

Technology Supported Collaborative and Discussion Based Learning at Scale

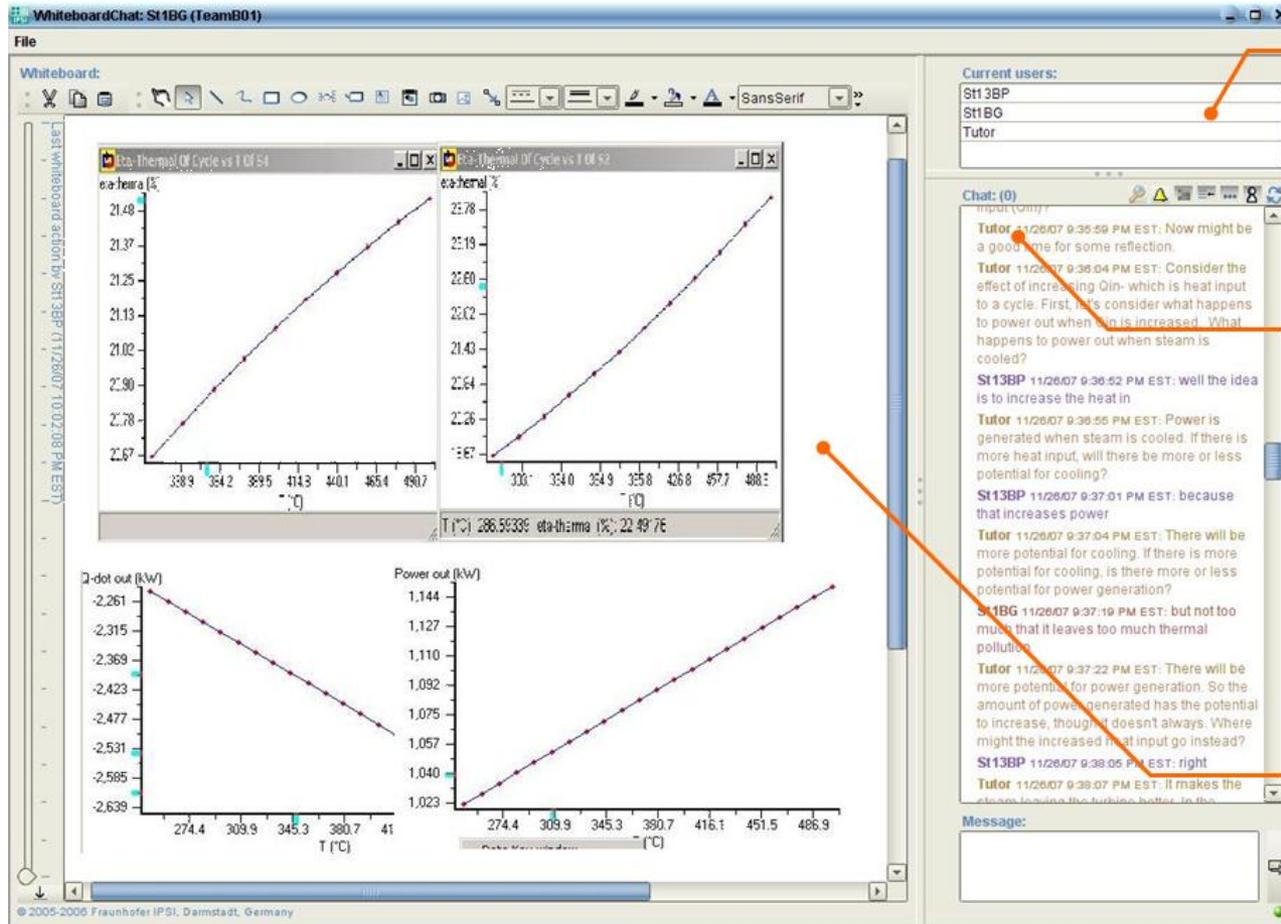
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Conversational Agent Based Support in Computer Supported Collaborative Learning



Students & Tutor working on designing a power plant

Tutor discusses thermodynamics concepts and makes arguments for design alternatives.

Students share results and ideas in a common workspace

Students learn 1.24 s.d. more when working with a partner and automated support than students working alone (Kumar et al., 2007)

Analysis

Design

TUTOR: What changes do you think you'll see in this condition? Agree on a prediction for what you'll observe over time. *You'll see an explanation that everyone understands.

411CS1: What changes do you think you'll see in this condition? Agree on a prediction for what you'll observe over time, "and" an explanation that everyone understands.

TUTOR: the glucose will slowly change over time into light green

412CS1: What changes do you think you'll see in this condition? Agree on a prediction for what you'll observe over time, "and" an explanation that everyone understands.

411CS1: the glucose will slowly change over time into light green

412CS1: I think that there will not have as much glucose in it

411CS1: Thanks for starting a prediction, 412CS1.

TUTOR: your welcome

411CS1: dont like this chat im being cheated

411CS1: but if the test strip is testing for glucose wouldnt the test strip stay dark green because there is more glucose than distilled water

412CS1: So is 411CS1 saying "a glucose test strip changes color when glucose is there?"

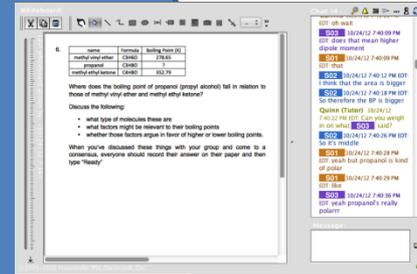
411CS1: hey SAGE

411CS1: yes I guess

411CS1: there is more glucose so the test strip would stay dark green not change to light green

412CS1: agree, is the distilled water in the dialysis tubing

411CS1: true but the tube is filled with water which doesnt do much but glucose does change the strip



Facilitating Effect On Teachers

Automated Support For Students



Accountable Talk:

Foundational Work in Classroom Discussion Facilitation

		Utterance	
1	Teacher	OK, does anyone want to respond to that? Who wants to respond and can prove that Marcel's explanation and can, kind of respond with their own ideas or can add another example? Frank, go ahead.	Add on
2	Frank	I um I agree with what you said because this for example like if you put-- if you had big um, can- like if you got a big cup of water and you put a- an eraser in there, like a- a ah, like the eraser over there, if you put something like that in a big cup of water, the water level would rise a lot, and, if you put in a copper cube, and it's not even gonna- it's not going to rise that much even though that copper cube will weigh more than a eraser.	
3	Teacher	Ahh ok, anyone agree with Frank's idea? I like that he kind of talked about another object and he chose an object that we know has a different volume than the eraser. So, can someone explain or repeat Frank's example of an object that has a much greater volume. And can someone explain or repeat Frank thought would happen if I put an object this big, in water? James, what he think would happen if I put an object, this big, into a cup of water?	Agree/Disagree Explain Other
4	James	He said that if you-- if you like a big- bur--like a big bottle of like water	
5	Teacher	Uh huh	
6	James	and you put the eraser in it, then it would probably like, rise a lot. Then--	
7	Teacher	Woah, woah, rephrase that – it has a what?	Press for Reasoning
8	James	a different vol-- a different volume...	
9	Teacher	And which has a greater volume?	Say More
10	James	The eraser.	
11	Teacher	The eraser. Which means it takes up more space. So if I were to put this into, a pitcher here, and a pitcher of water for example, if I were to put it into my little pitcher here, if I had this filled up and I had this pitcher of water for example, which direction would my water have to go?	Revoice

Empirical Support for Accountable Talk

- When teachers of math, science, and reading use structured teacher-lead discussion methods...
 - steep changes in student **achievement** (*Bill, Leer, Reams & Resnick, 1992; Chapin & O'Connor, 2004*)
 - **Retention** for up to 3 years (*Adey & Shayer, 1993, 2001; Shayer, 1999; Topping & Trickey, 2007a, 2007b*)
 - **Transfer** across domains for up to 3 years (*Bill, Leer, Reams & Resnick, 1992; Adey & Shayer, 1993, 2001; Shayer, 1999; Chapin & O'Connor, 2004*)
 - Students perform better on **non-verbal reasoning** tests e.g. Ravens (*Mercer, Wegerif & Dawes, 1999*)
 - **Reasoning** itself improves (*Kuhn & Zillmer, in press; Lin et al 2012*)

Agents as Support for Group Learning

Employing Accountable Talk Practices

The screenshot displays a digital whiteboard interface with a toolbar at the top. The main content area is titled "Condition B" and shows a sequence of three beakers labeled "Initial Observation", "After 1 Hour", and "After 24 Hours". Each beaker contains a yellow fish-shaped object. Below the beakers, a scale shows the weight of the object at each stage: 0.61 grams (Initial), 0.58 grams (After 1 Hour), and 0.56 grams (After 24 Hours). Red arrows indicate the progression from the initial state to the 1-hour mark, and then to the 24-hour mark. A separate scale shows the initial weight of 0.61g. To the right of the whiteboard is a chat window titled "Chat: (1)". The chat history shows a conversation between a Sage (Tutor) and two students (S01 and S02). The Sage's message is highlighted with a dashed blue box and an arrow pointing to it from the text "Agent support by revoicing".

Whiteboard:

Condition B

Initial Observation After 1 Hour After 24 Hours

Starch + Water
Iodine + Water

Weight: 0.61 grams Weight: 0.58 grams Weight: 0.56 grams

0.61g

Current users:
S01
Sage (Tutor)

Chat: (1)

Sage (Tutor) 12:12:50 PM EDT: Notice how the inside and outside environments changed. Why did these changes happen?

S01 12:13:01 PM EDT: I think the starch absorbed the iodine

Sage (Tutor) 12:13:09 PM EDT: Would another way to say that be "starch will make the iodine darker?"

S02 12:13:19 PM EDT: yeah, I agree

Sage (Tutor) 12:13:23 PM EDT: m-hmm

Message:

Agent support by revoicing

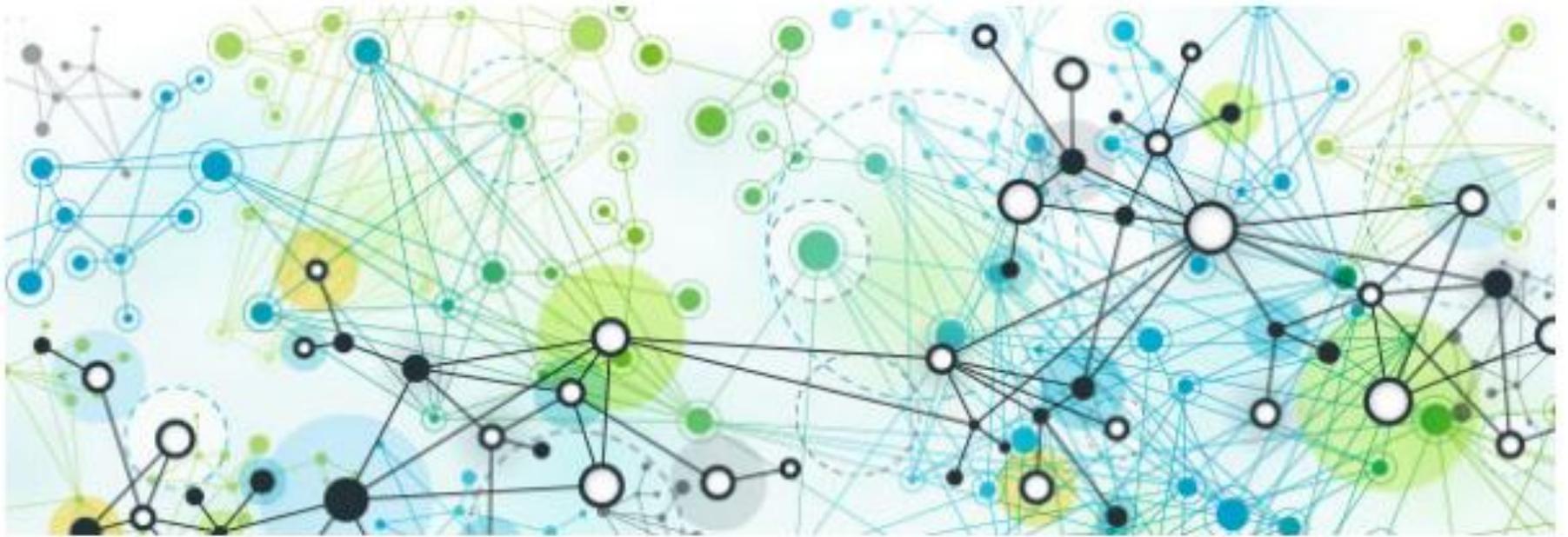
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Part of a professional development effort for 9th grade biology in an urban school district

Positive Effect on Student Learning



- **Study 1: Year 1, Diffusion Lab**
 - Students learn more on explanation questions in supported conditions ($F(1,46) = 4.3, p < .05$, effect size 1 s.d.)
 - Students in supported conditions more active in whole group discussion ($F(2,26) = 4.2, p < .05$, effect size .75 s.d.)
- **Study 2: Year 2, Diffusion Lab**
 - Students learn more on immediate post test in Revoicing Agent condition ($F(1,74) = 4.3, p < .05$, effect size .51 s.d.)
- **Study 3: Year 2, Punnett Square Lab**
 - Students learned marginally more ($p < .1$) on delayed post-test in Revoicing Agent condition



Data, Analytics and Learning

An introduction to the logic and methods of analysis of data to improve teaching and learning.

Individual learning followed by collaborative reflection supported by a virtual agent

Discussion

Student1 has joined the discussion. 8:10:33 PM

VirtualCarolyn 8:10:36 PM

In this collaborative activity, we will reflect on the use of Gephi for social network analysis with the Twitter and blog networks (Week 12) from the dataset provided in the course materials about the dataset for social network analysis. First, take a moment to introduce yourselves.

Student2 has joined the discussion. 8:10:41 PM

VirtualCarolyn 8:10:50 PM

When you've finished introducing each other, press the "We're Ready" button (or type "ready") to begin.

Student2 8:11:05 PM

Hi there, this is my first chat

Student1 8:11:20 PM

Me too, I joined the class late

Student1 has shared an [image](#). 8:12:16 PM

Student1 has shared an [image](#). 8:12:41 PM

Student1 8:12:52 PM

I pasted in a network visualization

Student2 8:13:09 PM

Hmmmm

Student2 8:13:18 PM

I had trouble with the assignment, maybe you can help me

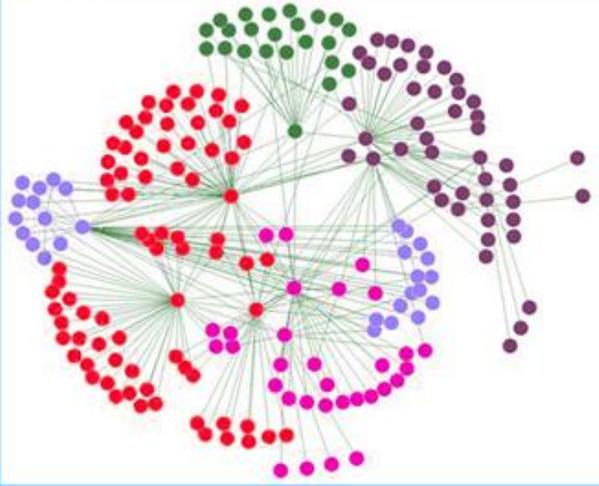
Send Message We're Ready

Information

Week302

Student1 8:12:16 PM

Student1 8:12:41 PM



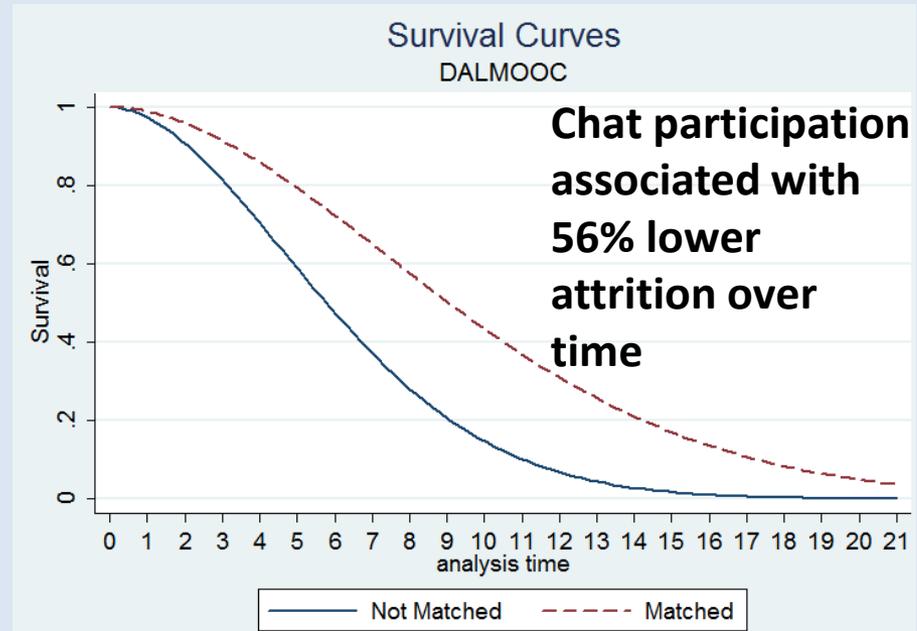
Want to share an image? Paste its URL here!

Share Image URL

Students engage in a significantly higher concentration of expressed reasoning in the chats than in the discussion forums or twitter.

Positive Impact of Chat Participation

- Assess impact of chat participation on dropout along the way using a survival analysis
 - **Unit of analysis:** each 2 day period
 - **Dependent variable:** Drop = 1 on the last active time period (0 otherwise)
 - **Control variables:** Number of clicks on videos and number of clicks on discussion forums
 - **Independent variables:**
 - Number of attempts to be matched for a chat (numeric)
 - Successful match (binary)
 - Interaction between Attempts and Match



Independent Variable	Hazard Ratio	P Value
Video Clicks	2.38	P < .0001
Forum Clicks	.51	P < .0001
Match Attempts	2.33	P < .0001
Match Success	.44	P < .01
Interaction between Attempts and Match	.76	P < .05

Deliberation-based Team Formation

- Maintain community connection and team connection simultaneously
 - Form teams later, after community engagement has started
 - Use community engagement as evidence of who would work well together
-
- **Big result:** Discourse Analytics enables effective team assignment
 - Transactivity automatically detected between pairs of students in threaded discussion
 - Max cost flow optimization to maximize averaged observed pairwise transactivity in assigned groups
 - Transactivity based teams perform **3 standard deviations better** on team task than randomly assigned teams

DANCE: Discussion Affordances for Natural Collaborative Exchange

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[RESOURCES](#)

About DANCE

Drawing from two decades of research in Computer Supported Collaborative Learning, we are working to design an extension of the [edX platform](#) to enhance instructionally beneficial discussion opportunities available to students. With this working group, we want to bring together people from academia and industry to build a common vision regarding what kinds of research would be valuable to the community once such a platform extension was in place to support it. Our work is initially focusing on the edX platform in particular, but in the long run we seek to provide these capabilities to Massive Open Online Courses and other online learning platforms more generally. In particular, this working group is partnering with edX as a satellite collaborative, seeking to involve researchers and developers from multiple universities, foundations, and industrial organizations.

Our foundational work is beginning with specific interventions designed to offer synchronous collaboration activities supported by intelligent conversational agents and enhancements to threaded discussions to support more intensive help exchange by leveraging social recommendation technology. However, our goals are much broader than this, seeking to leverage insights and methodologies from the field of Human-Computer Interaction and encompassing both synchronous and asynchronous communication very broadly. Our vision includes text, speech, and video based interactions, instrumented with all sorts of intelligent support powered by state-of-the-art analytics and leveraging language technologies and artificial intelligence more broadly in order to offer contextually appropriate support. We will coordinate this effort with regular online meetings and occasional in-person workshops.



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Looking to the future: What do we want to enable?

- Project and Problem based learning
- Collaborative reflection and Collaborative Problem Solving
- Community building and social support
 - Reducing attrition in MOOCsGateways to enduring communities of practice
 - Bridging learning and practice



Thank You!

Questions?