

# TOWARDS ACADEMICALLY PRODUCTIVE TALK SUPPORTED BY CONVERSATIONAL AGENTS

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# Accountable Talk

(O' Connor, Michaels, & Resnick)

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**Eddie:** Well, i don't think it matters what order the numbers are in. You still get the same answer. But three times four and four times three seem like they could be talking about different things.

**Teacher:** Rebecca, *do you agree or disagree* with what Eddie is saying?

**Rebecca:** Well, I agree that it doesn't matter which number is first, because they both give you twelve. But I don't get what Eddie means about them saying different things.

**Teacher:** Eddie, *would you explain what you mean?*

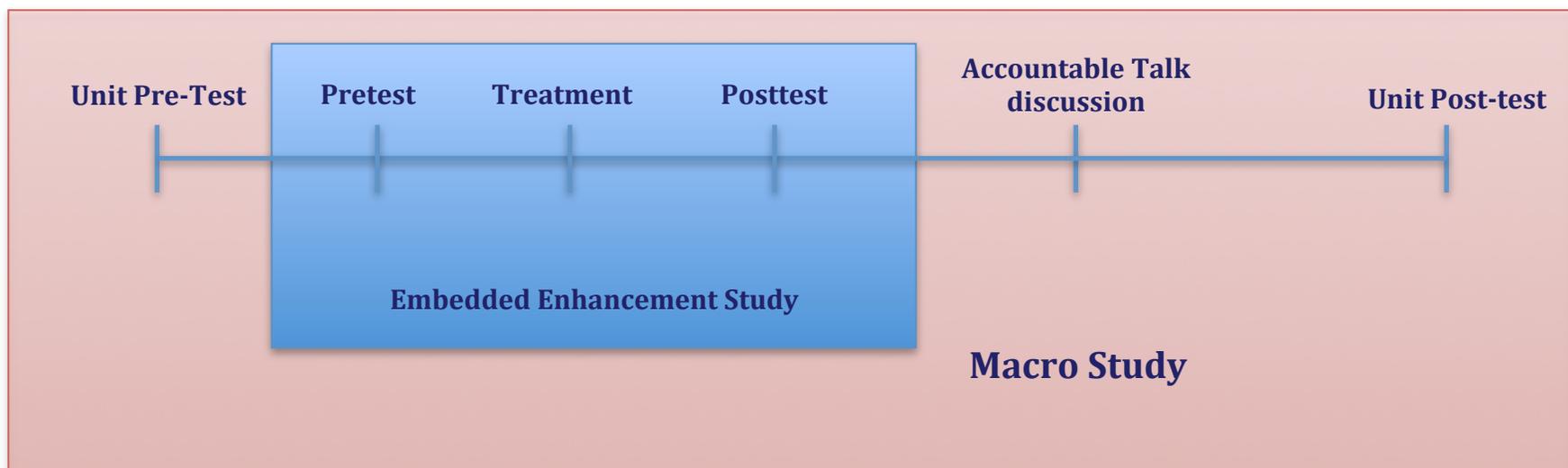
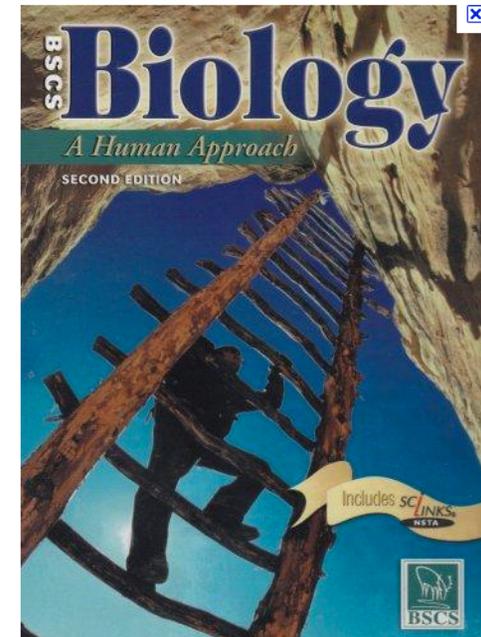
**Eddie:** Well, I just think that like three times four can mean three groups of four things, like three bags of four apples. And four times three means four bags of three apples, and those don't seem like the same thing.

**Tiffany:** But you still have the same number of apples, so they are the same!

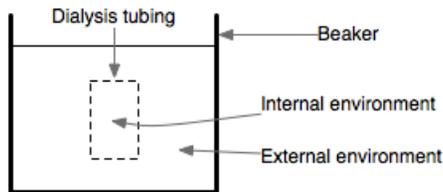
**Teacher:** OK, so *we have two different ideas* here to talk about. Eddie says the order does matter, because the two orders can be used to describe different situations. So Tiffany, *are you saying* that three times four and four times three can't be used to describe two different situations?

# Research Context

- Part of a district wide teacher training program
- Urban school, heavily tracked
- Reading level below that of their book
- Computers are 486s!
- Class period only 45 minutes long



# Supporting Accountable Talk



**Dialysis tubing** is a synthetic membrane made of a thin, cellulose-like material. Microscopic pores in dialysis tubing allow molecules smaller than a certain size to pass through the membrane.

**Glucose** is a simple sugar that dissolves readily in water. Glucose test strips indicate the presence of glucose in solutions by changing color (the darker the green, the more glucose is present). Starch is a complex molecule that forms a suspension in water.

**Iodine solution** is an indicator that turns blue-black in presence of starch. The size of a molecule is an important characteristic that partially governs how the molecule behaves. Chemists have shown that all the molecules of a given substance are the same size and that molecules of different substances can vary significantly in size. In other words, all water molecules are the same size, but water molecules are glucose or starch molecules are not the same size.

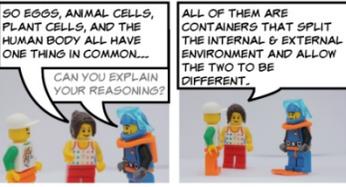
**Predicted results**

Condition	Contents of Internal Environment	Contents of External Environment	Initial Observations	Predicted Change	Explanation for Prediction
A	Glucose Solution	Distilled Water			
B	Distilled Water	Glucose Solution			
C	Starch Suspension	Iodine Solution			

**Observations**

Condition	Observation after 1h	Observation after 5h	Observation after 24h	Matches Prediction?	Explanation for observation
A					
B					
C					

- Research question: What form of support for small group discussion is most effective:
  - Elevating quality of small group discussion
  - Learning during small group discussion
  - Preparation for whole group discussion
- Instruction: Students read about Diffusion and receive training on Accountable Talk
- Online Lab in ConcertChat environment
  - Videos alternate with small group discussion
    - Students watch experimental setup and then predict outcomes
    - Students watch results at 1 hour, 5 hours, and 24 hours and then discuss whether effects matched predictions and what they learned

	<p><b>THE ACCOUNTABLE PRACTICES</b></p> 	<p>Alex(Tutor)</p> <p>You should now move on to discussing what will happen in Condition C and your explanation for this change.</p>
Revoicer	<p>#1</p> <p><b>REVOICING</b></p> <p>"REVOICING" IS WHEN YOU RESTATE SOMEONE ELSE'S REASONING, USING YOUR OWN WORDS.</p>	<p>s072</p> <p>when yue pue sugar and water its going to get smaller</p>
Challenger	<p>#2</p> <p><b>AGREE/DISAGREE</b></p> <p>SAYING WHY YOU AGREE OR DISAGREE (AND WHY) WITH A CLASSMATE'S STATEMENT IS IMPORTANT.</p>	<p>Alex(Tutor)</p> <p>S077, check with S067 if he/she agrees with S072.</p>
	<p>#3</p> <p><b>CHALLENGE</b></p> <p>SOMETIMES, THERE ARE EXCEPTIONS TO RULES. CAN YOU THINK OF A COUNTER-EXAMPLE?</p>	<p>S077.</p> <p>S067 do yue agree</p>
Explainer	<p>#4</p> <p><b>ADD-ON</b></p> <p>IF YOU HAVE SOMETHING MORE TO SAY, YOU CAN ADD-ON TO A CLASSMATE'S WORDS.</p> 	<p>Alex(Tutor)</p> <p>When you are in agreement, write down your predictions and explanations for Conditions A, B and C on your worksheet.</p>
	<p>#5</p> <p><b>EXPLAIN</b></p> <p>WHEN DISCUSSING WITH PARTNERS, YOU SHOULD TRY YOUR BEST TO EXPLAIN WHAT YOU'RE THINKING.</p> 	<p>s067</p> <p>yea</p>
	<p>I'M GLAD WE'RE USING THESE ACCOUNTABLE TALK MOVES FOR DISCUSSION.</p> <p>YEAH, IT REALLY HELPS US UNDERSTAND THE "EGGSPERIMENT" A LOT BETTER!</p> <p>BE SURE TO USE YOUR "ACCOUNTABLE TALK MOVES" WHEN HAVING DISCUSSIONS WITH YOUR CLASSMATES!</p> 	

– Each group assigned a **condition**

- No support: students just assigned roles
- Indirect Agent: agent reminds students to do their role
- Direct Agent: agent does accountable talk moves

# Accountable Talk Agents

WhiteboardChat: Alex(tutor) (microstudyTest)

File

Whiteboard:

Revoicer	<p>#1</p> <p><b>REVOICING</b></p> <p>"REVOICING" IS WHEN YOU RESTATE SOMEONE ELSE'S REASONING, USING YOUR OWN WORDS.</p>	<p>I THINK THE TOUGH EGG MEMBRANE WORKED LIKE A CELL MEMBRANE.</p> <p>JEROME, CAN YOU PUT WHAT SHE SAID IN YOUR OWN WORDS?</p>	<p>SO LET ME SEE IF I'VE GOT YOUR THINKING RIGHT. THE EGG WORKS LIKE A MODEL OF A CELL?</p> <p>YES.</p>
Challenger	<p>#2</p> <p><b>AGREE/DISAGREE</b></p> <p>SAYING WHY YOU AGREE OR DISAGREE (AND WHY) WITH A CLASSMATE'S STATEMENT IS IMPORTANT.</p>	<p>YEAH, AND THE MEMBRANE WAS IM-PERMEABLE.</p> <p>DOES EVERYONE AGREE WITH WHAT STEVE IS SAYING?</p>	<p>I DISAGREE WITH STEVE, BECAUSE THE MEMBRANE DIDN'T LET CORN SYRUP IN, BUT IT DID LET WATER IN.</p>
Explainer	<p>#5</p> <p><b>EXPLAIN</b></p> <p>WHEN DISCUSSING WITH PARTNERS, YOU SHOULD TRY YOUR BEST TO EXPLAIN WHAT YOU'RE THINKING.</p>	<p>SO EGGS, ANIMAL CELLS, PLANT CELLS, AND THE HUMAN BODY ALL HAVE ONE THING IN COMMON...</p> <p>CAN YOU EXPLAIN YOUR REASONING?</p>	<p>ALL OF THEM ARE CONTAINERS THAT SPLIT THE INTERNAL &amp; EXTERNAL ENVIRONMENT AND ALLOW THE TWO TO BE DIFFERENT.</p>

Current users:  
Alex(tutor)

Chat: (250)

Alex(tutor) 1/11/11 2:40:48 PM EST: Now discuss what you observed in the video about condition C. Compare what you observed to your predictions.

Student3 1/11/11 2:41:24 PM EST: I had predicted that the starch would turn dark. But I was surprised that it happened so fast.

Alex(Tutor) 1/11/11 2:42:03 PM EST: Student2, now would be a good time to ask Student1 if he agrees with what Student 3 has said, and why.

Student2 1/11/11 2:42:41 PM EST: Student1, what do you think? Were you also surprised? Please explain.

student1 1/11/11 2:43:32 PM EST: I wasn't that surprised since it was like what we saw in Condition A. But what did surprise me was how clear the iodine solution became.

Student2 1/11/11 2:44:05 PM EST: I figured that the reason why it became so clear is that it was getting soaked into the starch and then wasn't free to come back out again.

Alex(Tutor) 1/11/11 2:44:56 PM EST: Student3, now would be a good time to ask Student1 to rephrase what Student2 has said in his own words.

Student3 1/11/11 2:45:54 PM EST: Ok. Student1, can you tell me what Student2 meant in your own words?

student1 1/11/11 2:46:57 PM EST: OK, let me see if I have this right. You're saying that osmosis only happens with particles that are free. And once the iodine particles get into the cell and react with the starch, they are stuck there?

Student2 1/11/11 2:47:42 PM EST: I guess, but I'm not sure I would call iodine particles.

Message:

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# Results

Chat logs labeled by session (A, B, C, D are periods 1, 3, 6, and 9 respectively). Students did very poorly in all but session A, and we only see an effect of condition on learning in that class period.

	Supported (Session 1)	Unsupported (Session 1)	
<b>Shallow</b> ↓ <b>Deep</b>	Remember (High is better)	.6 (.54)	.66 (1)
	Understand (High is better)	.4 (.54)	.89 (1.1)
	Explain (High is better)	2 (.7)	1.1 (.9)
	Experiment (High is better)	2.2 (1.3)	1.6 (1.4)
	Ranking (Low is better)	2.4 (1.1)	4.8 (2.6)

**P < .05, effect size 1.1 s.d.**

**Learning Results based on Discussion Questions**

Period	No Support	Indirect Agent	Direct Agent
Period 1	4.2 (3.7)	8.0 (5.9)	3.7 (2.1)
Period 3	N/A	19 (8.5)	60 (49.5)
Period 6	1 (0)	3.2 (2.1)	5.8 (5.3)
Period 9	1 (0)	20 (0)	7 (0)

**Participation in Whole Class Discussion**

## Souflé Framework (Howley, Mayfield, & Rosé, in press)

### Negotiation Framework: Authoritativeness over Knowledge and Action

Label	Example
Primary Knower	“This is the end.”
Secondary Knower	“Is this the end?” (not all questions)
Primary Actor	“I’ m going to the end.”
Secondary Actor	“Go to the end.”
Challenge	“I don’ t have an end marked.”
Other	“So...”
Setup Move	“Where do you think the end is?” (with ability to judge correctness)

### Engagement Framework: Showing Awareness of Other Views

Label	Definition
No Assertion	No propositional content is asserted (honest questions, “yay”, etc).
Monoglossic	Does not acknowledge alternate perspectives (bald claims, no hedging, etc).
<i>Heteroglossic</i>	
Expand	Increases possibility of other viewpoints (making a suggestion, “might”, etc).
Contract	Decreases viable opinions (outright rejection, absolute assertions, etc).

### Transactivity: Identifying Thought Leaders and Receptivity to Ideas

Label	Definition
<i>Not Reasoning</i>	
Off-task	Blatantly off-topic contributions.
Social	Socially-oriented off-task contributions.
Tangent	Not related directly to the task-at-hand.
Assertion	Plain answers or procedures, or off-task reasoning.
Repetition	Purely repetitive contributions.
<i>Reasoning</i>	
Externalization	No reference to another’ s explicit reasoning.
Transactive	Connection to another’ s explicit reasoning.

# Results from Coded Chats

Condition	Academically Productive Talk Moves	Academically Productive Talk Moves Group + Tutor	Reasoning Moves	Transactive Moves
Unsupported	.56 (2.7%)	1.6 (1.8%)	1.6 (11%)	.55 (2.7%)
Indirect Agent	1.2 (4.9%)	3.8 (3.6%)	.53 (3.8%)	.13 (1.1%)
Direct Agent	.67 (6.4%)	4.25 (7%)	2 (17%)	.92 (5.1%)

- Significantly more Academically Productive Talk moves in supported conditions
  - $F(2,42) = 13.9, p < .0001$
  - Weak correlation between Academically Productive Talk moves and student reasoning,  $R^2 = .11, p < .05$
- Students in Direct contribute marginally more reasoning than Indirect
  - $F(2,42) = 2.46, p < .1$
  - Significant when we consider percentage of reasoning moves,  $F(2,42) = 4.47, p < .05$

# Authoritative vs. NonAuthoritative Student

Authoritative-ness correlates with amount of reasoning contributed,  $R^2 = .11$ ,  $p < .05$

Speaker	Contribution	Negotiation
s006	is anyone else seriously confused	k2
s010	{s006}, did you get any other observation other than the weight	k2
s010	yes	k1
s006	no i didnt write anything down for the observations	k1
s010	nice	o
s010	....	o
Alex(Tutor)	Ok, I gotta go.	o
Alex(Tutor)	It was nice talking to you all. :-)	o
s010	um bye?	o
s002	for 1 hour on a it was .620 they were both clear tube and beaker and	k1
s002	same for the B but the weight was .540	k1

S002 is high in Authoritativeness

Authoritativeness coding can be automated with high reliability ( $R^2 = .95$  with human coding) (Mayfield & Rosé, 2011)

Speaker	Contribution	Negotiation
Alex(Tutor)	Now discuss what you observed in the video about conditions A and B. Compare what you observed to your predictions.	a2
s008	does ne one know wat they r doing	k2
	(1 minute pause)	
Alex(Tutor)	You should now move on to discussing what you observed in the video about condition C. Compare what you observed to your predictions. How is this different from what happened in condition A?	a2
	(2 minute pause)	
Alex(Tutor)	Ok, I gotta go.	o
Alex(Tutor)	It was nice talking to you all. :-)	o
	(3 minute pause)	
s008	ok this video made no sense at all soes any one know what they are doing	o
s012	maybee	o
	(1 minute pause)	
s008	well then tell me	k2
s008	well then tell me	o
s012	well A is retarded	k1
s012	it gained twice then lost weight	k1
s008	well i only got the 1 hour thing nd the 5 hour one i dint watch the rest of the video	o

S008 is low in Authoritativeness

# Heteroglossia as a reflection of Attitude

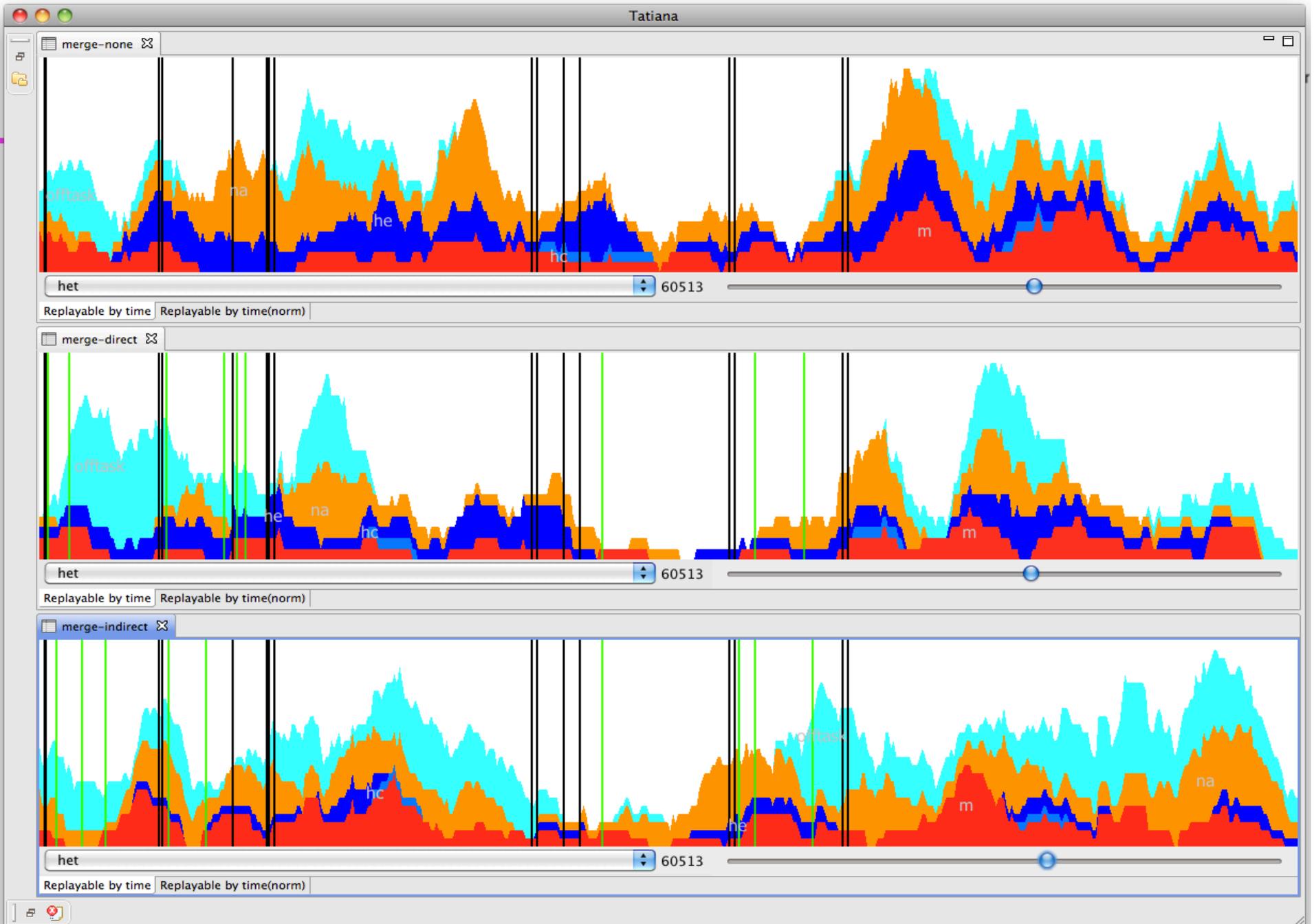
**S059 sounds less annoyed than s062.**

Speaker	Contribution	Heteroglossia
Alex(Tutor)	You are now going to watch a video showing the cell in Conditions A, B and C.	m
Alex(Tutor)	As you watch the video, write down your observations on your worksheet.	m
s059	umm a you can say that when you mix them together the colors will change and something may happen..okay	he
Alex(Tutor)	Go to the Videos folder on the Desktop, and watch the video which is there.	m
s056	maybe	na
s062	wacth the video	m
s059	okay so do you want to put that down	he
s056	who is this anyway	na
	(3 minutes pause)	
Alex(Tutor)	Is everyone back?	na
s059	{s059}...and we can say when you mix them together the color changes and they have different weight	he
Alex(Tutor)	Now discuss what you observed in the video about conditions A and B. Compare what you observed to your predictions.	m
s062	glucose will dissolve in the distilled water	m

# Heteroglossia as a reflection of Attitude

- Percentage of Heteroglossic statements in discussion correlates with percentage of student reasoning
  - $R^2 = .5, p < .0001$
- Significantly lower percentage of Heteroglossic statements in the Indirect Agent condition
  - $F(2,41) = 6.79, p < .005$

Condition	Authoritativeness Ratio	Percent Student Heteroglossia	Percent Student Reasoning	Percent Cheating	Percent Offtask
Indirect Agent	.54 (.21)	.08 (.06)	.03 (.1)	.18 (.15)	.35 (.15)
Direct Agent	.6 (.21)	.24 (.14)	.17 (.14)	.05 (.09)	.27 (.16)
No Support	.62 (.27)	.2 (.16)	.11 (.1)	.12 (.2)	.13 (.17)



# Frustrating Interaction in Indirect Condition

Alex(Tutor)	In condition C, we made a modification to condition A. We replace the glucose solution with a starch suspension. In order to detect the presence of starch, we replace the distilled water with Lugol's Iodine solution.	m
Alex(Tutor)	You should now move on to discussing what will happen in Condition C and your explanation for this change.	he
s041	the world is going to end in 2012	m
Alex(Tutor)	S027, now would be a good time to ask S034 to build on what S041 is saying.	he
s034	im so confused!	m
s027	034, would you like to build on to what 041 is saying? and me too!	he
Alex(Tutor)	When you are in agreement, write down your predictions and explanations for Conditions A, B and C on your worksheet.	m
s027	who is 34?	na
s034	{s034}	m

# Conclusions

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- First attempt at academically productive talk agents
  - Some glimmer of hope
  - Lot' s of room for improvement
- Improve triggering: biggest problem was triggering from non-serious contributions of students
- Improve coordination between macro and micro support mechanisms

# Problems and complaints!!

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- Login names instead of real names – wasted a lot of time trying to figure out who they were talking to
- Not a “real” collaborative task?
- No shared representation for predictions
  - But if it was shared, would students make their own predictions?
- Assigning people to roles within the chat took too much time/space
  - Tutor dominated the initial part of the conversation?
- The agent interrupted too often/too quickly in the supported conditions
  - Too much involvement?
- Trying to keep the students in lock step didn’ t work – or maybe 45 minutes was way too short

# Good Knowledge Sharing but Bad Coordination with the Agent (Session C)

s035	ook group what do we pedict
s042	I think that the water will seperate and travel to glucose. Because water has a lot of molecules and glucose is just sugar. So it would then balance out. What do you think?
s035	ook this is what i think...if we put the cell model in the water it will grow like the egg did....but if its in teh sugar it will shrink
s042	Oh I get it. But wouldn't it still expand and try to balance out?
s028	i am so confused
s035	im with {s028} on this one....
s042	It's like Osmosis I think. If it's water mixed in with sugar like liquid or another solvent it will try to balance out. Like salt. Does that help?
s028	thankyou! i have nothing written on my paper, i'm a bit stupid
Alex(Tutor)	Back from watching the video?
s028	no alex, we arent! jeeze!
Alex(Tutor)	Now discuss what you observed in the video about conditions A and B. Compare what you observed to your predictions.
s028	alright, i am still on A, for the first box thing
s035	haha its cool and {s042} that is a good idea.... i think we mite have to watch the movie
s028	what do you guys think?
s035	we need to watch the movie maybe??
s028	yeah, i think we should
s042	I think that it might balance out and that {s035}'s right with the shrinking of the water.
s042	Yeah we should
s035	ook were do we go lol
s028	down at the bottom of the screen
s035	thnx found it
Alex(Tutor)	You should now move on to discussing what you observed in the video about condition C. Compare what you observed to your predictions. How is this different from what happened in condition A?

# Trying to do the lab without the videos!

s028	i think that for C, the predicted change would be that the water will move into the starch
s042	The glucose weighed it down and then dispersed
s042	I agree with s028
Alex(Tutor)	Ok, I gotta go.
Alex(Tutor)	It was nice talking to you all. :-)
s028	wooo now all i need is B! and the entire second box haha
s035	i still hav eno clue what to write in all the boxes :(
s042	Okay, I think that when the distilled water is put into the glucose the glucose will get lighter and then well I don't know what then.....
s028	wouldnt for B, the water will once again shrink because its mixing water with glucose again?
s028	oh ok, or your prediction haha
s042	Oh I think it would, but it might expand at first then shrink
s028	yeah
s028	that makes sense
s028	wouldnt the explanation for C be that starch absorbs water, and thats why the water will move into it?
s042	the explanation I think would be that since when h2o is put into another solvent it expands its molecules and then maybe it would shrink from the glucose
s042	Yeah thats what shoud happen for the starch box
s035	i think we ahuld all write what we think an dthen talk about it
s042	Kay
s028	mkkk. now all we need is the explanation for box A
s042	Box A I think would be that there's a lot of water and glucose is sugar so it would shrink and like balance
s035	are we on the first set of boxes of the seconf??
s042	First
s028	ok, now we have to watch that stupid video, but didnt he tell us to X out of it?

# Trying to do accountable talk (Session 3)

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s027	idk what to do.
s034	someone predict something
s041	THE WORLD IS GOING TO END IN 2012 !
s034	oh i get it! what do you think is going to happen when you put the glucose in the distilled water?
s027	i think it will turn a different color.
s027	{s041}?
s041	ok dude what 27 said
s027	in your own words
s027	?!?!?!
s041	you have to be more specific 27
s027	ur one to talk!!!
s034	the answer to number one : the distilled water will move into the internal envorment of glucose solution
s027	kk
s034	and the explanation is glucose is denser
s041	huh?
s027	just write what she[ {s034} ] said.
s041	for the explanation

# Example coding

1	user	contents	AT	Reas	Trans	Neg	Het	time
37	s034	oh i get it! what do you think is going to happen when you put the glucose in the distilled water?	no	no	no	k2	na	12:04 PM
38	s027	i think it will turn a different color.	no	reas	ex	k1	he	12:04 PM
39	s027	{s041}?	at	no	no	a2	na	12:04 PM
40	s041	ok dude what 27 said	no	no	no	a1	he	12:04 PM
41	s027	in your own words	at	no	no	o	na	12:05 PM
42	s027	?!?!?!?	no	no	no	o	na	12:05 PM
43	s041	you have to be more specific 27	at	no	no	a2	hc	12:05 PM
44	s027	ur one to talk!!!	no	no	no	o	na	12:05 PM
45	s034	the answer to number one : the distilled water will move into the internal envorment of glucose solution	no	reas	ex	k1	m	12:05 PM
46	s027	kk	no	no	no	o	na	12:06 PM
47	s034	and the explanation is glucose is denser	no	reas	tr	k1	m	12:06 PM
48	s041	huh?	no	no	no	o	na	12:06 PM
49	s027	just write what she[{s034}] said.	no	no	no	a1	m	12:07 PM
50	s041	for the explination	no	no	no	o	na	12:07 PM
51	s034	#2 the distilled water will move into the external enviroment	no	reas	ex	k1	m	12:07 PM
52	s034	watch the video	no	no	no	a2	m	12:08 PM
53	Alex(Tutor)	Is everyone back?	no	no	no	k2	na	12:08 PM
54	s041	we have to do all the prediction , thats what NACHO said	no	no	no	a2	he	12:08 PM
55	s027	ok, but where do i click to watch it?	no	no	no	o	na	12:08 PM
56	Alex(Tutor)	Now discuss what you observed in the video about conditions A and B. Compare what you observed to your predictions.	no	no	no	a2	m	12:09 PM
57	s027	nevermind i found it.	no	no	no	a1	m	12:09 PM
58	s034	#3 the water will move into the starch because starch absorbs it	no	reas	ex	k1	m	12:10 PM
		S027, now would be a good time to ask S041 to build on what						