Assessing Medical Students' and Residents' Perceptions of the Learning Environment: Exploring Validity Evidence for the Interpretation of Scores From Existing Tools

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Abstract

Purpose

Although most agree that supportive learning environments (LEs) are essential for effective medical education, an accurate assessment of LE quality has been challenging for educators and administrators. Two previous reviews assessed LE tools used in the health professions; however, both have shortcomings. The primary goal of this systematic review was to explore the validity evidence for the interpretation of scores from LE tools.

Method

The authors searched ERIC, PsycINFO, and PubMed for peer-reviewed studies that provided quantitative data on medical students' and/or residents' perceptions of the LE published through 2012 in the United States and internationally. They also searched SCOPUS and the reference lists of included studies for subsequent publications that assessed the LE tools. From each study, the authors extracted descriptive, sample, and validity evidence (content, response process, internal structure, relationship to other variables) information. They calculated a total validity evidence score for each tool.

Results

The authors identified 15 tools that assessed the LE in medical school and 13 that did so in residency. The majority of studies (17; 61%) provided some form of content validity evidence. Studies were less likely to provide evidence of internal structure, response process, and relationship to other variables.

Conclusions

Given the limited validity evidence for scores from existing LE tools, new tools may be needed to assess medical students' and residents' perceptions of the LE. Any new tools would need robust validity evidence testing and sampling across multiple institutions with trainees at multiple levels to establish their utility.

The learning environment (LE) encompasses the educational, physical, social, and psychological context in which trainees are immersed and is thought to play a significant role in their professional[1] and moral[2] development. Although most agree that supportive LEs are essential for effective medical education, an accurate assessment of LE quality has been challenging for educators and administrators. The Liaison Committee on Medical Education stated that medical schools "should regularly evaluate the LE."[3] Yet, in the absence of a standard LE metric, schools do not know how to comply with this standard. In addition, the Accreditation Council for Graduate Medical Education (ACGME) recently created the Clinical Learning Environment Review program as part of their accreditation system.[4] Without knowing how students and residents perceive the LE, institutions are limited in their means to effectively improve it.

The first published tool to assess the LE in medical education was adapted by the Association of American Medical Colleges[5] from the College Characteristics Index, an LE tool used in higher education.[6] This Medical School Environment Inventory explored medical school graduates' perceptions of faculty and peers in 1960 using 180 items. Based on scales with the highest scores, the average medical school graduate that year thought that although faculty facilitated independence across students and were demanding of students' performance, they remained unaffiliated towards students. That is, students did not feel that faculty connected with the class as a group. The respondents also reported that peers were competitive and had little social interaction outside of class. In addition, they perceived both faculty and peers to be humanistic.

Over the ensuing decades, researchers continued to develop tools to assess medical students' perceptions of the LE. However, a tool to measure residents' perceptions of the LE was not developed until 1993.[7] Seelig's Residency Program Evaluation Questionnaire assessed residents' perceptions of workload, faculty, and stress as related to the LE. Since the early 1990s, many tools have been developed to assess either the LE of a particular specialty or the LE across specialties in graduate medical education. Thus, medical students' and residents' perceptions of the LE have remained important areas of research in medical education for more than 50 years.

Two reviews explored tools used in the health professions to assess the LE,[8,9] yet both missed some tools in their search. Schönrock-Adema and colleagues[9] identified 11 LE tools with the goal of generating a theoretical framework to guide future tool development. However, they did not include in their review 16 tools published prior to 2011, and their proposed framework seems less applicable

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to the LE issues that today's medical students and residents may encounter.[10] Soemantri and colleagues[8] reviewed the validity of LE tool scores published before 2008 but missed 12 tools.

The primary goal of this systematic review was to explore the validity evidence for the interpretation of scores from LE tools. Therefore, this review may help educators make an evidence-based decision on the right tool to use to assess the LE and may guide scholars on the most appropriate tool to use in specific circumstances and for particular research questions.

Undergraduate Medical Education Versus Graduate Medical Education

We decided to review the LEs of undergraduate medical education and graduate medical education separately because we see the two environments as different. Graduate medical education is purely a job training environment. Undergraduate medical education, however, is a blended LE, moving from an educational environment to a training environment. The preclinical years create a unique focus on the needs of the medical student, but the focus shifts to the patient once the medical student enters the clinical years. Also, medical students are paying customers; thus, their LE must support their learning and professional development. In graduate medical education, interns and residents have been hired and are paid to care for patients, while being supervised and taught. Finally, their interests are more discipline-specific; for example, all have opted to pursue one field, like psychiatry or pediatrics, compared with medical students, who have diverse interests.

Focused Questions

In this review, we aimed to address the following research questions: (1) What tools have been developed to measure the LE in medical education? and (2) What is the strength of the validity evidence (content, response process, internal structure, relationship to other variables) associated with the interpretation of the scores from these tools?

In 1999, the American Psychological and Educational Research Associations moved from three categories of validity (criterion, construct, content) to five sources of validity evidence (content, response process, internal structure, relationship to other variables, and consequence).[11] Content validity evidence refers to the evidence that a tool or set of items adequately represents the content domain of interest. Response process evidence relates to how well responses from the tool reflect what the tool intends to measure. Internal structure evidence deals with the psychometric quality of items and overall scores from a tool. Relationship to other variables evidence involves comparing scores from the tool with other assessment results; high correlations are expected with scores measuring similar constructs, and no correlation with scores from tools measuring unrelated concepts. Consequence validity evidence deals with the "intended and unintended" consequences of scores, which is particularly germane for high-stakes testing. We did not collect consequence validity evidence in this review because LE tool scores are more descriptive than prescriptive at this point in time.

Method

We conducted this systematic review in accordance with PRISMA standards.[12]

Search strategy

We combined controlled vocabulary (MeSH and thesaurus) with key word terms and phrases to describe LE concepts, which included educational, physical, social, and psychological environments, for both medical students and residents/housestaff. We then combined these terms using Boolean operators and adapted them for each database. We conducted our searches using ERIC (from 1966), PsycINFO (from 1881), and PubMed (from 1949), all through December 7, 2012. Next, we imported the search results into a citation management system; duplicate references were identified and removed upon import. See Supplemental Digital Appendix 1 (http://links.lww.com/ACADMED/A227) for the full PubMed search strategy.

Inclusion and screening process

Studies were limited to those providing quantitative data on medical students' and/or residents' perceptions of the LE in the United States and internationally. Additionally, we included only articles published in English in peer-reviewed journals in our review. See Figure 1 for our complete inclusion and screening process.

Because the search terms produced a large number of articles, we conducted a first pass for inclusion by reviewing each title and, if necessary, the abstract, to omit articles unrelated to the topic of the LE. Next, we examined abstracts to verify whether quantitative data were provided for medical students' and/or residents' perceptions of the LE. Each article that we judged to meet the inclusion criteria was reviewed, and data were extracted by two authors using a coding sheet. Each author extracted data from a subset of articles. Any differences were discussed until an agreement was reached.
Once all tools had been identified, we conducted another search using SCOPUS for articles citing the original article assessing each LE tool. We identified any cited article not already included. Finally, we conducted a hand search of the reference lists of all original articles to identify any other articles we missed.

Data abstraction

All authors piloted the coding sheet, reading the same articles, then refined it twice. The coding sheet included descriptive information questions (name and type [new, modified, existing] of tool), sample characteristics questions, and questions relating to each type of validity evidence. For content validity, we identified if the authors used a literature review, blueprint, and/or group consensus to generate items. For response process, we determined whether items were piloted and/or whether respondents provided feedback on the items or if actual scores were reviewed for accuracy. For internal structure, we indicated if a reliability coefficient was provided and if scores were analyzed with factor analysis. For relationship to other variables, we determined whether scores were correlated with other related or unrelated survey scores.

We adapted a validity evidence checklist from a prior study[13] to determine the strength of the validity evidence (see Table 1). We applied the checklist to the coding sheet responses, giving each of the four sources of validity evidence a rating of 2, 1, or 0. In this review, a rating of 2 confers "strong" evidence, a rating of 1 suggests "weak" evidence, and a rating of 0 was used when validity evidence was absent.

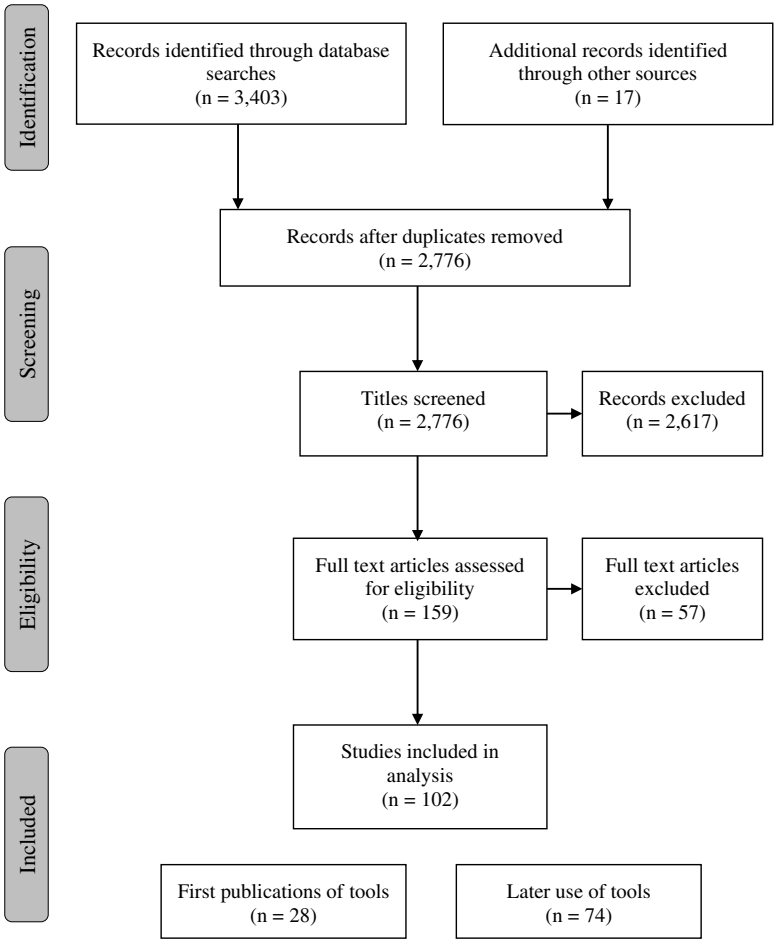

Figure 1 Flowchart of the literature search and study selection process in a systematic review of the literature on medical students' and residents' perceptions of the learning environment (LE), published from 1961 to 2012. Reasons for exclusion at the full-text review stage were as follows: did not assess medical students or residents (n = 2), no quantitative data (n = 26), did not assess the LE (n = 26), and data already published (n = 3).

Analysis

For each original article, we computed a total validity evidence score by summing the ratings across all four validity evidence sources and dividing that value by the total points possible (eight points). Next, we calculated the number of subsequent peer-reviewed publications in which each LE tool was used with a new sample of medical students and/or residents. Finally, we assessed the relationship between validity evidence and future use of a tool using Spearman rho.

Results

Number of studies and tools

As of 2012, 102 studies have assessed medical students' and/or residents' perceptions of the LE. Fifteen unique tools assessed the LE in medical school[5,14–27] and 13 in residency.[7,28–39] Thus, we included 28 unique tools in this systematic review. Only four tools have been used in both the medical school and residency settings—the Dundee Ready Education Environment Measure (DREEM), the Veterans Affairs Learners' Perceptions Survey (VA LPS), the Postgraduate Hospital Educational Environment Measure (PHEEM), and the Surgical Theatre Educational Environment Measure (STEEM).

These 28 unique tools included all LE studies listed in the previous reviews,[8,9] with a few exceptions. The Operating Room Educational Environment Measure was not classified as a new tool because the only difference between it and the earlier STEEM was the use of the words "Operating Room" instead of "Surgical Theater" in the title. Additionally, we omitted two LE studies—one only provided qualitative analysis,[40] and the second was not from a peer-reviewed journal.[41] Finally, our review included 10 tools and 2 shortened versions of previously published tools, which were not appraised in the earlier LE reviews.

Study quality and synthesis

Table 2 provides a summary of the validity evidence for each of the 28 unique LE tools, including an overall validity evidence score. Seventeen of these 28 tool studies (61%) provided some form of content validity evidence. Studies were less likely to provide evidence for the other three sources—32% (9/28) provided some form of internal structure evidence, 21% (6/28) provided some form of relationship to other variables evidence, and 14% (4/28) provided some form of response process evidence. Only 3 of the 6 studies that provided relationship to other variables evidence specified a hypothesis for the expected convergent or divergent relationships—the Course Valuing Inventory, the ACGME survey, and Fahy's LE tool. Additionally, the majority of studies (23/28; 82%) suggested multiple LE domains, but only 5 provided factor analysis results to support the hypothesized structure.

Table 1

Criteria Used to Determine the Strength of Validity Evidence in a Systematic Review of Studies That Assessed Medical Students' and Residents' Perceptions of the Learning Environment

Source	Rating[a]	Rating criteria
Content	1	Listing assessment themes with little or no reference to a theoretical basis or poorly defined process for creating and reviewing items
	2	Well-defined process for developing instrument content, including both explicit theoretical/conceptual basis for instrument items and systematic item review by experts
Response process	1	Minimal data regarding thought process and analysis of responses; description (without data) of systems that reduce response error
	2	Multiple sources of supportive data, including critical examination of thought processes and analysis of responses
Internal structure	1	Factor analysis incompletely confirming anticipated data structure or acceptable reliability with a single measure
	2	Factor analysis confirming anticipated data structure or multiple measures of reliability
Relationship to other variables	1	Correlation of assessment scores to outcomes with minimal theoretical importance or unanticipated score correlations
	2	Correlation (convergence) or no correlation (divergence) between assessment scores and theoretically predicted outcomes or measure of the same construct

[a]A zero rating indicates no data or evidence of validity evidence source. This table was adapted from Beckman et al.[13]

The average validity evidence score for undergraduate medical education LE tools was 21% (standard deviation = 16%), and no tools provided more than two sources of validity evidence. The average validity evidence score for graduate medical education LE tools was 32% (standard deviation = 17%), and no tools provided all four sources of validity evidence.

Figure 2 illustrates the weak relationship between the amount of validity evidence and the number of subsequent publications of the LE tool (later use) (Spearman rho = 0.10). When studies published recently (2009–2011) were omitted, the relationship between amount of validity evidence and later use was moderate (Spearman rho = 0.32). The majority of tools (75%, 21/28) were not used in subsequent studies published through 2012. The seven tools that were used in subsequent studies were the Medical School's Learning Environment Survey (MSLES), Learning Environment Questionnaire, DREEM, PHEEM, STEEM, VA LPS, and MSLES short version. DREEM was an outlier as it was used in 44 subsequent studies and accounted for 44% (45/102) of all LE tool publications to date.

Discussion

No gold standard exists for assessing medical students' or residents' perceptions of the LE. If one did, such a tool would ideally possess strong validity evidence for content, response process, internal structure, and relationship to other variables. It would be efficient to administer, quick for participants to complete, widely applicable, and sensitive to change over time. Assessing the LE should not be an exhaustive process completed once every three years; instead, the LE should be regularly reassessed using a nimble instrument.

This review focused on the more objective dimensions of LE tools—

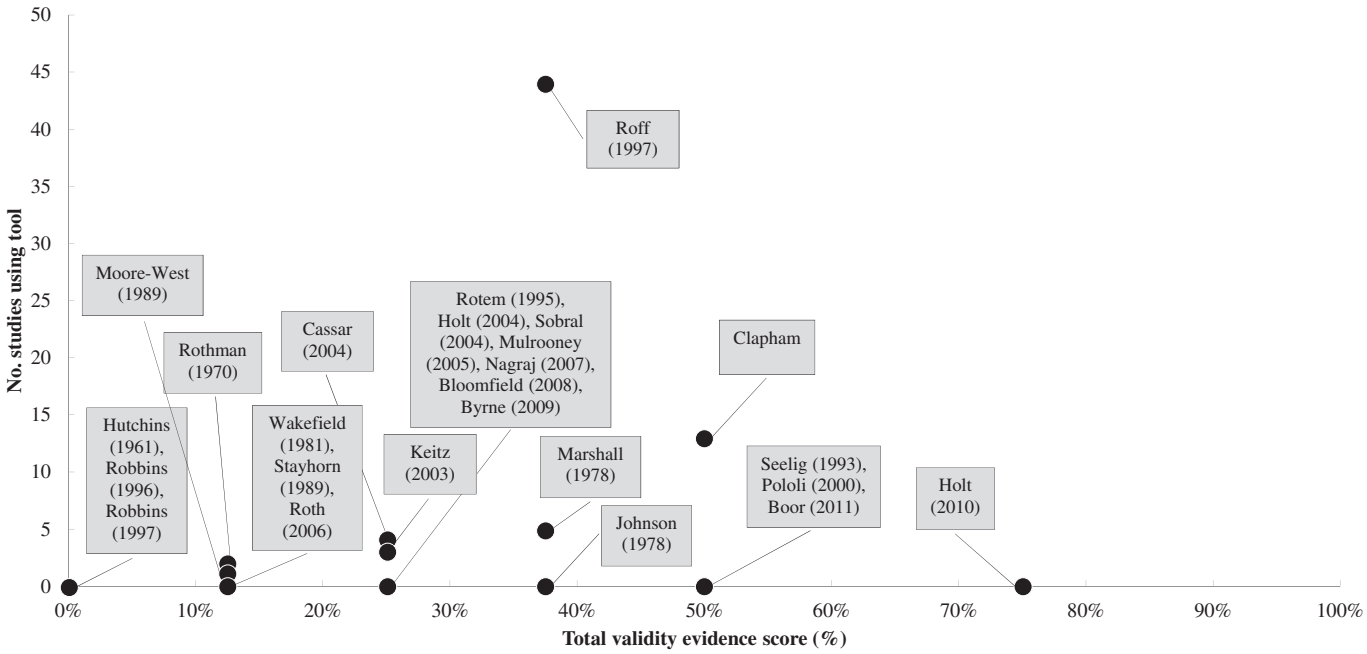

Figure 2 Total validity evidence scores and later use of 15 undergraduate medical education and 13 graduate medical education learning environment (LE) tools published from 1961 to 2012. Tools are identified by first author and publication year.

Table 2

Summary of the Validity Evidence in Studies That Assessed Medical Students' and Residents' Perceptions of the Learning Environment

First author, year	Country	Tool	No. of items	Validity evidence				Total validity score (%)
				Content	Response process	Internal structure	Relationship to other variables	
Medical students								
Hutchins, 1961[5]	US	MSEI	180	0	0	0	0	0
Rothman, 1970[14]	Canada	LEQ	65	1	0	0	0	13
Marshall, 1978[15]	US	MSLES	50	2	1	0	0	38
Johnson, 1978[16]	US	—	70	2	0	1	0	38
Wakefield, 1981[17]	UK	MSEQ	49	1	0	0	0	13
Moore-West, 1986[18]	US	MSLES short	30	0	0	0	1	13
Strayhorn, 1989[19]	US	—	99	1	0	0	0	13
Robins, 1996[20]	US	—	62	0	0	0	0	0
Robins, 1997[21]	US	—	7	0	0	0	0	0
Roff, 1997[22]	Spain	DREEM	50	2	0	1	0	38
Pololi, 2000[23]	US	—	26	2	0	2	0	50
Parry, 2002[24]	UK	—	20	0	1	0	0	13
Sobral, 2004[25]	Brazil	CVI	36	0	0	0	2	25
Nagraj, 2007[26]	UK	STEEM mini	13	0	1	1	0	25
Dyrbye, 2009[27]	US	—	14	1	0	0	1	25
Residents								
Selig, 1993[7]	US	RPEQ	15	2	0	2	0	50
Rotem, 1995[28]	Australia	—	46	2	0	0	0	25
Keitz, 2003[29]	US	VA LPS	57	2	0	0	0	25
Holt, 2004[30]	UK	ATEEM	40	2	0	0	0	25
Cassar, 2004[31]	UK	STEEM	40	2	0	0	0	25
Mulrooney, 2005[32]	Ireland	—	37	2	0	0	0	25
Roth, 2006[33]	US	LEA	49	0	0	0	1	13
Clapham, 2007[34]	UK	PHEEM	40	0	1	1	0	25
Bloomfield, 2008[35]	Australia, New Zealand	DR-CLE	24	0	0	2	0	25
Byrne, 2009[36]	US	—	29	2	0	0	0	25
Holt, 2010[37]	US	ACGME	29	2	0	2	2	75
Fahy, 2010[38]	US	—	53	0	0	0	2	25
Boor, 2011[39]	Netherlands	D-RECT	50	2	0	2	0	50

Abbreviations: MSEI indicates Medical School Environment Inventory; LEQ, Learning Environment Questionnaire; MSLES, Medical School Learning Environment Survey; MSEQ, Medical School Environment Questionnaire; DREEM, Dundee Ready Education Environment Measure; CVI, Course Valuing Inventory; STEEM, Surgical Theatre Educational Environment Measure; RPEQ, Residency Program Evaluation Questionnaire; VA LPS, Veterans Affairs Learners' Perceptions Survey; ATEEM, Anesthetic Theatre Educational Environment Measure; LEA, Learning Environment Assessment; PHEEM, Postgraduate Hospital Educational Environment Measure; DR-CLE, Diagnostic Radiology Clinical Learning Environment Questionnaire; ACGME, Accreditation Council for Graduate Medical Education; D-RECT, Dutch Residency Educational Climate Test.

validity evidence, use, and number of items. We used number of items as a proxy for efficiency and time to administer. The LE is a multifaceted construct, so an LE tool cannot be too short so as to not capture all of these facets. However, researchers should strive to keep LE tools relatively easy for participants to complete. Doing so will not only facilitate a higher response rate but also increase the odds that respondents will (a) finish the entire survey and (b) reflect on the questions and submit honest responses.

On the basis of our experience conducting both this review and research on the LE, we believe that the LE can be assessed with a survey of fewer than 50 items. We strongly urge researchers to use analytic methods, such as factor analysis, to limit the number of survey items. Factor analysis not only will allow researchers to determine the factor structure for LE scores but also can be used to reduce the number of survey items. For example, if the results

of a factor analysis suggest that the LE comprises 5 factors, a researcher could select the 6 items with the highest loading values for each factor, resulting in a 30-item survey.

Interestingly, the LE tools with the highest degree of validity evidence for undergraduate medical education (Pololi's tool) and graduate medical education (ACGME) were not used in subsequent publications. Although it is inferior in terms of validity evidence, the DREEM was used in more than 40 studies to assess the LE at academic medical centers around the world. The low correlation between total validity evidence score and later use could be due to the difference in time since publication between studies. When studies published recently were omitted from our analysis, the relationship between validity evidence score and later use was moderate.

Despite its low validity evidence score, the DREEM was used in a large number of studies relative to other LE tools. It was developed by a group of international students enrolled in Dundee University Medical School's medical education master's degree program. These students then used the survey at their home institutions, thus creating more of a network effect of use than would a survey created by a group of researchers at the same institution. The network effect also could have led to faster name recognition. When researchers needed an LE tool, they may have been more likely to consider using the DREEM because they knew of it, rather than conducting a literature review to find a different tool. Also, by using the DREEM, they could compare their school's results with those of other schools. Thus, researchers may be selecting LE tools for reasons other than validity evidence. We are hopeful that our results presented in Table 2 will guide researchers and educators in selecting LE tools on the basis of validity evidence.

This review adds depth and rigor to the findings of the two previously published reviews of LE tools used in the health professions.[8,9] The review by Schönrock-Adema and colleagues[9] aimed to build a theoretical base for the LE and focused on its different facets. Thus, our review offered a different lens for assessing the LE—the validity evidence of scores. The review by Soemantri and colleagues[8] also assessed validity evidence, but it had many shortcomings. In contrast to our conclusions, Soemantri et al concluded that the DREEM and PHEEM were the best tools for evaluating medical students' and residents' perceptions of the LE, respectively. We believe that we reached disparate conclusions from Soemantri et al for two reasons—the number of LE tools reviewed and the validity evidence paradigm. Our review captured more published LE tools because we sought a comprehensive search strategy, using multiple key words for "learning environment." Soemantri et al used the older paradigm with three types of validity (content, criterion-related, and construct), while we used the new paradigm with five sources of validity evidence (content, response process, internal structure, relationship to other variables, and consequences [not assessed in this review]).

Our review has several limitations. First, most of the original studies used relatively small numbers of learners at a single site, especially those assessing the undergraduate medical education LE. Thus, even if validity evidence had been stronger, generalizations about any tool's utility with learners at other institutions may be problematic. Second, we only included LE tools published in peer-reviewed journals. Medical schools and residency programs may be using various LE tools without publishing the results, so the later use variable is limited by publication bias. For example, the ACGME survey is administered annually by the ACGME, and results are shared with program directors.[42] That said, later use of tools as reported in published studies is an important measure of their perceived value among scholars in the field. Finally, as medical education continues to evolve because of factors such as technology and our ever-changing health care delivery systems, new tools will be needed to account for these factors. Thus, some of the tools we reviewed may in fact already be dated, and thus of lesser utility.

Given the limited validity evidence for the 28 LE tools that we reviewed, researchers may wish to collect validity evidence with further study or, alternatively, to develop new tools to assess medical students' and residents' perceptions of the LE. Any new LE tool will need robust validity evidence testing and sampling across multiple institutions with trainees at multiple levels to establish its utility. Additionally, medical educators and scholars should carefully consider validity evidence when selecting a metric to assess a complex construct, such as the LE. Such validity evidence is extremely important because, without it, educators are limited in their ability to accurately capture a construct.

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