Collaborative GeoGebra for Virtual Math Teams

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Virtual Math Teams (VMT) Project

- VMT is a research project funded by NSF from 2003-2016.
- The general goal has been to support online collaborative learning of mathematics.
- VMT software combines support for dynamic geometry with media for collaborative learning.
- The current goal is to refine a curriculum for group learning of the core concepts of dynamic geometry: dragging, constructing, and designing dependencies.
The VMT Collaboration Environment

- The VMT online environment includes components for students to work on and discuss math problems synchronously.
  - The VMT Lobby to find chat rooms on topics
  - GeoGebra tabs in chat rooms to do construction
  - Other tabs: whiteboard, help, web browser
  - The VMT wiki to share findings with other groups
  - The VMT replayer to review chat sessions
  - Logs of chat sessions and other visualizations
Multi-User 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.
Two Students Construct a Perpendicular Bisector (video)

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 constructions, which are used over and over in geometry. To make it easier to do these free you can program your own custom tools in Geogebra. In this activity, you will program a new tool for constructing a dynamic geometry perpendicular.

Do a construction of a perpendicular at a point

We want to construct a line GH perpendicular to line AB and passing through point C to intersect 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 tool.
3. Construct a circle with center at C using the Circle tool D not on AB. (passing through)
4. Use the Intersect tool to construct points E and F at the two intersections of the circle.
5. Construct a second circle with center at E passing through F.
6. Use the Intersect tool to construct points G and H at the two intersections of the circle.
7. Use the Tangent tool to construct line GH.

Use the angle tool for angle ACH to see if line GH stays perpendicular to line AB at point C.

Goal of the activity

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 constructions, which are used over and over in geometry. To make it easier to do these for you can program your own custom tools in Geogebra. In this activity, you will program a new tool for constructing a dynamic geometry perpendicular.

Warning: This activity has many steps. Give yourself plenty of time to work on this before you start.

Construction of a perpendicular at a point

We want to construct a line GH perpendicular to line AB and passing through point C to intersect C.

1. Clear anything on the drawing area with the menu "File" | "New" | "Don't Save".
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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.

**Gerry 5:31:53 PM EDT**: Hi team!
**Gerry 5:32:20 PM EDT**: Let's use Euclid's method to construct the outer triangle.
**Gerry 5:32:40 PM EDT**: First I will drag the example triangle around.

**Message**: Do you see point I, the third vertex of my new triangle?
VMT is an online environment for students to work on and discuss math problems synchronously.

Main communication is through text chat.

Can point from a chat posting to other postings and to GeoGebra objects.

Students take turns controlling the construction and watching each other’s GeoGebra actions.
VMT Lobby with Topics

Dynamic Geometry (18 Topics)

1. Topic 01
2. Topic 02
3. Topic 03
4. Topic 04
5. Topic 05
6. Topic 06
7. Topic 07
8. Topic 08
9. Topic 09
10. Topic 10
11. Topic 11

4. Topic: Constructing Triangles
   4a. Equilateral
   4b. Where's Waldo?
   4c. Exploring

5. Topic: Programming Custom Tools
   5a. Bisector
   5b. Perpendicular
   5c. Parallel
   5d. Right-Triangle

6. Topic: Finding Centers of Triangles
   6a. Circumscribing
   6b. Inscribing
   6c. Near Sides
   6d. Near Vertices
   6e. Centroid
   6f. Circumcenter
   6g. Orthocenter
   6h. Incenter
   6i. Euler Segment
   6j. Nine-Point

7. Topic: Transforming Triangles
   7a. Transformations
   7b. Symmetry
   7c. Areas

8. Topic: Exploring Angles of Triangles
   8a. Sum of Angles
   8b. Polygon
   8c. Corresponding
   8d. Dilation
   8e. Similar
   8f. Sides

9. Topic: Visualizing Congruent Triangles
   9a. Corresponding
   9b. SSS
   9c. SAS
   9d. Combinations
   9e. ASA
   9f. SSA

10. Topic: Solving Geometry Problems
    10a. Treasure Hunt
    10b. Square and Circle
    10c. Crossing an Angle

11. Topic: Inscribing Polygons
Supports for Student Reflection

- VMT chat rooms are persistent
- Students can always go back and see what their team did and then add to it
- Students can always scroll back in the chat
- Students can always scroll back in the history of a GeoGebra tab
VMT History Tracker In Action (Video)
Supports for Teacher Assessment

• Teachers can enter any chat room - when students are there or any time later
• Teachers can scroll back in the chat and the GeoGebra construction
• Teachers can view the room Dashboard
• Teachers can download chat logs
• Teachers can view rooms in the replayer
• Other visualizations and analytics are currently under development
Teacher Dashboard

**Dynamic Geometry** (9 Topics)

- **Topic 00: Warm-up** (9 Rooms, 0 Active)
- **Topic 01** (9 Rooms, 0 Active)
- **Topic 02** (9 Rooms, 0 Active)
- **Topic 03** (9 Rooms, 0 Active)
- **Topic 04** (9 Rooms, 0 Active)
- **Topic 05** (9 Rooms, 0 Active)

**Group 1**

**Group 2**

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<th>Username</th>
<th># of Messages</th>
<th>Last Active</th>
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<tr>
<td>cornflakes</td>
<td>41</td>
<td>Mar 4, 2013 16:12</td>
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<td>emilyl</td>
<td>9</td>
<td>Mar 9, 2013 15:53</td>
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<td>fruitloops</td>
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<td>Mar 8, 2013 15:12</td>
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<td>swampert</td>
<td>9</td>
<td>Mar 1, 2013 16:42</td>
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Add to Favorites  Save as JNO  View Chat Log

Get Log: columns for each user  Get Log: one column for all users  Get Log: Informatics
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<th>Line</th>
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<th>Post Time</th>
<th>Duration</th>
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<th>User</th>
<th>Action</th>
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<td>15:13:30</td>
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<td>cornflakes</td>
<td>i will go first</td>
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<td>when I move vertex a the whole triangle of abc moves</td>
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<td>when I moved point c the triangle stayed the same and either increased or decreased in size, but it was equivalent to the original triangle</td>
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</tr>
</tbody>
</table>
Supports for Researcher Analysis

- Researchers can access all chat rooms, spreadsheet logs and replayer files
- They can download data from selected courses, teams, sessions, etc.
- The complete, detailed interaction is logged: chat postings, GeoGebra actions, VMT actions, etc. - for comprehensive analysis of group cognition
The VMT Session Replayer (video)
Curriculum and Chat Rooms

• Anyone can offer chat rooms, topics and GeoGebra tabs that they design
• Anyone can make new rooms and invite people to them
Virtual Math Teams 3.0–Alpha–1

Welcome tony

View Chat Rooms as

Math Subject Tree  Tabular List

Filter Chat Rooms By...

Project  Last Activity

IGI 2012  Show All

Apply filters  Use default filters

Geometry  (1 Topic)
The VMT curriculum currently consists of:
- 18 topics in dynamic geometry
- 82 GeoGebra tabs (.ggb constructions)

The teacher professional development course consists of the 18 topics (18 rooms)

Teachers will then select 10 topics for students teams to work on (plus 1 intro and 1 wrap-up topic for students to work on individually)
Collaborative Dynamic Geometry Philosophy

- Dynamic dragging is an important way to discover the dependencies designed into a dynamic-geometry figure
- Dynamic construction is an important skill for designing dynamic-geometry figures
- Dynamic dependencies are important to understand in order to explain the behavior of dynamic-geometry figures

- Students should develop skills in
  - Dragging, constructing, custom tools, discussing dependencies, explaining proofs
  - These skills are more important than memorizing vocabulary or facts about geometry
Collaborative Dynamic Geometry
Topics

• Philosophy in: “Translating Euclid”

• Topics: Dragging and the drag test; visualizing Thales and Pythagoras’ theorems; constructing equilateral, right and isosceles triangles; centers of triangles; transformations; angles; congruence and similarity; quadrilaterals; problem solving; proving with dependencies; special explorations
Collaborative Dynamic Geometry Professional Development

- Course for math teachers
- Sept 2 - December 15
- Requires 2 hours per week online with team
- Work on 18 GeoGebra topics
Collaborative Dynamic Geometry Professional Development

• Reflect on issues of mathematics learning and teaching: discourse and collaboration with & without teacher guidance, task design, justification and proof, and effective use of technology.

• Grad credit through Rutgers University or CEUs through the Math Forum at Drexel U.

• Stipends of $500 or partial tuition reimbursement
Collaborative Dynamic Geometry SpringFest for Students

- Work in small teams of peers, organized by teacher
- Work on 10 sessions on GeoGebra topics
- Most collaborative teams win prizes
- Teachers earn stipend of $1,000 or tuition reimbursement
For More Info

- padlet.com/wall/GGB2013-Session133

Tony Mantoan, VMT developer
Steve Weimar, dir. MathForum
Gerry Stahl, PI, VMT research

tony@mathforum.org
steve@mathforum.org
gerry@mathforum.org
• **VMT server is available for all to use** - http://vmt.mathforum.org

• **Info on courses:**
  • vmt.mathforum.org/vmt/announcement.htm
  • vmt.mathforum.org/vmt/course.htm
  • vmt.mathforum.org/vmt/stipend.htm

• **Info on “Translating Euclid” book and topics:**
  • www.GerryStahl.net/elibrary/euclid
  • www.GerryStahl.net/elibrary/topics