# Groups, Group Cognition & Groupware

**Gerry Stahl**

**Drexel University, Philadelphia, USA**

**Gerry.Stahl@drexel.edu**

**www.cis.drexel.edu/faculty/gerry**

Software used to be designed to support computers :-(

Today, most good end-user software is designed to support individual cognition

Groupware should be designed to support "group cognition": the intertwining of group & individual efforts

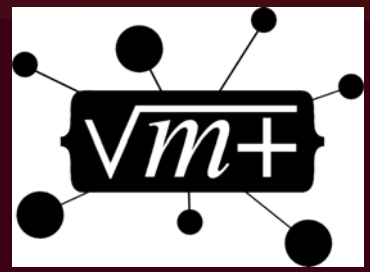
# Overview

1. Intro to Group Cognition
2. Experiment Design
3. Audience Individual Problem Solving
4. Audience Small-group Problem Solving
5. Analysis of Cooperation among Individuals
6. Analysis of Collaboration in Group
7. Implications for Groupware Design
8. Audience Discussion

# 1. Intro to Group Cognition

# My group research context

- Virtual Math Teams (VMT) at the Math Forum @ Drexel U.



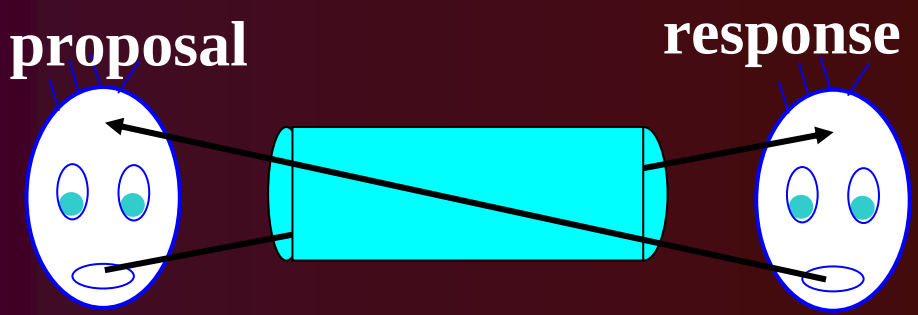

- Developing a math ed service– groups of 3-6 algebra & geometry students in chat rooms with challenging problems of math worlds to explore
- Design-based research project through iteration:
- Analyzing the chat medium; evolving software; letting service emerge
- Vision: a worldwide community of students discussing math online

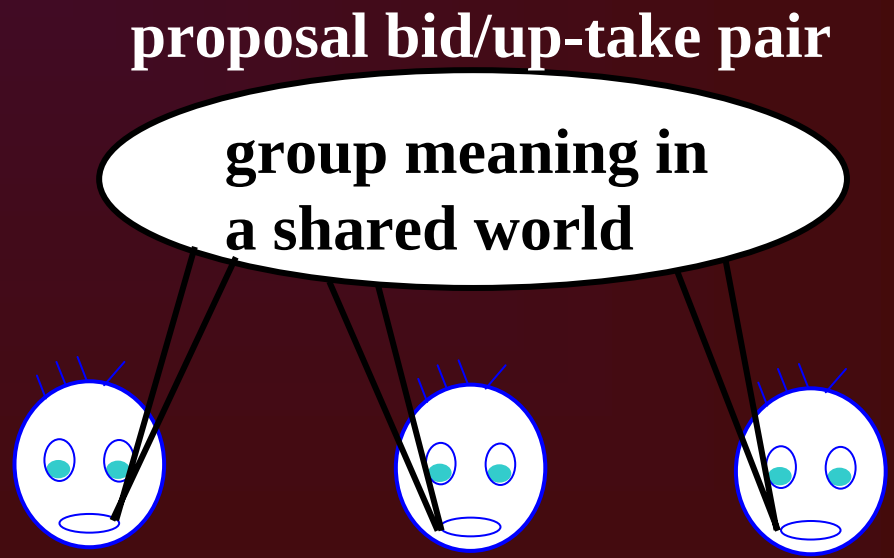
# Theoretical framework for groupware

- Groupware traditionally based on model of individuals cooperating, rather than groups collaborating (Shannon; Dillenbourg)
- In chat analysis, we distinguish
  "expository narrative" (indiv coop) from
  "exploratory inquiry" (group collab)
- Our chat data can be analyzed both ways
- Or as a combination of both processes

# Paradigms of CSCL research

- Sending messages across a chasm thru a channel. How does knowledge in heads change?
- Co-constructing a shared world. How is group knowledge constructed?



- Adapt Conversation Analysis (CA) to chat
- speech → text
- face-to-face → distant (computer-mediated)
- turn-taking → simultaneous responses
- visible production → finished postings
- detailed transcript → chat log
- social conversation → math discourse
- informal → institutional
- socialized methods → new methods
- facial expression → emoticons, etc.

- No longer really Conversation Analysis (CA)
- But ethnomethodological Chat Analysis
- How do participants in math chats “do math”, maintain chat, construct “social order”, define “member methods”?
- How are shared meanings and math objects co-constructed by the group as inter-subjectively shared? (e.g., symbolic artifacts that are meaningful for the group, e.g., words, themes, symbols, procedures)

- “Group Cognition”
- Problem solving, math arguments, other cognitive products emerge from discourse
- Individual contributions & interpretations
- Group meaning emerges from interactions, is visible in discourse, is socially shared
- Constructed thru adjacencies, references, indexing, context, flow of threads
- Groups have “methods” of doing things different from methods individuals have
- Part of multiple analytic approaches

# 2. Experiment Design

- Class of undergraduates formed into online groups of 2-5.
- Given 11 problems from SAT (national high school math & verbal test in US)
- 15 minutes to work individually on paper
- 45 minutes to work in group in chat room

# 3. Audience Individual Problem Solving

- Work on problem 10 in the space on your paper for 2 minutes
- Three years ago, men made up two out of every three internet users in America. Today the ratio of male to female users is about 1 to 1. In that time the number of American females using the internet has grown by 30,000,000, while the number of males who use the internet has grown by 100%. By how much has the total internet-user population increased in America in the past three years? (A) 50,000,000 (B) 60,000,000 (C) 80,000,000 (D) 100,000,000 (E) 200,000,000

# 4. Audience Small-group Problem Solving

- Form a group of 3-4 with your neighbors in the audience and collaborate on problem 10 for 6 minutes
- Three years ago, men made up two out of every three internet users in America. Today the ratio of male to female users is about 1 to 1. In that time the number of American females using the internet has grown by 30,000,000, while the number of males who use the internet has grown by 100%. By how much has the total internet-user population increased in America in the past three years? (A) 50,000,000 (B) 60,000,000 (C) 80,000,000 (D) 100,000,000 (E) 200,000,000

# 5. Analysis of Cooperation among Individuals

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | *Score* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hal** | | X | X | | | | | X | | | | 27% |
| **Dan** | | | X | X | | | | | | | | 18% |
| **Cosi** | | | X | | | | X | | X | | | 27% |
| **Mic** | | | | | X | | X | | | | | 18% |
| **Ben** | | | X | | | | | X | | | | 18% |
| ***Group*** | | X | X | X | X | | X | X | X | X | X | 82% |

- The results can be explained by:
- (a) Sharing of the best individual results
- (b) Motivation of extra time-on-task

- Cosi solves problem 10 in her head
- She explains her solution
- She provides an expository narrative to justify her solution

| Line | Time | Name | Message | Interval |
|---|---|---|---|---|
| 350 | 4:31:55 | Mic | how do we do this.. | |
| 351 | 4:31:59 | Mic | without knowing the total number | 0:00:04 |
| 352 | 4:32:01 | Mic | of internet users? | 0:00:02 |
| | | | …. | |
| 357 | 4:32:23 | Dan | it all comes from the 30000000 | |
| 358 | 4:32:23 | Mic | did u get something for 10? | 0:00:00 |
| 359 | 4:32:26 | Dan | we already know | 0:00:03 |
| 360 | 4:32:44 | Mic | 30000000 is the number of increase in american females | 0:00:18 |
| 361 | 4:33:00 | Mic | and since the ratio of male to female | 0:00:16 |
| 362 | 4:33:02 | Mic | is 1 to 1 | 0:00:02 |
| 363 | 4:33:09 | Mic | thats all i got to give. someone finish it | 0:00:07 |
| 364 | 4:33:10 | Mic | haha | 0:00:01 |
| 365 | 4:33:18 | Cosi | haha you jackass | 0:00:08 |

| | | | | |
|---|---|---|---|---|
| 366 | 4:33:20 | Mic | haha | 0:00:02 |
| 367 | 4:33:21 | Dan | hahaha | 0:00:01 |
| 368 | 4:33:26 | Mic | u all thought i was gonna figure it out didnt | 0:00:05 |
| 369 | 4:33:27 | Mic | u | 0:00:01 |
| 370 | 4:33:28 | Mic | huh? | 0:00:01 |
| 371 | 4:33:28 | Hal | it would be 60,000,000 | 0:00:00 |
| 372 | 4:33:30 | Mic | hal | 0:00:02 |
| 373 | 4:33:31 | Mic | its all u | 0:00:01 |
| 374 | 4:33:33 | Mic | see | 0:00:02 |
| 375 | 4:33:34 | Mic | i helped | 0:00:01 |
| 376 | 4:33:54 | Cosi | ok, so what’s 11 – just guess on 10 | 0:00:20 |
| | | | …. | |
| 386 | 4:34:45 | Mic | lets get back to 5 | |
| 387 | 4:34:47 | Cosi | i think it's more than 60,00000 | 0:00:02 |
| 388 | 4:34:57 | Mic | way to complicate things | 0:00:10 |
| 389 | 4:35:03 | Cosi | haha sorry | 0:00:06 |

| | | | | |
|---|---|---|---|---|
| 390 | 4:35:05 | Mic | life was good until you said that | 0:00:02 |
| 391 | 4:35:07 | Mic | :( | 0:00:02 |
| 392 | 4:35:18 | Cosi | they cant get higher equally and even out to a 1 to 1 ratio | 0:00:11 |
| 393 | 4:35:27 | Cosi | oh, no wait, less than that | 0:00:09 |
| 394 | 4:35:32 | Cosi | 50000000 | 0:00:05 |
| 395 | 4:35:34 | Cosi | yeah, it's that | 0:00:02 |
| 396 | 4:35:36 | Cosi | im pretty sure | 0:00:02 |
| 397 | 4:35:37 | Mic | haha | 0:00:01 |
| 398 | 4:35:38 | Mic | how? | 0:00:01 |
| 399 | 4:35:57 | Cosi | because the women pop had to grow more than the men in order to even out | 0:00:19 |
| 400 | 4:36:07 | Cosi | so the men cant be equal (30) | 0:00:10 |
| 401 | 4:36:11 | Mic | oh wow... | 0:00:04 |
| 402 | 4:36:16 | Mic | i totally skipped the first sentencwe | 0:00:05 |
| 403 | 4:36:16 | Cosi | therefore, the 50,000,000 is the only workable answer | 0:00:00 |
| 404 | 4:36:19 | Dan | very smart | 0:00:03 |
| 405 | 4:36:21 | Cosi | Damn im good | 0:00:02 |

- Mic facilitates the group choosing the best solutions and coming up with missing solutions
- He prompts for ideas
- He uses laughter to relieve competition, hesitation, embarrassment
- Uses wait-time to encourage contributions
- Solicits explanations to help decision making

- Cosi solves
- Responds to other attempts
- Computes
- Checks
- Revises
- Provides justification

- “I think it’s more than 60,000,000. It can’t be exactly 60,000,000 because the men and women cannot increase equally and even out from an unequal starting point to a 1-to-1 ratio. . . . Oh, no wait, I mean it’s less than 60,000,000. It must be 50,000,000. Yeah, I’m pretty sure that is what it is, because the women population had to grow more than the men in order to equal out – so the men must have grown less than 30,000,000. So the total must be less than 60,000,000 and the only answer like that is 50,000,000.”
- -- Cosi

- Cosi is “smart”
- Members attribute solution to her
- She accepts it as her individual solution

# 6. Analysis of Collaboration in Group

- The individuals scored 18%-27% on the test
- The group scored 82% on the test

- The group got every problem right that any member of the group got right
- The group also got problems 10 & 11 right
- This could be due to increased peer pressure and more time-on-task

- Skillful negotiation of group answers based on individual contributions and joint exploration

- The group solved the set of problems by effectively synthesizing their problem solving efforts
- The group solved problem 10 collectively

- Step 1 of the group solution:
- 350-352 Mic: How do we do this (problem) without knowing the total number of internet users?

- Don’t know past or present total – how can increase be computed?

- Step 2 of the group solution:
- 357-359 Dan: It all comes from the 30,000,000 – which we already know

- The only population number is 30,000,000; the population figures must be derived from this number

- Step 3 of the group solution:
- 360-364 Mic: 30,000,000 is the increase in female users and since the ratio of male to female users today is 1-to-1 …. That's my start – now someone else continue

- Let's build on the 30,000,000 number that Dan gave us. This is what we know about it.

- Step 4 of the group solution:
- 371 Hal: The increase would be 60,000,000
- 372-375 Mic: You did it Hal. See, I helped

- If the female increase is 30,000,000 and the male/female ratio is 1-to-1, then the total increase is 60,000,000
- The students combine available facts as resources for computation, without considering their full significance

- Step 5 of the group solution:
- 387-396 Cosi: No, I think it must be more than 60,000,000. The male and female numbers can not increase equally if they have to even out to a 1-to-1 ratio from starting out unequal. Oh, no wait, it must be less then 60,000,000. It must be 50,000,000 (the only choice less). Yeah, I am pretty sure its that.
- Considers how total must change to meet constraints, checks, repairs, confirms
- Males must increase less than 30,000,000 females, so total must be < 60,000,000

- Step 6 of the group solution:
- 397-398 Mic: Haha. How do you know that?

- Mic continues to tease Cosi, emphasizing that she is not sure of the answer. Jokingly requests an accounting

- Step 7 of the group solution:
- 399-403 Cosi: The women population was smaller 3 years ago so it had to grow more than the men to reach a 1-to-1 ratio. Therefore, the men cannot have also grown by 30,000,000. The only listed answer less than 60,000,000 is 50,000,000

- Cosi avoids putting the problem in algebra equations by reasoning about changes in growth of the two populations relative to each other

- Group meanings of words and math objects like “30,000,000” and “uneven”
- come from the group discourse context:
  - The problem statement
  - The temporal order of postings
  - The adjacencies of postings
  - The references among terms in postings
- The problem is collaboratively solved by Hal, Mic, Cosi & Dan

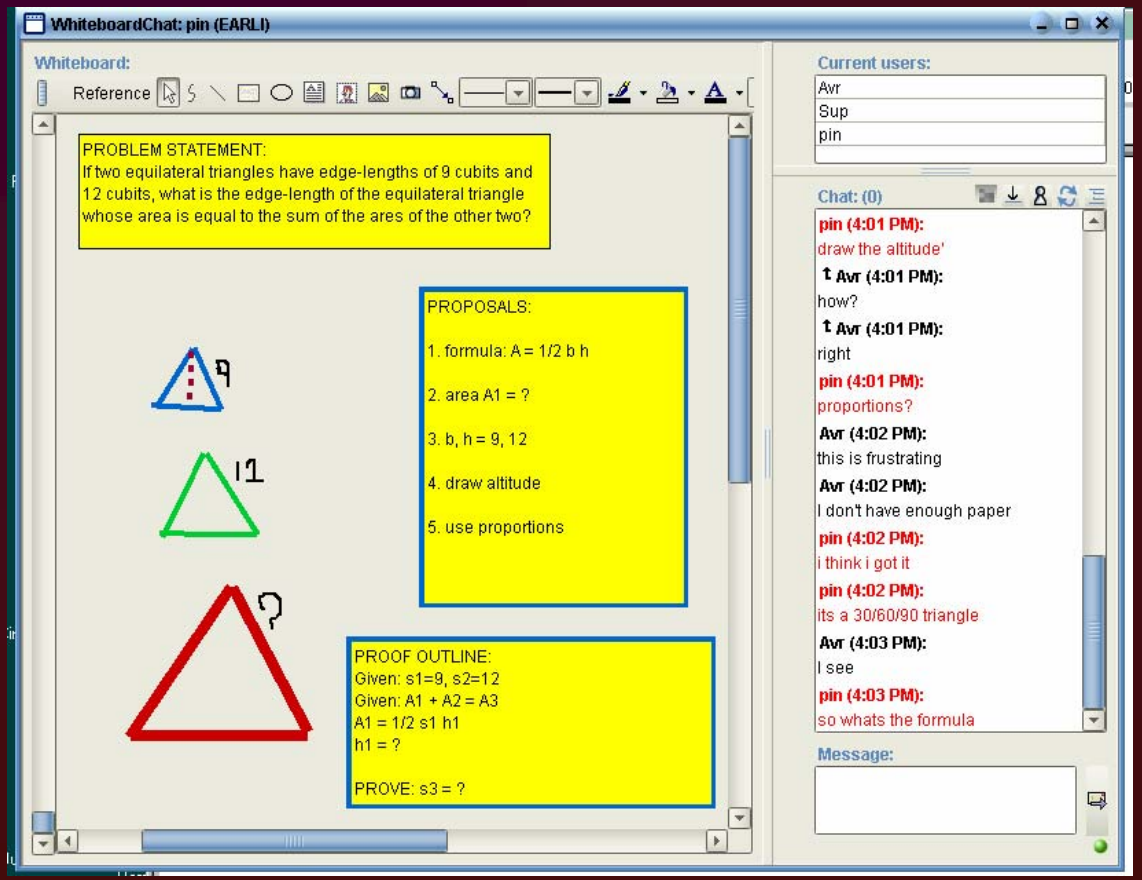
- How can I figure out the increase in users without knowing the total number of internet users? It seems to all come from the 30,000,000 figure. 30,000,000 is the number of increase in American females. Since the ratio of male to female is 1 to 1, the total of male and female combined would be 60,000,000. No, I think it must be more than 60,000,000 because the male and female user populations can't get higher at equal rates and still even out to a 1 to 1 ratio after starting uneven. No, I made a mistake, the total must be less than 60,000,000. It could be 50,000,000, which is the only multiple choice option less than 60,000,000. Very smart.

- The group solution reads like the cognitive result of one mind
- Cosi's solution was not from an isolated individual thinking in her head
- It emerged from the flow of interaction in the chat discourse
- It was mediated by the methods the group used to interact in the chat room
- Formed thru the intertwining of contributions & responses by individuals
- It is a product of group cognition

- To support group knowledge work, we must study what groups actually do in groupware environments, how they make meaning and solve problems

- To study what groups do, we must understand what the individuals are doing
- To study what groups do, we must understand what is happening at the group unit of analysis: “group cognition”

# 7. Implications for Groupware Design



- Support group processes
- Support group chat room methods
- Make individual contributions visible
- Support links, references among postings
- Support group negotiation
- Bring in resources
- Facilitate analysis & structuring
- Allow flexible language, lol, socializing

# Visible & Persistent

- People build on each other's work – let them see it
- Prevent good contributions from being lost in the confusion of chat

# Deictic Referencing

- Chat takes advantage of implicit referencing to save typing
- The referencing should be made clear to everyone, or the postings will not be understood

# Virtual Workspaces

- Provide spaces for different functions – where important conclusions can be kept visible when the chat scrolls on
- Allow annotations from the chat

# Shared & Personal Places

- Individuals, sub-groups and the group need different places to work out, store & organize ideas
- These should be optionally visible to others

# Computational Support

- Use the computer power to organize, tailor, sort, browse, filter, highlight

# Access to Tools & Resources

- Use the power of the Internet to provide structured access to resources, tools, information

# Opening Worlds & Communities

- Use connectivity to form new communities, work groups, networks, communication channels

# Allowing Subtle Language

- Avoid the (AI motivated) temptation to limit language & behavior to preconceived categories
- Encourage fun & socializing

- Encourage interaction
- Encourage dialog

- Understand how groups actually use the groupware & its features; what methods they define to take advantage of the new interaction medium

- Analyze both individual contributions and group cognition that takes place in the groupware

# 8. Audience Discussion

- Including the audience experiment

**Full paper:**

***www.cis.drexel.edu/faculty/gerry/publications/conferences/2005/criwg***

**"*Group Cognition*" (the book) from MIT Press in the Spring – prepublication version available now:**

***www.cis.drexel.edu/faculty/gerry/mit***

**Journal of CSCL:**

***ijCSCL.org***