includes UGs, medical students, and faculty, no further specification provided	UGs completed 2 open-ended questions on opinions about the program and a Likert scale survey on perceptions of professional development and changes in attitude	Qual findings suggested significant changes in the attitudes and abilities of the UGs, sense of empowerment and personal transformation. Quan findings show an increase in self-confidence, leadership, and abilities and an awareness of the importance of cultural diversity and serving the underserved population.
Karlin <i>et al.</i> , 2013	**Education for Sustainable Development (ESD; UNESCO, 2013, para. 1), relational, integrative thinking and/or systems theory (Barth & Tim, 2011; Cusick, 2008; Dale & Newman, 2005; Tilbury & Wortman, 2004),	4	MM, quan: Likert scale survey, qual: Open-ended questions N=7 includes UGs, GTAs, faculty, no further specification provided	UGs completed open-ended questions and a Likert scale survey on perceptions and perceived outcomes	Positive outlook on in-person interactions and helping students learn, and a reported development in leadership & communication skills. Challenges included organizational constraints, widely variable mentee research experience, and a lack of clarity on mentor authority.
Haddock <i>et al.</i> , 2013	**Family Systems Framework (Bowen, 1974)	4	Qual only: Semi-structured focus groups consisting of open-ended questions N=141	Mentor SR	Mentors reported personal growth and professional development, as well as positive influence on their civic attitudes and civic engagement.
Ward <i>et al.</i> , 2014	None explicitly stated as a framework for the study, but authors report development of a new framework through the study: Theory of Multidimensional Responsiveness	4	Qual only: Grounded theory journal entries, retrospective assessment questions, project director's observations N=26 mentors over 2 years	Mentor SR & project director's report	Themes by which mentors report to have fostered development in mentees were identified by authors to be guidance, emotional supportiveness, companionship, integrity, insight, demanding of accountability, and a multidimensional responsiveness.
Packard <i>et al.</i> , 2014	**Legitimate peripheral participation (Lave & Wenger, 1991)	4	Qual only: Nested case studies with purposeful sampling for interviews N=4	Interviews with mentors, faculty, and mentees	Mentors establish credibility from prior lab experience and faculty-scaffolded authority. Mentors feel authority when supervision is delegated to them.
James, 2014	Not explicitly stated	4	MM, quan: Likert scale survey Psychological Literacy Scale (Chester <i>et al.</i> , 2013), Likert scale survey Mentoring impact – mentors (Hryciw <i>et al.</i> , 2013) qual: 1 open-ended question and pre and post focus groups N=8	SR ranking and mentors' perceptions on improvement of skills and/or benefits, and focus groups to determine reasons for becoming a mentor, perceived value of training, perceived benefits, and challenges and rewards	Significant increases in valuing intellectual challenge required to use scientific thinking and being insightful and reflective pre- to post-mentoring. Verbally reported improvements in communication, confidence, and teamwork.

Washburn & Zevallos, 2014	Journaling as a tool for self-reflective practice (Terrion & Philion, 2008)	4	Qual only: Sharing Your Recipe for Academic Success (SYRAS) writing exercise with 4 open ended prompts N=15	UG mentors completed the SYRAS exercise once during their pre-program training	Mentors provided responses on chronic academic and social challenges, with some engaging in deeper reflection than others. Authors' state that this exercise better prepared mentors for the program. No other data on mentor perspectives were collected, but authors' do discuss a need for qualitative data collection throughout the program.
Lamb & Aldous, 2014	**Bernstein's model of pedagogical device (1990)	4	Qual only, "multi-method" and "qualitative case study approach" explicitly stated: Questionnaires, survey, focus group interviews, case study, discourse analysis of emails between mentors and mentees N=12	Mentor SR and faculty interpretation of emails	UG SR and faculty email analysis show a gain in experience with establishing guidelines for communicating and supporting mentees in managing their heavy academic and outside of school loads. Authors discuss limitations of electronic communication between mentors and mentees.
Monk <i>et al.</i> , 2014	**Place-based education & Student-Scientist Partnership	4	Qual only: Open-ended survey questions with written response (N=14 1st year, N=22 2nd year) and open-ended questions at focus groups (N=8 1st year), program included UG, postgraduate, and faculty mentors, but no further specification was provided	SR to open-ended questions, with mentors providing written responses OR focus group responses during the first year, and only written responses during the second year	Mentors reported improvement of their scientific communication skills, enjoyment in sharing their knowledge with mentees, and the program to be rewarding overall.
Schuetze <i>et al.</i> , 2014	**Socio-constructivist transformative lens (Freire, 1970; Vygotsky 1978), Mayan's notion of interdependence (Clark <i>et al.</i> , 2014), Papert's theory of constructionism (1980), Engeström's (2001) expansive theory	4	Qual only "multi-method" stated: meeting notes, interviews, field notes, and focus groups N=37	See Methods and N: Authors provide no further description of data collection	Authors use UG quotes to support observations of self-efficacy development attenuated by their involvement in the program and affirmation towards STEM career goals.
Tenenbaum <i>et al.</i> , 2014	**Near-peer mentorship model (Jett <i>et al.</i> , 2005)	4	Qual only: SR survey with 20 free-response questions N=7	Mentors completed a free-response survey electronically after completion of the program	Mentors expressed growth, maturation, career development, and increased confidence and/or ability in teaching.
Wasburn-Moses <i>et al.</i> , 2014	Service-learning (Jacoby, 1996; Missouri Department of Education, n.d.), Direct service-learning (Office of Research, 1993, p. 2)	4	MM, quan: Motivation to Volunteer Scale (MVS), qual: Diagnostic Learning Logs (DLLs) and focus groups N=20	UGs completed the MVS pre and post course, the DLLs four times throughout the semester, and attended a focus group at the end of the course	UG responses provided three major themes: Increased knowledge and awareness of the mentee population, a motivation to seek challenge through the program, and an improvement in communication skills.

Thalluri <i>et al.</i> , 2014	**Peer coaching	4	Qual only: 4 open-ended questions N=Not stated (Quan and qual stated for mentees but only qual stated for mentors)	During the final meeting mentors completed 4 open ended questions	Mentor quotes that were provided indicated further consolidation of knowledge, maintenance of focus on the course, increased sense of responsibility, improved leadership skills, improved time management, perceived advantage of being in the same class as mentees, increased empathy for teachers, and some challenge in feeling rushed to understand concepts.
Zentz <i>et al.</i> , 2014	**Peer-assisted learning (PAL)	4	MM, quan: Likert scale survey, qual: 3 open-ended questions N=136	UGs answered 3 open-ended questions and completed a Likert scale survey about their experience as mentors	UG mentors reported that the program reinforced their own knowledge and promoted self-reflection. The majority of mentors perceived themselves as teachers during the course and indicated it was effective in demonstrating a lifelong learner role.
Ross & Bertucci, 2014	**Peer-assisted learning (PAL)	4	Qual only: Likert scale survey and 1 open ended question N=not stated	At the end of the program, UGs completed 5-point Likert scale survey and answered a free-text question to gather their perspectives	UGs enjoyed the program and found it to be beneficial. They indicated an improvement of interpersonal and communication skills, their academic skills and knowledge, and an increase in confidence.
Anderson <i>et al.</i> , 2015	**Career advancement and psychosocial support frameworks, medical residency model (Papay <i>et al.</i> , 2012; Strawn & Livelybrooks,2012), near-peer mentor (NPM) model (Singleton & Simmons-Worthen,2014)	4	Qual only: Online surveys (authors claim mixed method study and qual only study, provided only qual data) N=42	SR pre and post survey responses were thematically analyzed	UGs reported gains in communication skills, professionalism, confidence, student management, pedagogy, and career education.
Lian <i>et al.</i> , 2015	Not explicitly stated	4	Qual only: SR questionnaire with demographic, Likert scale, closed ended, and open-ended questions N=91	UGs completed pre-test validated SR questionnaires after becoming involved in the program, no further specification of timing provided	Majority of mentors reported academic gains to be the greatest benefit and many reported it to be more beneficial than other mentoring programs. Challenges reported by mentors included negative attitudes of mentees and poor time management of all involved parties.
Aderibigbe <i>et al.</i> , 2015	**Critical constructivist	4	MM, quan: Survey N=19 qual: Focus groups N=8	Surveys were administered and focus groups were held post program	Mentors overall stated the peer mentoring experience was positive; however, reasoning varied considerably.
de Oliveira <i>et al.</i> , 2015	Not explicitly stated, near peer teaching discussed	4	Qual only: Open-ended written reports N=16	UG mentors provided written reports at the end of the course that were qualitatively analyzed for frequently reported challenges and benefits	The most frequently reported benefits of the program included gaining a deeper knowledge of the subject matter and improved academic performance, professional skills, and organizational skills. Challenges included learning how to teach, high demand on time, and shy or over confident mentees.

Walsh <i>et al.</i> , 2015	**Hellison's teaching personal and social responsibility (TPSR) model, Student proximal outcomes (Whitley & Walsh, 2014)	4	Qual only: Case studies, observations, mentor reflections, and semi-structured interviews N=8	Authors pulled qualitative data from mentor observations, perceived impact of the program, session reflections, and one on one interviews conducted at the end of the program	Authors identified themes of self-discovery, leadership/professional skill development, gains in career/life perspectives, and a sense of community influence.
Nelson & Youngbull, 2015	Tribal Critical Race Theory (TribalCrit)	4	Qual only: Cross-comparison of mentor testimony N=13	Collected and transcribed testimonials from mentors and cross-compared for content	Mentors reported tapping into their Indigenous knowledge, building relationships, being a positive influence on their tribal communities, and recognizing that learning is cyclical. They connected this experience and their role in society and as a whole to Native American students having the power to enact change.
Hemmerich <i>et al.</i> , 2015	Not explicitly stated	4	Qual only: Pre- and post-internship essays N =31	Mentors completed reflective essays and responses were coded to identify major themes	Following the program, a number of mentors expressed interest in pursuing a career in academia. Some endorsed increased comfort with teaching, increased empathy for challenges in teaching, improved understanding of content, and improved communication skills. Impressions of the program were overall positive.
Everhard, 2015	**Socio-constructivist approach	4	Qual only: Questionnaire and voluntary reports N=28	Mentoring questionnaire was given at the end of the semester, some participants provided voluntary reports on their specific experiences	Mentors mentioned enhanced ability to find and use resources and reported improved self-confidence, metacognition, and interpersonal skills.
Grant <i>et al.</i> , 2015	Not explicitly stated	4	MM, qual: Interviews N=13, observations, journal reflections, physical artifacts; quan: Surveys N=33	Journals, faculty observations, and physical artifacts were completed/collected throughout the program, interviews were conducted at end of year, and survey administration time was not stated, all data was triangulated for integration	Most UG mentors felt the program benefited their ability to work in a team, lead a team, lead group discussions, teach STEM concepts and methods, and generate interest in STEM activities and research. Another frequently reported positive was an opportunity to practice science communication skills. Nearly all mentors felt support from the instructor was necessary to carry out their role.
Santiago <i>et al.</i> , 2016	Intergroup Contact Theory Framework (Allport, 1954)	3	Quan only: pre-, during- and post-administration of the "Attitudes Toward Disabled Persons Scale" N=51 experimental & N=31 control	SR by ATDP-Form A was provided 2 weeks before the start of the program, during the program, and two weeks after the program	No significant difference in attitudes toward individuals with disabilities between UG Kinesiology students who participated in service learning and those who did not.
Menard & Rosen, 2016	University model of New York Philharmonic's Very Young Composer (VYC) program, "embedded design" (Yin, 2009)	4	Qual only: Case studies and interviews N=10	Observations of UGs throughout the program and post program interviews with UGs were transcribed and coded to identify commonality between and within each data set	Common observations and interview responses indicated major benefits to be professional development, improved understanding of musical composition, and a strengthening of participant identity as composers. The major challenges identified

were limited time and a lack of confidence in their teaching ability.

Philipp <i>et al.</i> , 2016	Not explicitly stated	4	Qual only: Likert scale SR survey adapted from the Efficacy Belief Instrument (Riggs & Enochs, 1990) N=97 and written reflections to 4 open-ended prompts, 99 completed N=21 analyzed	UGTAs completed SR surveys and reflections at the end of the academic semester, authors analyzed survey results as a whole and used a stratified random sample of 21 reflections - categorizing statements by research question	UGTAs reported improved academic skills as learners and teachers, improved communications skills, and increased depth of knowledge in their respective disciplines.
Keup, 2016	**Four essential learning outcomes and ten high impact practices (HIP) identified by the Association of American Colleges and Universities (AAC&U)	4	Quan only: 2009 Peer Leadership Survey (National Resource Center for The First-Year Experience and Students in Transition in the United States) on demographic information, peer leader experience, role and program structure, and SR change due to the role (Author stated qual data collected by open-ended questions but not analyzed at time of writing) N=1,972	UG students holding at least 1 peer leadership position from 142 institutions completed the survey which was provided to faculty at these institutions to be forwarded to qualifying individuals	Vast majority of UGs reported benefits to their skill development, academic ventures, and campus involvement. Peer leaders in community service roles reported the most positive change and peer leaders receiving financial compensation reported the broadest range of positive change.
Cutright & Evans, 2016	**Near peer mentoring	4	Qual only: Observations, SR survey, and interview - surveys and interviews contained the same 11 open-ended questions and 1 closed-ended question N=8	UG mentors completed SR exit surveys and exit interviews that were observed, results of each were blind coded	All mentors found the experience to be unique, more than half reported an expansion of knowledge, and all endorsed improvement in time management and communication skills - largely attributed to faculty support.
Roy & Brown, 2016	Not explicitly stated	4	Qual only: Semi-structured interviews, N=34	Qualitative analysis of data gathered through semi-structured interviews	Mentors reported their motivation and personal satisfaction improved due to their realization of their ability to support and help students they mentored.
Wong <i>et al.</i> , 2016	**Only one study in this review stated a framework: Maslow's framework of needs to assist transition to university life	4	Integrative review of 11 qual only studies, 9 of which had UG mentors, N=3 to 4, N=58, N=76, N=15, N=9, N=14, N=17, N=Not stated, N=8	Within the studies that had UG mentors, they completed/attended at least one of the following: Surveys, questionnaires, interviews, focus groups.	Overall positive outcomes most frequently reported in academic, social, mental health, professional, and personal skills essential to a profession in nursing.

Murphy, 2016	Not explicitly stated	4	Qual only: interviews N=10 over 4 years - authors report drop-outs but do not specify when	Mentor interviews were all conducted in 2014 at the end of the programs 4th year either in person, through email, or over the phone	Some mentors reported that the PAL program had specific positive outcomes in improving their skills in setting goals, planning, and public speaking. The primary goal for the program was for peer mentors to benefit through the experiential mentoring program, and mentors overall indicated the goal was achieved and noted it to be a memorable experience.
Köse & Johnson, 2016	Nested mentorship model	4	MM: qual: Informal survey with open-ended questions, participant field notes, and post-course letters to future UGs/middle school students quan: Fennema–Sherman Mathematics Attitude Scale (MAS) survey N=25	Throughout the course UGs completed field notes, they were given the Fennema–Sherman MAS survey during the first and final week of the course and the informal open-ended question survey on the 9th and the final week, during the last course session UGs wrote course letters to future UGs and/or middle school students on their experience	Qual: More than half of the UGs reported increased confidence in mathematical abilities and awareness of women's underrepresentation in mathematics. Quan: UG attitudes toward mathematics improved in all measured areas except for awareness of women's underrepresentation in mathematics (authors attribute this disparity between quan and qual to increased knowledge without a change in attitude).
Fogg-Rogers <i>et al.</i> , 2017	Not explicitly stated	4	MM: qual: Open-ended questions, quan: Perceived self-efficacy (PSE) scale N =20	Survey based post program. UGs filled out surveys and provided responses to open-ended questions provided by faculty post program	Mentors, both student engineers and pre-service teachers, agreed that the program was successful, enjoyable, and that it was beneficial to work in pairs. Student engineers largely reported an increase in confidence to engage with the public and improved communication skills.
Lee <i>et al.</i> , 2017	Multicultural service learning (Dunlap, 1998)	5	Qual only: Reflection essay N=58	Reflections essays were written by the UG mentors post program and were qualitatively analyzed	Majority of mentors reflected on a philanthropic or adverse view, and did not endorse a mutual relationship with mentees. This is in opposition to the authors' expected results of reflection on civic views and development of mutual relationships.
Bunting & Williams, 2017	**Legitimate peripheral participation (LPP; Lave and Wenger, 1991)	4	Qual only: Interviews collecting narrative data N=12	UG post program narrative provided in response to faculty inquiry.	All mentors agreed that one or more of 5 themes identified by authors contributed to their transformative experience through mentoring: Meaningfulness of everyday experience, pretending as a move toward transformation, unfamiliarity and surprise as catalysts, reflection in transformation, and the value of participating alongside one's own mentors.
Wallin <i>et al.</i> , 2017	**Not explicitly stated, Hunzicker's (2012) framework for teacher leadership and community learning discussed	4	Qual only: Interviews and focus group N=9	UG semi-structured focus groups and interviews conducted by faculty post program	Overall, mentors reported improved understanding of teacher leadership, more positive attitudes toward teacher leadership, development and improvement of teacher leadership skills, increased sense of and ability to foster a professional community, and

					improved confidence/ability in professional interactions.
Ryan <i>et al.</i> , 2017	Not explicitly stated	4	Qual only: Semi-structured interviews, reflective logs, observations, document analysis, and focus groups N=18	Semi-structured interviews, peer mentor notes and reflective logs, documents such as peer mentoring manuals and guidelines, and focus group member check de-briefing sessions, all collected/administered intermittently throughout the 3 years of the program - Semi-structured interviews and focus groups included similar open-ended questions, some participants were included in multiple of each throughout the program	Mentors frequently reported benefits and challenges concerning setting boundaries, providing academic tutoring, and interpersonal or organizational navigation – such as interactions with mentee parents and involved institutions. Frequently reported outright benefits included improved interpersonal skills, increased compassion and perspective, improved professional skills, and observing change in the mentees. All or nearly all mentors considered being a mentor for students with IDD one of the most meaningful experiences they had at this university.
Davis, 2017	**Mentoring mosaic (Mullen, 1999, p. 4)	4	Qual only: Interview questionnaire, journal entries, peer and member checks, researcher field notes N=11	Author reports collecting participant data and compiling their own, using triangulation, peer review, member checks, and qualitative description to obtain qual data for analysis - no description of timeline provided	UGs experienced an increased awareness of community member roles, a sense of shared ownership in learning and growth, and increased comfort in sharing their perspectives and concerns. Some noted challenges of negligent or indifferent peers and/or feeling underutilized as a teacher.
Masehela & Mabika, 2017	Morphogenic framework	4	Qual only: In-depth open-ended question interviewing N=3 (authors explicitly state MM, but only qual data provided for mentors)	Critical discourse analysis approach of Norman Fairclough (1989) used to analyze and pull data from interviews – no description of timeline provided	All three mentors interviewed reported improvement in confidence and/or academic ability of their mentees, and endorsed that the program provided them at least some academic or interpersonal benefits/improvement.
Gunn <i>et al.</i> , 2017	**Crisp and Cruz's (2009) mentoring framework	4	Qual only: Reporting of at least 4 critical incidents N=16	Data was analyzed using the Critical Incident Technique (CIT), no description of timeline provided	In relation to the 4 domains relevant the framework model used, the majority of UG mentors felt the Existence of a Role Model (ERM) was the most beneficial and challenging aspect of the mentoring program. Overall, what mentors reported to have liked most about the program was the gaining of leadership skills, a chance to share their experiences, and their participation in planning and organizing activities for mentees.
Finkel, 2017	**"Laddered" mentoring model	4	Qual only: Closed-ended survey N=15	UGs completed surveys provided by faculty post program	The majority of the UG mentors in the program reported becoming interested in exploring a career in teaching and that their participation in the program made them more likely to pursue such a career.

Rohatinsky <i>et al.</i> , 2017	Not explicitly stated	4	Of the studies included, 1 stated MM, 6 stated quan, 6 stated qual, and 6 did not indicate method, participant numbers reported for studies - N=25 (contains mentors & mentees, not further specified), N=54 (not further specified), N=15, N=20, N=58, N=125, N=16, N=34, N=11, N=17, N=180 (not further specified), N=342 (not further specified), 8 did not specify N	Literature review of mentoring in nursing education including 20 studies with UG mentors with each study using at least one of the following data collection methods: questionnaire, Likert scale survey, open-ended questions, observations, focus groups, journals or peer debriefing	Majority of UG mentors agreed the mentorship programs benefitted them across all four of the following domains: clinical, laboratory, socialization, and academia.
Lim <i>et al.</i> , 2017	Phenomenology and Symbolic Interactionism	4	Qual only: In-depth interviews N=12	Interviews with mentors were conducted by faculty and a research company, no description of timeline provided	UG mentors' views of their roles changed over the course of the program. They reported becoming more comfortable with their role, more egalitarian leaders, and that they were able to remain calm when being questioned by multiple mentees at a time. Mentors also endorsed improved communication skills and interpersonal skills that they feel they would not have gained in their traditional student role.
Draves, 2017	Not explicitly stated	4	Qual only: Written reflections, peer mentoring activities and assignments, individual and focus group interviews N=4	Peer mentoring activities and assignments were collected throughout the program, written reflections were completed by mentors after each activity, and the author conducted peer-mentoring interviews on an individual and focus group basis - one mid program individual interview, end of program individual and focus group interviews	Expanded professional knowledge was the most mentioned benefit by mentors. All mentors felt the program was beneficial, with two participants discussing how peer mentoring would fit into their post program future.
Abdolalazadeh <i>et al.</i> , 2017	Not explicitly stated	4	Qual only: Focus groups N=15	Qualitative analysis of mentor post program focus group comments	UG mentors preferred a formal relationship with their mentees and endorsed that their personal abilities and social skills improved as a result of the program.
Won & Choi, 2017	**GROW mentoring model (Whitmore, 2009)	4	Qual only: Focus groups N=12	Qualitative content captured from mentor comments in a post program focus group and analyzed through content analysis	UG nursing student mentors experienced a sense of gratification, accomplishment through helping mentees, and a sense of meaning in their life.

Goodrich <i>et al.</i> , 2018	Not explicitly stated	4	Qual only: Interviews, observations, and post course questionnaire N=26 (includes UGs and postgraduates, not further specified)	Data was collected through live observations of peer mentoring, a post program questionnaire, and author conducted interviews - once at semester midpoint and once at the end of the semester	UG peer mentors enjoyed the experience and endorsed benefits including enhanced awareness of themselves as teachers, additional comfort with providing and receiving critique, a sense of professional community, and improved confidence.
Najmr <i>et al.</i> , 2018	Not explicitly stated	4	Qual only: 3-4 guided written reflections N=26 (consisting of 4 sophomores, 7 juniors, 12 seniors, and 3 postbaccalaureate students) – data not separable	Analysis of 4 guided written reflections completed by mentors in the Fall of 2015 and 3 guided reflections in the Spring of 2016 – no further description of timeline provided	Mentors felt the program was effective in helping them to explore and identify competencies for teaching and communication of scientific concepts.
Fried <i>et al.</i> , 2018	Not explicitly stated	4	MM: qual: Pre-, mid- & post-intervention semi-structured interviews N=28, quan: Mid- and post-intervention Mental Health Inventory (MHI; Veit & Ware, 1983), Brief Resilience Scale (BRS; Smith <i>et al.</i> , 2008), and Short Form (36) Health Survey (SF-36; Ware, Kosinski, & Gandek, 2003) N=30	Qualitative data was gathered through semi structured interviews of the UG mentors mid and post program. For quantitative analysis mentors had to complete the brief resilience scale, mental health inventory and a short form health study pre-, mid-, and post-program.	UGs reported perceptions that the program had positive influence on their physical activity, resiliency, and mental health. Quantitative results were not consistent with these reports – authors discussed possibility of normal undergraduate stressors bringing about this dissonance.
Sweeney, 2018	Not explicitly stated	4	Qual only: Open-ended questions N=13	Qualitative data was gathered retrospectively through a post program evaluation session to illicit open feedback on the program	The UG mentors expressed satisfaction in their leadership roles and endorsed receiving the unanticipated benefits of improving their own nursing skills.
Kramer <i>et al.</i> , 2018	Not explicitly stated	4	Qual only: Journals, “mentor session reports”, questioning N=N.S. - author states it ranged from 10-20 per year	UG mentors kept journal logs of time and reflections of their experience and filled out planning forms intermittently throughout the program, and were questioned at the end of each semester – questioning procedure not further specified	Senior UG nursing student mentors described being a mentor as beneficial in their own education and understanding of themselves as a possible teacher or leader. They were also proud in being able to help another person.
James, 2019	Not explicitly stated	4	MM: qual: SR objectives, activities, and reflections N=N.S., quan: Self-efficacy, self-esteem and psychological literacy pre and posttests N=20	UGs took pre and post program tests to provide quantitative data. SR objectives, activities, and reflections were completed after each session and provided qualitative data.	Mentors reported improvement of presentation skills, confidence, and understanding of psychology. Author reported benefits beyond the program, citing that some mentors became involved in outreach and research as a result.

Bonner <i>et al.</i> , 2019	**Work-Integrated Learning (WIL; DISSRTE, 2013; Mahalinga-lyer et al., 2004)	4	MM: qual: Structured written reflections and semi-structured open-ended interview quan: Closed-ended 10-point ordinal rating questions N=12	Mentors completed written reflection just status post the program, 3 weeks later they each participated in a recorded interview which consisted of open-ended questions and closed-ended 10-point ordinal rating questions	The mentors reported that the experience gave them an opportunity to identify weaknesses, define their strengths, help their peers, and understand what mentees needed to know.
Hastings & Sunderman, 2019	**Generativity, Socially Responsible Leadership (Higher Education Research Institute, 1996)	4	MM: qual: In-depth, semi-structured interviews N=9, quan: Loyola Generativity Scale (LGS), Generativity Behavior Checklist (GBC), open-ended reports, Socially Responsible Leadership Scale (SRLS), and a demographic form N=82	Quantitative data was collected first and analyzed by multiple regression and qualitative data was used to support the former – no further description of timeline provided	Mentors acknowledged enhanced generativity conscientiousness as they continued to mentor and an increased desire to act on this awareness. Multiple regression analysis suggests significant associations between generativity, aspirations, and socially responsible leadership.
Wheat <i>et al.</i> , 2019	Not explicitly stated	4	Qual only: Semi-structured interviews, online survey with 4 demographic and 4 open-ended questions, and course evaluations N=7	End of course evaluations inquired about course value from current mentors, online surveys contained questions on UG perceptions of the program, and semi-structured interviews prompting UG SR on the experience were conducted with current and prior mentors – timeline of survey administration and interview conduction not further specified	UG mentors reported improved self-awareness and grief processing self-efficacy.
McIntosh, 2019	Not explicitly stated	4	Explicitly stated to be MM: qual: Focus group, questionnaire, quan: Not explicitly stated N=32	UGs at time point one answered a questionnaire, at point two they participated in a large-scale focus group, at point three another questionnaire was issued and data was subsequently thematically analyzed – no further description provided	Mentors reported increased confidence in their learning alongside its products and endorsed the practicing and development of social consciousness, mindfulness, and leadership in a non-hierarchical manner.
Weiler <i>et al.</i> , 2019	**Rhodes' (2005) model of youth mentoring	4	Qual only: Likert surveys throughout program N=458	UGs completed online surveys at week 9 and week 11 of the program	UG mentors survey results indicated a positive association between their mentoring relationship quality and their experiences within the program. Mentor perceptions of supportive relationships and skill building also moderated a negative relationship between environmental risk and relationship quality, but not individual risk.

Diaz <i>et al.</i> , 2019	**Cognitive development theory (Dewey, 1934; Dewey, 1938), constructivist epistemology (Piaget, 1970)	4	Quan only stated, only qual data provided: Two self-assessments, with 5 open-ended questions in the second N=525	Pre- and post-program self-assessments were completed by mentors and collected through Qualtrics - open-ended questions were thematically analyzed	More than half of mentors reported subjective improvement in content delivery, student engagement, classroom management, and professionalism. Through thematic analysis authors reported identifying benefits to mentors of improved self-awareness and skill in teaching, awareness of the importance of caring for and respecting students, and self-reflection through teaching.
Moy <i>et al.</i> , 2019	Tiered mentor framework employing a ten-week course-based research experience	4	Qual only: Mentor reflections N=5	Mentors submitted post program reflections that were qualitatively analyzed	UGTAs reported gains relating to their roles as teachers, scientists, and mentors.
Huvar <i>et al.</i> , 2020	Cultural Historical Activity Theory (CHAT; Engeström, 1987, 2001)	4	Qual only: Written reflections N=20	14 or 11 reflections per UG mentor were completed over a 16-week semester and used as data sources to be coded and analyzed through constant comparison	UG mentors reported improvements in and rethinking/construction of their scientific identities.
Dunn & Moore, 2020	**Fink's (2003) Taxonomy	4	Qual only: Pre- and post-semi-structured interviews N=5	Data collection via semi-structured interviews at the beginning and end of their 1-year peer mentor term	Improvement and/or presence of five of Fink's (2003) categories of learning were reported by authors after analysis of mentor reflections: Foundational knowledge of leadership learning and application learning (most prevalent), human dimension learning and caring (moderately prevalent), and integration learning (least prevalent). The only category not represented at all was learning how to learn.
Daley & Zeidan, 2020	Expectancy-value theory (Eccles, 2011).	4	Qual only: Semi-structured interviews N=6	UG mentors completed two interviews, the first was concerned with high school – higher education transition and the second had a broader academic focus, each were transcribed and recorded – no description of timeline provided	Participants endorsed improvement or affirmation in self-advocation, improved self-identity, and a sense of belonging through mentoring and their academic experience. Dissonance between confidence and ability was a commonly reported challenge.
Cruz & Diaz, 2020	Not explicitly stated	4	Qual only: Authors reflection on their own mentoring experiences N=2	UGs used their own reflections to determine whether spirituality plays a large role in effective mentoring	Each author professed some fulfillment in their need for spirituality through mentoring, and one mentioned that their mentoring experiences and the feeling of spiritual fulfillment helped her define her mission in life and her intended career path.

Matheson <i>et al.</i> , 2020	Not explicitly stated	4	Quan only: Therapist Belief Scale (TBS; Emery <i>et al.</i> , 2009; McLean <i>et al.</i> , 2003) N=16	Demographic questionnaires and a slightly modified Therapist Belief Scale (TBS) were administered pre-mentor training, the modified TBS was then administered a second time post-mentor training but prior to mentee assignment, and was administered for a third and final time near the end of program	UGs demonstrated the most significant positive change in beliefs from pretraining survey completion to survey completion near the end of the program, suggesting the mentor-mentee relationship was more impactful than the training.
Spaulding <i>et al.</i> , 2020b	Not explicitly stated	4	Quan only: Survey that included demographic questions and 19 closed-ended Likert questions N=309	Over 3 years researchers administered electronic surveys at the end of each Fall semester to mentors participating in the program	Both male and female mentors felt they became more successful scholars and endorsed an improved sense of academic fit. The reported experiences differed between male and females, with females more frequently reporting a better grasp of subject matter, leadership, and presentation skills, as well improved relationships with faculty and TAs.
Spaulding <i>et al.</i> , 2020a	Not explicitly stated	4	Quan only: Survey that included demographic questions and 19 closed-ended Likert questions N=309	Over 3 years researchers administered electronic surveys at the end of each Fall semester to mentors participating in the program	Majority of mentors reported making connections with faculty and friends, developing leadership and communication skills, and consideration of providing mentoring again.
Forrester <i>et al.</i> , 2020	Asset Based Community Development framework (Kretzmann and McKnight, 1993; Dewar, 1997; Kretzmann & McKnight, 1997; Turner <i>et al.</i> , 1999)	4	Qual only: Written reflections, interviews N=between 5 (end) and 13 (beginning), not otherwise specified	Authors state written reflections were provided in response to a series of prompts and describe interviews to have been produced in the form of reflective documentary videos – no further description of timeline or data collection provided	Mentors reported positive benefits of the program to include their observations of change in mentees and their own sense of accomplishment.
Athamanah <i>et al.</i> , 2020	Self-Determination Theory (SDT; Ryan & Deci, 2000; Fisher <i>et al.</i> , 2020)	4	Qual only: Individual interviews, focus groups, written reflections, and weekly check-ins (author mentions quan data collection, but states that it is not used for this article) N=13	All data collection methods were utilized year- and post-program	Peer mentors indicated their perceptions toward individuals with IDD in the community changed positively after participating in the program. They also reported willingness to engage those in the community and workplace with IDD. In addition, peer mentors reported increased sense of disability awareness outside of the program, including positive attitudes toward inclusion of individuals with IDD in work and community settings.
Baroudi & David, 2020	**Constructivist Theory	4	Qual only: Semi-structured interviews containing 9 open-ended questions N=22	Twenty-two semi-structured individual interviews were conducted and recorded to afford participants the opportunity to	Peer mentors reported improved confidence levels and felt they were provided leadership development opportunities.

				describe and elaborate on the benefits of the program	
Rompolski & Dallaire, 2020	Not explicitly stated	4	Qual only: SR reflections N=4, N=1 author reflection	UGTA self-reflection and self-monitoring submitted once every three weeks throughout one quarter, and reflection from one UGTA author	Every UGTA mentor, including the author, endorsed that determining how to teach peers pushed them to better understand the material and increased their confidence in presenting it. Each mentor, including the author, also mentioned the possibility of seeming unprepared or unsure as a major challenge.
Pica & Fripp, 2020	Not explicitly stated	4	MM: qual: Weekly reflections, quan: Attitudes toward juvenile offenders (AJO) Likert scale survey N=13	AJO survey was administered during the first session of the course prior to any other coursework or discussion, and again during the final session, UG mentors also wrote weekly reflection papers relating their meetings to class material	Survey results indicated a positive change of attitude in mentors toward juvenile offenders. Mentor reflections indicated that they became aware of their similarities with the mentee and that their meetings brought about respect for the cultural and systemic factors that attributed to the mentees involvement with the legal system.
Skjevik <i>et al.</i> , 2020	Kirkpatrick's four level evaluation model as a framework	4	Systemic review with qual analysis by the Medical Education Research Study Quality Instrument (MERSQI; Cook & Reed, 2015) of 17 different mentorship programs, only 5 contained UG mentors, 3 stated qual only: Questionnaires or interview, 1 stated MM, 1 provided no evaluation N=N.S. for each	Of the programs with UGs 2 administered questionnaires, 1 conducted interview individually or by focus groups, and 1 used mixed method design - no specification of data collection timeline was provided, but the 4 studies with forms of evaluation included mentor perspectives	Findings by analysis of mentor perspectives were not entirely separable from the studies without UG mentors. Overall, data is extremely supportive of mentoring medical students in groups, particularly when programs are longitudinal, mandatory, and aligned with curriculum. Some participants from programs with UG mentors endorsed improved comprehension of themselves and others, personal and professional gain, and gratification in observing improvement in mentees.
Haqque <i>et al.</i> , 2020	**Constructive Alignment (Biggs & Tang, 2003)	4	Qual only: Survey containing Likert scale and open-end questions N=32	UG mentors from two different programs completed the online SR survey at or near the end of their respective programs and qual data were coded by use of ATLAS-Ti	The majority of mentors stated that their program met or exceeded their expectations. Some reported enjoying the responsibility of mentoring, benefit from the leadership opportunity, and increased community engagement.

*Table originally used in Crisp and Cruz (2009) and adapted by Gershenfeld (2014). MM, mixed methods; quan, quantitative; qual, qualitative; SR, self-report; UG, undergraduate, GTA, graduate teaching assistant; UGTA, undergraduate teaching assistant. **Relates to at least one of four major theoretical frameworks of mentoring programs put forward by Jacobi (1991).

Table 4. Mixed methods research criteria.

Citation	Explicit statement that mixed methods research was used	Rationale for using mixed methods	Integration of data (triangulation or connecting/building)	Analytic logic (independent or dependent)	Timing (concurrent or sequential)	Priority (quan, qual or both)
Douglass <i>et al.</i> , 2013	Not explicitly stated, but quan and qual were explicitly stated	Quan SR to determine most important mentor characteristics and qual to allow mentor descriptions of experience and suggestions of improvement for the program	Not explicitly stated	Independent	Concurrent	Both
Afghani <i>et al.</i> , 2013	Not explicitly stated, but quan and qual were explicitly stated	Quan for program opinion and qual for changes in perception	Not explicitly stated	Independent	Concurrent	Both
Karlin <i>et al.</i> , 2013	Not explicitly stated, but quan and qual were explicitly stated	Improvement over prior evaluation of Education for Sustainable Development (ESD), typically incorporating only descriptive case studies	Triangulation of data, presentation of open-ended quotes in conjunction with related Likert survey results	Independent	Concurrent	Qual
James, 2014	Yes, in the text it states mixed methodology is used	None explicitly stated (used to assess impact of program and mentor perceptions), lack of quantitative data in prior research discussed by author	Not explicitly stated	Independent	Concurrent	Both
Wasburn-Moses <i>et al.</i> , 2014	Yes, in the text it states mixed methodology is used	Authors state that it allowed the analysis of various data sources and enhanced the credibility and quality of their results	Triangulation, each data source was used to observe/analyze college student motivation and learning from a different angle	Independent	Concurrent	Qual
Zentz <i>et al.</i> , 2014	Not explicitly stated, but quan and qual were explicitly stated	None explicitly stated	Not explicitly stated	Independent	Concurrent	Both
Aderibigbe <i>et al.</i> , 2015	Not explicitly stated, but quan and qual stated	Better understanding of the peer mentoring process	Triangulation	Independent	Concurrent	Both
Grant <i>et al.</i> , 2015	Yes, in the text it states mixed methodology is used	Mixed-methods was necessary in order to triangulate data from many different sources	Triangulation	Independent	Concurrent	Qual
Köse & Johnson, 2016	Not explicitly stated, but quan and qual were explicitly stated	To determine whether program goals were met, no other rationale stated	Not explicitly stated but authors reported looking for common patterns in quan and qual data	Independent	Concurrent	Both

Fogg-Rogers <i>et al.</i> , 2017	Yes, in the text it states mixed methodology is used	Allowed for quantitative and qualitative responses from the pre-service teachers and student engineers to be triangulated into one coding frame	Triangulated from 3 participant groups (student engineers, pre-service teachers, and children) into one coding frame	Independent	Concurrent	Both
Fried <i>et al.</i> , 2018	Yes, in the text it states mixed methodology is used	To most appropriately address participant experiences, as a mix of qualitative (inductive) and quantitative (deductive) data would emphasize the research questions	Not explicitly stated	Independent	Concurrent	Both
James, 2019	Yes, in the text it states mixed methodology is used	Not explicitly stated, but quan described as objective measure of self-efficacy, self-esteem and psychological literacy, and qual described as mentors' subjective perceptions	Not explicitly stated	Independent	Concurrent	Both
Bonner <i>et al.</i> , 2019	Yes, in the text it states mixed methodology is used	Not explicitly stated, but authors discussed at length the importance of analyzing qual and quan data inductively and deductively	Not explicitly stated but authors reported looking for common patterns in quan and qual data	Independent	Concurrent	Both
Hastings & Sunderman, 2019	Yes, in the text it states mixed methodology is used	Quantitative results needed enhancing to be fully understood	Integration explicitly stated, authors reported building onto quan data by use of supportive qual data	Dependent	Sequential	Quan
McIntosh, 2019	Yes, in the text it states mixed methodology is used	Not explicitly stated	Not explicitly stated	Indeterminate	Indeterminate	Qual
Pica & Fripp, 2020	Not explicitly stated, but quan and qual were explicitly stated	Not explicitly stated	Not explicitly stated, building implied as authors discussed using each data set (quan and qual) to support the other	Independent	Concurrent	Both

Mixed methods research statement, rationale, and integration were taken from the studies examined, if present. Analytic logic, timing, and priority were only detailed in Bonner *et al.* (2019) but were not detailed in any of the other studies; rather, these are interpretations from the authors of this review. Quan, quantitative; qual, qualitative; SR, self-report.