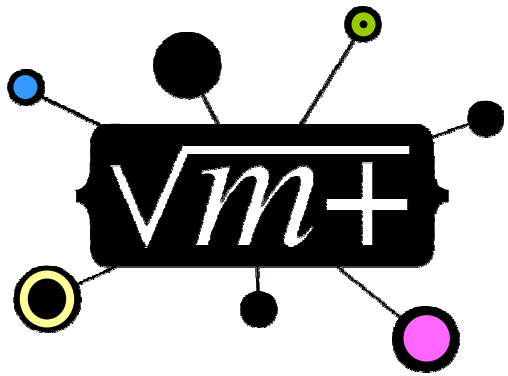
Virtual Math Teams:

Studying and Supporting Online Collaborative Problem-solving



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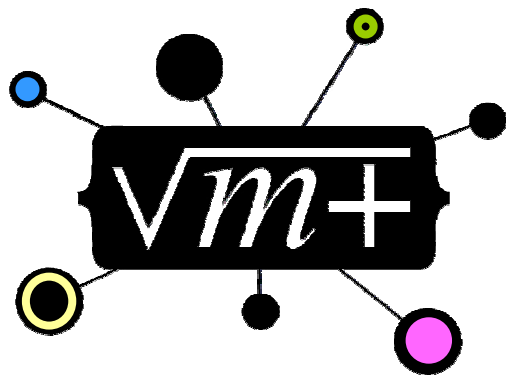
Drexel University
College of Information Science & Technology

National Science Foundation

The Math Forum
@ DREXEL UNIVERSITY

Overview

- Intro: The Math Forum Services and the VMT
- VMT Goals, Questions and Activities up to date.
- Let's try it together!
- Analyzing Student's Online Collaboration
- Research on Cooperative/Collaborative Learning
- Computer-support for Online Collaborative Problem-Solving
- Your students can participate in the VMT project!



The Math Forum's Services

- Ask Dr. Math
- Math Tools digital library and community
- Teacher2Teacher
- Problems of the Week (PoWs)
- And many more!

The Math Forum's Problems of the Week (Pow)

www.mathforum.org/pow/

- Designed to provide creative, non-routine challenges for students in grades three through twelve.
- Problem-solving and mathematical communication are key elements of every problem
- 4 areas: Math Fundamentals, Pre-Algebra Algebra, and Geometry

Virtual Math Teams: Overview

- Promote collaborative problem-solving
- Enable kids to help each other at The Math Forum and make better use of the limited expert mentoring
- Provide an important kind of engaged learning experience for students
- Investigate the nature of online collaboration for math problem-solving
- 5-year NSF-funded project

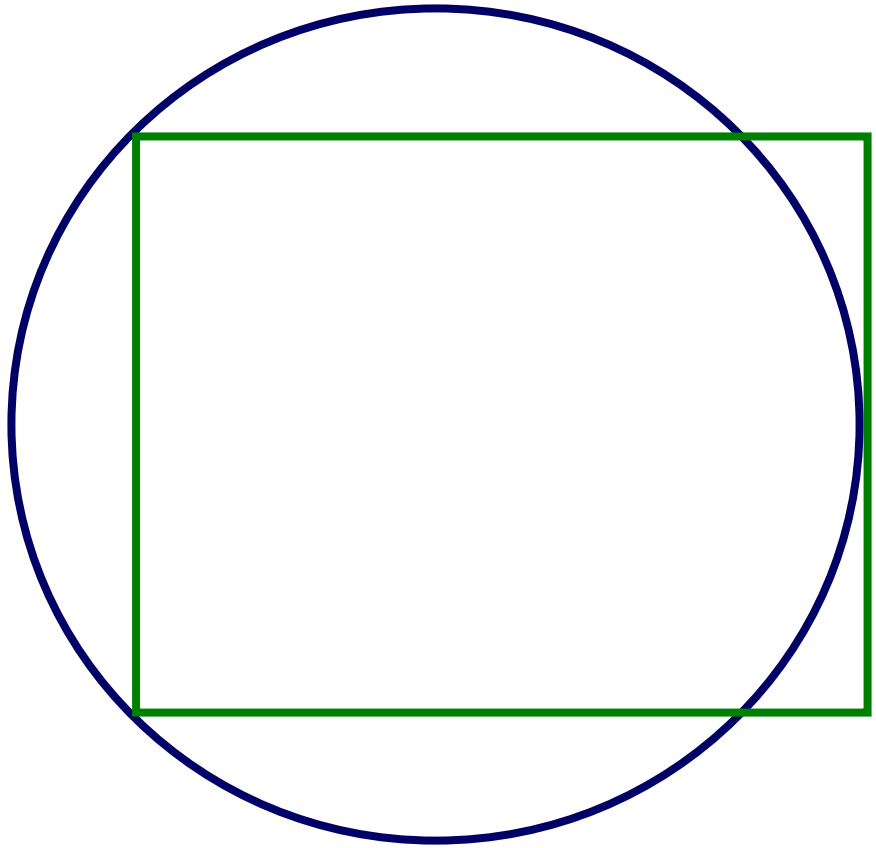
Driving Questions

- What **forms of collaboration** are more effective for math learning?
- What **types of problems** work best for collaborative problem-solving?
- What kind of human and software **support** are necessary?
- What **research methods** help us understand online collaboration better?

Some VTM Activities to date

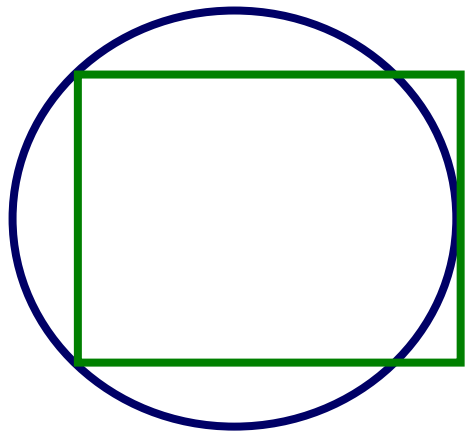
- Invited small groups of students to collaborate online to solve the Math Forum's Problem of the Week
- Investigated 5 different software platforms: AOLIM, Blackboard, WebCT, Open-Source Chat + Shared Whiteboard, ConcertChat
- Offered series of weekly, one-hour "Pow-wow" sessions with Algebra and Geometry PoWs.
- Conducted initial analysis of chat transcripts
- Explored software-support prototypes

Let's try a collaborative PoW: "*A Tangent Square and Circle*"



Let's Reflect on our Collaborative Problem-solving

- What are possible solution paths?
- How does **one** come upon those?
- What did you notice in terms of doing it alone or with others?
- How was this experience different than collaborative problem-solving in your classroom?



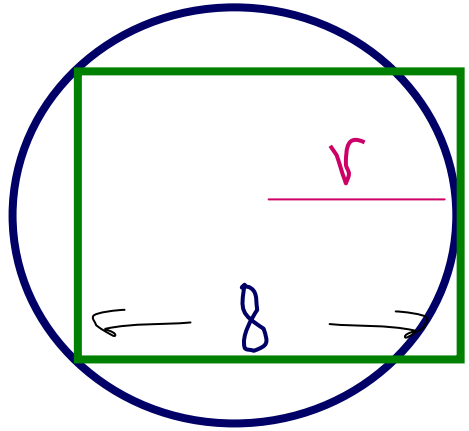
1. AME how close are you
2. KIL i know that its less than four
3. AME No its more
4. KIL ya thats wut i meant
5. KOH hahaha... typo...
6. KIL anyone else get any closer?
7. AME I solved it
8. KOH I solved it, too!
9. KIL i c
10. KOH hey, AME, tell me about your way first...
11. AME I need my pic

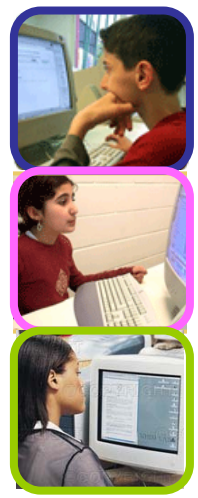
...

15. KOH I know you got the right answer, but your way is kinda wrong...

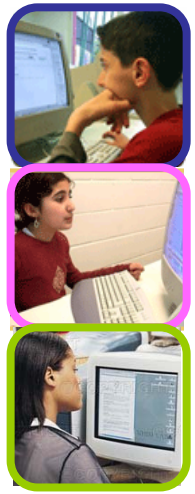
...

21. AME My way is fine
22. AME Its works
23. AME If the answer is right than what gives?
24. KOH well... ok...
25. KOH all goes well that ends well
26. KOH but I need explaination...
27. AME ok ...



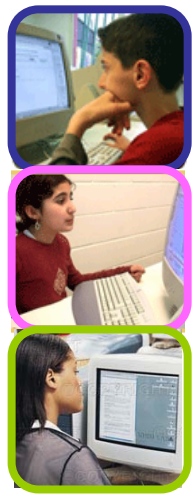


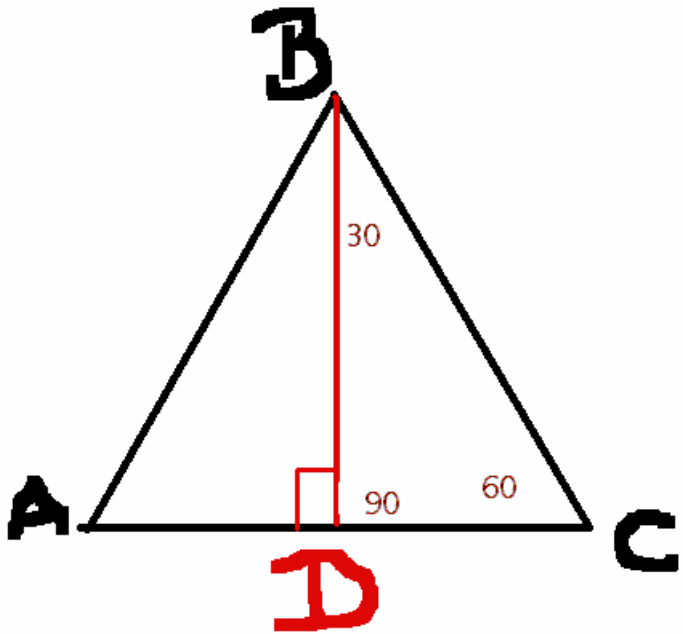
KOH so AME, please explain your way...
KIL yea please?
AME well I just used some equations
AME equation 1- x + r = 8
KOH ok... simple equations or complicated ones?
KIL yes
AME Simple
KOH ok...
AME As I was Saying
KOH where did that 1 came from?
AME The first equation is x + r = 8
KOH yes!
KIL i get it...
AME The second is 16 + x^2 = r^2
AME Now we substitute
KIL i c
AME And we are DONE!!!
KOH thats my way!!!
KIL i c now!
AME My way just makes more sense
KIL i c so 1) x + r = 8
KOH hey, so where do that x come from and how does it help ya?
KIL 2) x^2 + r^2 = 16
AME r + x = 8



1. ALR : Okay, I think we should start with the formula for the area of a triangle
2. SUP : ok
3. ALR : A = 1/2bh I believe
4. PIN: yes
5. PIN: i concue (*concur*)
6. ALR : then find the area of each triangle
7. ALR: oh, wait
8. SUP : the base and heigth are 9 and 12 right?
9. ALR : no
10. SUP : o
11. ALR : that's two separate triangles
12. SUP : ooo ok
13. ALR : right
14. ALR: i think we have to figure out the height by ou
15. ALR: if possible
16. PIN: : i know how
17. ALR how?
18. ALR right
19. SUP proportions?
20. ALR this is frustrating
21. ALR I don't have enough paper
22. PIN i think i got it
23. PIN its a 30/60/90 triangle
24. ALR I see
25. PIN so whats the formula

...

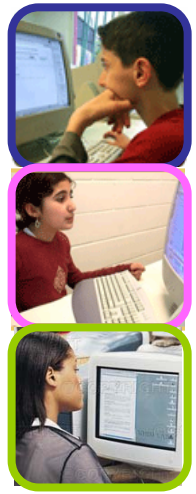




28. PIN so whats the formula
29. PIN to find it
30. PIN i think i remember
31. AVR to find what
32. AVR the height?
33. PIN ya
34. SUP if its equilateral its it a 45/45/90 triangle?
35. SUP o wait
36. SUP thats isosceles
37. AVR yeah
38. AVR ...
39. AVR equilateral is 60/60/60 triangle
40. PIN ya
41. AVR not 30/60/90
42. PIN anyone remember formula for 30/60/90 triangle?
43. PIN nooooo
44. PIN but look
45. PIN you drew the triangle
46. PIN here wait
47. AVR no I didn't
48. PIN let me make a pic
49. AVR okay
50. PIN wait a couple min
51. AVR okay
52. SUP so holws it goin
53. AVR I'll try to draw one in the meantime
54. PIN super!
55. AVR equilateral means all sides are equal
56. AVR therefore all angles are equal too
57. SUP yes
58. SUP 60
59. AVR so it can't be 30/60/90
60. AVR it's not a 30/60/90 triangle
61. SUP thats what i was thinking
62. SUP is there a formula for a 60/60/60?
63. AVR I have no idea
64. AVR I think once we find the formula it should be pretty easy
65. AVR I don't think there's a formula, though
66. PIN search google
67. AVR I think we find it some other way
68. AVR that's what I'm doing
69. SUP what does itmeans by edglengths?
70. SUP jone of the 3 sides?
71. AVR edgelength means length of a side
72. SUP ok ...



1. AVL: okay, Mod, just a question
2. AVL: basically, he's solving it by trial and error
3. AVL: by like putting random numbers in as sides and seeing if they work out
4. PIN: ya, and im pretty darn close
5. AVL: yeah
6. AVL: but is there any way else to do it
7. AVL: like, using a formula
8. PIN: hey Mod answer me this
9. OFS: thats what i was thinkin ov
10. PIN: is it 21.213X
11. AVL: because if you submit the solution you're not gonna say "do trial and error"
12. OFS: using a formula
13. PIN: where X is another number
14. PIN: is it or no
15. OFS: howd u get 21.213
16. PIN: trial and error



Research on Cooperative/Collaborative Learning and Achievement (Slavin, R.E.)

- “Research on cooperative learning is one of the greatest success stories in the history of educational research.”
- However, There is still a some confusion and disagreement about why cooperative learning methods affect achievement and, even more importantly, under what conditions cooperative learning has these effects.
- A great deal of knowledge about the effects of many types of cooperative interventions and about **the mechanisms** responsible for these effects.
- Cooperative learning is not only a subject of research and theory; it is used at some level by millions of teachers.

Slavin, R.E. Research on Cooperative Learning and Achievement: What We Know, What We Need to Know http://www.successforall.com/Resource/research/cooplearn.htm

Cooperative/Collaborative Learning

Students who work together to **clarify** questions, **discuss** and **select** problem-solving strategies, **co-construct** solutions, and **resolve** controversies usually demonstrate greater gains in **concept development** and **problem-solving abilities** than similar students who work alone.

Davidson, N. (1985). Small group cooperative learning in mathematics: A selective view of the research. In R. Slavin (Ed.), "Learning to cooperate: Cooperating to learn." (pp.211-30) NY: Plenum.

Also: Elizabeth Cohen, Paul Cobb, Mercer & Wegeriff

Bridging Research and Practice

- How to achieve effective grouping
- How to motivate participation and use appropriate rewards
- How to provide feedback and teach students to collaborate
- What authentic tasks work best for collaborative activities?
- How to align collaobrative activity with curricular goals

Share your experiences…

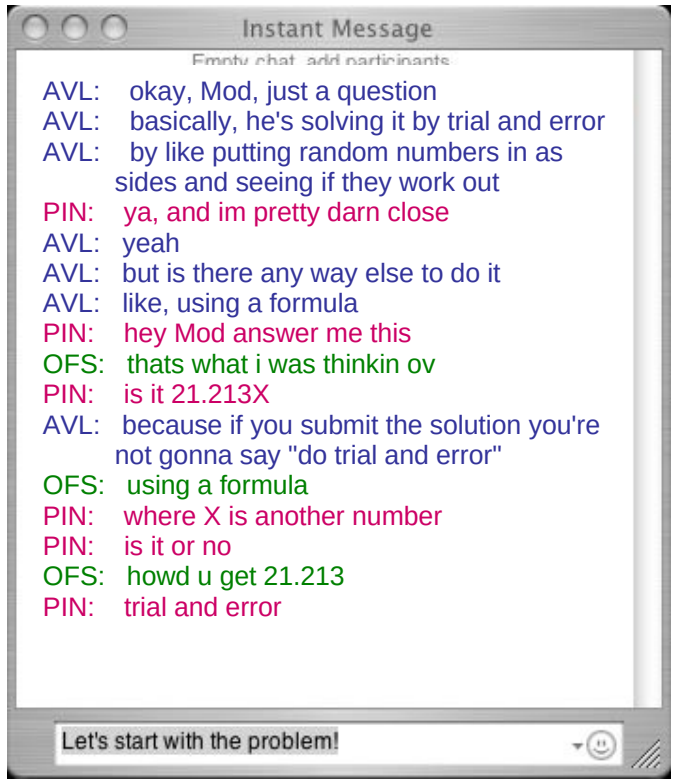
- Jigsaw?
- Complex instruction / Project-based Learning?
- Student teams-achievement divisions?
- Survivor Algebra anyone?

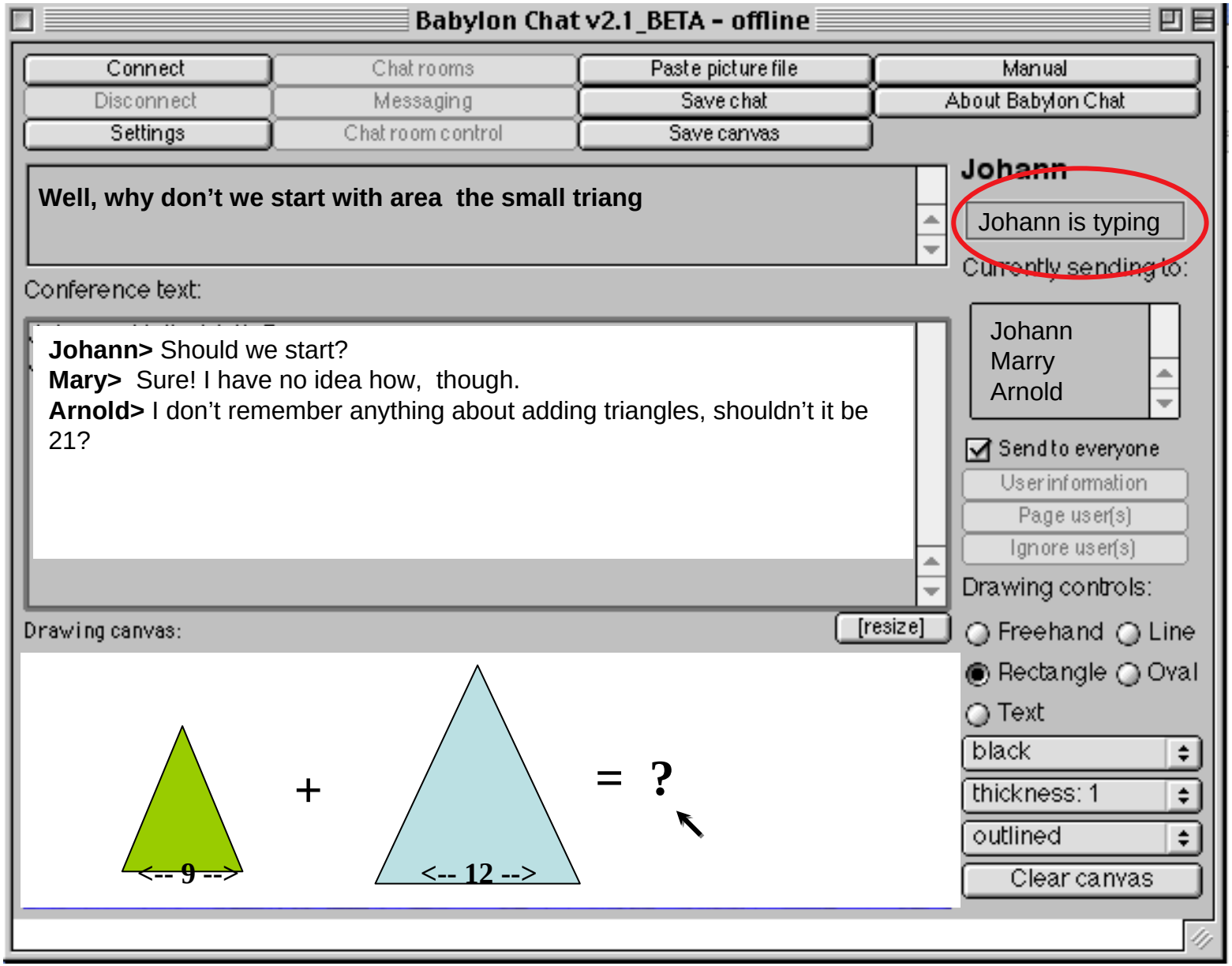
Some Sources:

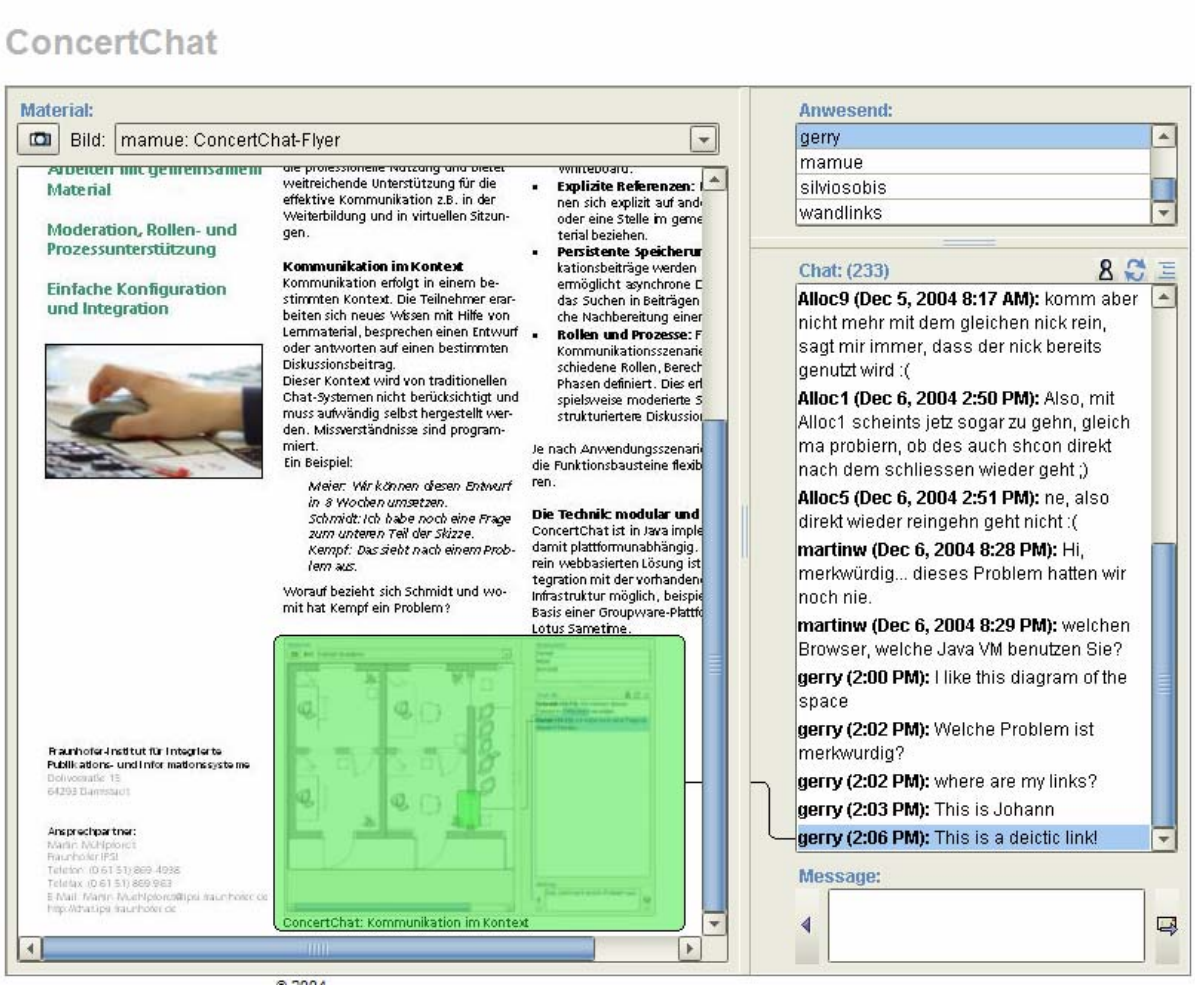
- Handbook of cooperative learning methods. Shlomo Sharan, (Ed.). Praeger, 1999.
- Cooperative Learning in Mathematics: A Handbook for Teachers. Davidson, Neil. (Ed.). : Addison-Wesley, 1990
- Artzt, Alice F. & Claire M. Newman. How to Use Cooperative Learning in the Mathematics Classroom. National Council of Teachers of Mathematics, 1990

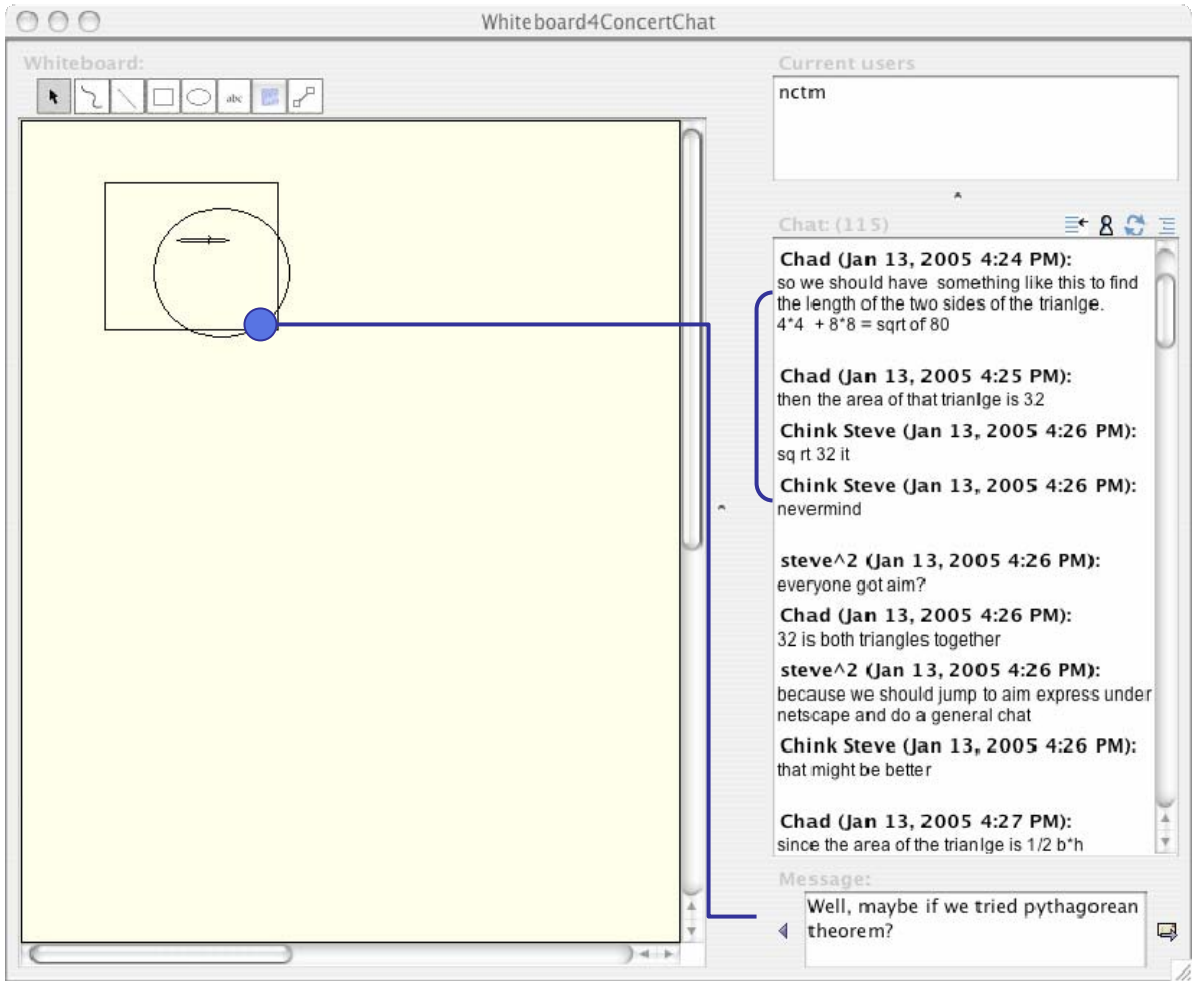
Software Supports

- Supporting activity awareness and coordination
- Threading
- Opportunistic Group formation
- Full-featured whiteboard
- Math support
- Online Community for sustained participation




Babylon Chat v2.1_BETA - offline
Connect
Disconnect
Settings
Chat rooms
Messaging
Chat room control
Paste picture file
Save chat
Save canvas
Manual
About Babylon Chat
Well, why don't we start with area the small triang
Johann
Johann is typing
Currently sending to:
Conference text:
Johann> Should we start?
Mary> Sure! I have no idea how, though.
Arnold> I don't remember anything about adding triangles, shouldn't it be 21?
Johann
Marry
Arnold
Send to everyone
User information
Page user(s)
Ignore user(s)
Drawing controls:
Drawing canvas:
[resize]
Freehand
Line
Rectangle
Oval
Text
black
thickness: 1
outlined
Clear canvas
<-- 9 -->
+
<-- 12 -->
= ?


ConcertChat
Material:
Bild:
mamue: ConcertChat-Flyer
Material
Moderation, Rollen- und Prozessunterstützung
Einfache Konfiguration und Integration
Kommunikation im Kontext
Kommunikation erfolgt in einem bestimmten Kontext. Die Teilnehmer erarbeiten sich neues Wissen mit Hilfe von Lernmaterial, besprechen einen Entwurf oder antworten auf einen bestimmten Diskussionsbeitrag.
Dieser Kontext wird von traditionellen Chat-Systemen nicht berücksichtigt und muss aufwändig selbst hergestellt werden. Missverständnisse sind programmiert.
Ein Beispiel:
Meier: Wir können diesen Entwurf in 3 Wochen umsetzen.
Schmidt: Ich habe noch eine Frage zum unteren Teil der Skizze.
Kempf: Das sieht nach einem Problem aus.
Worauf bezieht sich Schmidt und womit hat Kempf ein Problem?
Explizite Referenzen:
Persistente Speicherung
Rollen und Prozesse:
Die Technik: modular und
ConcertChat ist in Java
damit plattformunabhängig.
Lotus Sametime.
Fraunhofer-Institut für Integrierte Publikations- und Informationssysteme
Ansprechpartner:
ConcertChat: Kommunikation im Kontext
Anwesend:
gerry
mamue
silviosobis
wandlinks
Chat: (233)
Alloc9 (Dec 5, 2004 8:17 AM): komm aber nicht mehr mit dem gleichen nick rein, sagt mir immer, dass der nick bereits genutzt wird :(
Alloc1 (Dec 6, 2004 2:50 PM): Also, mit Alloc1 scheints jetzt sogar zu gehn, gleich ma probiern, ob des auch shcon direkt nach dem schliessen wieder geht ;)
Alloc5 (Dec 6, 2004 2:51 PM): ne, also direkt wieder reingehn geht nicht :(
martinw (Dec 6, 2004 8:28 PM): Hi, merkwürdig... dieses Problem hatten wir noch nie.
martinw (Dec 6, 2004 8:29 PM): welchen Browser, welche Java VM benutzen Sie?
gerry (2:00 PM): I like this diagram of the space
gerry (2:02 PM): Welche Problem ist merkwurdig?
gerry (2:02 PM): where are my links?
gerry (2:03 PM): This is Johann
gerry (2:06 PM): This is a deictic link!
Message:


Whiteboard4ConcertChat
Whiteboard:
Current users
nctm
Chat: (115)
Chad (Jan 13, 2005 4:24 PM):
so we should have something like this to find the length of the two sides of the trianlge.
4*4 + 8*8 = sqrt of 80
Chad (Jan 13, 2005 4:25 PM):
then the area of that trianlge is 32
Chink Steve (Jan 13, 2005 4:26 PM):
sq rt 32 it
Chink Steve (Jan 13, 2005 4:26 PM):
nevermind
steve^2 (Jan 13, 2005 4:26 PM):
everyone got aim?
Chad (Jan 13, 2005 4:26 PM):
32 is both triangles together
steve^2 (Jan 13, 2005 4:26 PM):
because we should jump to aim express under netscape and do a general chat
Chink Steve (Jan 13, 2005 4:26 PM):
that might be better
Chad (Jan 13, 2005 4:27 PM):
since the area of the trianlge is 1/2 b*h
Message:
Well, maybe if we tried pythagorean theorem?

Your students can be part of Virtual Math Teams @ The Math Forum!

http://mathforum.org/vmt/

Supported by the National Science Foundation, Grants REC 0325447 and DUE 0333493

Cooperative/Collaborative Learning

- Davidson (1985) reviewed 79 research studies comparing student achievement in small group and traditional whole-class instruction, and found that in more than 40% of these studies students in the classes using small group approaches significantly **outscored** control students on measures of student performance.

- From a review of 99 studies of cooperative group-learning methods, Slavin (1990) concluded that cooperative methods were **effective** in improving student achievement. The most effective methods emphasized both group goals and individual accountability.

Davidson, N. (1985). Small group cooperative learning in mathematics: A selective view of the research. In R. Slavin (Ed.), "Learning to cooperate: Cooperating to learn." (pp.211-30) NY: Plenum.

Slavin, R.E. (1990). Student team learning in mathematics. In N. Davidson (Ed.), "Cooperative learning in math: A handbook for teachers". Boston: Allyn & Bacon, (pp. 69-102).

Cited in the ERIC digest “Improving Student Achievement in Mathematics, Part 1: Research Findings.” (2000) Grouws, Douglas A. - Cebulla, Kristin J. ERIC Clearinghouse for Science Mathematics and Environmental Education http://www.ericdigests.org/2003-1/math2.htm

Virtual Math Teams Research

- How to group students for effective online collaboration (*opportunistic group formation*)
- How to design rich mathematical problems that foster collaboration and deep mathematical reasoning (*task scaffolding*)
- How to structure the online collaborative experience (*interaction design for learning)*
- How to study the forms of collaboration and reasoning that take place *(multidisciplinary research*)

1. Mod: If two equilateral triangles have edgelengths of 9 cubits and …
2. ALR: hmmm
3. ALR : interesting
4. Mod : If you create a picture that you would like to share…
5. PIN: : very
6. ALR: I think we can crack it, though
7. ALR : **begins to scribble on paper**
8. ALR : or should I not do that?
9. PIN: : doesnt matter
10. ALR : got it
11. ALR : **proceeds with scribbling..**
12. ALR : Okay, I think we should start with the formula for the area of a triangle
13. SUP : ok
14. ALR : A = 1/2bh
15. ALR : I believe
16. PIN: yes
17. PIN: i concue
18. PIN: concur*
19. ALR : then find the area of each triangle
20. ALR: oh, wait
21. SUP : the base and heigth are 9 and 12 right?
22. ALR : no
23. SUP : o
24. ALR : that's two separate triangles
25. SUP : ooo
26. SUP : ok
27. ALR : right
28. ALR: i think we have to figure out the height by ourselves
29. ALR: if possible
30. PIN: : i know how