

Supplemental Material

CBE—Life Sciences Education

Wang *et al.*

Table S1. Factor loadings and model fit indices for all measures.

Measures	Subconstructs	Items/Indicators	Standardized factor loadings	Model fit indices
Trust	Understanding	Trust 1	0.86	RMSEA = 0.071, SRMR = 0.021, CFI = 0.989, TLI = 0.978
		Trust 2	0.69	
		Trust 3	0.82	
	Acceptance	Trust 4	0.83	
		Trust 5	0.90	
	Care	Trust 7	0.89	
		Trust 8	0.92	
Mindset		Mindset 1	0.91	RMSEA = 0, SRMR = 0, CFI = 1, TLI = 1
		Mindset 2	0.96	
		Mindset 3	0.85	
Buy-in	Persuasion	Persuasion 1	0.87	RMSEA = 0.092, SRMR = 0.031, CFI = 0.945, TLI = 0.929
		Persuasion 2	0.82	
		Persuasion 3	0.77	
		Persuasion 4	0.87	
	Identification	Identification 1	0.83	
		Identification 2	0.74	
		Identification 3	0.72	
		Identification 4	0.80	

	Commitment	Commitment 1	0.90	
		Commitment 2	0.83	
		Commitment 3	0.78	
		Commitment 4	0.87	
Engagement	Organization	Organization 1	0.65	RMSEA = 0.070, SRMR = 0.047, CFI = 0.890, TLI = 0.878
		Organization 2	0.81	
		Organization 3	0.40	
		Organization 4	0.72	
	Critical thinking	Critical thinking 1	0.61	
		Critical thinking 2	0.50	
		Critical thinking 3	0.36	
		Critical thinking 4	0.84	
		Critical thinking 5	0.79	
	Elaboration	Elaboration 1	0.61	
		Elaboration 2	0.78	
		Elaboration 3	0.83	
		Elaboration 4	0.58	
		Elaboration 5	0.81	
		Elaboration 6	0.80	
Metacognitive Self-regulation	Metacognitive Self-regulation 1	0.55		

		Metacognitive Self-regulation 2	0.79	
		Metacognitive Self-regulation 3	0.71	
		Metacognitive Self-regulation 4	0.47	
		Metacognitive Self-regulation 5	0.48	
		Metacognitive Self-regulation 6	0.54	
		Metacognitive Self-regulation 7	0.67	
		Metacognitive Self-regulation 8	0.79	
		Metacognitive Self-regulation 9	0.74	
		Metacognitive Self-regulation 10	0.71	
	Time and Study Environment Management	Time and Study Environment Management 1	0.77	
		Time and Study Environment Management 2	0.81	
		Time and Study Environment Management 3	0.70	
		Time and Study Environment Management 4	0.67	
Science Persistence		Science Persistence 1	0.75	RMSEA = 0, SRMR = 0, CFI = 1, TLI = 1
		Science Persistence 2	0.85	
		Science Persistence 3	0.52	

Table S2. An illustration of how we created the first parcels of persuasion, identification, and commitment.

		Exposure	Persuasion	Identification	Commitment
EBPs items	EBP18	1	1	1	0
	EBP25	0	0	0	0
	EBP20	1	1	1	0
	EBP8	1	0	0	0
	EBP1	0	0	0	0
	EBP27	1	0	1	1
Observed indicators of buy-in	Persuasion_1		2/4 = 0.5		
	Identification_1			3/4=0.75	
	Commitment_1				1/4 = 0.25

Table S3. Intraclass-Correlation Coefficients for all endogenous variables

Variables	ICCs	Variables	ICCs
Persuasion_1	0.024	Commitment_3	0.035
Persuasion_2	0.014	Commitment_4	0.031
Persuasion_3	0.041	Engagement_1	0.049
Persuasion_4	0.022	Engagement_2	0.018
Identification_1	0.039	Engagement_3	0.022
Identification_2	0.020	Engagement_4	0.023
Identification_3	0.036	Persistence_1	0.323
Identification_4	0.020	Persistence_2	0.201
Commitment_1	0.044	Persistence_3	0.120
Commitment_2	0.017	Course grade	0.182

Table S4. Model fit indices for different groups

Group	Chi-squares	df	CFI	TLI	RMSEA [90% C.I.]
URM	953.03	570	.93	.92	.047[.042, .052]
Other	871.72	570	.95	.94	.039[.034, .045]
White	2226.12	570	.91	.90	.051[.049, .053]
Males	1355.55	570	.93	.92	.047[.044, .050]
Females	1978.50	570	.93	.92	.046[.043, .048]

Table S5. Measurement invariance analyses between female students and male students

	Unconditional model		Constrained model		p
	chi-square	df	chi-square	df	
Trust	128.11	22	148.50	26	<.001
Mindset	0	0	0.589	2	.74
Persuasion	11.20	4	13.52	7	.51
Identification	2.88	4	4.25	7	.71
Commitment	23.08	4	25.69	7	.45
Engagement	8.76	4	10.38	7	.65
Persistence	0	0	1.44	2	.49

Table S6. Correlations and descriptive statistics for all observed indicators

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Trust1	1	0.78	0.70	0.73	0.05	0.05	0.05	0.27	0.25	0.24	0.29	0.19	0.16	0.15
2. Trust2		1	0.7	0.7	0.0	0.06	0.05	0.30	0.27	0.26	0.31	0.2	0.1	0.1

			6	0	7							0	5	3
3. Trust3			1	0.61	0.08	0.10	0.08	0.30	0.27	0.23	0.31	0.17	0.14	0.11
4. Trust4				1	0.00	0.00	0.03	0.22	0.20	0.20	0.23	0.17	0.15	0.14
5. Mindset1					1	0.87	0.76	0.16	0.12	0.12	0.15	0.08	0.02	0.05
6. Mindset2						1	0.80	0.14	0.11	0.10	0.13	0.08	0.04	0.05
7. Mindset3							1	0.13	0.12	0.10	0.13	0.07	0.02	0.04
8.P1								1	0.69	0.67	0.73	0.10	0.04	0.06
9. P2									1	0.60	0.70	0.11	0.11	0.07
10. P3										1	0.64	0.12	0.06	0.14
11. P4											1	0.10	0.04	0.03
12. I1												1	0.59	0.59
13. I2													1	0.52
14. I3														1
Mean	3.61	3.73	3.86	3.16	4.48	4.53	4.24	0.68	0.61	0.59	0.68	0.55	0.49	0.46
SD	0.93	0.83	0.83	0.98	1.29	1.29	1.41	0.35	0.35	0.39	0.33	0.35	0.34	0.36

	15	16	17	18	19	20	21	22	23	24	25	26	27
1. Trust1	0.17	0.17	0.17	0.17	0.17	0.19	0.25	0.17	0.26	0.01	0.05	0.07	0.14
2. Trust2	0.16	0.19	0.20	0.18	0.19	0.18	0.26	0.16	0.25	0.06	0.09	0.08	0.19
3. Trust3	0.16	0.17	0.19	0.14	0.18	0.18	0.24	0.16	0.25	0.08	0.12	0.10	0.15

4. Trust4	0.13	0.11	0.12	0.12	0.10	0.19	0.24	0.15	0.26	-0.01	0.06	0.11	0.14
5. Mindset1	0.06	0.10	0.10	0.10	0.10	0.03	0.09	0.03	0.08	0.07	0.04	-0.03	0.08
6. Mindset2	0.07	0.09	0.08	0.08	0.09	0.03	0.09	0.04	0.07	0.08	0.06	0.00	0.05
7. Mindset3	0.04	0.08	0.08	0.08	0.08	0.02	0.07	0.03	0.07	0.05	0.01	-0.03	0.05
8.P1	0.12	0.34	0.32	0.29	0.32	0.17	0.22	0.14	0.24	0.09	0.08	0.08	0.14
9. P2	0.10	0.28	0.28	0.23	0.28	0.17	0.23	0.18	0.25	0.05	0.09	0.07	0.12
10. P3	0.08	0.30	0.26	0.29	0.26	0.14	0.18	0.12	0.22	0.05	0.06	0.09	0.11
11. P4	0.11	0.31	0.37	0.26	0.37	0.17	0.23	0.16	0.23	0.11	0.11	0.08	0.14
12. I1	0.63	0.52	0.41	0.41	0.39	0.10	0.13	0.09	0.17	-0.02	-0.01	0.08	0.12
13. I2	0.57	0.36	0.32	0.32	0.32	0.16	0.15	0.12	0.19	-0.05	-0.01	0.05	0.08
14. I3	0.55	0.35	0.48	0.30	0.30	0.14	0.13	0.11	0.19	-0.05	-0.02	0.09	0.02

	15	16	17	18	19	20	21	22	23	24	25	26	27
15. I4	1	0.44	0.41	0.39	0.51	0.09	0.13	0.07	0.15	0.03	0.02	0.07	0.12
16. C1		1	0.74	0.69	0.77	0.09	0.15	0.08	0.17	0.07	0.04	0.10	0.15
17. C2			1	0.62	0.72	0.09	0.15	0.10	0.16	0.07	0.05	0.06	0.14
18. C3				1	0.66	0.10	0.14	0.07	0.16	0.05	0.04	0.10	0.11
19. C4					1	0.09	0.15	0.08	0.15	0.10	0.09	0.07	0.15
20. E1						1	0.65	0.59	0.70	0.10	0.17	0.15	0.12
21. E2							1	0.65	0.72	0.13	0.19	0.15	0.19
22. E3								1	0.67	0.14	0.19	0.15	0.11

23. E4									1	0.10	0.19	0.17	0.17
24. SP1										1	0.64	0.39	0.09
25. SP2											1	0.44	0.11
26. SP3												1	0.07
27. Grade													1
Mean	0.58	0.45	0.44	0.36	0.44	4.47	4.67	4.38	4.74	4.34	3.93	3.49	2.66
SD	0.31	0.37	0.36	0.38	0.35	1.02	0.97	0.93	1.06	1.06	1.23	1.22	0.98

Note: P=Persuasion, I=Identification, C=Commitment, E=Engagement, SP=Science Persistence

Table S7. Correlations and descriptive statistics for all variables of interest between male and female students

	1	2	3	4	5	6	7	8
1 Trust	1	0.02 (0.10)	0.37 (0.33)	0.23 (0.21)	0.30 (0.17)	0.32 (0.25)	0.11 (0.09)	0.19 (0.17)
2 Mindset		1	0.17 (0.15)	0.07 (0.09)	0.12 (0.11)	0.05 (0.07)	0.04 (0.03)	0.06 (0.06)
3 Persuasion			1	0.09 (0.15)	0.43 (0.37)	0.26 (0.26)	0.14 (0.10)	0.16 (0.14)
4 Identification				1	0.54 (0.54)	0.15 (0.22)	0.00 (0.04)	0.08 (0.11)
5 Commitment					1	0.16 (0.17)	0.15 (0.07)	0.18 (0.15)
6 Engagement						1	0.19 (0.23)	0.13 (0.19)
7 Persistence							1	0.09 (0.12)
8 Grade								1
Mean	3.67 (3.65)	4.26 (4.50)	0.66 (0.65)	0.56 (0.51)	0.46 (0.41)	4.51 (4.60)	3.91 (3.93)	2.69 (2.68)

SD	0.81 (0.77)	1.36 (1.16)	0.30 (0.30)	0.28 (0.28)	0.33 (0.32)	0.86 (0.86)	0.98 (0.93)	0.98 (0.97)
----	----------------	----------------	----------------	----------------	----------------	----------------	----------------	----------------

Note: Numbers in parentheses represent the values for the female students.

Table S8. Correlations and descriptive statistics for all variables of interest across White, URM, and Other students

	1	2	3	4	5	6	7	8
1 Trust	1	0.11 (0.12) [-0.08]	0.33 (0.32) [0.37]	0.24 (0.12) [0.22]	0.22 (0.16) [0.26]	0.26 (0.31) [0.27]	0.06 (0.12) [0.20]	0.17 (0.17) [0.23]
2 Mindset		1	0.19 (0.11) [0.12]	0.10 (0.08) [-0.03]	0.14 (0.12) [0.01]	0.04 (0.23) [0.00]	0.05 (0.10) [-0.01]	0.07 (0.02) [0.14]
3 Persuasion			1	0.18 (0.01) [0.09]	0.42 (0.35) [0.30]	0.28 (0.21) [0.23]	0.10 (0.10) [0.17]	0.16 (0.07) [0.13]
4 Identification				1	0.56 (0.58) [0.46]	0.21 (0.15) [0.23]	0.02 (0.02) [0.05]	0.12 (0.11) [0.04]
5 Commitment					1	0.17 (0.20) [0.13]	0.10 (0.07) [0.16]	0.18 (0.13) [0.07]
6 Engagement						1	0.18 (0.24) [0.30]	0.18 (0.14) [0.19]
7 Persistence							1	0.12 (0.11) [0.11]
8 Grade								1
Mean	3.64 (3.70) [3.70]	4.42 (4.57) [4.23]	0.66 (0.65) [0.64]	0.53 (0.52) [0.55]	0.44 (0.39) [0.45]	4.55 (4.58) [4.61]	3.93 (3.85) [4.01]	2.73 (2.47) [2.77]
SD	0.77 (0.79) [0.79]	1.19 (1.31) [1.27]	0.29 (0.30) [0.32]	0.27 (0.29) [0.29]	0.31 (0.33) [0.33]	0.80 (0.95) [0.95]	0.93 (1.02) [0.91]	0.97 (0.95) [0.94]

Note: The values for the URM students are presented in parentheses. The values for Other students are presented in square brackets.

Buy-In Framework Student Survey

Buy-in: Exposure, Persuasion, Identification, and Commitment (EPIC)

Prompt for Exposure:

Below is a list of things that you may or may not have done in this course. *Scale: In this class, In another class, Never.*

Prompt for Persuasion, Identification, and Commitment:

We want to learn about the practices you experienced in this course. In this section, please select ALL that apply. *Scale: I believe this advances my learning (Persuasion), I like to learn this way (Identification), I want to do this in future courses (Commitment), None of these.*

1. I had learning goals for what I was expected to know and be able to do
2. I received feedback on my progress towards course objectives throughout the semester
3. I received exam grades that I did not understand*
4. I provided feedback to my instructor on his or her teaching methods
5. I related scientific concepts to everyday experiences
6. I developed hypotheses and made predictions based on my hypotheses
7. I designed and/or conducted experiments
8. I completed exercises that led me to draw my own conclusions
9. I presented my scientific ideas in writing
10. I read and evaluated scientific literature or media articles
11. I completed in-class activities other than listening to a lecture
12. I listened to lecture presentations and took notes
13. I responded to short in-class writing prompts
14. I completed in-class activities in groups of two or more
15. I answered questions in class using a clicker or other polling method
16. I heard from members of the whole class about their group work
17. I worked in diverse groups
18. I considered the contributions of diverse people and perspectives
19. I used examples or analogies that included a diversity of people and cultures
20. I engaged in higher level thought processes that required me to apply my knowledge and skills
21. I memorized facts from the textbook*
22. I applied knowledge of other subjects
23. I identified appropriate strategies for solving different types of problems
24. I reflected on the effectiveness of my study habits
25. I analyzed or interpreted scientific data shown in graphs or tables
26. I provided feedback to my classmates on projects, assessments, or other activities
27. I participated in open-ended exercises, such as case-studies or questions in which multiple correct answers are possible

Follow up question: Did you select ALL possible boxes that apply? *Answer option: Yes*

Subscales:

Assessment = 1, 2, 3, 4, 26

Active learning = 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 20, 21, 22, 23, 24, 25, 27

Inclusive teaching = 17, 18, 19

Note: Items with * were eliminated from the current analysis.

Trust (Cavanagh et al., 2018)

Indicate your level of agreement with each of the following statements. *Scale: Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly Agree.*

1. My instructor can be described as someone who listens very carefully to me
2. It's important to my instructor to understand what my educational goals are
3. My instructor "gets" me
4. My instructor accepts me for who I am
5. My instructor is careful not to dismiss my concerns
6. It is difficult for my instructor to accept the nature of me* (R)
7. My instructor cares about my education
8. My instructor truly cares about my educational welfare
9. My instructor is not the sort of person who goes out of his or her way to show compassion to me* (R)

Sub-scales:

Understanding = 1, 2, 3

Acceptance = 4, 5, 6

Care = 7, 8, 9

*Note: items with * were eliminated from the current analysis. Items with (R) are reverse coded items.*

Growth Mindset (Dweck et al., 1995)

Please rate your level of agreement with each of the following statements. *Scale: Strongly disagree, Disagree, Mostly disagree, Mostly agree, Agree, Strongly Agree.*

1. You have a certain amount of intelligence, and you really can't do much to it
2. Your intelligence is something about you that you can't change very much
3. You can learn new things, but you can't really change your basic intelligence

Note: All these items are reverse coded.

Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993)

Using the answering scale below, indicate the extent to which the following statements are true for you. *Scale: Not at all true of me, 2, 3, 4, 5, 6, Very true of me.*

1. When I study the readings for this course, I outline the material to help me organize my thoughts
2. During class time I often miss important points because I'm thinking of other things (R)
3. I usually study in a place where I can concentrate on my course work
4. When reading for this course, I make up questions to help focus my reading
5. I often find myself questioning things I hear or read in this course to decide if I find them convincing

6. When I become confused about something I'm reading for this class, I go back and try to figure it out
7. When I study for this course, I go through the readings and my class notes and try to find the most important ideas
8. I make good use of my study time for this course
9. If course readings are difficult to understand, I change the way I read the material
10. When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence*
11. I make simple charts, diagrams, or tables to help me organize course material*
12. I treat the course material as a starting point and try to develop my own ideas about it*
13. I find it hard to stick to a study schedule* (R)
14. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions
15. Before I study new course material thoroughly, I often skim it to see how it is organized*
16. I ask myself questions to make sure I understand the material I have been studying in this class*
17. I try to change the way I study in order to fit the course requirements and the instructor's teaching style
18. I often find that I have been reading for this class but don't know what it was all about (R)
19. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course
20. I try to relate ideas in this subject to those in other courses whenever possible
21. When I study for this course, I go over my class notes and make an outline of important concepts
22. When reading for this class, I try to relate the material to what I already know
23. I have a regular place set aside for studying
24. I try to play around with ideas of my own related to what I am learning in this course
25. When I study for this course, I write brief summaries of the main ideas from the readings and my class notes
26. I try to understand the material in this class by making connections between the readings and the concepts from the lectures
27. I make sure that I keep up with the weekly readings and assignments for this course
28. Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives
29. I attend this class regularly
30. When studying for this course I try to determine which concepts I don't understand well
31. I often find that I don't spend very much time on this course because of other activities (R)
32. When I study for this class, I set goals for myself in order to direct my activities in each study period
33. If I get confused taking notes in class, I make sure I sort it out afterwards
34. I rarely find time to review my notes or readings before an exam (R)
35. I try to apply ideas from course readings in other class activities such as lecture and discussion

Subscales:

Critical thinking = 5, 10, 12, 24, 28

Elaboration = 14, 20, 22, 25, 26, 35

Metacognitive self-regulation = 2, 4, 6, 9, 15, 16, 17, 18, 19, 30, 32, 33

Organization = 1, 7, 11, 21

Time and study environment management = 3, 8, 13, 23, 27, 29, 31, 34

*Note: Items with * were eliminated from the current analysis. Items with (R) are reverse coded items.*

College Student Persistence in the Sciences (PITS)

Rate the degree to which you agree or disagree with the following statements concerning your future intentions and career choices. *Scale: Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree.*

1. Following this course, I intend to enroll in similar courses*
2. I intend to complete a science related undergraduate degree
3. In the future, I intend to enroll in a science related graduate program
4. My future career will involve collecting, analyzing and reporting scientific data
5. In the future, I would like to be a research scientist*

Note: *Items with * were eliminated from the current analysis.*

Demographic Information

1. Open-ended: What is your enrollment status? (e.g., first-year)
2. Open-ended: What is your major(s)? If you have not yet declared a major, what is your intended field of study?
3. Which of the following is true for this course? *Answer options: It is part of my major credit requirement, It is part of a general credit requirement, It is an elective.*
4. What is your cumulative GPA? *Answer options: Below 2.5, 2.6-3.0, 3.1-3.5, 3.6-4.0, 4.1 and higher.*
5. I identify as: *Answer options: Male, Female, Other, I choose not to answer.*
6. I am (select all that apply): *Answer options: African American/Black, East Asian, Hispanic/Latino, Middle Eastern, Native American, South Asian, White non Hispanic, Not listed (please specify), I choose not to answer.*
7. My age is: *Answer options: Under 18, 18-19, 20-21, 22-24, 25 or above, I choose not to answer.*
8. What is your expected final grade for this course? *Answer options: A+-F.*
9. Open-ended: If you would like to relate any comments about the survey or if you would like to tell us more about your experiences in this course, please do so here.