Supplemental Material

CBE—Life Sciences Education

Price *et al*.

Supplemental Materials

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SM Table 7. The amount of overlap between behaviors.

SM Table 8. Percentage of intervals in each class with coded behavior.

SM Table 1. Titles of the seminar courses taught.

Senior seminars courses for biology majors
Disease treatment from protein blueprint to function
DNA and data: what genetic testing can--and can't--tell us about our health
The Future of Sex
Harnessing the Immune System to Fight Disease: Advances and Challenge in Immunotherapy
Neuroscience of Pain and Addiction
2nd year seminar courses for multiple majors
You're more than you think you are! Why your microbiome matters
Stress from microbes to ecosystems: how life survives on a tough planet

SM Table 2. Additional descriptions of coding strategy.
RMP and CJS quantified the behaviors in classes by applying the Classroom Observation Protocol for Undergraduate STEM (COPUS, Smith et al., 2013). Bold face in the table is original text. Plain font explains how the coding scheme was applied to this dataset, elaborating on Smith et al.'s description as necessary. * indicates codes used in Stains et al.'s cluster analysis (2018).

Instructor codes

***Lec** Lecturing. This can include expanding on a student answer, along with FUp.

***PQ** Posing non-clicker question to students (non-rhetorical). This applies to asking any questions, even a cursory "Any questions?" that lacks a substantial pause after being asked. It can also refer to substantial, open-ended content questions. Some of the instructors posed substantial content questions in their worksheets, but we only counted questions in this category if they were stated aloud or if they offered instructions aloud to answer questions on the worksheet, e.g., "Complete questions 1-3 on the worksheet."

***CQ** Asking a clicker question (mark the entire time the instructor is using a clicker question, not just when first asked)

***1o1** One-on-one extended discussion with one or a few individuals, not paying attention to the rest of the class (can be along with MG or I_AnQ). While the original phrasing emphasizes that talking to one group of students necessitates not attending to others, in our opinion, this teaching move is one of the strengths of active learning, especially if the instructor uses this along with MG.

RtW Real-time writing. With audio recordings, we could hear when the pen was in contact with the board.

FUp Follow-up/feedback on clicker question or activity to entire class. The phrase *entire class* is critical here to distinguish this code from 1-on-1 interactions. This is often coded with Lec or with AnQ. To be more conservative in an assessment of student-centered instruction, the instructor must be following up on materials from that class session rather than answering questions raised at the end of previous class or in homework.

I_AnQ Listening to and answering student questions with entire class listening. The phrase *entire class* is critical here, as with FUp.

MG Moving through class guiding ongoing student work during active learning task. The key here is moving; the moving is part of what guides students to focus on the activity. In other words, the instructors are guiding by moving.

D/V Showing or conducting a demo, experiment simulation, video, or animation

Adm Administration. This code includes handing out worksheets, discussing the course schedule, e.g., "final exam is next week," logistics about the learning management system, tying activities to the course calendar, giving instructions on how to complete an activity, and giving time checks (e.g., "You have two minutes left to complete the activity."). Highly structured classrooms include a lot of administration.

I_W Waiting when there is an opportunity for an instructor to be interacting with or observing/listening to student or group activities and the instructor is not doing so. This code is about losing the opportunity to engage with students.

I_O Other—explain in comments

Student Codes

***CG** Clicker question groups. We interpreted this as any way to poll the class through forced-response questions. Because there were never more than 24 students in our classes, students could be polled by a raise of hands.

***WG** Working in groups on worksheet activity, even if not prompted by instructor to do so.

***OG** Other assigned group activity. This refers to any group activity that is not a worksheet or that does not include polling. This code captures "turn and talk."

***SQ** Student asks question in a small group, one-on-one, or before the entire class.

L Listening. Students are also listening when other students are reporting or asking questions.

Ind Individual thinking/problem solving. Only mark when an instructor explicitly asks students to think about a clicker question or another question/problem on their own.

S_AnQ Student answering a question posed by the instructor with rest of class listening. The student can be volunteering an answer or called on by the instructor to answer.

WC Engaged in whole class discussion by offering explanations, opinion, judgment, etc. to whole class, often facilitated by instructor. This code describes how students are interacting with each other, and usually means that the instructor does not ask a question or talk much in between students. The instructor

is facilitating the students sharing ideas, however, and so may call on different students who wish to participate.
Prd Making a prediction. We noticed that an activity that includes a prediction may last for 20 minutes, for example a worksheet leading up to experimental design. In such cases, we coded the whole activity as making a prediction, because that was the activity's end goal. While many of the classes we coded included aspects of experimental design, these aspects did not necessarily include asking students to make a prediction.
SP Presentation by student(s). This includes presentations at the end of an in-class activity, such as drawing diagrams on the board or making posters to present in a gallery walk (*18*).
TQ Test or quiz.
S_W Waiting. We used this code when the instructor was not ready to teach. In our scheme, it did not refer to some groups who finished an activity before others.
S_O Other—explain in comments.

SM Table 3. Questions that guided the semi-structured interviews

Focus group

Briefly describe your previous teaching experience.
What did you hope to get out of participating in STEP? Did you achieve your goals? Explain.
What was the most useful aspect of the STEP-WISE meetings held in the fall?
Any feedback on other resources, practices, or tools that you wish you had received during the STEP-WISE orientation meetings?
Did you have enough time to meet with your teaching team ahead of collaborating together? Explain.
During the teaching quarter, the main mode of collaboration was via e-mail/Google Drive/Canvas. How was collaborating digital successful? What was challenging about it
How did you use the feedback from your mentor's observations, both written and oral?
Are there other ways that you wish you had received or given feedback?
Were the debrief sessions sufficient or excessive (in duration/topic/structure) to help you reflect on your practice and prepare you for future teaching opportunities?
As the non-teaching instructor, how did the debrief sessions help prepare you for your own teaching? And/or: help you reflect on your own teaching?
For the classes that you were the main instructor, did you feel adequately supported by your STEP-WISE mentor/co-instructors as you prepared for class? during class? debriefing after class?
Are there ways that you wish you had received further support, especially from your STEP-WISE mentor?
Are there resources that you wish you had received to help in your teaching?
What are your professional goals? How does participating in STEP-WISE relate to those goals?
Do you plan/did you attend the spring session on how to leverage your STEP-WISE experience on the job market? How do you think you will use the discussion / materials from the workshop?

Faculty mentors

How long have you been teaching?
How did you learn how to teach?
How long been mentoring STEP-WISE postdocs? How did you get involved?
Describe any prior experience in mentoring novice teachers.
How would you characterize your mentoring practice? What "kind of mentor" do you aim to be and how do you accomplish that?
How do you involve yourself in the preparation of materials/etc for class (both before and during quarter)?
How do you decide when to give postdocs feedback (and/or "intervene") during class?
How do you present feedback when you feel like class did not go well?
How do you elicit honest/meaningful feedback from other postdocs?
Besides giving feedback, what else are important qualities of being a STEP-WISE mentor?
How do you manage interpersonal dynamics between postdocs?
And help postdocs manage interpersonal / other issues that may arise w/ students
What was your overall experience as mentor this quarter?
What do you think postdocs got out of their experience?
What do you think students got out of the class?
How do you structure your debriefs?
How do you use the form in your debriefs w/ postdocs?
How is it useful? Challenging? Anything you would take away or add?
For "best three activities" box section: How do you assess "level of student engagement"? What are characteristics of an engaged student or classroom?
How do you use the RTOP score? [RTOP is the Reformed Teaching Observation Protocol, as presented in Ebert-May et al. 2011]
Are there other teaching techniques or resources that you provide postdocs with, or think should be provided during the STEP-WISE orientation meetings?
What supports do you need as a STEP-WISE mentor?

SM Table 4. Survey questions (questions are open-ended unless otherwise indicated)

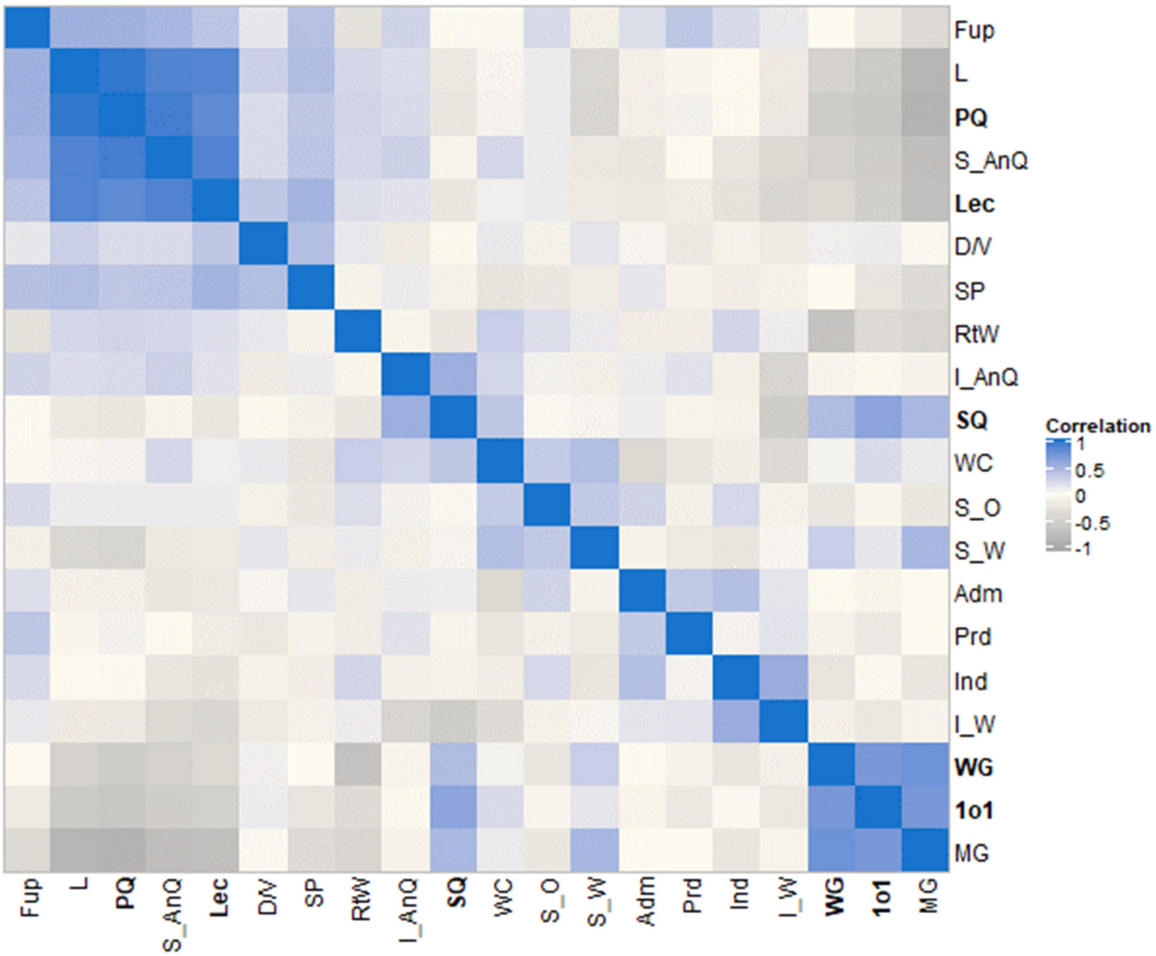
1. What did you learn by participating in STEP?
2. During the quarter that you taught, about how many hours did you spend preparing for your class, for weeks that you were the main instructor?
3. During the quarter that you taught, about how many hours did you spend preparing for your class, for weeks that you were NOT the main instructor?
4. Rate your level of expertise in the topic of your STEP-WISE class, prior to designing and teaching it:
5. Please rate the following aspects of the STEP-WISE program, in terms of their value to your learning: (scale 1: not valuable, 5: extremely valuable)
    a. Designing a course, including using Bloom's taxonomy to identify learning goals for the whole class and individual class meetings
    b. Discussing and participating in active learning exercises (e.g., jigsaw and gallery walk) during the Fall 2018 meetings
    c. Exposure to and engagement with the literature about scientific teaching during the Fall 2018 meetings
    d. Gaining classroom teaching experience, including the opportunity to design and implement active learning exercises
    e. Working with a mentor on course design, teaching, and assigning grades
    f. Debriefing with mentor after class
    g. Debriefing with co-instructors after class, including the opportunity to receive and provide feedback
    h. Receiving advice about how to use your experience in STEP-WISE for the job market
    i. Being part of a community of teaching-interested scientists
6. Choose one aspect that you rated as valuable (4 or 5) and explain your rating.
7. Choose one aspect that you rated as slightly or not valuable (1 or 2) and explain your rating.
8. Which of the aspects listed in Question 5 would you improve? How?
9. What other aspects of the program do you find critically important? Why?
10. What are your professional goals? How does participating in STEP-WISE relate to those goals?
11. Would you recommend the STEP-WISE program to other postdocs? Why or why not?

SM Table 5. Comparisons of each instructor and student behavior between the STEP-WISE data and the Stains et al. (2018) data.
These data were coded with the COPUS between STEP-WISE data and the Stains et al. data (Mann Whitney U-test with Hold-Bonferroni correction for multiple comparisons). Behaviors that were not observed in STEP-WISE classes have been removed (CQ, I_O, CG, OG, and TQ).

	Comparing STEP-WISE data to all Stains *et al.* data		Comparing STEP-WISE data to Stains *et al.* data in Cluster 6	
	P	adjusted P	P	adjusted P
Instructor behaviors				
Lec	1.77E-08	2.48E-07	5.56E-02	4.12E-01
PQ	4.64E-05	5.10E-04	3.27E-05	5.23E-04
1o1	2.49E-13	4.23E-12	5.15E-02	4.12E-01
RtW	8.47E-04	7.63E-03	1.23E-03	1.59E-02
FUp	2.08E-03	1.67E-02	2.00E-05	3.40E-04
I_AnQ	5.64E-01	7.00E-01	2.50E-01	7.49E-01
MG	1.35E-14	2.43E-13	1.81E-02	1.99E-01
D/V	1.31E-01	3.92E-01	4.05E-01	8.09E-01
Adm	1.76E-11	2.82E-10	8.30E-07	1.66E-05
I_W	1.63E-02	1.14E-01	3.18E-02	3.18E-01
Student behaviors				
WG	3.48E-28	6.97E-27	1.03E-01	6.20E-01
SQ	9.58E-08	1.25E-06	1.54E-06	2.92E-05
L	2.94E-10	4.41E-09	1.06E-01	6.20E-01
Ind	3.58E-02	1.79E-01	1.66E-01	6.63E-01
S_AnQ	1.98E-02	1.19E-01	9.49E-03	1.14E-01
WC	7.98E-06	9.57E-05	5.23E-04	7.84E-03
Prd	4.15E-04	4.15E-03	1.13E-03	1.58E-02
SP	1.85E-17	3.51E-16	2.51E-06	4.53E-05
S_W	3.50E-01	7.00E-01	8.74E-01	8.74E-01
S_O	6.19E-02	2.48E-01	4.35E-02	3.92E-01

SM Table 6. Spearman rank correlations between classes.
CQ, I_O, CG, OG, and TQ are excluded from the matrix because their use was not observed in STEP-WISE classes.

		WG	SQ	L	Ind	S_AnQ	WC	Prd	SP	S_W	S_O	Lec	PQ	1o1	RtW	FUp	I_AnQ	MG	D/V	Adm	I_W
Student Behaviors	WG	1.00																			
	SQ	0.43	1.00																		
	L	-0.47	-0.21	1.00																	
	Ind	-0.25	-0.09	-0.01	1.00																
	S_AnQ	-0.48	-0.07	0.86	-0.24	1.00															
	WC	0.06	0.36	0.04	-0.13	0.24	1.00														
	Prd	-0.09	-0.07	-0.05	0.06	-0.01	-0.25	1.00													
	SP	0.00	-0.10	0.42	-0.14	0.36	-0.26	-0.08	1.00												
	S_W	0.30	0.05	-0.41	-0.24	-0.20	0.41	-0.20	-0.15	1.00											
	S_O	-0.24	0.02	0.10	0.23	0.10	0.33	-0.11	-0.21	0.34	1.00										
Instructor Behaviors	Lec	-0.40	-0.23	0.86	-0.27	0.87	0.07	-0.16	0.49	-0.20	0.10	1.00									
	PQ	-0.56	-0.23	0.96	0.01	0.91	0.06	0.06	0.35	-0.43	0.10	0.81	1.00								
	1o1	0.70	0.61	-0.57	0.01	-0.53	0.21	-0.20	-0.25	0.13	-0.06	-0.50	-0.60	1.00							
	RtW	-0.66	-0.21	0.24	0.25	0.24	0.30	-0.15	-0.09	0.11	0.19	0.19	0.26	-0.36	1.00						
	FUp	0.00	0.01	0.52	0.21	0.47	0.01	0.35	0.40	-0.12	0.22	0.37	0.52	-0.19	-0.28	1.00					
	I_AnQ	-0.07	0.53	0.20	-0.12	0.28	0.25	0.16	0.10	-0.12	0.06	0.16	0.21	-0.03	-0.06	0.26	1.00				
	MG	0.75	0.46	-0.84	-0.23	-0.72	0.10	0.00	-0.36	0.47	-0.22	-0.70	-0.86	0.71	-0.43	-0.38	-0.08	1.00			
	D/V	0.08	-0.02	0.29	-0.10	0.21	0.12	-0.21	0.41	0.14	-0.10	0.36	0.21	0.10	0.12	0.13	-0.17	0.02	1.00		
	Adm	-0.02	0.09	-0.11	0.41	-0.23	-0.40	0.33	0.14	-0.08	0.26	-0.21	-0.12	-0.06	-0.15	0.20	0.10	0.00	0.04	1.00	
	I_W	-0.12	-0.54	-0.19	0.55	-0.39	-0.36	0.15	-0.10	0.04	-0.10	-0.42	-0.20	-0.21	0.09	0.12	-0.43	-0.07	-0.18	0.14	1.00



SM Figure 1. Heat map of Spearman rank correlations between behaviors across classes. Variables are sorted so that most similar (blue clusters) and most dissimilar (gray clusters) variables are together. Variables are defined in SM Table 2. The correlation matrix is in SM Table 6.

SM Table 7. The amount of overlap between behaviors.
Instead of correlations, this matrix indicates the percentage of times that the behavior mentioned in the column occurred out of all the times that the row behavior occurred. For example, 63% of the intervals in which instructors lectured, students were answering student questions (S_AnQ), whereas 72% of the intervals in which students were answering instructor questions, instructors also lectured. NA indicates no overlap.

		Student Behaviors										Instructor Behaviors									
		WG	SQ	L	Ind	S_AnQ	WC	Prd	SP	S_W	S_O	Lec	PQ	1o1	RtW	Fup	I_AnQ	MG	D/V	Adm	I_W
Student Behaviors	WG	1.00	0.41	0.28	0.08	0.12	NA	0.10	0.04	0.05	NA	0.10	0.26	0.50	0.04	0.11	0.02	0.86	NA	0.33	0.02
	SQ	0.68	1.00	0.42	0.09	0.21		0.05	0.05	0.03	0.03	NA	0.22	0.33	0.55	0.05	0.19	0.32	0.64	0.01	0.27	0.01
	L	0.27	0.24	1.00	0.08	0.57		0.06	0.03	0.07	0.03	0.00	0.66	0.81	0.08	0.11	0.41	0.21	0.21	0.01	0.33	0.01
	Ind	0.37	0.26	0.38	1.00	0.09		NA	0.11	0.02	NA	NA	0.12	0.42	0.23	0.06	0.09	0.11	0.68	0.02	0.51	0.09
	S_AnQ	0.20	0.21	0.98	0.03	1.00		0.08	0.01	0.10	0.01	NA	0.72	0.99	0.08	0.15	0.59	0.18	0.13	NA	0.19	0.02
	WC	NA	0.50	1.00	NA	0.78		1.00	NA	NA	NA	NA	0.44	0.89	NA	0.17	0.56	0.56	NA	NA	NA	NA
	Prd	0.81	0.24	0.24	0.19	0.05		NA	1.00	0.03	0.03	NA	0.08	0.35	0.30	NA	NA	0.05	0.92	NA	0.51	0.08
	SP	0.38	0.21	0.83	0.03	0.66		NA	0.03	1.00	0.03	NA	0.41	0.69	0.24	0.07	0.69	0.14	0.28	NA	0.38	NA
	S_W	0.80	0.30	0.45	NA	0.05		NA	0.05	0.05	1.00	0.05	0.15	0.20	0.30	0.25	0.15	0.05	0.80	0.05	0.40	0.15
	S_O	NA	NA	1.00	NA	NA		NA	NA	NA	1.00	1.00	NA	NA	NA	1.00	NA	NA	NA	NA	1.00	NA
Instructor Behaviors	Lec	0.15	0.19	1.00	0.04	0.63		0.04	0.01	0.06	0.01	NA	1.00	0.83	0.02	0.13	0.43	0.20	0.10	0.02	0.21	NA
	PQ	0.29	0.22	0.94	0.10	0.66		0.06	0.05	0.07	0.01	NA	0.63	1.00	0.07	0.11	0.43	0.20	0.22	0.01	0.35	0.01
	1o1	0.97	0.63	0.17	0.09	0.09		NA	0.07	0.04	0.04	NA	0.03	0.12	1.00	0.01	0.09	0.01	0.89	NA	0.22	0.01
	RtW	0.27	0.23	0.80	0.09	0.61		0.07	NA	0.05	0.11	0.02	0.64	0.70	0.05	1.00	0.32	0.16	0.20	0.02	0.16	0.02
	Fup	0.24	0.26	0.99	0.04	0.81		0.07	NA	0.15	0.02	NA	0.68	0.89	0.11	0.10	1.00	0.21	0.14	0.01	0.21	0.01
	I_AnQ	0.10	0.83	0.96	0.10	0.46		0.14	0.03	0.06	0.01	NA	0.60	0.76	0.01	0.10	0.40	1.00	0.10	0.01	0.38	NA
	MG	0.91	0.40	0.23	0.15	0.08		NA	0.12	0.03	0.05	NA	0.07	0.21	0.49	0.03	0.06	0.02	1.00	0.00	0.33	0.03
	D/V	NA	0.25	1.00	0.25	NA		NA	NA	NA	0.25	NA	1.00	0.50	NA	0.25	0.25	0.25	0.25	1.00	0.50	NA
	Adm	0.61	0.30	0.64	0.20	0.21		NA	0.11	0.07	0.05	0.01	0.27	0.58	0.21	0.04	0.17	0.16	0.57	0.01	1.00	0.02
	I_W	0.54	0.15	0.31	0.46	0.23		NA	0.23	NA	0.23	NA	NA	0.31	0.15	0.08	0.15	NA	0.62	NA	0.31	1.00

SM Table 8. Percentage of intervals in each class with coded behavior.

			Instructor behaviors									
instructor	Major	students	Lec	PQ	1o1	RtW	FUp	I_ANQ	MG	DV	Adm	I_W
1	biology	seniors	21.9	43.8	34.4	0.0	37.5	9.4	37.5	0.0	28.1	3.1
2	biology	seniors	37.5	56.3	31.3	0.0	25.0	3.1	46.9	0.0	28.1	0.0
3	biology	seniors	53.3	70.0	20.0	10.0	46.7	33.3	30.0	0.0	40.0	0.0
4	biology	seniors	66.7	80.0	0.0	0.0	36.7	23.3	30.0	0.0	16.7	0.0
5	biology	seniors	35.3	44.1	26.5	0.0	23.5	11.8	47.1	0.0	32.4	0.0
6	biology	seniors	45.2	45.2	38.7	6.5	22.6	3.2	48.4	3.2	29.0	0.0
7	biology	seniors	56.7	53.3	26.7	0.0	33.3	6.7	50.0	6.7	20.0	0.0
8	biology	seniors	18.8	34.4	25.0	0.0	25.0	12.5	62.5	0.0	28.1	0.0
9	biology	seniors	66.7	63.3	0.0	16.7	6.7	0.0	20.0	0.0	16.7	0.0
10	biology	seniors	9.1	45.5	9.1	6.1	24.2	3.0	45.5	0.0	30.3	24.2
11	biology	seniors	76.7	70.0	3.3	26.7	13.3	23.3	20.0	0.0	10.0	0.0
12	biology	seniors	25.0	37.5	25.0	0.0	18.8	9.4	46.9	0.0	43.8	0.0
13	biology	seniors	14.7	17.6	8.8	17.6	11.8	0.0	55.9	0.0	29.4	11.8
14	biology	seniors	20.0	30.0	36.7	0.0	23.3	13.3	63.3	0.0	26.7	0.0
15	multiple	sophomore	9.4	31.3	31.3	0.0	3.1	31.3	59.4	0.0	50.0	0.0
16	multiple	sophomore	15.6	9.4	50.0	0.0	0.0	3.1	81.3	0.0	18.8	0.0
17	multiple	sophomore	9.4	37.5	46.9	18.8	9.4	18.8	56.3	0.0	12.5	0.0
18	multiple	sophomore	46.9	50.0	18.8	21.9	21.9	9.4	37.5	3.1	31.3	0.0
19	multiple	sophomore	38.9	47.2	25.0	11.1	30.6	11.1	30.6	0.0	33.3	0.0
20	multiple	sophomore	12.9	19.4	51.6	3.2	12.9	3.2	58.1	0.0	19.4	0.0

instructor	Student Behaviors									
1	WG	SQ	L	Ind	S_Anq	WC	PRD	SP	S_W	S_O
2	62.5	15.6	50.0	25.0	18.8	0.0	0.0	12.5	0.0	0.0
3	65.6	31.3	65.6	12.5	34.4	3.1	0.0	0.0	0.0	0.0
4	43.3	50.0	76.7	20.0	56.7	0.0	6.7	10.0	0.0	0.0
5	33.3	23.3	83.3	0.0	66.7	0.0	0.0	6.7	0.0	0.0
6	47.1	20.6	38.2	0.0	26.5	0.0	47.1	0.0	0.0	0.0
7	54.8	32.3	64.5	9.7	25.8	0.0	0.0	6.5	0.0	0.0
8	63.3	26.7	73.3	0.0	36.7	3.3	0.0	6.7	3.3	0.0
9	68.8	31.3	37.5	0.0	21.9	3.1	37.5	6.3	3.1	0.0
10	20.0	0.0	66.7	0.0	53.3	0.0	0.0	6.7	0.0	0.0
11	21.2	12.1	42.4	45.5	24.2	0.0	21.2	0.0	0.0	0.0
12	13.3	23.3	93.3	6.7	56.7	10.0	0.0	0.0	0.0	0.0
13	56.3	31.3	43.8	0.0	25.0	0.0	0.0	15.6	0.0	0.0
14	52.9	11.8	32.4	14.7	8.8	0.0	0.0	0.0	23.5	0.0
15	60.0	73.3	26.7	0.0	26.7	3.3	0.0	3.3	10.0	0.0
16	56.3	40.6	34.4	15.6	6.3	0.0	0.0	0.0	0.0	0.0
17	81.3	25.0	21.9	0.0	6.3	0.0	0.0	0.0	6.3	0.0
18	56.3	59.4	37.5	0.0	25.0	21.9	0.0	0.0	3.1	0.0
19	34.4	15.6	53.1	12.5	31.3	3.1	0.0	18.8	3.1	0.0
20	33.3	30.6	61.1	16.7	30.6	5.6	0.0	0.0	8.3	2.8