



“The Structure of Collaborative Problem Solving in a Virtual Math Team”

Gerry Stahl

How does (group) cognition take place (and how can it be analyzed) in a socio-technical setting?

- 1. Cognitive accomplishments can be achieved by small groups, mediated by technological media, tools, resources**
- 2. Cognition can take place primarily as textual discourse**
- 3. Research can now capture adequate traces of meaning making, problem solving, knowledge building, group cognition**

Talk overview: show social construction of mathematical meaning through collaboration and argumentation

- 1.The hierarchy of levels of temporal structure for online collaboration**
- 2.The sequential structure of collaborative math discourse**
- 3.Virtual Math Teams case study**
- 4.10 discourse moves (in detail)**
- 5.Group cognition in math**

Hierarchy of structural layers

- 1. Group event:** E.g., Team B's participation in the VMT Spring Fest 2006.
- 2. Temporal session:** Session 4 of Team B on the afternoon of May 18, 2006.
- 3. Conversational topic:** E.g., determining the number of sticks in a diamond pattern. (A longer sequence.)
- 4. Discourse move:** A sequential accomplishment built on an elementary interchange.
- 5. Adjacency pair:** A base interaction involving two or three utterances, which drives a discourse move.
- 6. Textual utterance:** A text chat posting by an individual participant, which may contribute to an adjacency pair.
- 7. Indexical reference:** An element of a textual utterance that points to a resource in the context.

“Longer sequences” in CSCL

The sequential structure of collaborative math discourse

The problem of longer sequences

Between CA (conversation analysis – e.g., Sacks, Schegloff) and DA (discourse analysis – e.g., Gee)

Between utterances or adjacency pairs & identity or ideology issues

Science of small-group cognition between individual unit of analysis & communities of practice

“Longer sequences” in CA

Conversation Analysis (CA): Sacks (1962), Schegloff (2007), etc. looks at how people construct their interactions, e.g., with turn taking and adjacency-pair responses

Traditionally focused on adult, American, face-to-face, informal speech

Needs to be adapted to online text

Needs to be extended from adjacency pairs to longer sequences that accomplish cognitive tasks by groups

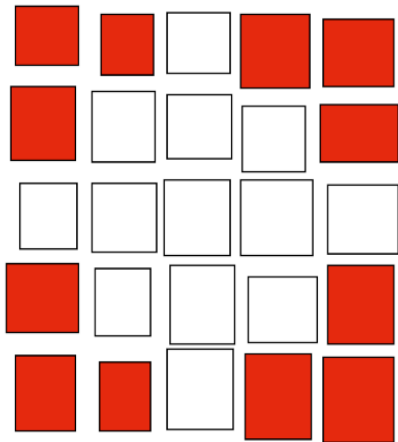
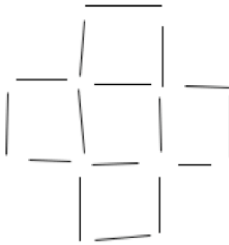
The VMT environment

Whiteboard:

Questions and are all contributing and also making use of each other's ideas. It is sometimes hard for us to tell what you are writing and thinking. It seems that there are times when you say you are following each other, but it is not clear that you are really in agreement or completely understand each other. You might actually discover some more paths if you state things in more detail - to be completely sure you are in agreement.

For session four, you could revisit a problem you were working on before, in order to state more clearly for other groups in the wiki: (a) a definition of your problem, (b) a solution and how you solved the problem. Or you could create a new variation of these pattern problems, or a 3-D version of group C's diamond pattern.

It is up to you to pursue whatever most interests you and what enables you to improve and enjoy your ability to work together. As you know, one hour goes by pretty quickly, so it's easy to run out of time for a complicated problem. Be creative and enjoy the session.

$$\sum_{n=1}^n = 4n(n+1) + (n+1)^2$$



big square: $(2n-1)^2$
 4 corners: $n(n+1)/2 * 4$
 number of squares:
 $(2n-1)^2 - n(n+1)/2 * 4$

of sticks
 $n^2 + (n-1)^2 * 2 + n * 3 - 2$
 # of squares
 $n^2 + (n-1)^2$

Current users:
 Aznx
 Gerry
 Quicksilver
 bwang8

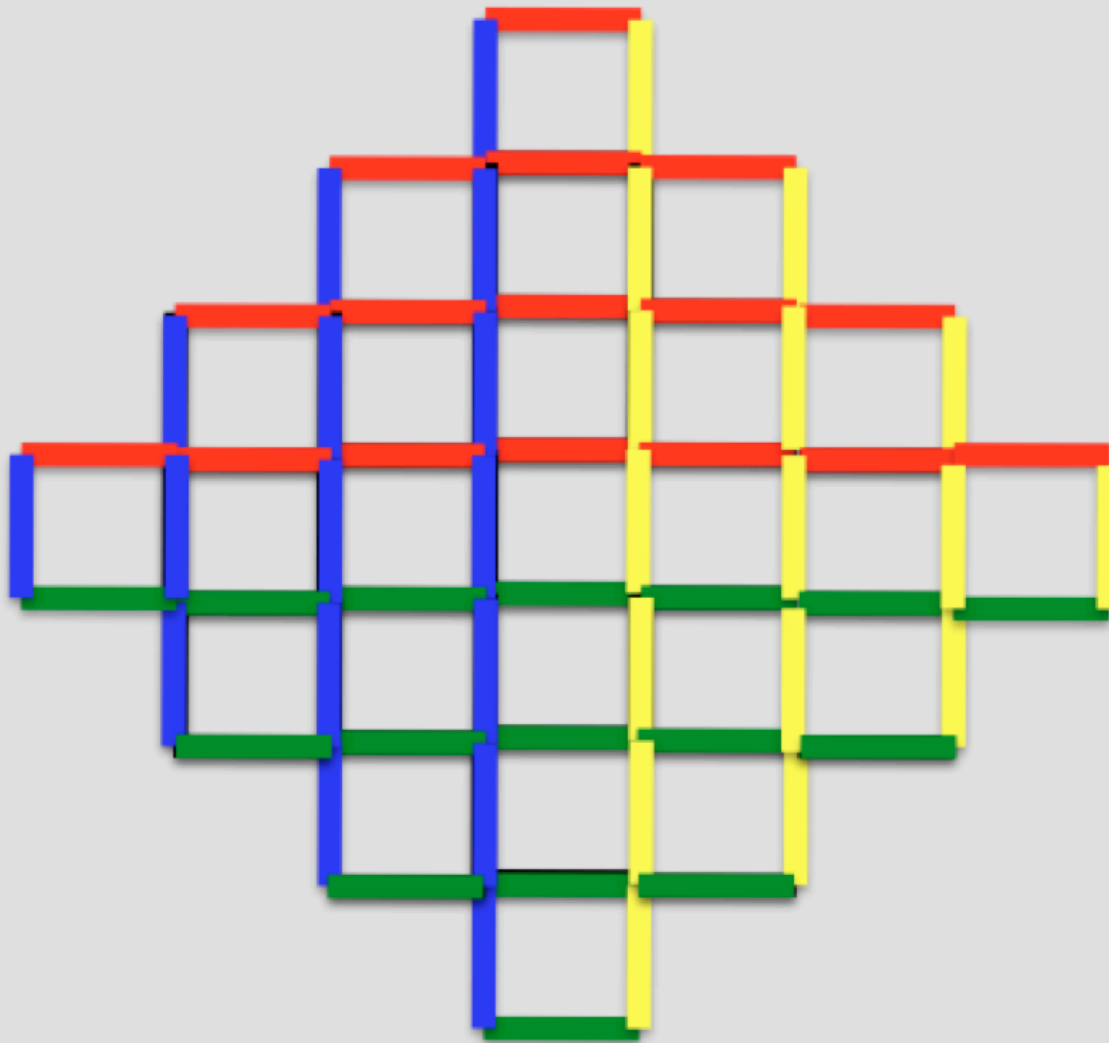
Chat: (0)

bwang8 5/18/06 8:17:05 PM EDT: ok
bwang8 5/18/06 8:17:20 PM EDT: i think we are very close to solving the problem here
Quicksilver 5/18/06 8:17:35 PM EDT: Oh great...I have to leave
Aznx 5/18/06 8:17:39 PM EDT: We can solve on that topic.
Quicksilver 5/18/06 8:17:42 PM EDT: Sorry guys
bwang8 5/18/06 8:17:45 PM EDT: oh
Aznx 5/18/06 8:17:46 PM EDT: It shouldn't take much time.
bwang8 5/18/06 8:17:47 PM EDT: ok
Aznx 5/18/06 8:17:50 PM EDT: k, bye aditya
Quicksilver 5/18/06 8:17:52 PM EDT: Just tell me the name of the room
bwang8 5/18/06 8:17:52 PM EDT: bye
Gerry 5/18/06 8:18:14 PM EDT: The new room is in the lobby under Open Rooms
Gerry 5/18/06 8:18:44 PM EDT: It is under The Grid World. It has your names on it

Message:
 Gerry is typing

Gerry Stahl -- CSCL 2011

Case study topic



Select a problem

LINE	TIME	AUTHOR	TEXT OF CHAT POSTING
1734	08.17.20	<u>bwang8</u>	i think we are very close to solving the problem here
1735	08.17.35	Quicksilver	Oh great...I have to leave
1736	08.17.39	Aznx	We can solve on that topic.
1737	08.17.42	Quicksilver	Sorry guys
1738	08.17.45	<u>bwang8</u>	<u>oh</u>
1739	08.17.46	Aznx	It shouldn't take much time.
1740	08.17.47	<u>bwang8</u>	<u>ok</u>
1741	08.17.50	Aznx	<u>k</u> , bye Quicksilver
1742	08.17.52	Quicksilver	Just tell me the name of the room
1743	08.17.52	<u>bwang8</u>	<u>bye</u>
1744	08.18.14	Gerry	The new room is in the lobby under Open Rooms
1745	08.18.44	Gerry	It is under The Grid World. It has your names on it
1746	08.18.49	Quicksilver	<u>leaves</u> the room
1747	08.19.00	Aznx	<u>Alright</u> found it.
1748	08.19.04	Aznx	Thanks.

Decide to start

1749	08.19.12	Aznx	I guess we should leave then.
1750	08.19.34	<u>bwang8</u>	<u>well</u> do you want to solve the problem
1751	08.19.36	<u>bwang8</u>	<u>i</u> mean
1752	08.19.39	<u>bwang8</u>	<u>we</u> are close
1753	08.19.48	Aznx	<u>Alright.</u>
1754	08.19.51	<u>bwang8</u>	<u>i</u> don't want to wait til <u>tomorrow</u>
1755	08.19.53	<u>bwang8</u>	<u>ok</u>

Pick an approach

1756	08.19.55	Aznx	How do you want to approach it?
1757	08.20.14	<u>bwang8</u>	1st level have $1*4$
1758	08.20.20	Gerry	You can put something on the wiki to summarize what you found today
1759	08.20.29	<u>bwang8</u>	2st level have $(1+3)*4$
1760	08.20.32	Aznx	<u>bwang</u> you put it.
1761	08.20.35	Aznx	<u>for</u> the wiki
1762	08.20.37	<u>bwang8</u>	<u>ok</u>
1763	08.20.42	Aznx	<u>we</u> actually did quite a lot today
1764	08.20.53	<u>bwang8</u>	3rd level have $(1+3+5)*4$
1765	08.21.05	<u>bwang8</u>	4th level have $(1+3+5+7)*4$
1766	08.21.10	Gerry	This is a nice way to solve it

Identify the pattern

1767	08.21.12	Aznx	So it's a pattern of +2s?
1768	08.21.15	Aznx	Ah ha!
1769	08.21.15	<u>bwang8</u>	<u>yes</u>
1770	08.21.20	Aznx	There's the pattern!

Seek the equation

1771	08.21.39	<u>bwang8</u>	now we have to find a equation that describe that pattern
1772	08.21.49	Aznx	Hold on.
1773	08.21.51	Aznx	I know it.
1774	08.21.57	<u>bwang8</u>	<u>what is it</u>
1775	08.21.58	Aznx	But I'm trying to remember it. =P
1776	08.22.04	Aznx	<u>and explain it as well.</u>
1777	08.22.17	Aznx	<u>try and think of it</u>
1778	08.22.53	Gerry	Maybe Quicksilver can come back here tomorrow or next week to finish it with you
1779	08.23.01	Gerry	I have to go now
1780	08.23.05	Gerry	Bye!
1781	08.23.06	<u>bwang8</u>	<u>ok</u>
1782	08.23.07	<u>bwang8</u>	<u>bye</u>
1783	08.23.23	Gerry	<u>leaves the room</u>
1784	08.23.29	<u>bwang8</u>	<u>ok</u>
1785	08.23.32	<u>bwang8</u>	<u>so</u>
1786	08.23.37	<u>bwang8</u>	<u>i think it is this</u>
1787	08.23.53	Aznx	<u>ok</u>
1788	08.23.55	Aznx	<u>i found it</u>
1789	08.24.00	Aznx	<u>n^2</u>
1790	08.24.01	<u>bwang8</u>	<u>(2*n)*n/2</u>
1791	08.24.09	Aznx	<u>or (n/2)^2</u>

Negotiate the solution

1792	08.24.14	Aznx	I'm simplifying
1793	08.24.30	Aznx	if u simplify <u>urs</u>
1794	08.24.35	Aznx	<u>its</u> n^2
1795	08.24.59	Aznx	<u>bwang</u>
1796	08.25.01	Aznx	<u>you</u> there?
1797	08.25.03	<u>bwang8</u>	<u>so</u> that's wrong
1798	08.25.07	<u>bwang8</u>	<u>yeah</u>
1799	08.25.08	<u>bwang8</u>	<u>i</u> am here

Check cases

1800	08.25.11	Azrx	<u>so</u>
1801	08.25.13	Azrx	<u>the formula</u>
1802	08.25.22	Azrx	<u>would be $4n^2$?</u>
1803	08.25.28	<u>bwang8</u>	<u>let's check</u>
1804	08.25.55	<u>bwang8</u>	Yes
1805	08.26.00	<u>bwang8</u>	<u>it actually is</u>
1806	08.26.02	Azrx	So we got it!

Celebrate the solution: the “Aha” moment in math

1807	08.26.02	<u>bwang8</u>	<u>omg</u>
1808	08.26.04	Aznx	<u>yay!</u>
1809	08.26.08	<u>bwang8</u>	<u>i think we got it!!!!!!!!!!!!!!</u>
1810	08.26.12	Aznx	WE DID IT!!!!!!
1811	08.26.12	<u>bwang8</u>	<u>and it is so simple</u>
1812	08.26.14	Aznx	YAY!!!!
1813	08.26.16	Aznx	<u>i know</u>
1814	08.26.17	<u>bwang8</u>	<u>lol</u>
1815	08.26.18	Aznx	<u>lol</u>

Present a formal solution (proof)

1816	08.26.34	Aznx	So you're putting it in the wiki, right?
1817	08.26.37	<u>bwang8</u>	<u>yes</u>
1818	08.26.41	Aznx	<u>Alright then.</u>
1819	08.26.43	<u>bwang8</u>	<u>ok</u>
1820	08.26.53	Aznx	Give an email to <u>Gery</u> , telling him that we got it. =)
1821	08.26.57	<u>bwang8</u>	<u>ok</u>
1822	08.26.59	Aznx	I meant Gerry
1823	08.27.04	<u>bwang8</u>	<u>are you going to do it</u>
1824	08.27.07	<u>bwang8</u>	<u>or am i</u>
1825	08.27.12	Aznx	You do it.
1826	08.27.14	<u>bwang8</u>	<u>ok</u>
1827	08.27.19	Aznx	Tell him that we both <u>dervied</u> n^2
1828	08.27.29	Aznx	And then we saw that pattern
1829	08.27.37	Aznx	<u>and we got the formula</u>

Close the topic

1830	08.27.44	Aznx	<u>when should we meet again?</u>
1831	08.27.49	Aznx	<u>hat's your email?</u>
1832	08.27.52	Aznx	<u>we should keep in touch</u>
1833	08.27.57	<u>bwang8</u>	<u>yeah</u>

Group cognition in math: The sequential structure

The sequential structure of collaborative math discourse?

Longer sequence is 10 discourse moves, each built on an adjacency pair

Together, they accomplish group cognitive problem solving

Structure of collaborative knowledge building: longer sequence of discourse moves, each at the group (interactional) unit of analysis

Group cognition in math: The longer-sequence structure

- Log 1. Open the topic**
- Log 2. Decide to start**
- Log 3. Pick an approach**
- Log 4. Identify the pattern**
- Log 5. Seek the equation**
- Log 6. Negotiate the solution**
- Log 7. Check cases**
- Log 8. Confirm the solution**
- Log 9. Present a formal solution**
- Log 10. Close the topic**

Group cognition in math: the learning (knowledge building)

The group solved a math problem that had eluded the larger group and that another group had gotten wrong
They did this through a longer sequence of 10 interactional discourse moves
Each move was a mundane (everyday) practice of discourse
The problem solving took place in the discourse, not in private mental space
Knowledge building could be observed and analyzed in detail
Math facts and procedures were not the focus (happened “between the lines”)

Meaning making

Details of how the group co-constructs meaning:

The symbolic expression “ $4n^2$ ” as meaningful to the group

Analyzed from traces of the participants’ perspective (ethnomethodology)

Multi-modal movement: visual reasoning, narrative description, symbolic abstraction

Analysis of group cognition

First detailed analysis of a “longer sequence”

Showed how it is a sequence of discourse moves each built on an adjacency pair

Shows how the group – as a group, not as an expression of individual mental acts – accomplished problem solving in a socio-technical environment

An example of a microanalysis of group cognition in an online team of students discussing math

For Further Information:

- **“*Group Cognition*” (2006, MIT Press)**
- **“*Studying Virtual Math Teams*” (2009, Springer)**

***** now in paperback *****

- **This paper: GerryStahl.net/pub/cscl2011stahl.pdf**
- **These slides: GerryStahl.net/pub/cscl2011stahl.ppt.pdf**

