Supplemental Material

CBE—Life Sciences Education

Durham *et al.*

Supplemental Material 1. Full MIST survey. The first column indicates the order in which questions appear on MIST. Boxes in gray indicate questions included in MIST-Short. The second column indicates the ST taxonomy supporting practice to which each question applies (See Couch et al., 2015, Table 3). The third column lists the MIST question. Conditional response formatting is indicated in purple. The remaining columns indicate the answer choices for each question.

MIST

Measurement Instrument for Scientific Teaching

survey order	refers to taxonomy item #	MIST question	"Please consider only the lecture portion of this course." will appear on each page of the survey.						
		Learning Goals & Alignment							
1	20	Indicate the average percent of class time during which students were asked to answer questions, solve problems, or complete activities other than listening to a lecture:	slider bar 0-100%						
2	1	***Learning goals*** *are statements provided by the instructor that inform students of the specific knowledge and skills that the instructor expects students to master in a course. Learning goals can be presented to students in the form of learning objectives, specific study questions, study guides, focal points, etc.* [definition above to be included on all pages related to alignment (clickers, in-class, out-of-class, assessment)] **Learning goals were provided for:** ***Please select all that apply.***	not provided to students	the course as a whole	each unit or exam	each broad topic or chapter	each specific subtopic or chapter subsection	some or most individual activities or assignments	each individual activity or assignment
		Polling questions							
3	25	***Polling methods*** *include clickers, Poll Anywhere, Learning Catalytics, colored cards, or other audience response systems that are used to determine how many students answer a question in a particular way.* Students were asked to use a **polling method** to answer questions in the classroom approximately:	zero questions	1-2 questions per month	3-4 questions per month	2-3 questions per week	4-5 questions per week	6-10 questions per week	more than 10 questions per week
4	2	If a YES option to #2 and #3 ONLY: Indicate the approximate percent of **polling questions** that overlapped with the **learning goals** provided by the instructor:	slider bar 0-100%						
5	22,23	If a YES option to #3 ONLY: Indicate the approximate percent of **polling questions** for which students were asked to discuss the question in pairs or small groups:	slider bar 0-100%						
		In-Class Activites							
6	21	***In-class activities*** *other than polling questions include any exercise or activity in which the students are not listening to a lecture during class, such as student discussions, worksheets, problem sets, case studies, hands-on demonstrations, role plays, concept maps, one-minute essays, think-pair-shares, inquiry-based activities, low point value quizzes, and other related activities.* Students were asked to complete **in-class activities** approximately:	zero times	up to 1 activity per month	2-3 activities per month	4-7 activities per month	2-3 activities per week	4-5 activities per week	more than 5 activities per week
7	2	If a YES option to #2 and #6 ONLY: Indicate the approximate percent of **in-class activities** that overlapped with the **learning goals** provided by the instructor:	slider bar 0-100%						
8	21	If a YES option to #6 ONLY: Indicate the approximate percent of **in-class activities** for which students were given some form of general or individualized **feedback** during class beyond simply providing correct or incorrect answers:	slider bar 0-100%						

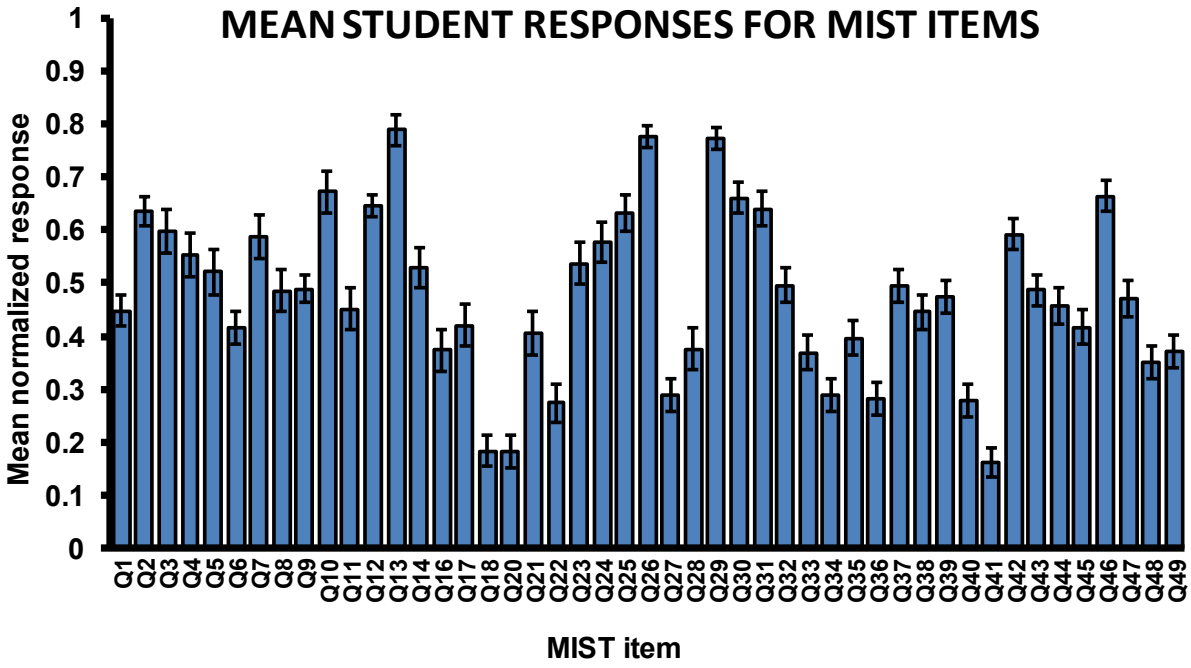
		Out-of-Class Activites							
9	21	***Out-of-class assignments*** *are any required exercise, activity, or project completed outside of class time, other than reading a textbook or watching a video. Out-of-class assignnments include worksheets, problem sets, case studies, online learning tools, inquiry-based activities, low point value quizzes, discussion boards, and other related activites.* Students were asked to complete **out-of-class assignments** approximately:	zero times	up to 1 assignment per month	2-3 assignments per month	1 assignment per week	2-3 assignments per week	4-5 assignments per week	more than 5 assignments per week
10	2	If a YES option to #2 and #9 ONLY: Indicate the approximate percent of **out-of-class assignments** that overlapped with the **learning goals** provided by the instructor:	slider bar 0-100%						
11	21	If a YES option to #9 ONLY: Indicate the approximate percent of **out-of-class assignments** for which students were given some form of general or individualized **feedback** beyond simply providing correct or incorrect answers:	slider bar 0-100%						
		Summative Assessment							
12	3	Students were asked to complete **major exams or term projects,** including final exams approximately:	zero times	1 time during the semester	2 times during the semester	3 times during the semester	4 times during the semester	5 times during the semester	6 or more times during the semester
13	3	If a YES option to #2 and #12 ONLY: Indicate the approximate percent of questions or components on **major exams or term projects** that overlapped with the **learning goals** provided by the instructor:	slider bar 0-100%						
14	21	If a YES option to #12 ONLY: Indicate the approximate percent of questions or components on **major exams or term projects** for which students were given some form of general or individualized **feedback** beyond simply providing correct or incorrect answers:	slider bar 0-100%						
		Student-Student Interactions							
15	22	Students were asked to **work in groups** of two or more for any portion of this course: If "no" is selected, skips to #22	yes	no					
16	22	Indicate the average percent of class time during which students were asked to **work in groups** of two or more:	slider bar 0-100%						
17	22	[In-class activities definition reappears here] Students were asked to **work in groups** of two or more on **in-class** activities, discussions, assignments, or projects other than polling questions approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
18	22	[Out-of-class activities definition reappears here] Students were asked or encouraged to **work in groups** of two or more on **out-of-class** activities, assignments, or projects approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
19	30	(Instructor version only) *Diversity includes differences in race, ethnicity, culture, background, religion, affiliation, age, gender, orientation, course performance, personality type, etc.* Students were grouped using a strategy that considers the diversity of each group:	yes	no					
20	24	The instructor used a strategy, such as assigning roles, to promote the participation of each group member during in-class group activities:	not at all	rarely	less than half of the time	half of the time	more than half of the time	almost always	always
21	26	At least some students were asked to verbally share the results of any group work or group discussions with the whole class approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
22	23	Students were asked to comment or make suggestions on each other's work on class assignments, activities, or projects approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week

		Inclusivity							
23	27	To what extent do you agree with the following statement: Students were encouraged to respond to classmates' ideas during whole-class discussions:	this course did not include whole class discussions	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
24	29	*Diversity includes differences in race, ethnicity, culture, background, religion, affiliation, age, gender, orientation, course performance, personality type, etc.* Examples or analogies used in this course included a diversity of people and cultures.	humans were not discussed in this course	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
25	28	*Diversity includes differences in race, ethnicity, culture, background, religion, affiliation, age, gender, orientation, course performance, personality type, etc.* Students were encouraged to consider the ideas and contributions of a diversity of researchers and other people involved in science.	humans were not discussed in this course	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
26	31	The instructor was sensitive to socially controversial issues.	X	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
		Student Influence on Course Structure							
27	5	Students were asked to provide formal or informal feedback on course activities and content prior to the end of the semester evaluation.	zero times	1 time during the semester	2 times during the semester	3 times during-the semester	4 times during the semester	5 times during the semester	6 or more times during the semester
28	5	If a YES option to #27 ONLY: Student feedback on course activities and content was used to make adjustments to the course within the semester:	none of the time	some of the time that feedback was collected	every time that feedback was collected				
29	6	Students stated interests or asked questions related to the topic at hand during class:	X	strongly disagree	disagree	somewhat disagree	somewhat agree	agree	strongly agree
30	7	The instructor was generally aware of instances when a concept was not understood by the majority of students in the class prior to an exam:	not at all	rarely	less than half of the time	half of the time	more than half of the time	most of the time	always
31	7	When it became clear that the class did not understand a concept, students were provided with follow-up discussion, activities, or resources.	not part of this course	rarely	less than half of the time	half of the time	more than half of the time	most of the time	always
		Student Participation & Science Practices							
32	11	Students were asked to identify or formulate hypotheses or make predictions about the results of demonstrations, experiments, or examples approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
33	11,12	Students were asked to critique scientific hypotheses or experimental strategies approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
34	12	Students were asked to design experiments to answer scientific questions approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
35	13	Students were asked to summarize, interpret, or analyze data using mathematical or computational procedures approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
36	14	Students were asked to make graphs or tables approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week

		Student Participation & Science Practices (continued)							
37	14	Students were asked to analyze or interpret scientific data shown in graphs or tables approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
38	16, 17	Students were asked to use data to make decisions or defend scientific conclusions approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
39	15	*Models are tools used to summarize a scientific process, including drawing pathways, diagrams, schematics, concept maps, flow charts, "road maps", tables, illustrative models, box-and-arrow diagrams, etc.* Students were asked to make or interpret models to summarize scientific processes approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
40	18	Students were asked to interpret or critique scientific literature or media articles related to science approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
41	19	Students were asked to communicate scientific ideas in formal written papers or oral presentations approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
42	9	Students were provided with examples or explanations showing that course concepts are applicable to everyday human experiences or real-life applications approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
43	8	Historical context was used to recognize why certain discoveries or advancements changed the way people viewed related scientific principles approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
		Student Cognitive Engagement							
44	33	Students were asked to interpret or represent concepts in non-written formats, such as pictures, diagrams, videos, simulations, role-plays, graphs, mathematical models, etc. approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
45	35	Students were asked to practice knowledge or skills from other Science, Technology, Engineering, and Math (STEM) subjects when answering questions or completing class approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
46	32	Students engaged in higher level thought processes that required them to apply, analyze, incorporate, or evaluate their knowledge or skills rather than just memorizing facts or processes approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
47	34	Students were asked to participate in open-ended exercises, such as case-studies or questions in which multiple correct answers are possible approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
48	37	Students were provided with opportunities or suggestions to reflect on whether their study habits were effective for learning approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week
49	36	Students were provided with opportunities or suggestions to reflect on their problem-solving strategies approximately:	zero times	1-2 times during the semester	about 1 time per month	2-3 times per month	1-2 times per week	3-4 times per week	more than 4 times per week

Supplemental Material 2. Factor loadings and cross-loadings of the 7-factor EFA model.

		EFA-derived factors						
Item	Item Description	1	2	3	4	5	6	7
Q38	Use data to make decisions/defend conclusions	**.850**	.001	-.015	.056	.118	-.059	-.035
Q37	Analyze/interpret data graphs/tables	**.838**	.018	-.042	.055	.144	-.045	-.045
Q35	Summarize, interpret, analyze data with math	**.710**	.026	.009	-.039	-.035	-.090	.016
Q36	Make graphs or tables	**.678**	.011	.021	-.063	-.073	-.030	.071
Q33	Critique hypotheses & experimental strategies	**.645**	-.118	.050	.048	-.014	.025	-.045
Q34	Design experiments	**.621**	-.150	.053	-.031	-.043	.047	.020
Q39	Use models	**.611**	.036	.003	.020	-.037	.010	-.092
Q32	Make hypotheses/predictions	**.537**	-.134	.044	-.016	-.032	-.070	-.165
Q40	Scientific literature or media articles	**.490**	-.086	.060	.157	-.077	.107	.102
Q41	Science communication: written papers/oral pres.	**.413**	-.048	.042	.013	-.214	.099	.160
Q45	Interdisciplinary	**.399**	.034	.011	.024	-.187	-.056	-.104
Q44	Use non-written formats	**.319**	.018	-.019	.006	-.224	-.011	-.104
Q47	Open-ended exercises/case studies	**.253**	-.214	.006	.137	-.183	-.066	-.089
Q46	Higher level thought processes	**.230**	-.008	-.005	.037	-.104	-.135	-.270
Q15	Group work: y/n[1]	-.114	**-.930**	-.048	-.011	.039	-.068	-.056
Q17	Group work: In-class frequency	.021	**-.890**	.013	.016	.047	-.002	-.033
Q21	Group work: Share results with whole class	.006	**-.806**	-.078	.084	.064	-.106	-.044
Q20	Group work: Group participation strategy	.035	**-.638**	.016	.033	-.110	.055	-.058
Q18	Group work: Out-of-class frequency	.020	**-.612**	-.024	-.025	-.167	.025	.008
Q16	Group work: % of class time	.044	**-.527**	.187	.004	.079	-.146	.084
Q6	In-class: frequency	.151	**-.462**	.274	.004	-.005	.048	-.008
Q22	Peer feedback	.191	**-.435**	-.005	.031	-.125	-.035	-.020
Q23	Students respond to each other	.161	**-.309**	.035	.168	-.004	-.097	-.149
Q1	% active	.110	**-.289**	.235	-.053	.053	-.248	.046
Q9	Out-of-class: frequency	.156	**-.183**	.097	.044	-.039	-.109	.174
Q7	In-class: % alignment	-.014	-.127	**.696**	-.032	.047	-.142	.026
Q8	In-class: % feedback	-.012	-.147	**.690**	.001	-.006	-.082	.039
Q11	Out-of-class: % feedback	.065	.004	**.566**	.017	-.071	.064	.065
Q10	Out-of-class: % alignment	.031	.041	**.496**	.047	.020	-.126	.030
Q14	Exams: % feedback	.007	.022	**.465**	.008	-.054	.089	-.130
Q13	Exams: % alignment	-.090	.128	**.416**	.035	.032	-.044	-.211
Q2	Learning goal max frequency	.040	-.067	**.230**	.023	-.104	.007	-.112
Q25	Diverse scientist/researcher contributions	-.022	.004	-.044	**.941**	.009	-.009	.062
Q24	Diverse examples & analogies	-.046	-.026	.007	**.810**	-.043	.025	.038
Q26	Instructor sensitivity	.025	.034	.057	**.245**	.033	-.010	-.237
Q48	Reflection: effective study habits	-.048	.019	.022	.067	**-.875**	-.027	-.003
Q49	Reflection: problem-solving strategies	.019	-.010	.045	.034	**-.834**	-.054	-.037
Q27	Students provide feedback on activities/content	.092	-.103	.034	.020	**-.352**	-.118	-.054
Q28	Make adjustment from student feedback	.087	-.141	.055	.041	**-.276**	-.080	-.169
Q4	Polling method: % alignment	-.006	.126	.147	.005	-.045	**-.882**	-.019
Q5	Polling method: % peer learning	-.006	-.048	.067	.025	.008	**-.736**	.038
Q3	Polling method: frequency	.034	-.133	-.147	-.029	-.098	**-.679**	-.019
Q30	Instructor aware of student non-understanding	-.023	-.072	.073	-.011	-.101	.013	**-.768**
Q31	Follow-up activities provided if not understood	.010	-.058	.076	.002	-.119	-.010	**-.700**
Q29	Student state interests & ask original questions	.065	-.083	.035	.063	.057	-.023	**-.510**
Q42	Course concepts applicable to life	.181	.058	.027	.118	-.147	.039	**-.298**



Supplemental Material 3. Mean normalized scores for individual MIST items. Bars represent the mean of all individual normalized student responses for each MIST item ± SE. *n* = 7767 students.

Supplemental Material 6. Summary of MIST questions in handout form.

MIST

Measurement Instrument for Scientific Teaching

Q #	MSC[1]	MIST question	Instructor Response:
		Learning Goals & Alignment	
1	ALS	Indicate the average percent of class time during which students were asked to answer questions, solve problems, or complete activities other than listening to a lecture:	0-100%
2	LGF	Learning goals[2] were provided for:	select all: 7-pt frequency
		Clickers	
3	ALS	Students were asked to use a **polling method**[2] to answer questions in the classroom approximately:	7-pt frequency
4	LGF	Indicate the approximate percent of **polling questions** that overlapped with the **learning goals** provided by the instructor:	0-100%
5	ALS	Indicate the approximate percent of **polling questions** for which students were asked to discuss the question in pairs or small groups:	0-100%
		In-Class Activites	
6	ALS	Students were asked to complete **in-class activities**[2] approximately:	7-pt frequency
7	LGF	Indicate the approximate percent of **in-class activities** that overlapped with the **learning goals** provided by the instructor:	0-100%
8	LGV	Indicate the approximate percent of **in-class activities** for which students were given some form of general or individualized **feedback** during class beyond simply providing correct or incorrect answers:	0-100%
		Out-of-Class Activites	
9	ALS	Students were asked to complete **out-of-class assignments**[2] approximately:	7-pt frequency
10	LGV	Indicate the approximate percent of **out-of-class assignments** that overlapped with the **learning goals** provided by the instructor:	0-100%
11	LGV	Indicate the approximate percent of **out-of-class assignments** for which students were given some form of general or individualized **feedback** beyond simply providing correct or incorrect answers:	0-100%
		Summative Assessment	
12	none	Students were asked to complete **major exams or term projects,** including final exams approximately:	7-pt frequency
13	LGV	Indicate the approximate percent of questions or components on **major exams or term projects** that overlapped with the **learning goals** provided by the instructor:	0-100%
14	LGV	Indicate the approximate percent of questions or components on **major exams or term projects** for which students were given some form of general or individualized **feedback** beyond simply providing correct or incorrect answers:	0-100%
		Student-Student Interactions	
15	none	Students were asked to **work in groups** of two or more for any portion of this course:	no/yes
16	ALS	Indicate the average percent of class time during which students were asked to **work in groups** of two or more:	0-100%
17	ALS	Students were asked to **work in groups** of two or more on **in-class** activities, discussions, assignments, or projects other than polling questions approximately:	7-pt frequency
18	ALS	Students were asked or encouraged to **work in groups** of two or more on **out-of-class** activities, assignments, or projects approximately:	7-pt frequency
19	none	(Instructor version only) Students were grouped using a strategy that considers the diversity[2] of each group:	no/yes
20	ALS	The instructor used a strategy, such as assigning roles, to promote the participation of each group member during in-class group activities:	7-pt frequency
21	ALS	At least some students were asked to verbally share the results of any group work or group discussions with the whole class approximately:	7-pt frequency
22	ALS	Students were asked to comment or make suggestions on each other's work on class assignments, activities, or projects approximately:	7-pt frequency

		Inclusivity	
23	ALS	Students were encouraged to respond to classmates' ideas during whole-class discussions:	6-pt disagree/agree + n/a
24	Inc	Examples or analogies used in this course included a diversity[2] of people and cultures.	6-pt disagree/agree + n/a
25	Inc	Students were encouraged to consider the ideas and contributions of a diversity[2] of researchers and other people involved in science.	6-pt disagree/agree + n/a
26	Inc	The instructor was sensitive to socially controversial issues.	6-pt disagree/agree
		Student Influence on Course Structure	
27	CSR	Students were asked to provide formal or informal feedback on course activities and content prior to the end of the semester evaluation.	7-pt frequency
28	CSR	Student feedback on course activities and content was used to make adjustments to the course within the semester:	3-pt frequency
29	RtS	Students stated interests or asked questions related to the topic at hand during class:	6-pt disagree/agree
30	RtS	The instructor was generally aware of instances when a concept was not understood by the majority of students in the class prior to an exam:	6-pt disagree/agree + n/a
31	RtS	When it became clear that the class did not understand a concept, students were provided with follow-up discussion, activities, or resources.	6-pt disagree/agree + n/a
		Student Participation & Science Practices	
32	EDC	Students were asked to identify or formulate hypotheses or make predictions about the results of demonstrations, experiments, or examples approximately:	7-pt frequency
33	EDC	Students were asked to critique scientific hypotheses or experimental strategies approximately:	7-pt frequency
34	EDC	Students were asked to design experiments to answer scientific questions approximately:	7-pt frequency
35	DAI	Students were asked to summarize, interpret, or analyze data using mathematical or computational procedures approximately:	7-pt frequency
36	DAI	Students were asked to make graphs or tables approximately:	7-pt frequency
37	DAI	Students were asked to analyze or interpret scientific data shown in graphs or tables approximately:	7-pt frequency
38	DAI	Students were asked to use data to make decisions or defend scientific conclusions approximately:	7-pt frequency
39	DAI	Students were asked to make or interpret models[2] to summarize scientific processes approximately:	7-pt frequency
40	EDC	Students were asked to interpret or critique scientific literature or media articles related to science approximately:	7-pt frequency
41	EDC	Students were asked to communicate scientific ideas in formal written papers or oral presentations approximately:	7-pt frequency
42	RtS	Students were provided with examples or explanations showing that course concepts are applicable to everyday human experiences or real-life applications approximately:	7-pt frequency
43	none	Historical context was used to recognize why certain discoveries or advancements changed the way people viewed related scientific principles approximately:	7-pt frequency
		Student Cognitive Engagement	
44	CS	Students were asked to interpret or represent concepts in non-written formats, such as pictures, diagrams, videos, simulations, role-plays, graphs, mathematical models, etc. approximately:	7-pt frequency
45	CS	Students were asked to practice knowledge or skills from other Science, Technology, Engineering, and Math (STEM) subjects when answering questions or completing class activities approximately:	7-pt frequency
46	CS	Students engaged in higher level thought processes that required them to apply, analyze, incorporate, or evaluate their knowledge or skills rather than just memorizing facts or processes approximately:	7-pt frequency
47	CS	Students were asked to participate in open-ended exercises, such as case-studies or questions in which multiple correct answers are possible approximately:	7-pt frequency
48	CSR	Students were provided with opportunities or suggestions to reflect on whether their study habits were effective for learning approximately:	7-pt frequency
49	CSR	Students were provided with opportunities or suggestions to reflect on their problem-solving strategies approximately:	7-pt frequency

[1]MIST subcategory abbreviations: ALS: Active Learning Strategies, LGF: Learning Goal Use and Feedback, Inc: Inclusivity,RtS: Responsiveness to Students, EDC: Experimental Design and Communication, DAI: Data Analysis and Interpretation, CS: Cognitive Skills, CSR: Course and Self Reflection

[2]These terms are defined in the survey, and definitions can be found in Supplemental Material 1.