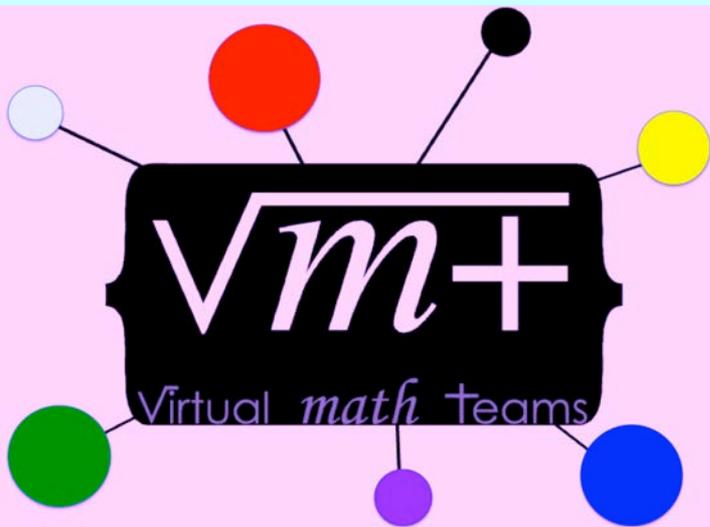
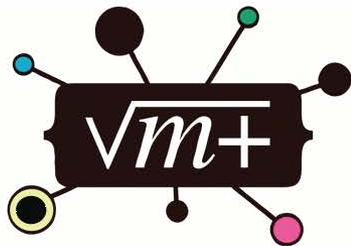


A DIGITAL DIDACTIC DESIGN FOR GROUP COGNITION

University of Umea, Sweden
June 2015

Gerry Stahl





Virtual Math Teams

A Focus on Thinking, Rather Than Thoughts

The Math Forum, Rutgers University, and Drexel University

vmt.mathforum.org



This material is based upon work supported by the
National Science Foundation under Grant No. DRL-1118773

A Digital Didactic Design for Group Cognition

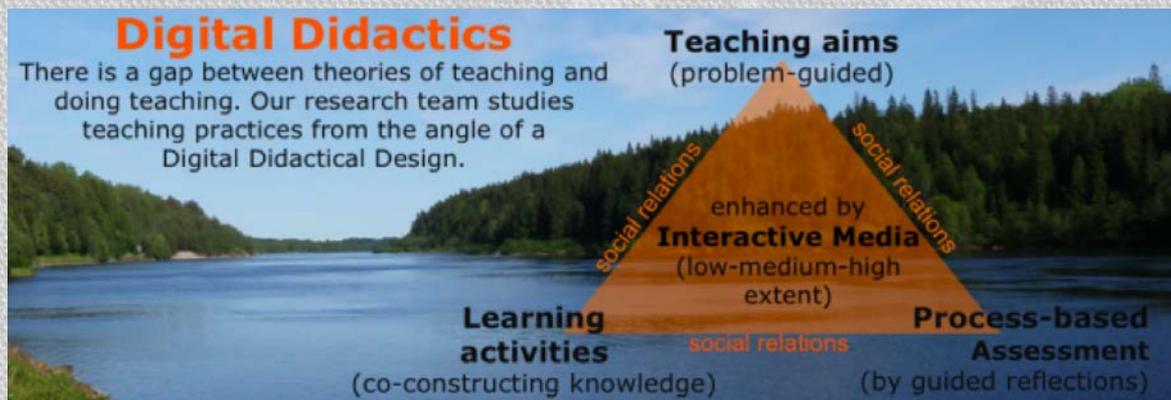
- 1. Virtual Math Teams as an example of DDD**
- 2. DDD and CSCL as designing for group cognition**
- 3. The socio-technical design of VMT**
- 4. VMT as design-based research in group cognition**
- 5. The centrality of group cognition to learning**
- 6. Expanding VMT to CrossActionSpaces**

1. Virtual Math Teams as an example of DDD

Teaching Aim: To provide students with hands on experience working on challenging geometry problems. (extend Math Forum problems-of-the-week)

Learning Activities: Collaborative math: co-constructing geometry figures and exploring them together. (networked computers, multi-user apps)

Process-based Assessment: Sequential interaction analysis of chat logs and geometry actions. (EM)



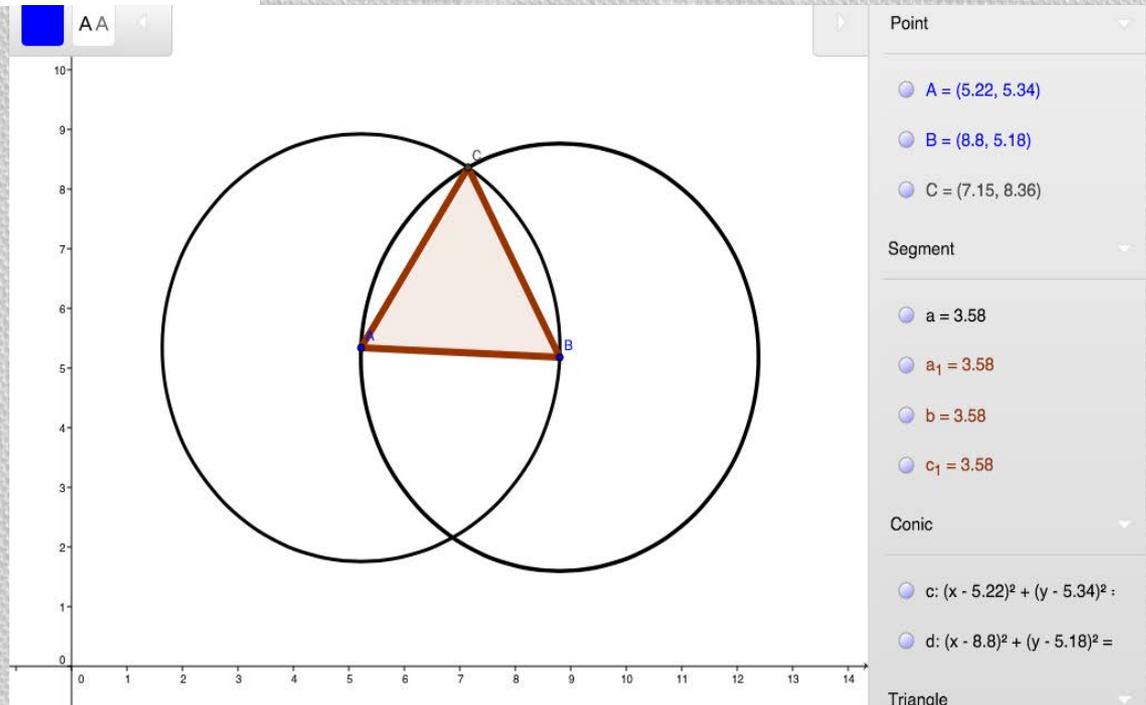
Translating geometry education from clay tablets to iPad tablets



-300

translate

2013



A specific DDD Research Question:

How should one translate the classic-education approach of Euclid's geometry into the contemporary vernacular of social networking, computer visualization, and discourse-centered pedagogy?

VMT as a response:

A multi-dimensional, iteratively evolving design-based research (DBR) approach to designing a human-centered, 21st century geometry education using computer-supported collaborative learning (CSCL).

VMT-mobile on an iPad

geogebra
none

control

Point

- A = (0, 6)
- B = (-4, 0)
- C = (6.38, 4.84)
- D = (5.9, 1.34)
- E = (7, 0)
- F = (0, 0)
- G = (3.5, -6.06)

Quadrilateral

- poly1 = 10.02

Segment

- a = 7.21
- b = 11.45
- c = 3.53
- d = 7.52
- e = 7
- e₁ = 7
- f₁ = 7
- g₁ = 7

Conic

Users in session:
gerry

server: tony joined the session
Mar 30th 15, 10:37:34 am
tony: hello everyone
Mar 30th 15, 10:37:53 am
server: tony left the session
server: no-name left the session
geogebra: 6
server: osamasw joined the session
Mar 30th 15, 11:21:59 am
server: osamasw left the session
Mar 30th 15, 11:22:32 am
server: gerry joined the session
10:04:53 am
geogebra: 20

Hey, look at my crossed quadrilateral!

2. DDD and CSCL as designing for group cognition

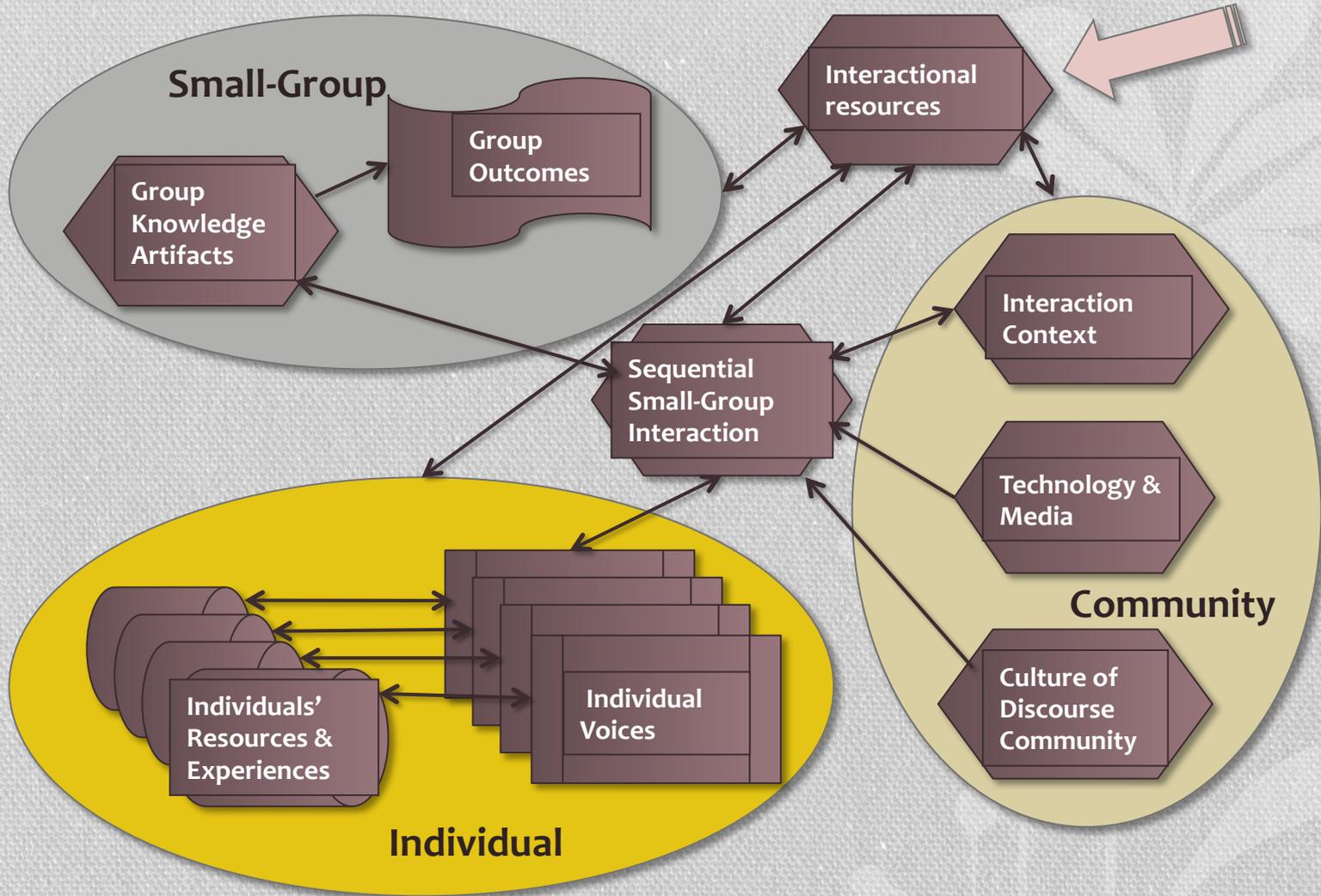
Networked computers and tablets allows global collaborative learning – but need special apps, curriculum, pedagogy, incentives, social context.

Small group as engine of knowledge building!

VMT research project designed to demonstrate potential of CSCL.

The screenshot displays a user interface for a CSCL application. At the top, a chat window shows a conversation about a geometry problem: "Sup (8:22:17 PM): OK", "Avr (8:22:28 PM): A = 1/2bh", "Avr (8:22:31 PM): I believe", "pin 805 (8:22:35 PM): yes", "pin 805 (8:22:37 PM): i concue", "pin 805 (8:22:39 PM): concur*", "Avr (8:22:42 PM): then find the area of", "Avr (8:22:54 PM): oh, wait", "Sup (8:23:03 PM): the base and heighth ar", "Avr (8:23:11 PM): no". Below the chat is a dark red header with the text "GROUP COGNITION" and "Computer Support for Building Collaborative Knowledge". To the right of the header is a black box with the name "Gerry Stahl". The main area features a diagram of a triangle with vertices labeled A, B, and C. A vertical line segment from vertex B to the base AC is labeled D. The angle at vertex B is labeled 30, and the angle at vertex C is labeled 60. A right-angle symbol is shown at vertex D on the base AC. Below the diagram is a text area with a conversation: "Brent: This one's different", "Jamie: Yeah, but it has same nose", "Chuck: Pointy nose=", "Steven: =Oh, yeah=", "Chuck: =But it's not the same engine", "Jamie: Yeah it is.", "Brent: =Yes it is.", "Jamie: Compare two n one".

Group Cognition: Computer Support for Building Collaborative Knowledge. 2006. MIT Press



Levels of analysis connected by interactional resources

VMT with generic shared whiteboard

1. What is the shortest path along the grid between the two points?

2. How many possible routes are there from point A to point B?

3. What is the shortest distance from point A to B if you can only travel on each POINT path?

4. How many ways are there to get from A to B in rectangle ABCD?

5. Make a right triangle with AB as the hypotenuse. What is the area of the circumscribed circle?

6. Can you go off the edge and come back (unattached state)?

Edges

7. What is the shortest path along the grid between any two points A(x1, y1), B(x2, y2)?

8. How many shortest paths are there from A to B and how does this vary with changes in the positioning of A relative to B?

9. (Depends on the right and left edges of the grid are connected. How does that change the distances between points?)

Chat (219)

↳ Inlhere (May 12, 2005 8:42 PM):
What is the area of this shape?

↳ Jason (May 12, 2005 8:42 PM):
which shape?

↳ Inlhere (May 12, 2005 8:43 PM):
square

↳ Inlhere (May 12, 2005 8:43 PM):
why?

↳ Jason (May 12, 2005 8:42 PM):
What is the area?

↳ Jason (May 12, 2005 8:42 PM):
The one highlighted in black and dark red?

↳ Inlhere (May 12, 2005 8:43 PM):
between the stars and the hypotenuse

↳ Jason (May 12, 2005 8:43 PM):
ok

↳ Jason (May 12, 2005 8:43 PM):
that would be "number" is

ConcertChat Session Player - Room : channel:OID:1147211767857

Whiteboard:

Current users:
137
Jason
nan
quertyuioip

Chat: (0)

hexagonal array?

↳ quertyuioip 5/16/06 7:15:45 PM EDT: What's the shape of the array? a hexagon?

↳ 137 5/16/06 7:16:02 PM EDT: Ya.

↳ quertyuioip 5/16/06 7:16:15 PM EDT: Ok...

↳ Jason 5/16/06 7:16:41 PM EDT: wait- can someone highlight the hexagonal array on the diagram? I don't really see what you mean...

↳ Jason 5/16/06 7:17:30 PM EDT: hmm.. okay

↳ quertyuioip 5/16/06 7:17:43 PM EDT: oops

↳ Jason 5/16/06 7:17:44 PM EDT: so it has at least 6 triangles?

↳ Jason 5/16/06 7:17:58 PM EDT: In this, for instance

Message:

Jason is typing

© 2005-2006 Fraunhofer IPSI, Darmstadt, Germany

This is a tricky case.

Given triangle ABC, construct another triangle with an angle equal to $\angle ABC$, a side along the angle equal to side AB, and a side opposite the angle equal to side AC.

1. Use the compass tool to copy angle ABC to angle HGI
2. Use the compass tool to copy side AB to side GJ and
3. to copy side AC to side JK.
4. Now drag point K to meet the side extending GI.
5. Notice that for some shapes of triangle ABC, there are two points that satisfy the constraint SSA, but that only one of them constructs a triangle congruent to ABC
6. Discuss this in the chat.



To construct the centroid of a triangle, construct the midpoints of the three sides (you can use the Midpoint tool for this). Then construct Segments from the Midpoints to the opposite vertex. Construct the Point where these Segments intersect. (Note that all three Segments intersect at the same location, so you can use the intersection of any two Segments.)

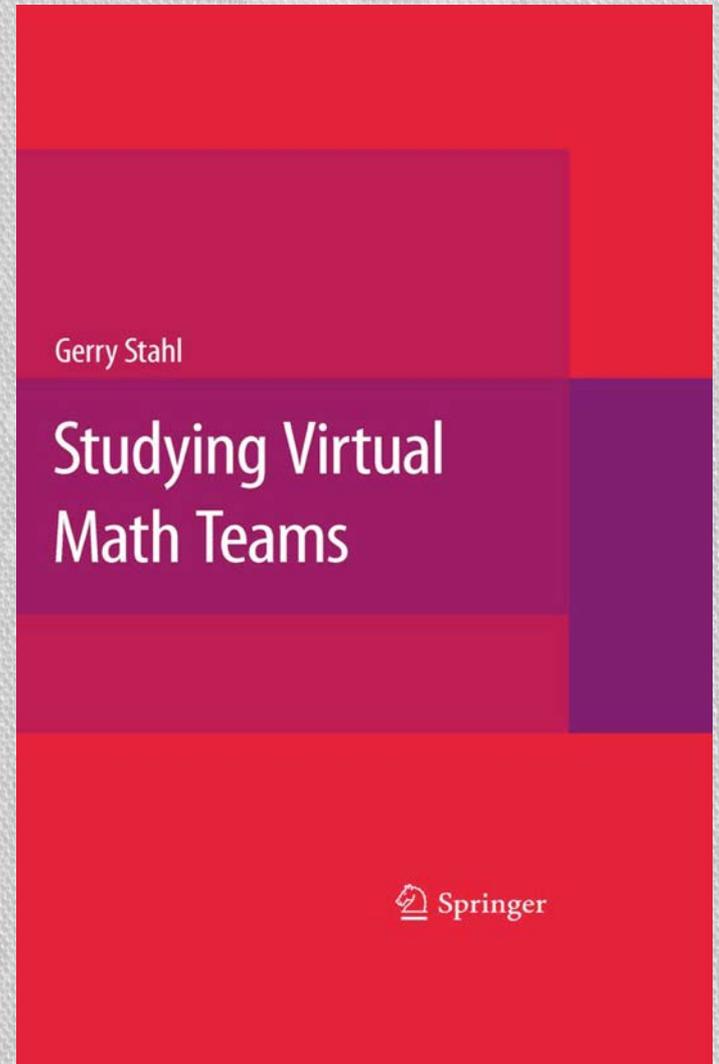
Now create a custom tool to automatically construct the centroid given the three vertices of a triangle.

Create some different triangles and their centroids. Drag the vertices of the triangle and observe how the centroid behaves. Is it always inside the triangle?

3. The socio-technical design of VMT

The development of VMT took a global team, a decade, many grants, countless trials.

DDD vision, group cognition theory, networked technology, collaboration pedagogy, dynamic-geometry curriculum, DBR iterations, trials by researchers, teachers, students, adoption of EM-CA to analysis of online math logs.



Studying Virtual Math Teams.
2009. Springer.

VMT with multiple GeoGebra tabs

The image shows a VMT (Virtual Meeting Tool) interface with multiple GeoGebra tabs. The main window is titled "Demo_1: student1 (CID:1368226612637)". The interface includes a menu bar (File, Edit, Chat, GeoGebra), a toolbar with various icons, and a central workspace displaying a geometric diagram with points A through I and a pink text box. The text box contains the following text:

Welcome to the WARM-UP space for Dynamic Geometry!
This is a space for you to explore the most important tools of this mathematical software.
You can try out things on your own or collaboratively with the other members of your team.
Try to create and move around the basic OBJECTS of Dynamic Geometry: points, lines, circles, triangles, etc.
To get started, press the 'Take Command' button below. Use the chat to communicate with group members.

On the right side, there is a chat window with the following messages:

- student1 7:04:11 PM EDT: Here is our triangle
- student1 7:05:22 PM EDT:
- student1 7:05:23 PM EDT:
- student1 7:05:24 PM EDT:
- student1 7:08:52 PM EDT: And here is our circle
- student1 7:09:51 PM EDT: Note the reference to the whiteboard

At the bottom, there is a "Take Control" button and a "Move Graphi" button. The interface also includes a "History Slider" and a "Throttle" control.

Labels and arrows pointing to various elements:

- VMT menu
- GeoGebra menu
- Tool Bar
- Views Bar
- History Slider
- Throttle
- Referencing Tool
- Take/ Release Control Button
- Current Tool Indicator
- GeoGebra Reference
- Chat Reference

Building the technology

- **Geometer's Sketchpad, Cabri, etc. pioneered the creation of dynamic geometry**
- **GeoGebra makes it freely available and integrated with other math (3-d, algebra, statistics, spreadsheet, trig, calculus, etc.)**
- **VMT provides a collaboration environment and integrates the first multi-user dynamic geometry**
- **The next slides describe the design of the Virtual Math Teams (VMT) online environment**

Integration with GeoGebra

- **Remote students can synchronously work on a shared construction together.**
- **Users can take turns manipulating the construction.**
 - Adding, deleting, modifying and moving objects
- **The construction will stay in sync on each user's screen.**
- **Users can chat about the problem as they work.**

Multi-user GeoGebra

The image displays two side-by-side screenshots of the GeoGebra multi-user interface. Both windows show a 'Goal of the activity' section with instructions for constructing a perpendicular line. A chat window on the right of each window shows a conversation between 'amantoan' and 'tony'.

Left Window (User: tony):

- File Edit Chat
- GeoGebra Task GeoGebra2
- In this activity, you will use the equivalent of straightedge-and-compass tools to construct parallel lines, and a midpoint. Then you will construct a right triangle. These are basic con relationships, which are used over and over in geometry. To make it easier to do these fre you can program your own custom tools in GeoGebra. In this activity, you will program a nev constructing a dynamic-geometry perpendicular.
- Warning: This activity has many steps. Give yourself plenty of time to work on this before y
- Construction of a perpendicular at a point**
- We want to construct a line GH perpendicular to line AB and passing through point C to inte C.
- 1. Clear anything on the drawing area with the menu "File" | "New" | "Don't Save".
- 2. Construct line AB with the Line tool. Construct an arbitrary point C with the Point too AB. Now you want to construct a perpendicular to line AB, which intersects line AB at
- 3. Construct a circle with center at C using the Circle tool D not on AB). (passing throu
- 4. Use the intersect tool to construct points E and F at the two intersections of the cir Notice that points E and F are equidistant from point C.
- 5. Construct a second circle with center at E passing through F.
- 6. Construct a third circle with center at F passing through E (and therefore having the previous circle).
- 7. Use the intersect tool to construct points G and H at the two intersections of the cir E and F) with each other.
- 8. Construct line GH.
- Use the angle tool for angle ACH to see if line GH is perpendicular (90°) to line AB at Point C
- Use the drag test to see if line GH stays perpendicular to line AB at point C.
- Think about why GH is perpendicular to AB at point C. Was every step necessary? Can you s construction?
- Retrieved from "http://vmttest.mathforum.org/vmtwiki/index.php?title=Demo1 - demo&ol Categories:
- Demo1
- Demo
- Geometry

Right Window (User: amantoan):

- File Edit Chat
- GeoGebra Task GeoGebra2
- In this activity, you will use the equivalent of straightedge-and-compass tools to construct parallel lines, and a midpoint. Then you will construct a right triangle. These are basic con relationships, which are used over and over in geometry. To make it easier to do these fre you can program your own custom tools in GeoGebra. In this activity, you will program a n constructing a dynamic-geometry perpendicular.
- Warning: This activity has many steps. Give yourself plenty of time to work on this before
- Construction of a perpendicular at a point**
- We want to construct a line GH perpendicular to line AB and passing through point C to int C.
- 1. Clear anything on the drawing area with the menu "File" | "New" | "Don't Save".
- 2. Construct line AB with the Line tool. Construct an arbitrary point C with the Point to AB. Now you want to construct a perpendicular to line AB, which intersects line AB
- 3. Construct a circle with center at C using the Circle tool D not on AB). (passing thro
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- Think about why GH is perpendicular to AB at point C. Was every step necessary? Can you construction?
- Retrieved from "http://vmttest.mathforum.org/vmtwiki/index.php?title=Demo1 - demo& Categories:
- Demo1
- Demo

Chat Log (Shared):

- tony leaves the room 12:33:19 PM EDT
- tony joins the room 12:34:56 PM EDT
- tony 12:36:11 PM EDT: Hello.
- amantoan 12:36:15 PM EDT: HI again.
- tony 12:36:25 PM EDT: What is our assignment today?
- amantoan 12:36:34 PM EDT: Let's look at the Task tab to see.
- tony 12:36:59 PM EDT: We are going to create a perpendicular line based on Euclid's method
- amantoan 12:37:13 PM EDT: Right.
- amantoan 12:37:28 PM EDT: We will only use straight edge and compass like tools.
- tony 12:37:39 PM EDT: Sounds fun.
- amantoan 12:37:45 PM EDT: Let's get started.
- tony 12:37:53 PM EDT: OK, I'll start

Other Shared Tools

- **Shared Whiteboard**
 - Users can doodle on the shared whiteboard
 - Draw simple shapes
 - Summarize work, draft shared statements, note observations or hypotheses in text boxes
 - History of the whiteboard is also tracked.
- **Web browser**
 - Simple web browser
 - Can be used to show instructions for the student's assignments or other related information on the web.

History Tracker

- **Built-in history tracker allows users to scroll back and forth in time to see how the construction developed.**
- **Shows everything that happened including style changes and object movements.**
- **Each GeoGebra workspace is tracked separately.**

VMT has built in tools for session analysis

- **VMT records every chat, and action in the session.**
- **Provides a session replayer to go back and forth through the session step by step.**
- **Chat, whiteboard, and GeoGebra events all playback in the order they occurred in the original session.**

The VMT Session Replayer

Chat player

CID:1346942242703

File Options

GeoGebra Task

File Edit View Perspectives Options Tools Window Help

Move Graphics View: Drag graphics view or one axis (Shift + Drag)

Refresh View Take Control nobody has control

Speed: 1

Time to previous: -0:00 (Awareness info)
Current action at: 11:57:54 AM (Message by: tony)
Time to next:

Current users:

CHAT (0)

amantoan 9/6/12 11:27:00 AM EDT: That's it.
tony 9/6/12 11:27:04 AM EDT: Lets check. ■■■■■
tony 9/6/12 11:27:21 AM EDT: Looks good. ■■■■■
amantoan 9/6/12 11:28:01 AM EDT: It stays that way! ■
tony 9/6/12 11:28:40 AM EDT: Lets show the teacher how we did this. ■■■■■
amantoan leaves the room 9/6/12 11:57:44 AM EDT
tony leaves the room 9/6/12

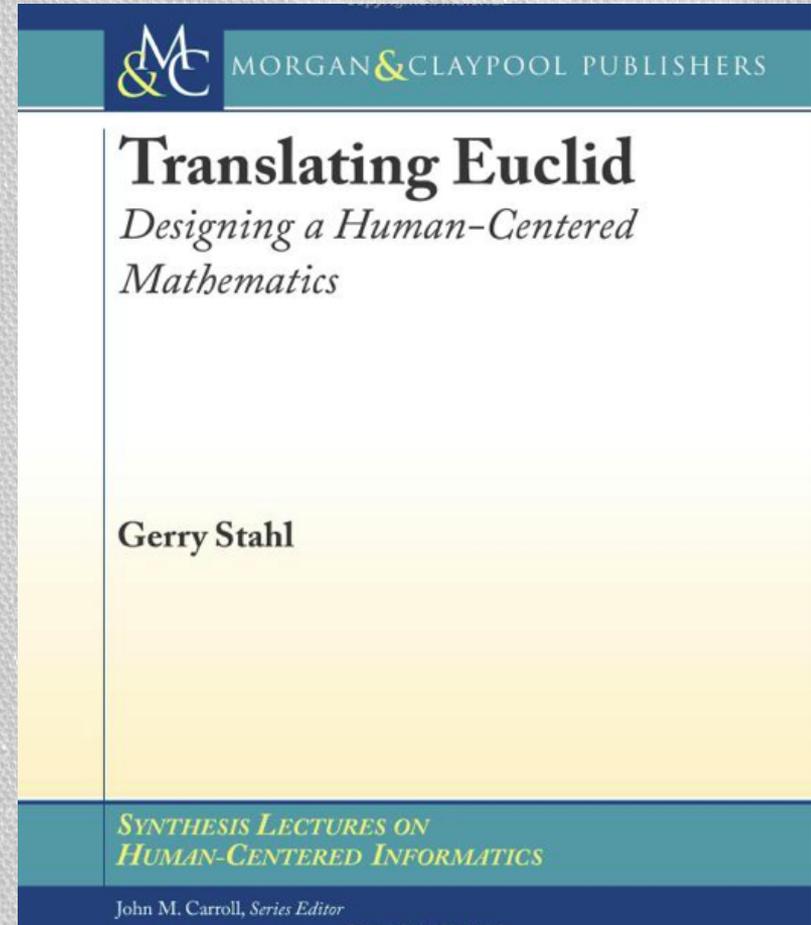
Message:

Session Log Files

	A	B	C	D	E	F	G	H
1	Line	Date	Start Time	Post Time	Duration	EventType	tony	<u>amantoan</u>
2	1	09/06/2012		10:38:42	00:00:00	chat	joins the room	
3	2	09/06/2012		10:39:54	0:1:12	chat		joins the room
4	3	09/06/2012		11:24:49	0:44:55	chat	Hello	
5	4	09/06/2012		11:25:07	0:0:18	chat		Hi. Lets start by looking at the task description.
6	5	09/06/2012		11:25:11	0:0:4	chat	Ok.	
7	6	09/06/2012		11:25:31	0:0:20	chat	Alright, I'll start.	
8		09/06/2012		11:25:42	0:0:11	<u>Geogebra: GeoGebra</u>	added point:Point "A"	
9		09/06/2012		11:25:44	0:0:2	<u>Geogebra: GeoGebra</u>	added point:Point "B"	
10		09/06/2012		11:25:44	0:0:0	<u>Geogebra: GeoGebra</u>	added line:Line "a"	
11		09/06/2012		11:25:50	0:0:6	<u>Geogebra: GeoGebra</u>	added point:Point "C"	
12		09/06/2012		11:25:52	0:0:2	<u>Geogebra: GeoGebra</u>	added point:Point "D"	
13		09/06/2012		11:25:52	0:0:0	<u>Geogebra: GeoGebra</u>	added conic:Circle "c"	
14		09/06/2012		11:26:01	0:0:9	<u>Geogebra: GeoGebra</u>	added point:Point "E"	
15		09/06/2012		11:26:02	0:0:1	<u>Geogebra: GeoGebra</u>	added point:Point "F"	
16	7	09/06/2012		11:26:18	0:0:16	chat		Great, I'll take it from here.
17		09/06/2012		11:26:29	0:0:11	<u>Geogebra: GeoGebra</u>		added conic:Circle "d"
18		09/06/2012		11:26:33	0:0:4	<u>Geogebra: GeoGebra</u>		added conic:Circle "e"
19		09/06/2012		11:26:40	0:0:7	<u>Geogebra: GeoGebra</u>		added point:Point "G"
20		09/06/2012		11:26:43	0:0:3	<u>Geogebra: GeoGebra</u>		added point:Point "H"
21		09/06/2012		11:26:52	0:0:9	<u>Geogebra: GeoGebra</u>		added line:Line "b"
22	8	09/06/2012		11:27:00	0:0:8	chat		That;s it.
23	9	09/06/2012		11:27:04	0:0:4	chat	Lets check.	
24		09/06/2012		11:27:15	0:0:11	<u>Geogebra: GeoGebra</u>	added angle:Angle "?"	
25	10	09/06/2012		11:27:21	0:0:6	chat	Looks good.	
26								
27								

4. VMT as design-based research into group cognition

1. **Pedagogic goals
(translate Euclid)**
2. **Domain-specific
curriculum (game)**
3. **Social practices of
collaboration**
4. **Collaboration support
technology**
5. **DBResearch of group
cognition**



*Translating Euclid: Designing a
Human-Centered Mathematics.*
2013. Morgan & Claypool.

Design-based research of human-centered geometry

Discover: The curricular topics guide student teams and teacher teams to discover dependencies in dynamic-geometric figures

Create: The curricular topics guide student teams and teacher teams to creatively design and construct dependencies in dynamic-geometric figures

Understand, explain, prove: Students and teachers learn to view geometric truths in terms of constructed dependencies. They begin to see the causality of the world as human/social creative-discovery involving designed dependencies

The VMT Project evolves its pedagogical approach through iterative analysis of interactions among teams of researchers or teachers or students using the technology and resources. The research process is reflected in its publications and presentations.

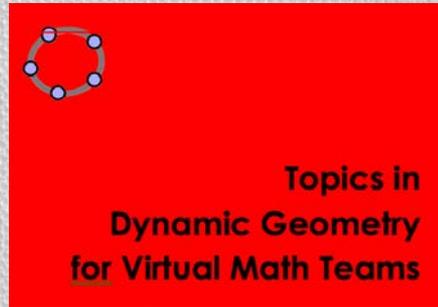
Pedagogical focus

The approach emphasis includes:

- 1. The importance of experiencing first-hand the actual doing of mathematics: exploration, noticing, discovering, wondering, conjecturing, creating, designing, constructing, explaining, understanding, proving, teaching**
- 2. Resisting the tradition of accepting on authority the definitions and understandings of geometric objects**
- 3. Resisting the temptation to use GeoGebra just to illustrate geometric facts with pretty figures or flashy simulations**
- 4. Guiding teachers and students to design their own constructions, including the definition of custom tools**
- 5. Emphasizing the role of dependencies in dynamic geometry**

Developing the curricular resources

Although the VMT Project was funded to just develop the technology and analyze its effectiveness, the real problem is to design the pedagogy: approach & resources

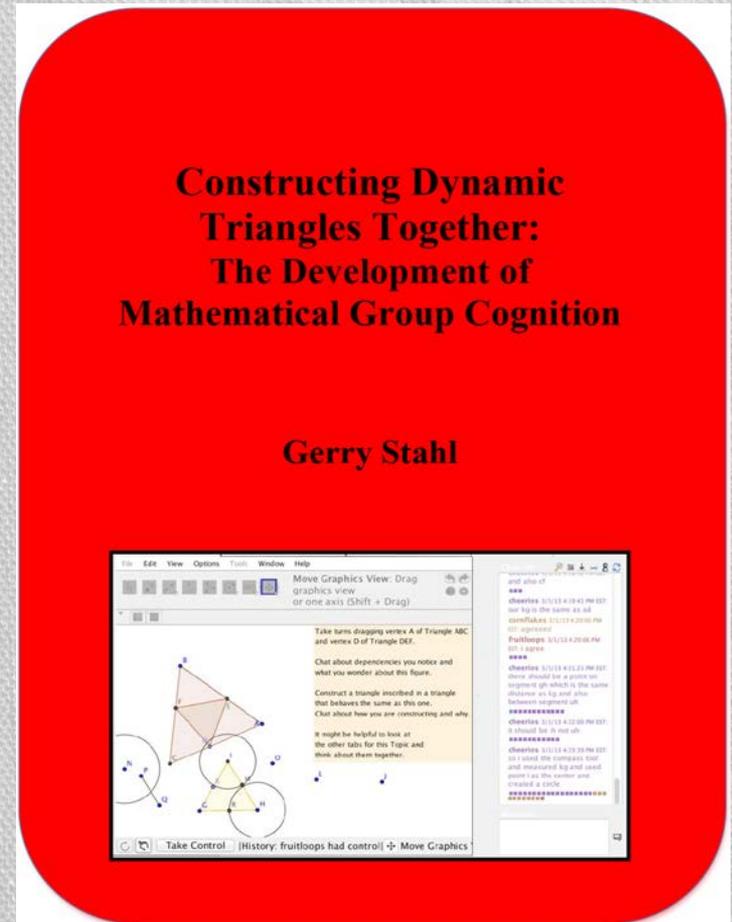


We developed a set of about 18 “topics” in a workbook format that included tutorial “tours” of the technology. Each topic was intended for about a one-hour online, synchronous, collaborative session. Each topic included 3 to 10 GeoGebra tabs with guiding tasks

5. The centrality of group cognition to learning

I analyzed the complete process of a team of three 14-yr-old girls learning collaborative dynamic geometry. They worked together online for 8 hour-long sessions.

They learned how to collaborate in VMT, use GeoGebra, discuss math, drag/explore/construct dynamic-geometry figures.



Constructing Dynamic Triangles Together: The Development of Mathematical Group Cognition. 2015. Cambridge University Press

Group cognition as group practices

The Virtual math teams learned by adopting many “group practices”—I identified over 60 in the book.

The adoption process proceeds as follows:

- The team is stuck; breakdown in group action**
- They express that they have a problem**
- Someone proposes a solution**
- They discuss it and all agree (explicit knowledge)**
- Then they adopt it and proceed (practical kn.)**
- In the future, they do it without discussion (tacit)**

Adopting collaboration group practices

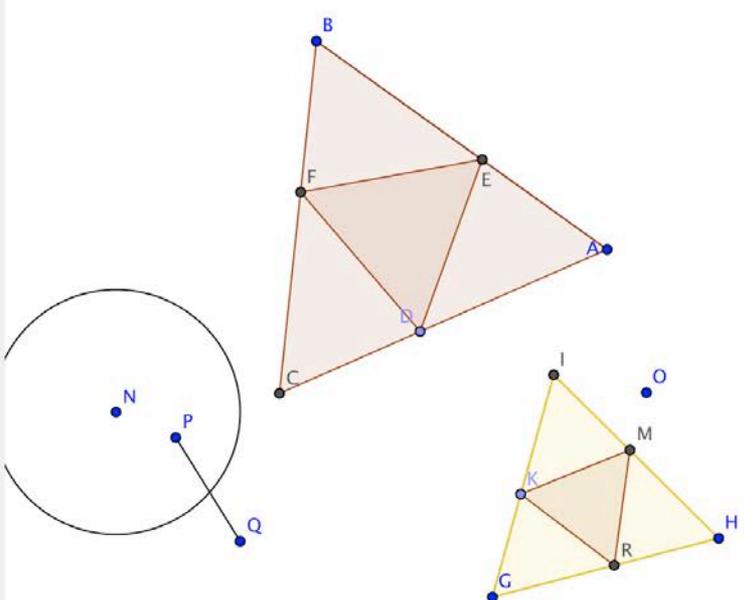
9	15:10.8	cheerios	whose taking control
10	15:20.1	cheerios	taking*
21	16:18.4	cheerios	so whoses doing what
22	16:44.4	fruitloops	who wants to take control?
23	17:30.6	cheerios	xxxxxxx do you want to
24	17:52.2	fruitloops	no... cornflakes you take controll.....
25	18:01.7	fruitloops	who wants to do what steps?
26	18:02.9	cheerios	cornflakes take control
27	18:03.6	cornflakes	no cheerios you can
28	18:14.6	cheerios	cornflakes
29	18:25.4	fruitloops	cornflakes
30	18:33.6	cornflakes	NO
31	18:40.0	cheerios	why not
32	18:52.3	fruitloops	i just took control. lets takes turns
33	19:01.9	cheerios	alright
34	19:03.0	cornflakes	ok

Adopting construction group practices

Material: Triangles Squares Hexagons Add a tab +

File Edit View Options Tools Window Help

Move Graphics View
Drag graphics view or one axis (Shift + Drag)



Take turns dragging vertex A of Triangle ABC and vertex D of Triangle DEF.

Chat about dependencies you notice and what you wonder about this figure.

Construct a triangle inscribed in a triangle that behaves the same as this one. Chat about how you are constructing and why.

It might be helpful to look at the other tabs for this Topic and think about them together.

Current users:

Chat (0)

cheerios 3/1/13 4:18:30 PM EST: as i was movign d segment da is the same distance as segment be

cheerios 3/1/13 4:18:52 PM EST: and also cf

cheerios 3/1/13 4:19:41 PM EST: our kg is the same as ad

cornflakes 3/1/13 4:20:06 PM EST: agrreed

fruitloops 3/1/13 4:20:06 PM EST: i agree

cheerios 3/1/13 4:21:21 PM EST: there should be a point on segment gh which is the same distance as kg and also between segment uh

cheerios 3/1/13 4:22:00 PM EST: it should be ih not uh

cheerios 3/1/13 4:23:39 PM EST: so i used the compass tool and measured kg and used point i as the center and created a circle

Take Control | History: nobody has control | Move Graphics View

Speed: 1



Time to previous: -1:30 (Message by: swampert)
Current action at: 4:31:55 PM (Message by: swampert)
Time to next: 2:51 (Awareness info)

6. Expanding VMT to CrossActionSpaces

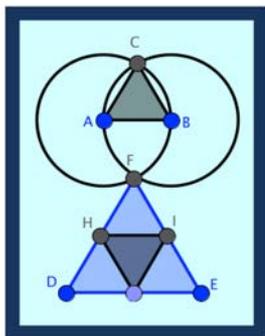
VMT-mobile: on iPads, laptops, tabletop displays, smart boards

Integration of individual, group, classroom

Community of VMT game players

Community of analysis and discussion of excerpts from VMTeams

The Construction Crew Game



The Game

11. Advanced Geometer Level.....
 - Challenge 39: The Centroid of a Triangle
 - Challenge 40: The Circumcenter of a Triangle
 - Challenge 41: The Orthocenter of a Triangle
 - Challenge 42: The Incenter of a Triangle
 - Challenge 43: The Euler Segment of a Triangle.....
 - Challenge 44: The Nine-Point Circle of a Triangle....
12. Problem Solver Level.....
 - Challenge 45: Treasure Hunt
 - Challenge 46: Square and Circle
 - Challenge 47: Cross an Angle
13. Expert Level.....
 - Challenge 48: How Many Ways Can You Invent?.....
 - Challenge 49: Dependencies in the World
 - Challenge 50: Into the Future

To construct the circumcenter of a triangle, construct the perpendicular bisectors of the three sides (you can use the Midpoint and Perpendicular tools for this).

Construct the Point where these Lines intersect. (Note that all three Lines intersect at the same location, so you can use the intersection of any two Lines.) Drag the vertices of the triangle and observe how the circumcenter behaves. Is it always inside the triangle?

**A GeoGebraBook
on GeoGebraTube:
<http://ggbtu.be/b154045>**

DDD: Orchestrating a Collaborative MOOC

- **Math teacher professional development: VMT, readings, reflection on logs**
- **Teachers form student groups and assign VMT MOOC**
- **Student groups engage in level of VMT game**
- **Individual students practice constructions**
- **Student groups share experiences in class**
- **Teachers reflect on student logs; give feedback**
- **Teachers form, motivate, assign, orchestrate, feedback student teams**
- **VMT provides MOOC content/ collab experience**

Teachers collaborate on inscribed triangles

Chat player
CID:1353122104578

Material: Add a tab +

Summary Original Figure Our Team's Construction

File Edit View Options Tools Window Help

Drag vertex A or vertex D to explore the dependencies in this figure.

Explain in the chat what the dependencies are.
Can you prove why these dependencies are needed to make this figure?

Then construct a similar figure with the same dependencies.
Explain in the chat how you constructed the dependencies.

5.67 2.84 5.67 2.84 2.84

Take Control | nobody has control | Move Graphics View

Current users:

Chat (10)

michele_colon 11/26/12 8:07:23 PM EST: ending early, woo hoo

JL123 11/26/12 8:07:24 PM EST: that seems to work

sholland 11/26/12 8:07:32 PM EST: sounds good to me

sholland 11/26/12 8:08:24 PM EST: So did we use the compass tool for all 3 points or just 2?

emilyL 11/26/12 8:08:45 PM EST: only 2

JL123 11/26/12 8:08:49 PM EST: yes lets just discuss dependencies further and I think our work is done here

emilyL 11/26/12 8:08:52 PM EST: in ours G and U

JL123 11/26/12 8:09:04 PM EST: compass for 2

sholland 11/26/12 8:09:30 PM EST: I laugh thinking how hard it was to create an equilateral triangle the first time. We are much better with geogebra now

emilyL 11/26/12 8:09:31 PM EST: CG and BU are dependent of AD because we used the compass tool to keep the same radii

JL123 11/26/12 8:09:31 PM EST: points were made be intersecting for E and poin tool for U

emilyL 11/26/12 8:09:42 PM EST: lol me too!!

emilyL 11/26/12 8:09:48 PM EST: well the ind also helped

JL123 11/26/12 8:09:55 PM EST: I know its crazy n always beneficial working with this group

sholland 11/26/12 8:10:11 PM EST: yes

michele_colon 11/26/12 8:10:14 PM EST: so true!

sholland 11/26/12 8:10:40 PM EST: So the first point D was just a point on the object or what?

Message:

emilyL is typing

Speed: 1

Time to previous: -0:00 (Message by: sholland)
Current action at: 8:10:40 PM (Awareness info)
Time to next: 0:06 (Awareness info)

Researching the learning processes

Students are asked to identify chat log segments that show effective collaboration and to reflect on what they noticed and wondered about

Teachers are asked to select and reflect on student chat log segments – and to discuss how to improve the resources, approach and experience

Researchers analyze logs and replayer to understand strengths and weaknesses of resources and to investigate how student teams collaboratively master dynamic geometry practices, skills and understanding

Create your own topic rooms

← → ↻ 144.118.94.160:8080/VMTLobby/commons/index.jsp ☆ ✖ 🌐 📄

 **The Math Forum @ Drexel**
PEOPLE LEARNING MATH TOGETHER

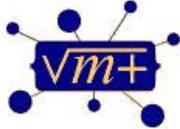
Collaboration and Dynamic Mathematics in Middle and High School
Online professional development course offered Fall 2012 by the Math Forum, Drexel University, and Rutgers University (Graduate credit and stipends available)

Home Math Help Problems & Puzzles Math Talk Resources & Tools About The Math Forum

Welcome What's New Students Educators Parents & Citizens Researchers

Virtual Math Teams 3.0-Alpha-1

Welcome tony



- ☒ New to VMT?
- ☒ List of All Rooms
- ☒ My Profile
- ☒ My Teammates
- ☒ My Rooms
- ☒ Messages
- ☒ Manage Activities

[VMT Help](#) Pages
[VMT Sandbox](#) Room
[VMT Lounge](#) Room
[VMT Wiki](#) Pages
[VMT Replayer 3 Alpha-1](#)
[Logout](#)

View Chat Rooms as

Math Subject Tree Tabular List

Filter Chat Rooms By...

Project: IGI 2012 Last Activity: Show All

Apply filters Use default filters

► **Geometry** (1 Topic)

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[Collaborators](#) |

The Virtual Math Teams Quartet

Group Cognition (2006)



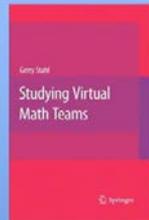
Computer Support for Building Collaborative Knowledge

MIT Press, 510 pages
Available for Kindle

The theory of group cognition emerges from several studies of CSCL and CSCW technologies. Analysis of interaction. Theory of CSCL.

www.GerryStahl.net/elibrary/gc

Studying Virtual Math Teams (2009)



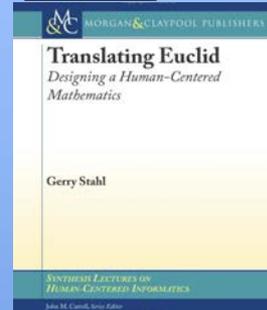
Springer Press, 626 pages
CSCL Book Series, paperback

Studies of the VMT Project technology, pedagogy, analysis, theory by team members and international collaborators

www.GerryStahl.net/elibrary/svmt



Translating Euclid (2013)



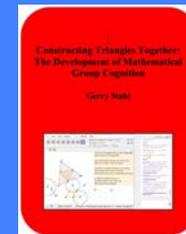
Creating a Human-Centered Mathematics

Morgan Claypool Publishers,
325 pages, e-book & paperback

Latest results of this design-based CSCL research from many perspectives.

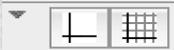
www.GerryStahl.net/elibrary/euclid

Constructing Dynamic Triangles Together: The Development of Mathematical Group Cognition (2015)

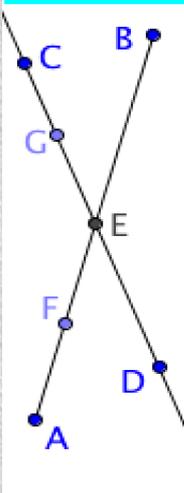


Cambridge University Press, 250 pages
www.GerryStahl.net/elibrary/analysis

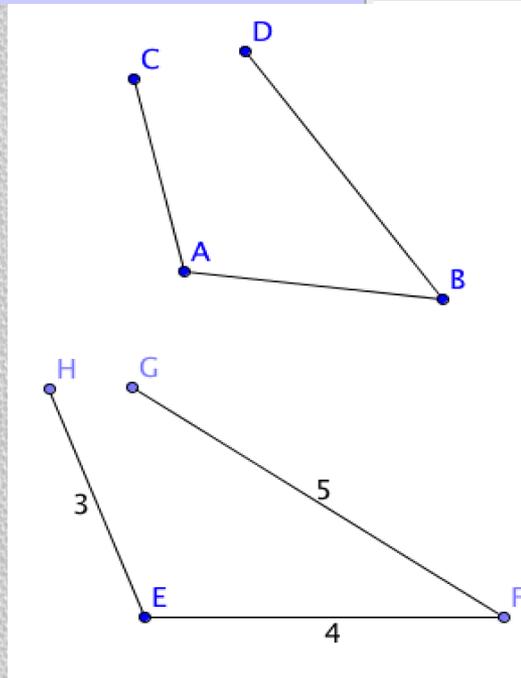
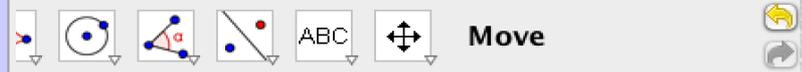
See www.GerryStahl.net/elibrary for access to these books



An example of what you will construct:



- ***Construct dependent objects***
 Take turns controlling the construction.
1. Select the Segment Tool and click on two points to construct a segment like AB.
 2. Select the Line Tool and click on two points to construct a line like CD that crosses the segment.
 3. Select the Intersection Tool and construct a point where the line cuts the segment.
 4. Construct another point on the segment and another point on the line, like F and G.
 5. Drag each point, the line and the segment.
 6. Discuss in the chat how each object is free, constrained or dependent on other objects.

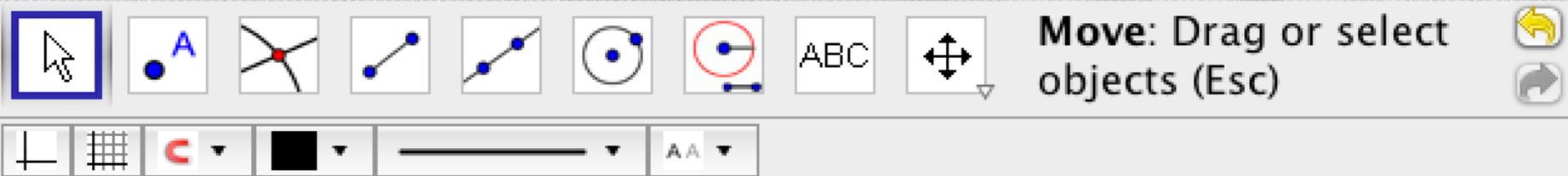


If one triangle is congruent to another, then all its angles and all its sides are dependent on the corresponding angles and sides of the other triangle.

Given three segments -- AB, AC, BD -- for constructing a triangle, how many angles or sides do you have to constrain to fully constrain the triangle?

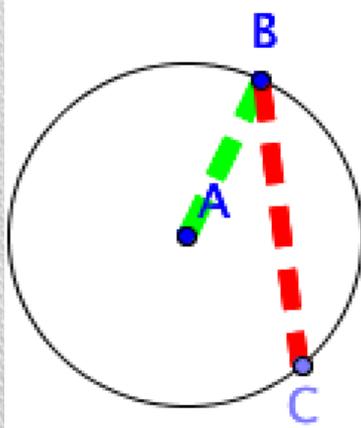
The three segments EF, DH, FG have been constructed with the Segment-with-Given-Length-from-Point tool to constrain their lengths. How many triangles can you construct with these segments?

What do you conclude?



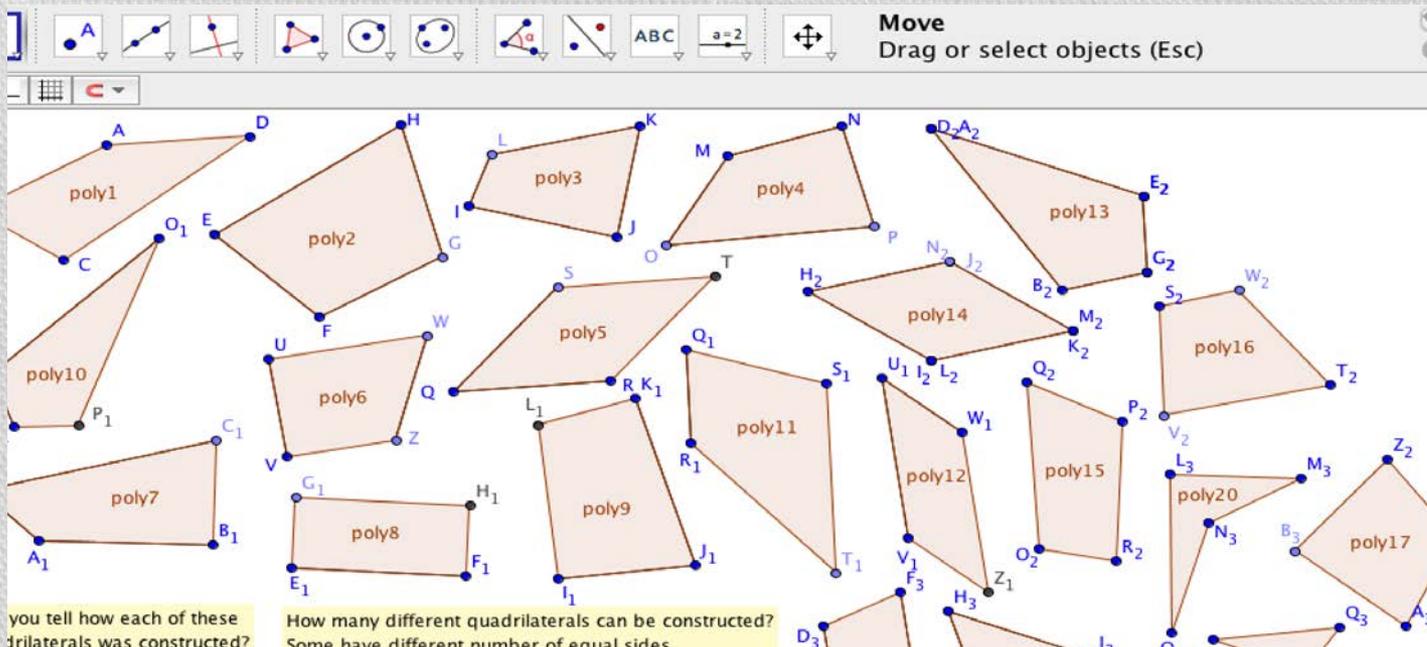
Move: Drag or select objects (Esc)

An example of what you will construct:



Construct a segment whose length = sum of two lengths
1. Construct a circle with center through a point, its radius and a chord.
(A radius is a segment from a circle's center to a point on its circumference--like AB--and a chord is a segment connecting two points on its circumference--like BC.)
2. Construct a line like DE and construct a segment along it, whose length is the sum of the lengths of your radius + chord.
3. Drag each point, segment or circle to make sure that the length of the segment changes dynamically correctly.

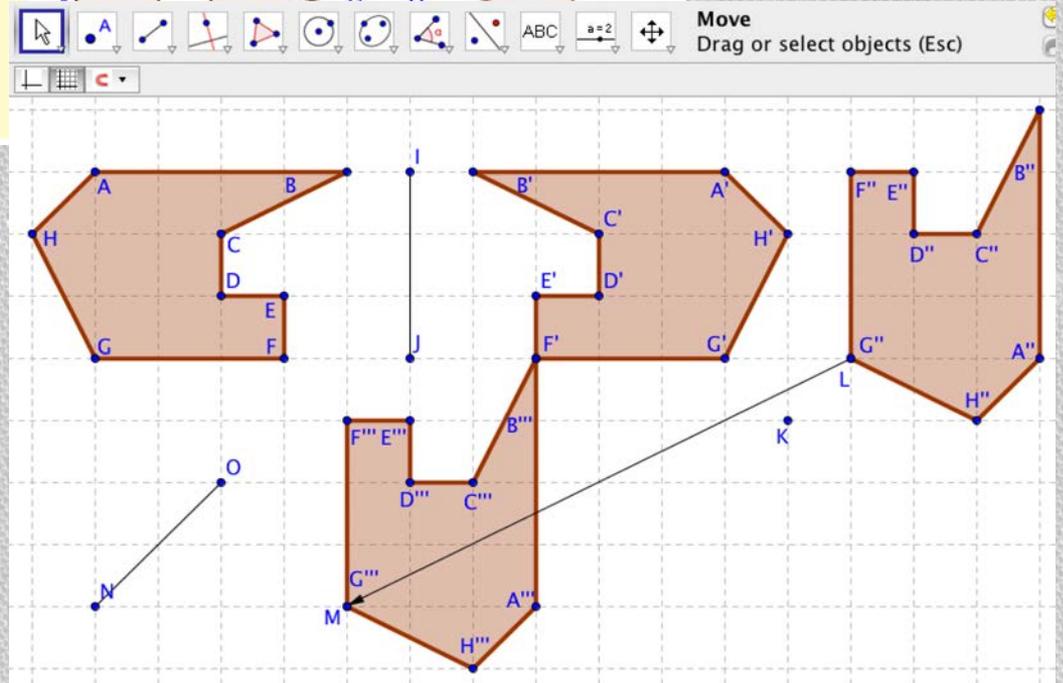




How many of these quadrilaterals were constructed? What are its dependencies?

By moving the vertices of these quadrilaterals to see what is special about each one.

How many different quadrilaterals can be constructed? Some have different number of equal sides. Some have different number of equal angles. Some have different number of right angles. Some have different number of parallel sides. Some have different number of lines of symmetry. Some have diagonals with different characteristics.



A Digital Didactic Design for Group Cognition

Abstract. Designing digital didactics involves multiple dimensions of innovation, including the collaboration technology, the domain-specific curriculum, the social practices for collaborative learning. Such design requires iterative cycles of theorizing, development, usage trials and formative evaluation. The Virtual Math Teams (VMT) Project has pursued this in an extended attempt to introduce students to collaborative dynamic geometry. Students work together virtually on laptops or tablets to explore GeoGebra figures and to construct their own objects with desired dependencies. This symposium presentation will look closely at project data to see how students engage in group cognition, how it differs from individual learning and how it can be analyzed. This will suggest how group cognition may be an appropriate goal for digital didactic design.

30 min presentation; 15 min discussion