Electronic Supplementary Material (ESI) for Chemistry Education Research and Practice

Supplementary Material

Codes	Code Notes
Group Arrangement	e.g., audio recorder number, where to put computer, who is 'clicking'
School (not sim or polarity related)	e.g., homework, lab, tutors, readings. Includes discussing non-chemistry courses.
Polarity	e.g., sim, polarity, related topics
Other	anything that doesn't fit into other categories
Instructor Student Discussion (on polarity)	conversation where instructor is talking to a student about the topic

General Notes on Coding:	
Length:	Discussion segment must be *at least* 2 consecutive speakers in length For example, 'other' utterances of only one line (one speaker) are coded as the line (speaker) immediately preceeding
Incomplete comments:	If a speaker's comment is unclear (for example "You _") code as the line immediately preceeding.
Getting Context:	You can look across the entire conversation to try to extract meaning from lines.
Comments on multiple topics:	For individual student comments that include more than one topic:

Scenario	Code As:
If there is any 'other' component…	Other
If no 'other', but there is 'group arrangement'…	Group Arrang.
If no 'other' and no 'group arrangment', but there is 'school'…	School

Segmenting Instructor-student conversation:	For instructor-student on-topic discussions: If a student has 'polarity' parts of one comment with asking for help from the instructor, start the segment with the instructor's response. (not with the student's question). End segment when instructor makes last response. If after the instructor's last response, the student is still clearly speaking to instructor, include that. Otherwise, segment ends with end of instructor talking.

Example Transcripts

Each transcript below contains all transcript recorded during the 10 minutes of exploration time.

Example 1 contains:
Total Utterances: 44
Total Conversation Segments: 2
Conversation Segments Consists of:
1 'Group Arrangement' Discussion Segment
1 'Polarity' Discussion Segment

Utterance #	Example 1 Transcript	Discussion Segment Code
1	*F1: We did a lot of clicking yesterday. If you would like to do some clicking—that didn't last very long.*	Group Arrangment
2	*F1: I think I'm gonna scootch over, make it easier.*	
3	*F1: OK.*	
4	*F1: I don't know what this symbol means. Oh. We can move it around. So this one is because I made it super-negative. So if I make this closer—oh!*	Polarity
5	*F2: Cool!*	
6	*F1: If they're similar in electronegativity—whoa!*	
7	*F2: Electrostatic potential.*	
8	*F1: So the redder it is, the more negative it is. OK. So it's basically those numbers that they showed already. Electron density. More electrons over here than over here. OK.*	
9	*F2: Oh, yeah, because it's negatively charged.*	
10	*F1: Oooh, it looks like we're running an electric field through here! So this side is negative and this side is positive, so our positive goes to negative. Let's do three atoms. All right. Atom A. Which one do we want to have more? Let's make B have more. What if we make C—if they all—let's turn all the thingies on.*	
11	*F2: What's ___?*	
12	*F1: OK. What does this one mean? Is it that there's a pair out here?*	
13	*F2: That's a negative force, charge.*	
14	*F1: Yeah, because it's in the middle and the other two have less electronegativity. So if I make it more, now the electrons want to be over here by C. Oh, so this is the—this must be for the lone pair that we don't see, right?*	
15	*F2: Yeah. That's the direction of the negativity, right?*	
16	*F1: That says it's the molecular dipole.*	
17	*F2: What does that mean?*	
18	*F1: For those of you listening, we both just had confused faces. [laughs]*	
19	*F2: Yeah! [laughs]*	
20	*F1: Let's turn on the field. We just ran an electric field.*	
21	*F2: Yeah, always point to the ___.*	
22	*F1: OK. If I fling you around, you're gonna—OK, so in that case our molecular dipole is moving OK. So that's what that does. So I'm able to change the angles. Is that something that can really happen?*	
23	*F2: I don't know. I didn't think so.*	
24	*F1: Let try it with real molecules, maybe it'll make more sense. Hydrogen and fluorine.*	
25	*OK. So that's saying fluorine is more electronegative. That makes sense, considering where it is up there on the globe. It just started spinning.*	
26	*So is that just—the molecular dipole is where the—I don't know.*	
27	*F2: It must be—*	
28	*F1: OK. So fluorine tends to be more negative, that makes sense. Atom electronegativities. That's nice, it shows you.*	
29	*F2: It didn't make sense, because I thought it pointed to the positive.*	
30	*F1: The yellow one? Yeah, me, too. Let's figure this out.*	
31	*OK. It looks like those rocket pops!*	
32	*F2: Yeah.*	
33	*F1: The blue and the white. It's a very patriotic electrostatic thing there. OK. Those all make sense. So maybe this is just where the electrons tend to go?*	
34	*F2: Yeah, the density.*	
35	*F1: Which is why it pointed not to the positive of the molecule, it pointed to the positive—when you run a current through it, your negative wants to go to the positive side of the current, right?*	
36	*F2: Yeah.*	
37	*F1: So it does make sense. That's what that is. That's saying what way the electrons are gonna go if you run a current through it. Oh! Light bulb! Let's try it then with nitrogen. Let's turn off all our things so we can look at them. All right. Nitrogen into—it's a triple bond.*	
38	*F2: Yeah.*	
39	*F1: Looks like a little—it looks like what it looks like. Bond dipoles. But it's not gonna be polar, so that's why there's nothing that really changed.*	
40	*F2: Yeah.*	
41	*F1: Molecular dipole, nothing, they're not polar. Partial charge is zero and zero, OK. Same electronegativity. Oxygen.*	
42	*OK. That's what a nonpolar dude looks like.*	
43	*F2: That'd be, like, the same.*	
44	*F1: Yup. It has to be, because they can't really have a difference. Fluorine, same deal. Hydrogen fluoride.*	

Example 2 contains:
Total Utterances: 65
Total Conversation Segments: 9
Conversation Segments Consists of:
1 'Group Arrangement' Discussion Segment
4 'Polarity' Discussion Segments
3 'Other' Discussion Segments
1 'School' Discussion Segment

Utterance #	Example 2 Transcript	Discussion Segment Code
1	*M1: What are we supposed to do?*	Group Arrangement
2	*Instructor: Can I get you guys to pair up? Would that be all right? Can I let ___ use your computer?*	
3	*M1: That'd be fine.*	
4	*Instructor: Are you sure?*	
5	*M1: Mm-hmm.*	
6	*M1: So what are we doing?*	
7	*F1: Last time I made a ___. But you have to give it back.*	
8	*M2: I'm gonna struggle with this.*	
9	*F1: Hi. OK. So. What's a dipole?*	Polarity
10	*M2: Do you know what dipoles are?*	
11	*F1: So it doesn't matter?*	
12	*F2: It's just showing you the thing. Hmm. Freakin' Mac.*	
13	*F2: I like that. I don't want to know this.*	
14	*F1: Wait, what's the dipole of the—*	
15	*F1: OK, now put bond dipole. Oh. It changed.*	
16	*M2: So oxygen is more polar, right?*	
17	*F1: Yeah.*	
18	*F2: Hmm.*	
19	*F1: This one.*	
20	*M2: ___ cuts than ___. You get—those are bad, cuts, don't you think?*	Other
21	*F2: Take a longer time to heal.*	
22	*M2: What do these [in the sim] do? Ah!*	Polarity
23	*F2: This one.*	
24	*F1: Oh, what did you do?*	
25	*F2: Switched it to—*	
26	*F1: Oh!*	
27	*F2: Hmm.*	
28	*M2: Do you have fillings in your mouth?*	Other
29	*F1: Me? Mm-hmm. How'd you know?*	
30	*M2: I saw them.*	
31	*F1: Oh. Yeah, I do. As a bad child. It's OK, though, because my brother got one whole silver tooth. Made me laugh. Made me feel better about myself.*	
32	*F2: Do you want the—*	
33	*F1: Oh!*	
34	*M2: Is that the jump drive we were given, or is that another one?*	
35	*F1: Yeah, this is the jump drive—no, no, no, the jump drive we were given—*	
36	*F2: —is in my pocket.*	
37	*F1: Yeah.*	
38	*F2: I'm stealing it. No, just kidding.*	
39	*F1: Do you not have fillings?*	
40	*M2: Unh-unh.*	
41	*F2: I thought you just asked the question, "Do you not have feelings?" and I'm like, "What kind of question is this?"*	
42	*F1: No, fillings! Fillings!*	
43	*F2: Make it do a beryllium*	
44	*M2: I have a crown on one of my teeth.*	
45	*F2: Slo-mo. [refers to sim]*	Polarity
46	*F1: [laughs]*	
47	*F2: Yay!*	
48	*M2: You're like a kid.*	Other
49	*F1: You're just old. [laughs]*	
50	*F2: Let's do three atoms.*	Polarity
51	*F1: Oh! Hey! Wow!*	
52	*F2: [laughs] It's fun. Nice.*	
53	*M2: So when you increase the—*	
54	*F1: —electronegativity—*	
55	*M2: Why this didn't move up?*	
56	*F2: But it doesn't move if the other two atoms are—*	
57	*M2: I got it. Try C.*	
58	*M2: Move C all the way to ___.*	
59	*F2: 'Cause if B is less, what if A's more? That's in between.*	
60	*M2: Oh, it points to the one that's—*	
61	*F2: Yeah. If A is less and then B is less.*	
62	*M2: Try that.*	
63	*F2: Where's that paper? [class activity being handed out]*	School
64	*F1: Oh.*	
65	*M2: She gave me some more.*	