

Supplemental Material

CBE—Life Sciences Education

Hoskinson *et al.*

716 Table S1. Cluster centers from cluster analysis characterized by the given pairs. Not all problem pairs
717 helped to characterize the two distinct clusters.

718

719 Table S2. Mean edit distance data across all sections, with SEM in parentheses. Normalized ED_{deep}
720 was calculated by scaling ED_{deep} to the possible changes in ED_{deep} (see Metrics).

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722 Figure S1. Investigational setup for each of the three semesters (left) in which data were collected,
723 arranged by course topic (columns), course sequence (1st or 2nd; rows), and sort type (F=framed,
724 U=unframed). Numerals in the cells correspond to the fifteen participating courses. See Tables 1, 2,
725 and S2 for descriptive statistics from each course.

		Topic			
		Cell/molec		Org/pop	
Spring 2014	1 st	1F	1U	4F	4U
	2 nd	2F	2U	7F	8F
Fall 2014	1 st	3F		5F	5U
	2 nd	13U		6F	14U
Spring 2015	1 st	10U	11U	12U	
	2 nd			9F	15U

Sequence

Figure S1

Cluster Center	Superficial Pairs	Deep Pairs	Unexpected Pairs
1		AD, BE, BJ, BO, EJ, JO, IM, IP, CF	
2	DI, DJ, DK, IJ, IK, JK, BF, BH, BM, FH, FM, HM, LN, LO, LP, NO, NP, OP, AE, AG, CG		

Table S1.

Course	N	Semester	Sort Type	Sequence	Topic	Mean Edit Distance to Deep (pre)	Mean Edit Distance to Deep (post)	Mean Change in Edit Distance to Deep	Mean Change in Normalized Edit Distance to Deep
1F	29	1	F	1st	Cell-Molec	4.3 (0.5)	4.9 (0.4)	0.7 (0.4)	-4.6 (5)
2F	47	1	F	1st	Cell-Molec	4.7 (0.4)	4.0 (0.4)	-0.6 (0.3)	19 (6)
3	76	2	F	1st	Cell-Molec	5.3 (0.3)	5.0 (0.3)	-0.3 (0.3)	10 (4)
4F	22	1	F	1st	Org-Pop	4.9 (0.6)	3.2 (0.6)	-1.6 (0.5)	33 (9)
5F	39	2	F	1st	Org-Pop	3.4 (0.4)	3.4 (0.3)	0.0 (0.3)	7.8 (5.1)
6	68	2	F	1st	Org-Pop	4.5 (0.3)	4.5 (0.2)	2.1 (0.3)	3.5 (2.1)
7F	17	1	F	2nd	Org-Pop	4.5 (0.5)	2.9 (0.5)	-1.6 (0.6)	41 (11)
8F	44	1	F	2nd	Org-Pop	4.3 (0.4)	2.7 (0.4)	-1.7 (0.2)	40 (5)
9	70	3	F	2nd	Org-Pop	4.4 (0.3)	2.7 (0.3)	-1.7 (0.3)	36 (4.8)
1U	17	1	U	1st	Cell-Molec	8.5 (0.7)	8.6 (0.6)	0.1 (0.6)	-13 (10)
2U	22	1	U	1st	Cell-Molec	7.9 (0.7)	6.6 (0.6)	-1.3 (0.4)	17 (7)
10	39	3	U	1st	Cell-Molec	8.4 (0.5)	8.2 (0.5)	-0.2 (0.4)	-14 (7)
11	57	3	U	1st	Cell-Molec	7.6 (0.4)	7.5 (0.4)	-0.1 (0.3)	-6.0 (5.8)
4U	10	1	U	1st	Org-Pop	6.6 (0.8)	5.1 (0.7)	-1.5 (1.2)	17 (12)
5U	27	2	U	1st	Org-Pop	8.1 (0.6)	8.1 (0.6)	0.0 (0.4)	-9.5 (6.8)
12	39	3	U	1st	Org-Pop	8.4 (0.4)	7.0 (0.5)	-1.3 (0.4)	6.9 (6.6)
13	16	2	U	2nd	Cell-Molec	6.5 (0.8)	4.8 (0.4)	-1.7 (0.8)	21 (8)
8U	25	1	U	2nd	Org-Pop	7.7 (0.5)	6.4 (0.6)	-1.2 (0.6)	11 (8)
14	67	2	U	2nd	Org-Pop	7.4 (0.4)	6.5 (0.4)	-1.0 (0.4)	6.7 (5.1)
15	20	3	U	2nd	Org-Pop	8.3 (0.6)	6.3 (0.5)	-2.0 (0.6)	19 (8)

Table S2: Mean edit distance data across all sections, with SEM in parentheses. Normalized ΔED_{deep} was calculated by scaling ΔED_{deep} to the possible changes in ED_{deep} .