Supplemental Digital Appendix 1
Example Search Strategy in the OVID (Medline) Database

1. exp Students, Medical/
2. exp Education, Medical, Undergraduate/
3. 1 or 2
4. limit 3 to (english language and yr = "2002 - 2013")
5. exp Curriculum/
6. exp Professional Competence/
7. exp Clinical Competence/
8. exp Program Evaluation/
9. exp Mind-Body Therapies/
10. exp Behavior/
11. exp Health Behavior/
12. exp Attitude to Health/
13. exp Health Knowledge, Attitudes, Practice/
14. exp Life Style/
15. exp Physician-Patient Relations/
16. exp Physician's Role/
17. exp Professional Practice/
18. exp Public Health/
19. exp "Delivery of Health Care"
20. exp Culture/
21. exp Anthropology, Medical/
22. exp Philosophy, Medical/
23. exp Medicine, Traditional
24. exp Health Policy/
25. olicy making/
26. exp "Delivery of Health Care"/
27. exp Health Care Costs/
28. exp Economics, Medical/
29. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28
30. 5 or 6 or 7 or 8
31. 4 and 29 and 30

Supplemental Digital Appendix 2

Characteristics of Articles Reviewed as Part of a Systematic Review of the Literature on Tools to Assess Behavioral and Social Science Competencies in Medical Education, 2002-2014

Step 1 of data abstraction (n = 170): Article characteristics	Instrument development, no. (% of 21)	Educational research, no. (% of 62)	Curriculum evaluation, no. (% of 87)
BSS competency			
Yes	20 (95)	59 (95)	83 (95)
No	1 (5)	3 (5)	4 (5)
Quality of assessment instrument			
Yes	21 (100)	48 (77)	46 (53)
No	0	14 (23)	41 (47)
Step 2 of data abstraction (n = 114): Article characteristics	**Instrument development, no. (% of 20)**	**Educational research, no. (% of 48)**	**Curriculum evaluation, no. (% of 46)**
Institutional review board (IRB) review mentioned	13 (65)	35 (73)	36 (78)
Approval granted	12 (60)	30 (63)	27 (56)
Exemption granted	1 (5)	3 (6)	8 (15)
Waiver granted	0	2 (4)	0
IRB not applicable	0	0	1 (2)
Research/Evaluation design[a]			
Randomized design with or without controls	1 (5)	23 (48)	0
Prospective cohort with historical controls	0	3 (6)	7 (15)
Prospective cohort pre-post	1 (5)	6 (13)	24 (52)
Prospective cohort without baseline	1 (5)	13 (27)	9 (20)
Retrospective cohort	1 (5)	2 (4)	1 (2)
Case control	0	0	3 (7)
Cross-sectional	3 (15)	4 (8)	3 (7)
Crossover	1 (5)	0	0
Case series	0	1 (2)	1 (2)
Multiple groups	7 (35)	0	2 (4)
Quasi-experimental	0	1 (2)	1 (2)
Quasi-cohort control	0	1 (2)	0
Longitudinal	2 (10)	1 (2)	1 (2)
Observational	4 (20)	1 (2)	0
Instrument validation methodology[a]			
Extensive pilot testing	4 (20)	6 (13)	5 (11)
Test/retest	4 (20)	3 (6)	1 (2)
Multiple observer	11 (55)	14 (29)	17 (37)
Formal psychometric assessment	19 (95)	25 (52)	17 (37)
Learner level of participants[a]			

Medical students	11 (55)	41 (85)	42 (91)
Residents	4 (20)	7 (15)	3 (7)
Practicing physicians	5 (25)	2 (4)	0
Other[b]	2 (10)	4 (8)	6 (13)
BSS framework or competency measurement used[a]			
Framework			
Transtheoretical model/ motivational interviewing	1 (5)	9 (19)	4 (9)
Miller's Assessment Model	0	2 (4)	0
Bandura's Self-Efficacy/Cognitive Learning Theory	0	1 (2)	3 (7)
Other[c]	1 (5)	11 (23)	7 (15)
Competency measurement			
Kalamazoo Consensus Statement	2 (10)	1 (2)	2 (4)
Jefferson Scale of Physician Empathy	2 (10)	2 (4)	3 (7)
Calgary Cambridge Observation Guide	0	3 (6)	4 (9)
5 A's (Ask, Advise, Assess, Assist, Arrange)	0	1 (2)	2 (4)
Four Habits Model/Coding Scheme	2 (10)	1 (2)	0
Other[d]	20 (100)	34 (71)	38 (83)
None/not specified	1 (5)	3 (6)	5 (11)

[a] These categories are not mutually exclusive.

[b] One with dental students, physician assistant students, fellows, psychology students, consultants, and non-professional undergraduates, and two each with nursing and pharmacy students.

[c] One with Health Belief Model, Stanford Model of Behavioral Change, Blended Conceptual Model, Biopsychosocial Model, Generalizability Theory, Ecological Model, Socioemotional Framework, Howell (unconscious incompetent to unconsciously competent), Experimental teaching mode for communication, Bloom's educational domains, Gardner's theory of multiple intelligences, Bowen and Carline strategy for adult learning, Knowles Adult Learning theory, Kolb's experiential learning, Perkins Dispositional Theory of Thinking, Shared Model for treatment, and two with SEGUE framework.

[d] See Supplemental Digital Appendix 8 for the complete list of other competency measurements.

Supplemental Digital Appendix 3

Additional Characteristics of Articles Included in a Systematic Review of the Literature on Tools to Assess Behavioral and Social Science (BSS) Competencies in Medical Education, 2002-2014

Characteristics	Instrument development, no. (% of 20)	Educational research, no. (% of 48)	Curriculum evaluation, no. (% of 46)
BSS learner competencies assessed[a,b]			
Communication/patient education (n = 65)	14 (70)	30 (63)	21 (46)
Cultural competence/patient-centered care (n = 20)	1 (5)	8 (17)	11 (20)
Empathy/compassion (n = 17)	4 (20)	7 (15)	6 (13)
Behavioral health counseling/motivational interviewing (n = 20)	0	9 (19)	11 (24)
Professionalism (n = 8)	3 (15)	4 (8)	1 (2)
Teamwork (n = 5)	0	1 (2)	4 (9)
Type of assessment tool used[a]			
Validated knowledge, attitudes, skills assessment tool (n = 84)	17 (85)	37 (77)	30 (65)
Assessment of learner performance with standardized patients (videotaped or observer in the room) (n = 45)	6 (30)	21 (44)	18 (39)
Assessment of learner performance with actual patients (videotaped or observer in the room) (n = 5)	2 (10)	1 (2)	2 (4)
Trainee evaluations (evaluations of learners by training observers in the rotation) (n =1)	0	1 (2)	0
Other[b] (n = 17)	0	11 (23)	6 (13)
Strength of findings[a]			
Testing mentioned but no specifics on methods (n = 16)	1 (5)	7 (15)	8 (17)
Pilot testing without, or no mention of, cognitive interviewing/multiple observers (n = 14)	3 (15)	5 (10)	6 (13)
Pilot testing with cognitive interviewing/ multiple observers (n = 4)	2 (10)	2 (4)	0
Validation testing with test-retest (n = 18)	7 (35)	6 (13)	5 (11)
Validation with expert consensus (n = 43)	3 (15)	20 (42)	17 (37)
Psychometric assessment (e.g., factor analysis, Cronbach's alpha) (n = 76)	18 (90)	34 (71)	24 (52)
Ranking of evidence			

Weak: no or limited information about the validity/reliability of the measures or study design limited (n = 19)	3 (15)	5 (10)	11 (24)
Moderate: some information about the reliability of the measures but not tested/reassessed in the specifics of the study and/or study design moderately rigorous (n = 62)	6 (30)	24 (50)	32 (70)
Strong: tool retested/evaluated in current study and/or study design strong (n = 33)	11 (55)	19 (40)	3 (7)
Accreditation Council for Graduate Medical Education core competencies[a]			
Patient care (n = 84)	13 (65)	30 (63)	41 (89)
Medical knowledge (n = 59)	9 (45)	21 (44)	29 (63)
Practice-based learning and improvement (n = 3)	2 (10)	1 (2)	0
Interpersonal skills and communication (n = 111)	18 (90)	48 (100)	45 (98)
Professionalism (n = 69)	12 (60)	14 (29)	23 (50)
Systems-based practice (n = 6)	2 (10)	1 (2)	3 (7)
None (n = 1)	0	1 (2)	0

[a] These categories are not mutually exclusive.
[b] These categories met our conceptual framework for review as outlined in Table 1.

Supplemental Digital Appendix 4
Other Study Characteristics

Study Characteristics	Instrument Development with Psychometric Assessment Only (n=20)	Educational Research Studies (n=48)	Curriculum Evaluation Studies (n=46)
	n (%)	n (%)	n (%)
Site of Study	**n=20**	**n=48**	**n=46**
United States	8 (40.0%)	19 (39.6%)	32 (69.6%)
Canada	3 (15.0%)	4 (8.3%)	0
United Kingdom	4 (20.0%)	4 (8.3%)	4 (8.7%)
Netherlands	2 (10.0%)	4 (8.3%)	0
Germany	0	3 (6.3%)	4 (8.8%)
New Zealand	0	3 (6.3%)	0
Other*	3 (15.0%)	11 (22.9%)	5 (10.9%)
Specialty†	**n=20**	**n=48**	**n=46**
Not specified	8 (40.0%)	33 (68.8%)	30 (65.2%)
Multi-disciplinary	4 (20.0%)	4 (8.3%)	8 (17.4%)
Internal Medicine	3 (15.0%)	4 (8.3%)	3 (6.5%)
Family Medicine	2 (10.0%)	3 (6.3%)	1 (2.2%)
Pediatrics	1 (5.0%)	3 (6.3%)	0
Surgery	3 (15.0%)	3 (6.3%)	1 (2.2%)
Psychiatry	0	2 (4.2%)	1 (2.2%)
Emergency Medicine	0	2 (4.2%)	0
Other††	2 (10.0%)	1 (2.1%)	3 (6.5%)
Describes Educational Program	**n=20**	**n=48**	**n=46**
Yes	4 (20.0%)	35 (72.9%)	44 (95.7%)
No	16 (80.0%)	13 (27.1%)	2 (4.3%)
If yes, # hours	**n=4**	**n=35**	**n=44**
1-4	1 (25.0%)	8 (22.9%)	9 (20.5%)
5-8	0	4 (11.4%)	3 (6.8%)
9-12	0	0	1 (2.3%)
> 12	1 (25.0%)	7 (20.0%)	11 (25.0)%
Not specified	2 (50.0%)	16 (45.7%)	20 (45.4%)
Curriculum Format Tested (categories not mutually exclusive)†	**n=4**	**n=35**	**n=44**
Didactic lecture	1 (25.0%)	19 (52.3%)	26 (59.1%)
Seminar	1 (25.0%)	24 (68.6%)	39 (88.6%)
Role play with peers/health provider	0	18 (51.4%)	17 (38.6%)
Practice/demonstration with standardized patients	2	15 (42.9%)	16 (36.4%)
Practice/demonstration with actual patients	0	2 (5.7%)	15 (34.1%)

Practice/demonstration with expert instructors	0	0	3 (6.8%)
Observe clinician interaction with SPs	0	1 (2.9%)	3 (6.8%)
Observe clinician interaction with actual patients	0	4 (11.4%)	4 (9.1%)
Curriculum Format Tested (categories not mutually exclusive) †	**n=4**	**n=35**	**n=44**
Virtual patients/Avatars	0	3 (8.6%)	2 (4.5%)
Web-based module	1 (25.0%)	6 (17.1%)	6 (13.6%)
Written/video vignettes	1 (25.0%)	9 (25.7%)	11 (25.0%)
Case-based learning	2 (50.0%)	5 (14.3%)	10 (22.7%)
PBL Cases	0	1 (2.9%)	3 (6.8%)
Clinical rotations/ clerkships/ preceptorships	1 (25.0%)	2 (5.7%)	5 (11.4%)
Clinical tutorials	1 (25.0%)	6 (17.1%)	3 (6.8%)
Community experience	0	1 (2.9%)	3 (6.8%)
Assigned Readings	0	4 (11.4%)	11 (25.0%)
Teamwork/ interdisciplinary meetings	0	0	2 (4.5%)
Feedback	2 (50.0%)	7 (20.0%)	11 (25.0%)
Self-reflection/ self-evaluation	0	5 (14.3%)	7 (15.9%)
Essays/ narrative writing/ projects	2 (50.0%)	1 (2.9%)	6 (13.6%)
Workshops	1 (25.0%)	2 (5.7%)	4 (9.1%)
Poetry/theater performances/skits/ DVDs	0	5 (14.3%)	1 (2.3%)

Categories are not mutually exclusive.

* One from Yemen, Malaysia, Ireland, Taiwan, Spain and Indonesia; two from Norway, Switzerland, Japan, Turkey, Finland, Belgium, and Israel.

† Includes: avatar assessment, web-based module assessment, analysis of video vignettes, linguistic analysis, and content analysis of written reports, reflective essays, critical incident reports, and email messages.

†† One with OB/GYN, geriatrics, public health, palliative care, primary care, and nursing

Supplemental Digital Appendix 5

Publications with Moderate Ranking of Evidence for Behavioral and Social Science Competencies According to ACGME Competencies, LCME Accreditation Requirements, Learner Level, Guiding Framework, Type of Study and Assessment Methodology

Assessment Tool	Framework	Validation Methodology	Type of Study	Learner Level	*LCME Accreditation Requirements	ACGME Competencies Assessed	Author, Year & Citation #
Communication Competencies (n=28)							
SPs	• ICST • Calgary Cambridge Observation Guide	• Psychometric assessment • Pilot testing (no mention of cognitive interviewing)	Curriculum Development	Medical Students	ED-10, ED-19	• Patient care • Interpersonal/ communication skills	Bachmann et al, 2013 [1]
Validated KAS assessment tool	• Doctor-Patient Scale • Social Context Scale • Leeds Attitude to Concordance Scale • Jefferson Scale of Physician Empathy • Communication Attitude Scale • Calgary-Cambridge Observation Guide	• Test-retest • Expert consensus • Psychometric assessment	Curriculum Development	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Bombeke et al, 2011 [2]

SPs	None	Psychometric assessment	Curriculum Development	Medical Students	ED-19, ED-21, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills	Feeley et al, 2010 [3]
• Validated KAS assessment tool • SPs	Kalamazoo Consensus Statement	Psychometric assessment	Curriculum Development	Medical Students	ED-10, ED-19	• Patient care • Interpersonal/ communication skills	Hausberg et al, 2012 [4]
• Validated KAS assessment tool • SPs	Professional development	• Pilot testing (no mention of cognitive interviewing) • Psychometric assessment	Curriculum Development	Medical Students	ED-19, ED-23	• Patient care • Interpersonal/ communication skills • Professionalism	Joekes et al, 2011 [5]
Validated KAS assessment tool	Poirier	Psychometric assessment	Curriculum Development	Medical Students	ED-19, ED-20, ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Tiuraniemi et al, 2011 [6]
• Validated KAS assessment tool • SPs	Calgary Cambridge Observation Guide	Testing mentioned (no specifics on methods)	Curriculum Development	Medical Students	ED-19	• Patient care • Interpersonal/ communication skills	Turan et al, 2009 [7]

• Validated KAS assessment tool • Actual patients	FM-GMU Skills	Psychometric assessment	Curriculum Development	Residents	ED-19, ED-14	• Patient care • Interpersonal/ communication skills	Claramita and Majoor, 2006 [8]
Actual patients	• Patient-Centered Observation form • Kalamazoo Consensus Statement	• Expert consensus • Testing mentioned (no specifics on method)	Curriculum Development	Medical Students and Faculty	ED-19, ED-14	• Interpersonal/ communication skills	Mauksch et al, 2013 [9]
Evaluation of student essays derived from video OSCE	Miller's Assessment Pyramid	• Expert consensus • Test-retest • Pilot testing (no mention of cognitive interviewing)	Educational Research	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Hulsman et al, 2004 [10]
• Validated KAS assessment tool • SPs • Trainee evaluations	• ALACT reflection scale • History Taking Assessment Scale • Social and Academic Reputation • TIPI • Student peer assessment	Psychometric assessment	Educational Research	Medical Students	ED-10, ED-19, ED-20	• Patient care • Interpersonal/ communication skills	Hulsman et al, 2013 [11]

• Validated KAS assessment tool • SPs	Bayer-Fetzer Kalamazoo Consensus Statement	• Test-retest • Expert consensus • Psychometric assessment	Educational Research	Medical Students	ED-19	• Interpersonal/ communication skills	Ishikawa et al, 2010 [12]
SPs	• Patient-Physician Interaction Scale • Interpreter Impact Rating Scale	Psychometric assessment	Educational Research	Medical Students	ED-19, ED-21, ED-22	• Interpersonal/ communication skills	Lie et al, 2010 [13]
• Validated KAS assessment tool • SPs • OSVE • EUFM • MAAS	• Generalizability theory • Calgary-Cambridge Observation Guide	• Pilot testing (no mention of cognitive interviewing) • Expert consensus • Psychometric assessment	Educational Research	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Karabilgin et al, 2012 [14]
• Validated KAS assessment tool • SPs	• Self-Assessment of Interpersonal Competence Questionnaire (SAICQ) • Interpersonal Skills Rating Scale (ISRS) • Staff-Patient Interaction Rating Scale (SPIR)	Psychometric assessment	Educational Research	Medical Students	ED-19	• Interpersonal/ communication skills	Shapiro et al, 2009 [15]

• Validated KAS assessment tool • SPs	• Calgary-Cambridge Observation Guide	Psychometric assessment	Educational Research	Medical Students	ED-19	• Interpersonal/ communication skills	Simmenroth-Nayda et al, 2012 [16]
Validated KAS assessment tool	Miller's Assessment Model	• Expert consensus • Psychometric assessment	Educational Research	Medical Students	ED-19	• Interpersonal/ communication skills	Yeap et al, 2008 [17]
SPs	Integrated Procedural Performance Instrument (IPPI)	• Test-retest • Psychometric assessment	Instrument Development	• Medical Students • Residents	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	LeBlanc et al, 2009 [18]
• Validated KAS assessment tool • SPs • Actual patients	• Art of Medicine Survey Instrument • Interpersonal Skills Rating Form • ABIM Patient Satisfaction Questionnaire • Ware's Patient Satisfaction Questionnaire	Psychometric assessment	Instrument Development	Residents	ED-19	• Patient care • Medical knowledge • Practice-based learning and improvement • Professionalism • Systems-based practice	Leung et al, 2012 [19]

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• Validated KAS assessment tool • SPs	• Master Interview Rating Scale (MIRS) • Arizona Clinical Interview Rating Scale (ACIR)	Psychometric assessment	Educational Research	Medical Students	ED-19, ED-20, ED-21	• Patient care • Medical knowledge • Interpersonal/ communication skills	Wagner et al, 2011 [20]
• Validated KAS assessment tool	• Psychological Medical Inventory Scale • Bio-psychosocial Model	Psychometric assessment	Curriculum Development	Medical Students	ED-19	Interpersonal/ communication skills	Bachner et al, 2012 [21]
SPs	Simulation measures	Expert consensus	Curriculum Development	Medical Students	ED-19	• Patient care • Interpersonal/ communication skills • Systems-based practice	King et al, 2012 [22]
Validated KAS assessment tool	None	Psychometric assessment	Educational Research	Medical Students	ED-19	Interpersonal/ communication skills	Koponen et al, 2012 [23]
• Validated KAS assessment tool • Actual patients	Arizona Clinical Interviewing Rating Scale	Expert consensus	Curriculum Development	Medical Students	ED-10, ED-19, ED-21, ED-14	• Patient care • medical knowledge • Interpersonal/ communication skills • Professionalism	Hook and Pfeiffer, 2007 [24]

• Validated KAS assessment tool • Qualitative grounded theory	Bandura's Cognitive theory	• Expert consensus • Psychometric assessment	Curriculum Development	Medical Students	ED-19, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills • Systems-based practice	Mason and Ellershaw, 2008 [25]
• Validated KAS assessment tool	• Program in Palliative Care Education • Program in Palliative Care Education and Practice • Collet-Lester-Fear-of-Death-Scale • Bandura's Theory	Psychometric assessment	Curriculum Development	Medical Students	ED-19, ED-22, ED-23, ED-13	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Schulz et al, 2013 [26]
• Video vignette assessment • Validated assessment tool	Bandura's Self-Efficacy	Psychometric assessment	Educational Research	Medical Students	ED-19	• Patient care • Interpersonal/ communication skills	Aper et al, 2012 [27]

Analysis of email messages	None	• Expert consensus • Pilot testing (no mention of cognitive interviewing)	Educational Research	Medical Students	ED-19, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Christner et al, 2010 [28]
Cultural Competence/Patient-centered Care Competencies (n=12)							
• Validated KAS assessment tool	• Howell (unconscious incompetent to unconscious competent) • Bennett's intercultural sensitivity • Culhane-Pera adaptation of the Bennett model	Psychometric assessment	Curriculum Development	Medical Students	ED-10, ED-19, ED-21, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Crandall et al, 2003 [29]
• Validated KAS assessment tool	IOM: Confronting Racial and Ethnic Disparities in Health Care	Testing mentioned (no specifics on method)	Curriculum Development	Medical Students	ED-10, ED-19, ED-20, ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Jarris et al, 2012 [30]

• Validated KAS assessment tool	Cultural competency (TACCT)	• Test-retest • Expert consensus • Psychometric assessment	Curriculum Development	Medical Students	ED-10, ED-19, ED-20, ED-21, ED-22, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Mihalic et al, 2010 [31]
• Validated KAS assessment tool	Deaf cultural competency	• Pilot testing (no mention of cognitive interviewing) • Expert consensus	Curriculum Development	• Medical Students • Faculty	ED-10, ED-19, ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Hoang et al, 2011 [32]
Validated KAS assessment tool	Knowledge of cultural competency	Testing mentioned (no specifics)	Educational Research	Medical Students	ED-10, ED-19, ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills	Genao et al, 2009 [33]
Validated KAS assessment tool	• Attitudes about cross cultural care • self-reported preparedness • self-assessment of skills	Pilot testing (cognitive interviewing)	Educational Research	Residents	ED-19, ED-20, ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Weissman et al, 2005 [34]

• Validated KAS assessment tool	• Sexual response phases • PLISSIT	• Psychometric assessment • Pilot testing (no mention of cognitive interviewing)	Curriculum Development	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Cushing et al, 2005 [35]
Validated KAS assessment tool	• Kalamazoo Consensus Statement • Project RESPECT's client-centered counseling model	• Expert consensus • Psychometric assessment	Instrument Development	Medical Students	ED-10, ED-19, ED-20	• Patient care • Interpersonal/ communication skills • Professionalism	Kim et al, 2009 [36]
Validated KAS assessment tool	• CanMEDS framework • CELI (Control, Explain, Listen, Influencing and Support)	Psychometric assessment	Instrument Development	• Residents • Practicing Physicians	ED-19	• Interpersonal/ communication skills • Patient care • Medical knowledge • Professionalism	Wouda et al, 2011 [37]
Content analysis of students' written reports	• Population health competencies recommended by AAMC and RMPHECs • Ecological model	Expert consensus	Curriculum Development	Medical Students	ED-10, ED-20, ED-21, ED-22	• Patient care • Medical knowledge • Professionalism • Systems-based practice	Hoover and Wong, 2012 [38]

• Validated KAS assessment tool	Sexual attitude scale	Testing mentioned (no specifics on method)	Curriculum Development	Medical Students	ED-19, ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	McGarvey et al, 2003 [39]
• Validated KAS assessment tool	None	Psychometric assessment	Curriculum Development	Medical Students	ED-10, ED-19, ED-20, ED-21, ED-22, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Tang et al, 2002 [40]
Empathy/Compassion Competencies (n=4)							
Validated KAS assessment tool	• Transtheoretical model • Behavior Change Counseling Index (BECCI)	• Test-retest • Psychometric assessment	Educational Research	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Lim et al, 2013 [41]
• SPs • Linguistic analysis	None	• Expert consensus • Psychometric assessment	Educational Research	Medical Students	ED-19	• Interpersonal/ communication skills • Patient care • Medical knowledge • Professionalism	Shapiro et al, 2006 [42]

Validated KAS assessment tool	• Reynolds Empathy Scale • Barrett-Lennard Empathy Scale • Consultation and Relational Empathy (CARE) measure	• Test-retest • Expert consensus • Psychometric assessment • Pilot testing (cognitive interviewing)	Instrument Development	• Residents • Practicing Physicians	ED-19, ED-14	Interpersonal/ communication skills	Mercer et al, 2004 [43]
Validated KAS assessment tool	Jefferson Scale of Physician Empathy	• Testing mentioned (no specifics on method)	Educational Research	• Medical Students • Residents	ED-19	• Patient care • Interpersonal/ communication skills	Fernandez-Olano et al, 2008 [44]
Behavioral Health Counseling (n=12)							
• Validated KAS assessment tool	• 5 A's Patient-Centered Care Model	• Expert consensus • Pilot testing (no mention of cognitive interviewing)	Curriculum Development	Medical Students	ED-10, ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Bass et al, 2004 [45]
• Validated KAS assessment tool	Transtheoretical model/ motivational interviewing	Testing mentioned (no specifics on method)	Curriculum Development	Medical Students	ED-19, ED-20	• Patient care • Interpersonal/ communication skills	Bell and Cole, 2008 [46]
• Validated KAS assessment tool	• Transtheoretical model • University of Arizona's Cessation Skills Certification Guide	Expert consensus	Curriculum Development	Medical Students	ED-10, ED-19, ED-20, ED-14	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Brown et al, 2004 [47]

SPs	• Shared decision-making (Elwyn et al) • Making Good Decisions In Collaboration (MAGIC)	Expert consensus	Curriculum Development	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Han et al, 2014 [48]
SPs	• Stanford Model of Behavioral Change • 5 A's (Ask, Advise, Assess, Assist, Arrange)	Expert consensus	Curriculum Development	Medical Students	ED-10, ED-19, ED-20, ED-14	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Kosowicz et al, 2007 [49]
• Validated KAS assessment tool	• Transtheoretical model/ motivational interviewing • Helpful Response Questionnaire	Psychometric assessment	Curriculum Development	Medical Students	ED-10, ED-19, ED-20	• Patient care • Medical knowledge • Interpersonal/ communication skills	Martino et al, 2007 [50]
• SPs • Analysis of post-encounter note	George Washington Institute for Spirituality and Health (GWISH) competencies	• Expert consensus • Psychometric assessment	Curriculum Development	Medical Students	ED-19, ED-21, ED-22, ED-23	• Patient care • Interpersonal/ communication skills • Professionalism	McEvoy et al, 2014 [51]
SPs	Transtheoretical model/ motivational interviewing (MITI)	Psychometric assessment	Curriculum Development	Medical Students	ED-10, ED-19, ED-20	• Patient care • Interpersonal/ communication skills	White et al, 2007 [52]

• SPs	Cohen-Cole scoring sheet for identifying and treating HPV	• Expert consensus	Educational Research	Medical Students	ED-19, ED-20	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Edwardsen et al, 2006 [53]
• SPs	• Transtheoretical model/ motivational interviewing	• Expert consensus • Psychometric assessment	Educational Research	Medical Students	ED-19, ED-20	• Patient care • Interpersonal/ communication skills	Haeseler et al, 2011 [54]
• Validated KAS assessment tool • SPs	Transtheoretical model	• Psychometric assessment	Educational Research	Medical Students	ED-19, ED-20	• Patient care • Medical knowledge • Interpersonal/ communication skills	Prochaska et al, 2007 [55]
• Validated KAS assessment tool • SPs	Transtheoretical model/ motivational interviewing	Expert consensus	Educational Research	Medical Students	ED-10, ED-19, ED-20, ED-14	• Patient care • Medical knowledge • Interpersonal/ communication skills	Stolz et al, 2012 [56]
Professionalism Competencies (n=4)							
• Validated KAS assessment tool • analysis of vignettes	Boenink measures of reflective skills and knowledge of professional behavior	• Expert consensus • Psychometric assessment	Educational Research	Medical Students	ED-19, ED-20, ED-23	• Interpersonal/ communication skills • Professionalism	Boenink et al, 2005 [57]

Assessment of critical incident reports	None	Expert consensus	Educational Research	Medical Students	ED-19, ED-21, ED-22, ED-23	• Patient care • Medical knowledge • Practice-based learning and improvement • Interpersonal/ communication skills • Professionalism • Systems-based practice	Kittmer et al, 2013 [58]
Validated KAS assessment tool	• ABIM Patient Assessment • Physician peer assessment	• Expert consensus • Psychometric assessment • Pilot testing (no cognitive interviewing)	Educational Research	Residents	ED-19, ED-21, ED-23	• Interpersonal/ communication skills • Professionalism	Abadel and Hattab, 2014 [59]
• Validated KAS assessment tool • SPs	Clinical Conscientiousness Index	• Test-retest • Psychometric assessment	Instrument Development	Medical Students	ED-19, ED-23	Professionalism	Kelly et al, 2012 [60]
Teamwork Competencies (n=2)							
• Validated KAS assessment tool	• TeamSTEPPS • Bandura's Self-Efficacy	Psychometric assessment	Curriculum Development	Medical Students	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Brock et al, 2013 [61]

SPs	GICS geriatric SP exam	Psychometric assessment	Curriculum Development	• Medical Students • Residents	ED-19	• Patient care • Medical knowledge • Interpersonal/ communication skills	Yuasa et al, 2014 [62]

*LCME Accreditation Requirements (Social & Behavioral Science _Specific_)—Curriculum of a medical education program must include/prepare:
- ED-10. Behavioral and socioeconomic subjects (in addition to basic science and clinical disciplines).
- ED-19. Specific instruction in communication skills as they relate to physician responsibilities, including communication with patients, their families, colleagues & other health professionals.
- ED-20. Medical students for their role in addressing the medical consequences of common societal problems (e.g. abuse)
- ED-21. Medical students (and faculty) to demonstrate an understanding of the manner in which people of diverse cultures and belief systems perceive health and illness and respond to various symptoms, diseases, and treatments.
- ED-22. Medical students to recognize and appropriately address gender and cultural biases in themselves, in others, and in the process of healthcare delivery.
- ED-23. Instruction in medical ethics and human values and require its medical students to exhibit scrupulous ethical principles in caring for patients and in relating to patients' families and to others involved in patient care.

LCME Accreditation Requirements (Social & Behavioral Science _Integrative_)—Curriculum of a medical education program must include/prepare:
- ED-13. All organ systems, and important aspects of preventive, acute, chronic, continuing, rehabilitative, and end-of-life care.
- ED-14. Clinical experience in primary care
- ED-15. Prepare students to enter any field of graduate medical education and include content and clinical experiences related to each phase of the human life cycle to enable recognizing wellness, determinants of health, opportunities for health promotion; recognize and interpret symptoms and signs of disease; develop differential diagnoses and treatment plans; and assist patients in addressing health-related issues involving all organ systems.

Supplemental Digital Appendix 6
Publications with Weak Ranking of Evidence for Behavioral and Social Science Competencies According to ACGME Competencies, LCME Accreditation Requirements, Learner Level, Guiding Framework, Type of Study and Assessment Methodology

Assessment Tool	Framework	Validation Methodology	Type of Study	Learner Level	*LCME Accreditation Requirements	ACGME Competencies Assessed	Author, Year & Citation #
Communication Competencies (n=7)							
• Validated KAS assessment tool	Kalamazoo Consensus Statement	• Psychometric assessment • Pilot testing (no mention of cognitive interviewing)	Instrument Development	• Non-Professional Undergraduates	ED-19	• Interpersonal/ communication skills	Baribeau et al, 2012 [63]
• Tool tested by panel of 11 judges	• Calo-RE Taxonomy • Health Behavior Change Competency	• Expert consensus	Instrument Development	• Medical Students	ED-10, ED-19	• Interpersonal/ communication skills	Chisolm et al, 2014 [64]
• Validated KAS assessment tool	METT (Micro Expression Training Tool)	Testing mentioned (no specifics on method)	Educational Research	• Medical Students	ED-19	• Interpersonal/ communication skills	Endres and Laidlaw, 2009 [65]

• SPs	• SPIKES • Breaking Bad News Assessment Scale • Global Rating Scale	• Expert consensus • Pilot testing (no mention of cognitive interviewing)	Curriculum Development	• Medical Students	ED-21, ED-22	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Kalet et al, 2005 [66]
• SPs • Web-based module assessment	None	• Testing mentioned (no specifics on methods)	Curriculum Development	• Medical Students	ED-19	• Patient care • Interpersonal/ communication skills	Lee et al, 2011 [67]
SPs	• Calgary-Cambridge Observation guide • SEGUE • Macy Initiative in Health Communication	• Expert consensus	Curriculum Development	Medical Students	ED-19	• Interpersonal/ communication skills	Mukohara et al, 2004 [68]
• SPs	• SPIKES • Breaking Bad News Assessment Scale • Global Rating Scale	• Psychometric assessment	Curriculum Development	• Medical Students	ED-19	• Patient care • Interpersonal/ communication skills	Schildmann et al, 2012 [69]
Cultural Competence/Patient-centered Care Competencies (n=3)							

• Validated KAS assessment tool • SPs	• Cross-Cultural Care Survey	• Testing mentioned (no specifics on methods)	Educational Research	• Residents	ED-19, ED-21, ED-23	• Patient care • Interpersonal/ communication skills • professionalism	Chun et al, 2012 [70]
• Adaptation of a validated tool	• None	• Testing mentioned (no specifics on methods)	Educational Research	• Medical Students	• ED-19, E21, ED-22	• Interpersonal/ communication skills • patient care • medical knowledge • professionalism	Sanchez et al, 2006 [71]
• Validated assessment tool	• None	• Test-retest	Curriculum Development	• Residents	ED-19, ED-21, ED-23, ED-13	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Yacht et al, 2006 [72]
Empathy/Compassion Competencies (n=6)							
• Validated assessment tool • SPs	• Cross-cultural Care Survey	• Test-retest	Curriculum Development	• Residents	ED-19, ED-21, ED-23	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Chun et al, 2013 [73]

• Emotional Intelligence	• Emotional Intelligence	• Testing mentioned (no specifics on method)	Educational Research	• Medical Students	ED-19	• None	Fletcher et al, 2009 [74]
• Qualitative analysis of evolving case statements that were audio-taped and transcribed	• SPIKES	• Expert consensus	Curriculum Development	• Medical Students	ED-19, ED-13	• Patient care • Medical knowledge • Interpersonal/ communication skills	Goldsmith et al, 2011 [75]
• Avatar assessment of compassionate patient care	• Perkins Dispositional Theory of Thinking	• Expert consensus	Educational Research	• Medical Students	ED-19, ED-14	• Patient care • Medical knowledge • Interpersonal/ communication skills • professionalism	Loke et al, 2012 [76]
• Validated assessment tool	• Jefferson Scale of Physician Empathy	• Testing mentioned (no specifics on method)	Curriculum Development	• Medical Students	ED-19	• Interpersonal/ communication skills	Rosenthal et al, 2011 [77]
• Validated KAS assessment tool	• Jefferson Scale of Empathy	• Testing mentioned (no specifics on method)	Curriculum Development	• Medical Students	ED-19, ED-21	• Patient care • Interpersonal/ communication skills	Van Winkle et al, 2012 [78]
Behavioral Health Counseling Competencies (n=2)							

• Validated KAS assessment tool • SPs	• Tobacco Intervention Risk Factor Interview Scale	• Psychometric assessment	Curriculum Development	• Medical Students	ED-19, ED-20, Ed-21	• Patient care • Medical knowledge • Interpersonal/ communication skills	Foley et al, 2006 [79]
• Validated KAS assessment tool • SPs	• None	• Expert consensus	Curriculum Development	• Medical Students	ED-19, ED-20	• Patient care • Medical knowledge • Interpersonal/ communication skills • Professionalism	Haist et al, 2003 [80]
Professional Competencies (n=1)							
• Validated KAS assessment tool • SPs	• Bowen and Carline Strategy for Adult Learning • Knowles Adult Learning Theory	• Testing mentioned (no specifics on method)	Educational Research	• Practicing Physicians	ED-19, ED-14	• Medical knowledge • Interpersonal/ communication skills	Margalit et al, 2005 [81]

*LCME Accreditation Requirements (Social & Behavioral Science _Specific_)—Curriculum of a medical education program must include/prepare:
- ED-10. Behavioral and socioeconomic subjects (in addition to basic science and clinical disciplines).
- ED-19. Specific instruction in communication skills as they relate to physician responsibilities, including communication with patients, their families, colleagues & other health professionals.
- ED-20. Medical students for their role in addressing the medical consequences of common societal problems (e.g. abuse)

- ED-21. Medical students (and faculty) to demonstrate an understanding of the manner in which people of diverse cultures and belief systems perceive health and illness and respond to various symptoms, diseases, and treatments.
- ED-22. Medical students to recognize and appropriately address gender and cultural biases in themselves, in others, and in the process of healthcare delivery.
- ED-23. Instruction in medical ethics and human values and require its medical students to exhibit scrupulous ethical principles in caring for patients and in relating to patients' families and to others involved in patient care.

LCME Accreditation Requirements (Social & Behavioral Science *Integrative*)—Curriculum of a medical education program must include/prepare:
- ED-13. All organ systems, and important aspects of preventive, acute, chronic, continuing, rehabilitative, and end-of-life care.
- ED-14. Clinical experience in primary care
- ED-15. Prepare students to enter any field of graduate medical education and include content and clinical experiences related to each phase of the human life cycle to enable recognizing wellness, determinants of health, opportunities for health promotion; recognize and interpret symptoms and signs of disease; develop differential diagnoses and treatment plans; and assist patients in addressing health-related issues involving all organ systems.

Supplemental Digital Appendix 7
Relevant LCME Accreditation Requirements According to Social and Behavioral Science Domain

Competencies Assessed1	Behavioral & Social Science Institute of Medicine Domains					
LCME Accreditation Requirements – Social & Behavioral Science *Specific* Curriculum must include/prepare:	Mind-Body Interactions in Health & Disease	Patient Behavior	Physician-Patient Interactions	Physician Role & Behavior	Social & Cultural Issues in Healthcare	Health Policy & Economics
	n (weight)	n (weight)	n (weight)	n (weight)	n (weight)	n (weight)
ED-10. Behavioral and socioeconomic subjects.	4 (+)	27 (++)	NA	NA	13 (+++)	2 (+++)
ED-19. Communication skills with patients, families, colleagues, and other health professionals.	NA	58 (++)	107 (+++)	104(+++)	NA	NA
ED-20. Role in addressing medical consequences of common societal problems (e.g. violence/abuse).	NA	24 (+++)	25 (+++)	25 (++)	14 (+++)	5 (++)
ED-21. Understanding of the manner in which people of diverse cultures and belief systems perceive health and illness and respond to various symptoms, diseases, and treatments.	6 (++)	15 (+++)	29 (+++)	31 (+++)	19 (+++)	2 (++)
ED-22. Recognize and appropriately address gender and cultural biases in themselves, in others, and in the process of health care delivery.	2 (+)	12 (++)	20 (++)	22 (+++)	14 (+++)	NA
ED-23. Medical ethics and human values in caring for patients and relating to families and others involved in patient care.	NA	NA	19 (++)	20 (+++)	6 (+++)	NA
TOTALS	12	136	200	202	66	9
LCME Accreditation Requirements – Social & Behavioral Science *Integrative*: Curriculum must include/prepare:	Mind-Body Interactions in Health & Disease	Patient Behavior	Physician-Patient Interactions	Physician Role & Behavior	Social & Cultural Issues in Healthcare	Health Policy & Economics

	n (weight)	n (weight)	n (weight)	n (weight)	n (weight)	n (weight)
ED-13. All organ systems, and important aspects of preventive, acute, chronic, continuing, rehabilitative, and end-of-life care.	0 (+)	1 (+)	3 (+)	NA	0 (+)	0 (+)
ED-14. Clinical experience in primary care.	2 (+)	7 (+)	9 (+)	8 (+)	2 (+)	0 (+)
ED-15. Include content and clinical experiences related to each phrase of the human life cycle regarding wellness, determinants of health, opportunities for health promotion; recognizing and interpret symptoms and signs of disease; develop differential diagnoses and treatment plans; and assist patients in addressing health-related issues involving all organ systems.	0 (+)	1 (++)	1 (++)	0 (+++)	0 (+++)	0 (+)
TOTALS	2	9	13	8	2	0

1 The plus sign (+) in each box represented the weights to be applied to the strength of the interaction between the IOM domains and the LCME Accreditation Requirements.
N/A = Not Applicable.
Weights for relevance to BSS domains (+=somewhat relevant,++ = moderately relevant, +++ = highly relevant, blank not directly relevant.

Supplemental Digital Appendix 8

Other Competency Measures Continued from Supplemental Digital Appendix 2

Study Characteristics	Instrument Development with Psychometric Assessment only (n=20)	Educational Research Studies (n=48)	Curriculum Evaluation studies (n=46)
Project RESPECT client-centered counselling model	1	0	0
Emotional intelligence	0	2	0
Cultural competency	0	1	1
Scale of Attitudes Toward Disabled Persons (SADP)	0	1	0
SPIKES protocol for delivering bad news	0	0	2
Liverpool Undergraduate Communication Assessment Scale	1	0	0
Motivational Interviewing Treatment Integrity (MITI)	0	1	1
Self-reported preparedness and self-assessment of skills	0	1	0
Behavior Change Counseling Index (BECCI)	0	1	0
ABIM patient and physician assessment	1	1	0
Cross-cultural care survey	1	0	1
Arizona Clinical Interviewing Rating Scale	0	1	1
Master Interview Rating Scale	0	1	0
CELI (Control, Explain, Listen, Influence)	1	1	0
CanMEDs Framework	1	0	0
Communication Skills Attitude Scale	0	1	1
Reynolds empathy measure (RES)	1	0	0
Barrett-Lennard empathy scale (BLESS)	1	0	0
Consultation and Relational Empathy (CARE) measure	1	0	0
Clinical Conscientiousness Index	1	0	0
Calo-RE Taxonomy (behavior change techniques)	1	0	0
Health Behavior Change competency	1	1	0
Integrated Procedural Performance Instrument (IPPI)	1	0	0
Art of Medicine Survey Instrument	1	0	0
Interpersonal Skills Rating Form	1	0	0
Ware's Patient Satisfaction Questionnaire	1	0	0
Communication Items Evaluation (Forrest Lang)	1	0	0

Rochester Communication Rating Scale	1	0	0
Deaf cultural competency	0	0	1
Bennett's intercultural sensitivity model	0	0	1
IOM: Confronting Racial and Ethnic Disparities in Health care	0	0	1
Population health competencies recommened by AAMC and RMPHECs	0	0	1
Professional Development	0	0	1
Psychological Medical Inventory (PMI-S)	0	0	1
Breaking bad news assessment scale	0	0	1
Doctor-Patient scale (de Monchy)	0	0	2
Confidence in Communicating (Doherty and Marteau)	0	0	1
University of Arizona's Cessation Skills Certification Guide	0	0	1
Tobacco Intervention Risk Factor Interview Scale	0	0	1
Helpful Response Questionnaire	0	0	1
Team Strategies and Tools to Enhance Performance and Patient Safety (TeamSTEPPS)	0	0	1
George Washington Institute for Spirituality and Health (GWISH) competencies	0	0	1
Shared Decision-Making	0	0	1
Making good decisions in collaboration (MAGIC)	0	0	1
Program in Palliative Care Education and Practice	0	0	1
Collet-Lester-Fear-of-Death-Scale	0	0	1
FM-GMU Communication Behavior Skills Questionnaires	0	0	1
Leeds Attitude to Concordance Scale	0	0	1
Social Context Scale	0	0	1
Sexual response phases and PLISSIT	0	0	1
Patient-centered observation form	0	0	1
Poirier Communication Skills Questionnaire	0	0	1
Sexual attitude scale	0	0	1
Patient-centered care model	0	0	1
Interpersonal skills rating scale	0	1	0
Staff-patient interaction rating scale	0	1	0
Self-assessment of interpersonal competence questionnaire	0	1	0
Patient-centered communication /interpersonal skills scale	0	1	0

Revised UIC Communication/ interpersonal skills scale	0	1	0
Patient-physician interaction scale	0	1	0
Interpreter Impact Rating Scale	0	1	0
Cohen-Cole HPV scoring sheet	0	1	0
Boenink measures of reflective skills and knowledge of professional behavior	0	1	0
Transactional analysis/ communication theories (von Thun)	0	1	0
Empathy Construct Rating Scale	0	1	0
Balanced Emotional Empathy Scale	0	1	0
National institute on alcohol abuse and alcoholism	0	1	0
Modified Saitz Pre-Post test	0	1	0
Micro Expression Training Tool (METT)	0	1	0
Attitudes about cross-cultural care	0	2	0
ALACT reflection scale	0	1	0
History Taking Assessment Scale	0	0	0
Social and academic reputation	0	0	0
Ten Item Personality Inventory (TIPI)	0	0	0
Amsterdam Attitudes and Communication Scale	1	0	0
ACGME Competencies	0	1	0
Professional Identity Development	1	0	0
Mead and Bower on Patient Centeredness	0	1	0
Kleinmon's questions on patient experience of illness	0	1	0
Macy Initiative in Health Communication	0	0	1
Geriatrics Interdisciplinary Care Summary SP exam	0	0	1
Interdisciplinary Communication Skills Training	0	0	1
Health Belief Attitude Survey	0	0	1

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