Supplemental Material

CBE—Life Sciences Education

Andrews *et al.*

SUPPLEMENTAL MATERIALS

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A. Additional details on student cognitive interviews

All think-aloud interviews began by asking students what "math" meant to them. We then explained the think-aloud process, and students practiced answering several items unrelated to the study in a think-aloud manner. Once students felt comfortable with the think-aloud process, we provided the students with a comprehensive definition of math to keep in mind as they answered the MBVI items: "Math includes arithmetic, algebra, geometry, calculus, and statistics." Each Likert-type item had a 7-point response scale, ranging from "strongly disagree" to "strongly agree." The think-aloud data also provided us with insight into students' definitions of math, which informed the definition we used on the pilot survey.

These think-aloud data were used to further modify some items or remove items that were not useful. As students reasoned through their responses, it became clear that they were not interpreting some items in the same way that we were interpreting them, so these items were removed. For example, we had intended for the item, "It is important for me to be able to do math for my life science major," to measure how useful students view math for understanding the biological content associated with their major. However, students routinely answered "strongly agree" to this item with the reasoning that it was important to be able to do math simply to fulfill the math requirement for completion of the major. Additionally, there was little variation in how the students answered the biology attainment value items (consistent high attainment value) so we eliminated this entire subscale. Based on this cognitive interview data, a total of 25 items were selected for inclusion in the pilot survey: eight items that represented interest, six items that represented utility value, eight items that represented perceived cost, and three items that represented math attainment value (Table B1).

B. MBVI, math task-value, and MCSDS items included in the pilot survey

TABLE B1. Initial set of MBVI items included in the pilot survey.[a,b]

Interest
Int1: I am interested in using math to understand biology.
Int2: Using math to understand biology intrigues/would intrigue me.
Int3: Learning new topics that integrate math and biology is/would be interesting.
Int4: Using math to understand biology is/would be intellectually stimulating.
Int5: I find/would find it interesting to use math in my biology courses.
Int6: It is/would be fun to use math to understand biology.
Int7: Using math to understand biology appeals/would appeal to me.
Int8: Using math to understand biology is/would be interesting to me.
Utility Value
Uty1: Math is important for me to succeed in my life science career.
Uty2: I will be more successful in my life science career if I understand math.
Uty3: Math is valuable for me for my life science career.
Uty4: It is important for me to be able to do math for my career in the life sciences.
Uty5: An understanding of math is essential for me for my life science career.
Uty6: Math will be useful to me in my life science career.
Perceived Cost
Cst1: Using math to understand biology is/would be difficult for me.
Cst2: Trying to use math to understand biology causes/would cause me anxiety.
Cst3: Taking a biology test that incorporates math causes/would cause me to stress out more than a biology test without math.
Cst4: I have/would have to devote more time and effort to studying for a biology test that incorporates math than for one that does not.
Cst5: Biology exams that involve math intimidate/would intimidate me.
Cst6: I have/would have to work harder for a biology course that incorporates math than for one that does not.
Cst7: I worry/would worry about getting worse grades in a biology course that incorporates math than one that does not.
Cst8: Taking a biology course that incorporates math intimidates/would intimidate me.
Math Attainment Value
Atn1: Being good at math is an important part of who I am.
Atn2: Doing well in math, in particular, improves my overall confidence in myself.
Atn3: Being someone who is good at math is important to me.

[a]Students were instructed: "The following questions will ask about your attitudes and values towards using math to understand biology. To help you answer these questions, think about the times in which you used math in your biology courses. If you have never used math in your biology courses, imagine how you would feel if your biology courses expected you to do math in order to understand the biology concepts presented. For the purposes of this survey, math includes arithmetic, algebra, calculus, and statistics."

[b]Items bolded were retained in the final survey. All items were on a scale of 1 ("strongly disagree") to 7 ("strongly agree") with options for "I don't know" and "Prefer not to respond."

TABLE B2. Math task-value items[a] used in the pilot survey.[b]

Item (Construct)	Scale[c]
1. In general, how useful is what you learn in math? (Utility)	Not at all useful to Very useful
2. For me, being good at math is… (Attainment)	Not at all important to Very important
3. Compared to most of your other activities, how useful is what you learn in math? (Utility)	Not at all useful to Very useful
4. Compared to most of your other activities, how important is it to you to be good at math? (Attainment)	Not at all important to Very important
5. In general, I find working on math activities… (Interest)	Very boring to Very interesting
6. How much do you like doing math? (Interest)	Not at all to Very much
7. Compared to most of your other activities, how much do you like doing math? (Interest)	Not as much to A lot more

[a] Eccles et al., 1983; Fredricks & Eccles, 2002

[b] Students were instructed: "The following questions relate to your attitudes and values towards math in general."

[c] All items were on a 7-point scale and included a "Prefer not to respond" option.

TABLE B3. Marlowe-Crowne Social Desirability Scale (MCSDS)[a] used in the pilot survey.[b]

Item (socially desirable choice)[c]
1. Before voting I thoroughly investigate the qualifications of all the candidates. (T)
2. I never hesitate to go out of my way to help someone in trouble. (T)
3. It is sometimes hard for me to go on with my work if I am not encouraged. (F)
4. I have never intensely disliked anyone. (T)
5. On occasion I have had doubts about my ability to succeed in life. (F)
6. I sometimes feel resentful when I don't get my way. (F)
7. I am always careful about my manner of dress. (T)
8. My table manners at home are as good as when I eat out in a restaurant. (T)
9. If I could get into a movie without paying and be sure I was not seen I would probably do it. (F)
10. On a few occasions, I have given up doing something because I thought too little of my ability. (F)
11. I like to gossip at times. (F)
12. There have been times when I felt like rebelling against people in authority even though I knew they were right. (F)
13. No matter who I'm talking to, I'm always a good listener. (T)
14. I can remember "playing sick" to get out of something. (F)
15. There have been occasions when I took advantage of someone. (F)
16. I'm always willing to admit it when I make a mistake. (T)
17. I always try to practice what I preach. (T)
18. I don't find it particularly difficult to get along with loud mouthed, obnoxious people. (T)
19. I sometimes try to get even rather than forgive and forget. (F)
20. When I don't know something I don't mind at all admitting it. (T)
21. I am always courteous, even to people who are disagreeable. (T)
22. At times I have really insisted on having things my own way. (F)
23. There have been occasions when I felt like smashing things. (F)
24. I would never think of letting someone else be punished for my wrongdoings. (T)
25. I never resent being asked to return a favor. (T)
26. I have never been irked when people expressed ideas very different from my own. (T)
27. I never make a long trip without checking the safety of my car. (T)
28. There have been times when I was quite jealous of the good fortune of others. (F)
29. I have almost never felt the urge to tell someone off. (T)
30. I am sometimes irritated by people who ask favors of me. (F)
31. I have never felt that I was punished without cause. (T)
32. I sometimes think when people have a misfortune they only got what they deserved. (F)
33. I have never deliberately said something that hurt someone's feelings. (T)

[a]Crowne & Marlowe, 1960

[b]Students were instructed: "Listed below are a number of statements concerning personal attitudes and traits. Read each item and decide whether the statement is true or false as it pertains to you personally."

[c]All items were on a True/False scale and included a "Prefer not to respond" option.

C. Results from the initial series of exploratory factor analyses and all MBVI item correlations

TABLE C1. Factor loadings and correlations from the initial series of exploratory factor analyses (*n* = 207).[a]

Item[b]	1-factor	2-factor		3-factor			4-factor			
		I	II	I	II	III	I	II	III	IV
Interest										
Int1	**0.75**	**0.75**	-0.06	**0.78**	0.06	0.07	**0.85**	0.04	0.09	-0.08
Int2	**0.85**	**0.81**	-0.11	**0.95**	0.05	0.00	**0.91**	0.04	0.00	0.04
Int3	**0.84**	**0.79**	-0.12	**0.89**	0.02	0.02	**0.83**	0.02	0.02	0.07
Int4	**0.77**	**0.71**	-0.14	**0.84**	0.00	-0.02	**0.82**	-0.01	-0.02	0.02
Int5	**0.86**	**0.82**	-0.12	**0.95**	0.04	0.00	**0.91**	0.03	0.00	0.05
Int6	**0.81**	**0.67**	-0.23	**0.78**	-0.10	0.00	**0.76**	-0.11	0.00	0.02
Int7	**0.88**	**0.77**	-0.20	**0.89**	-0.06	-0.01	**0.88**	-0.06	0.00	0.02
Int8	**0.88**	**0.78**	-0.20	**0.93**	-0.04	-0.03	**0.95**	-0.05	-0.02	-0.02
Utility Value										
Uty1	**0.65**	**0.71**	0.02	0.04	-0.13	**0.70**	0.04	-0.13	**0.69**	0.03
Uty2	0.48	**0.69**	0.22	0.07	0.08	**0.66**	0.08	0.08	**0.65**	0.00
Uty3	**0.64**	**0.81**	0.15	0.01	-0.03	**0.84**	0.06	-0.04	**0.84**	-0.05
Uty4	**0.64**	**0.82**	0.18	-0.01	-0.01	**0.88**	-0.04	-0.01	**0.86**	0.07
Uty5	**0.58**	**0.81**	0.23	-0.03	0.05	**0.88**	-0.07	0.05	**0.86**	0.07
Uty6	**0.59**	**0.78**	0.18	0.00	0.00	**0.81**	0.05	-0.01	**0.81**	-0.05
Perceived Cost										
Cst1	**-0.58**	-0.07	**0.70**	-0.16	**0.67**	0.07	-0.07	**0.65**	0.08	-0.13
Cst2	**-0.72**	-0.22	**0.68**	-0.19	**0.68**	-0.05	-0.12	**0.67**	-0.05	-0.09
Cst3	**-0.71**	-0.14	**0.80**	-0.09	**0.80**	-0.05	-0.11	**0.80**	-0.05	0.01
Cst4	-0.48	0.15	**0.85**	0.08	**0.86**	0.09	0.05	**0.85**	0.09	0.03
Cst5	**-0.75**	-0.16	**0.82**	-0.13	**0.82**	-0.04	-0.10	**0.82**	-0.04	-0.05
Cst6	**-0.52**	0.14	**0.90**	0.15	**0.94**	0.03	0.14	**0.93**	0.03	0.00
Cst7	**-0.66**	-0.05	**0.84**	0.04	**0.89**	-0.08	0.01	**0.89**	-0.08	0.04
Cst8	**-0.71**	-0.12	**0.82**	-0.08	**0.83**	-0.04	-0.07	**0.83**	-0.04	-0.02

[a]Factor loadings greater than |0.50| are bolded; loadings less than |0.50| are in gray.
[b]Abbreviations (e.g., Int1) correspond to the items in Table B1.

TABLE C1, cont. Factor loadings from the initial series of exploratory factor analyses with factor correlations (*n* = 207).[a]

Item[b]	1-factor	2-factor		3-factor			4-factor			
		I	II	I	II	III	I	II	III	IV
Math Attainment Value										
Atn1	**0.72**	**0.58**	-0.22	**0.60**	-0.14	0.05	0.10	-0.07	-0.01	**0.73**
Atn2	**0.60**	**0.58**	-0.05	**0.53**	0.00	0.12	0.11	0.06	0.07	**0.62**
Atn3	**0.74**	**0.63**	-0.18	**0.60**	-0.11	0.11	-0.03	-0.01	0.03	**0.94**
PVE[c]	0.50	0.39	0.24	0.31	0.23	0.16	0.26	0.22	0.16	0.09
CVE[d]	0.50	0.39	0.63	0.31	0.53	0.70	0.26	0.48	0.64	0.73
Factor correlations							I	-		
				I	-		II	-0.53	-	
		I	-	II	-0.54	-	III	0.64	-0.29	-
		II	-0.47	III	0.65	-0.31	IV	0.72	-0.47	0.54

[a]Factor loadings greater than |0.50| are bolded; loadings less than |0.50| are in gray.
[b]Abbreviations (e.g., Int1) correspond to the items in Table B1.
[c]PVE = Proportion of variance explained by the factor.
[d]CVE = Cumulative variance explained by the factor.

TABLE C2. Correlation matrix with item means and standard deviations (SD) for all items included in the exploratory factor analyses (*n* = 207).[a]

Item	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 7	Int 8	Uty 1	Uty 2	Uty 3	Uty 4	Uty 5	Uty 6	Cst 1	Cst 2	Cst 3	Cst 4	Cst 5	Cst 6	Cst 7	Cst 8	Atn 1	Atn 2	Atn 3
Int1	--																								
Int2	.79	--																							
Int3	.75	.84	--																						
Int4	.69	.75	.78	--																					
Int5	.77	.86	.82	.78	--																				
Int6	.65	.76	.71	.68	.79	--																			
Int7	.74	.84	.79	.75	.87	.83	--																		
Int8	.74	.85	.84	.78	.87	.82	.91	--																	
Uty1	.52	.57	.56	.44	.52	.46	.49	.49	--																
Uty2	.39	.39	.39	.44	.43	.38	.41	.40	.55	--															
Uty3	.52	.54	.53	.43	.53	.46	.53	.55	.68	.63	--														
Uty4	.49	.51	.53	.39	.54	.47	.54	.53	.66	.56	.73	--													
Uty5	.44	.47	.44	.43	.49	.45	.50	.46	.62	.53	.68	.78	--												
Uty6	.46	.49	.49	.48	.49	.45	.47	.49	.58	.53	.70	.71	.74	--											
Cst1	-.32	-.42	-.41	-.34	-.42	-.41	-.45	-.45	-.26	-.05	-.23	-.26	-.13	-.20	--										
Cst2	-.40	-.52	-.52	-.49	-.52	-.51	-.56	-.58	-.42	-.17	-.37	-.34	-.28	-.34	.77	--									
Cst3	-.40	-.47	-.48	-.46	-.51	-.55	-.55	-.55	-.35	-.20	-.35	-.31	-.25	-.29	.63	.74	--								
Cst4	-.24	-.26	-.27	-.27	-.28	-.35	-.34	-.35	-.21	-.06	-.12	-.11	-.05	-.09	.54	.53	.64	--							
Cst5	-.45	-.54	-.53	-.48	-.52	-.54	-.58	-.57	-.42	-.21	-.32	-.33	-.28	-.30	.69	.79	.82	.66	--						
Cst6	-.25	-.27	-.28	-.32	-.29	-.38	-.36	-.34	-.25	-.11	-.15	-.13	-.11	-.11	.56	.56	.69	.83	.70	--					
Cst7	-.37	-.42	-.43	-.44	-.43	-.46	-.48	-.48	-.36	-.18	-.31	-.27	-.22	-.25	.57	.64	.81	.70	.79	.81	--				
Cst8	-.42	-.48	-.47	-.45	-.51	-.53	-.54	-.54	-.37	-.19	-.31	-.30	-.25	-.30	.63	.73	.76	.64	.85	.73	.83	--			
Atn1	.50	.64	.60	.53	.62	.59	.64	.64	.41	.29	.43	.44	.40	.39	-.44	-.49	-.46	-.29	-.51	-.33	-.40	-.49	--		
Atn2	.46	.51	.54	.52	.55	.46	.51	.51	.39	.37	.39	.41	.37	.34	-.25	-.32	-.31	-.18	-.35	-.23	-.33	-.31	.60	--	
Atn3	.51	.63	.64	.56	.65	.58	.64	.62	.47	.36	.42	.47	.46	.40	-.41	-.50	-.46	-.28	-.49	-.32	-.40	-.45	.78	.67	--
Mean	5.18	4.76	5.03	5.29	4.71	4.33	4.62	4.75	5.68	5.98	5.75	5.76	5.54	5.76	3.93	3.69	4.20	4.72	3.96	4.63	4.20	3.81	4.64	5.45	4.86
SD	1.65	1.78	1.71	1.54	1.78	1.82	1.82	1.80	1.44	1.18	1.26	1.28	1.44	1.17	1.83	2.02	2.07	1.85	1.92	1.93	2.05	2.03	1.77	1.55	1.59

[a]Gray blocks are used to highlight item groupings. Abbreviations (e.g., Int1) correspond to the items in Table B1.

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