

Sustaining Online Collaborative Problem Solving with Math Proposals

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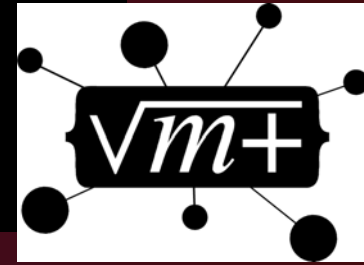
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Promoting Collaborative Learning

- How can we promote collaborative learning?
- For example, math discourse and math problem solving skills & discourse.
- How can we create an online world-wide community of students engaging in chats about math with their peers?

The VMT Project



- Virtual Math Teams (VMT) at the Math Forum @ Drexel University.
- Research project – groups of 3-6 algebra & geometry students in chat rooms with challenging problems of math worlds to explore.
- *“If two equilateral triangles have edge-lengths of 9 cubits and 12 cubits, what is the edge-length of the equilateral triangle whose area is equal to the sum of the areas of the other two?”*

How Do Students Sustain Interaction?

- How do students “do math” together online in small groups?
- How do they get started, decide what to talk about, and keep the interaction going?
- An empirical question!

How Can We Help to Sustain their Knowledge Building?

- Interaction takes place in the moment.
- Learning takes place over time, across interactions.
- How can the software design and the curriculum scaffolding sustain the knowledge that is built in brief moments of interaction? (Goals of VMT project)

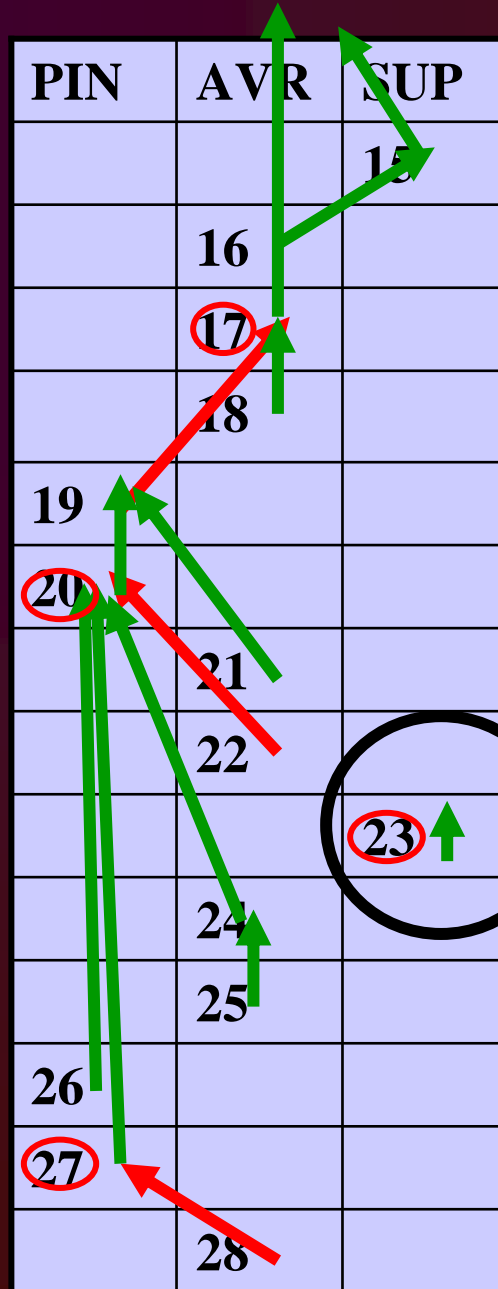
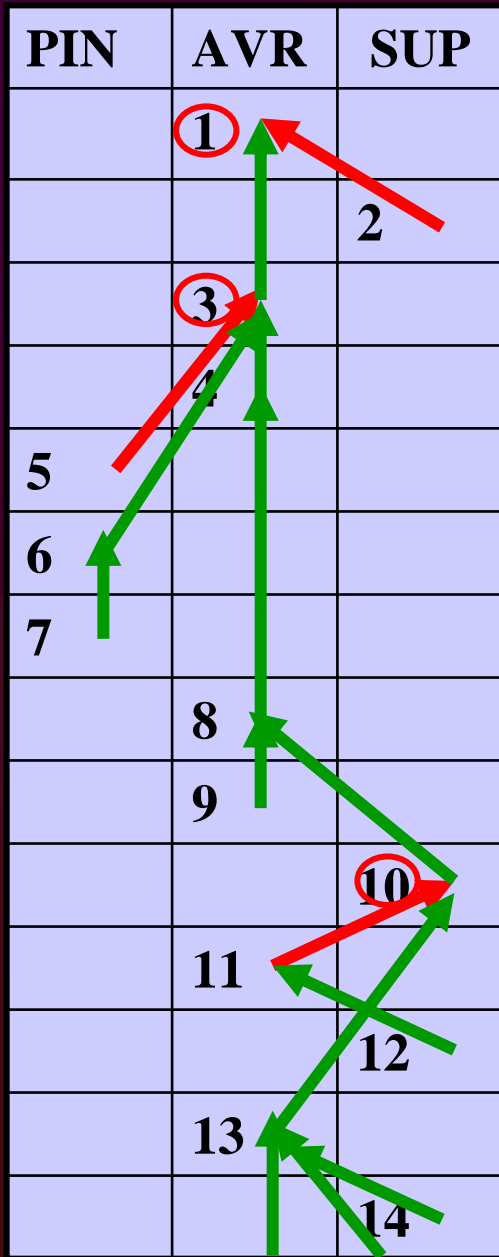
Proposals: A Method for Sustaining

- We will identify a “method of interaction”: making proposals
- We will look at how one small group did “making proposals” in a simple chat environment.
- A “method” is a recurrent pattern of interaction, shared by members of the community.

The Transcript

- A 3 ½ minute excerpt from an hour chat
- Contains several proposals
 - 6 proposal bids that get taken up by others
 - 1 failed proposal that is ignored in the chat

- **1.** Avr (8:21:46 PM): Okay, I think we should start with the formula for the area of a triangle
- 2.** Sup (8:22:17 PM): ok
- 3.** Avr (8:22:28 PM): $A = 1/2bh$
- 4.** Avr (8:22:31 PM): I believe
- 5.** pin (8:22:35 PM): yes
- 6.** pin (8:22:37 PM): i concue
- 7.** pin (8:22:39 PM): concur*
- 8.** Avr (8:22:42 PM): then find the area of each triangle
- 9.** Avr (8:22:54 PM): oh, wait
- 10.** Sup (8:23:03 PM): the base and heigth are 9 and 12 right?
- 11.** Avr (8:23:11 PM): no
- 12.** Sup (8:23:16 PM): o
- 13.** Avr (8:23:16 PM): that's two separate triangles
- 14.** Sup (8:23:19 PM): ooo
- 15.** Sup (8:23:20 PM): ok
- 16.** Avr (8:23:21 PM): right
- 17.** Avr (8:23:27 PM): i think we have to figure out the height by ourselves
- 18.** Avr (8:23:29 PM): if possible
- 19.** pin (8:24:05 PM): i know how
- 20.** pin (8:24:09 PM): draw the altitude'
- 21.** Avr (8:24:09 PM): how?
- 22.** Avr (8:24:15 PM): right
- 23.** Sup (8:24:19 PM): proportions?
- 24.** Avr (8:24:19 PM): this is frustrating
- 25.** Avr (8:24:22 PM): I don't have enough paper
- 26.** pin (8:24:43 PM): i think i got it



adjacency pair



other uptake



intersubjective
small-group
meaning
making

co-construction
of sequentiality
in doing math

“Math Proposal Adjacency Pairs”

- We define the method of group interaction in terms of a recurrent pattern of proposal bid/uptake
- Proposals are only effective as interactional phenomena, not as “expressions of internal mental representations” of individuals

Structure of a Proposal

- 1. A bid for a proposal is made by an individual for the group to work on: “**I think we should**”
- 2. An acceptance, confirmation or up-take is made on behalf of the group by a second person: “**Ok,**” “**right**”
- 3. There is an elaboration of the proposal by members of the group. The proposed work is begun, often with a secondary proposal for the first sub-step.

A “Failed Proposal”

- A failed attempt to initiate a proposal interaction
- A “breakdown” case
- Highlights conditions for success
- A promising place to look closely

Comparing Proposals

- 17, 18. Avr (8:23: 29 PM): **i think we have to figure out the height by ourselves ... if possible**
- 19. pin (8:24:05 PM): i know how
- 21. Avr (8:24:09 PM): how?
- 20. pin (8:24:09 PM): **draw the altitude'**
- 22. Avr (8:24:15 PM): right
- 24. Avr (8:24:19 PM): this is frustrating [...]
- 23. Sup (8:24:19 PM): **proportions?**
- 25. Avr (8:24:22 PM): [...] I don't have enough paper

Problems with the Failed Proposal Bid

- A. No clear semantic, syntactic structure
- B. Timing within the flow of discussion
- C. No interruption of on-going work
- D. Doesn't elicit some kind of response
- E. Doesn't specify work to be done
- F. Not based on a history of helpful work

What Methods Do Students Use?

- To form themselves into groups
- Define a problem to work on
- Start work
- Agree on how to proceed
- Bring in math resources
- Agree on solutions
- Close the problem solving
- Get to know each other
- Socialize, have fun, flirt
- Adapt to institutional setting

Conclusions: Practical & Theoretical

- A group can advance through *math proposal adjacency pairs*
- It would help to have support to keep going without getting
 - (a) stuck or
 - (b) sidetracked

Potential Helpful Computer Supports

- 1. A persistent and visible list of proposals
- 2. A persistent and visible summary of work
- 3. Perhaps a proof template that gets filled in
- 4. Representations of the developing problem, such as a shared drawing whiteboard for geometry problems


VMT-Chat Prototype

WhiteboardChat: pin (EARLI)


Whiteboard:

Reference


PROBLEM STATEMENT:
If two equilateral triangles have edge-lengths of 9 cubits and 12 cubits, what is the edge-length of the equilateral triangle whose area is equal to the sum of the areas of the other two?



9



12



?

PROPOSALS:

1. formula: $A = 1/2 b h$
2. area $A_1 = ?$
3. $b, h = 9, 12$
4. draw altitude
5. use proportions

PROOF OUTLINE:
Given: $s_1=9, s_2=12$
Given: $A_1 + A_2 = A_3$
 $A_1 = 1/2 s_1 h_1$
 $h_1 = ?$
PROVE: $s_3 = ?$

Current users:
Avr
Sup
pin

Chat: (0)

pin (4:01 PM):
draw the altitude'

↑ Avr (4:01 PM):
how?

↑ Avr (4:01 PM):
right

pin (4:01 PM):
proportions?

Avr (4:02 PM):
this is frustrating

Avr (4:02 PM):
I don't have enough paper

pin (4:02 PM):
i think i got it

pin (4:02 PM):
its a 30/60/90 triangle

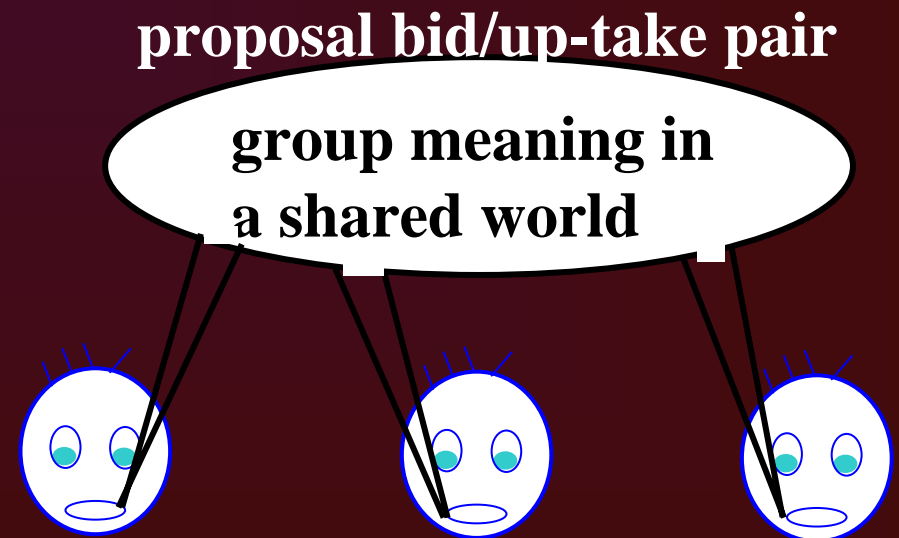
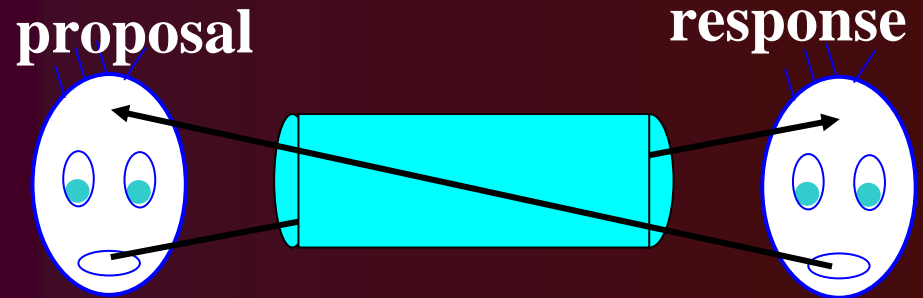
Avr (4:03 PM):
I see

pin (4:03 PM):
so whats the formula

Message:

Paradigms of CSCL research

- Sending messages thru a medium. How does knowledge in heads change?
- Constructing a shared world. How is group knowledge co-constructed?



Group Cognition

- The problem gets formed, developed, explored, incrementally solved through interactions (e.g., adjacency pairs)
- Progress involves group interaction (on behalf of the group – “we”)

Group Cognition, continued

- Group learning and individual learning are not two different things here.
- They are different aspects of one process: e.g., “*I* think that *we* should” “Ok”
- Individual cognitive resources are brought into group interactions; meaning is constructed inter-subjectively; group experiences, meanings and methods can be internalized.

“Group Cognition”

(the book)

**MIT Press in the Spring
prepublication version
available now:**

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