

# Virtual Math Teams: An Online Tool for Collaborative Learning in the Mathematics Disciplines

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**Abstract:** The Virtual Math Teams (VMT) service provides an integrated Internet-based environment for small teams of people to discuss math and to work collaboratively on math problems or explore interesting mathematical micro-worlds together. We are presenting an overview of VMT's traditional features and usage in K-12 teaching and group cognition research contexts, and the potential impact on learning of its new features, including the first collaborative Internet-based dynamic mathematics whiteboard.

## The VMT Project

The Virtual Math Teams (VMT) Project has conducted research for the past seven years on how to support small teams of students around the world to collaborate online in discussions of stimulating mathematical topics. The project has developed an extensive Internet-based environment and conducted about 400 sessions of usage. Analysis of usage has resulted in over a hundred academic publications (Stahl, 2006, 2009; Çakir, Zemel & Stahl, 2009; Sarmiento & Stahl, 2008). The Math Forum of Drexel University offers the VMT free of charge to the world and also provides VMT professional development workshops to practitioners and school districts.

Various features of VMT have traditionally enabled its ability to enhance collaborative learning and teaching of mathematics:

- A social networking Web portal called the VMT Lobby (<http://vmt.mathforum.org/VMTLobby/>).
- A Java Web Start application that:
  - Integrates text chat (much like chat facilities found in instant messaging applications) with a shared whiteboard tab for synchronous collaboration. The chat panel includes social awareness indicators, so collaborators can easily see who is typing and who is graphically making changes.
  - Has an embedded Web browser linked to an asynchronous community wiki
  - Has an embedded Web browser linked to topic-based pages.
  - Includes referencing from chat to sections of Web pages in an embedded Web browser.
  - Includes referencing from chat messages to previous chat messages.
  - Includes referencing from chat to an area or an object in the whiteboard.
  - Features scrollable history of the chat and the whiteboards, allowing learners, educators, and researchers to see at any time the history of a group's interaction.

## Dynamic Math

We wanted to tailor the system more to the discipline of school mathematics by taking advantage of new computer-based tools for dynamic math. We hypothesized that this would enhance mathematical exploration and communication in VMT to foster more powerful and precise inquiry of mathematical disciplinary content. Dynamic math tools (like Geometer's Sketchpad, Cabri and GeoGebra) have been thought to have "revolutionized" K-12 math learning. We wanted to include this power in VMT. We selected GeoGebra as the most accessible (available in open source) and powerful (including algebra, geometry, spreadsheet, graphing and calculus). However, GeoGebra—like all available dynamic math systems—was only available as a single-user application and VMT is designed to support collaborative learning and group cognition.

## A New Version of VMT

To improve inquiry of mathematical disciplinary content we implemented the first multi-user and synchronous dynamic mathematics whiteboard (see Figure 1). This was accomplished using the open source dynamic geometry/algebra/calculus GeoGebra system (<http://www.geogebra.org>). This new GeoGebra whiteboard includes all the history and chat referencing features of our traditional whiteboard. It also has all of the features of GeoGebra, including the ability to support importing and exporting of GeoGebra dynamic worksheets. This allows teachers and students to take advantage of available curricular materials. It also provides a multi-user version of GeoGebra for the community of teachers and students currently using the single-user versions of GeoGebra.

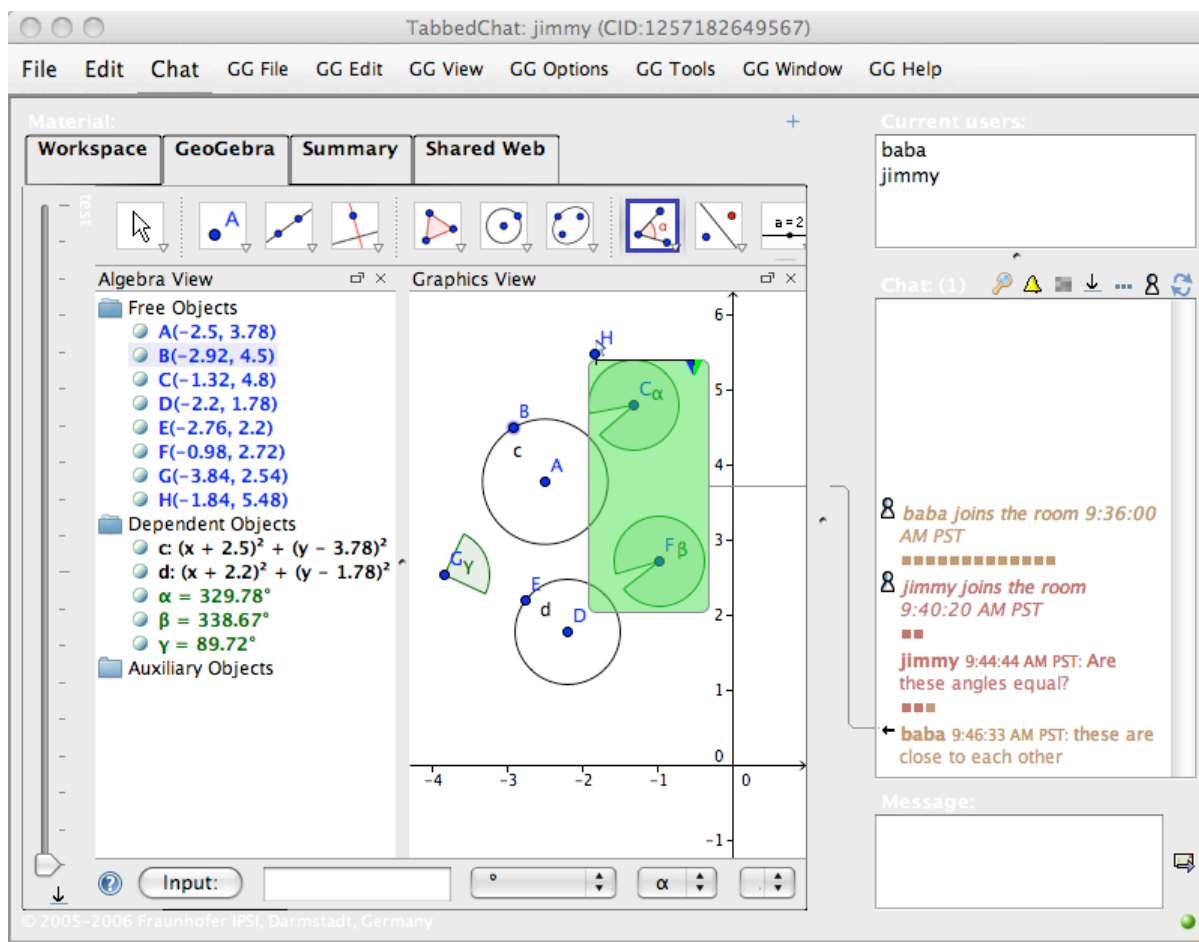


Figure 1. The GeoGebra Tab of VMT.

Despite the reputation of dynamic math systems to potentially transform the way that mathematics is taught and learned, there is relatively little research about the cognitive effects of these tools. In particular, there is almost no analysis of how these tools can mediate collaborative learning of the important discipline of mathematics. We have found that VMT provides excellent data sets for the study of how students learn in a collaborative, computer-supported environment by engaging in mathematical discourse. The VMT system includes a Replayer tool that reproduces an entire student session, allowing a researcher to study the interaction as closely as desired, progressing through the session like in a digital video and observing everything that the students observed. Because mathematical thinking is made visible in a collaborative problem-solving session (Stahl, 2006), it is possible to conduct a broad range of analyses (Stahl, 2009). For instance, one can describe in detail how students coordinate their graphical, narrative and symbolic constructions (Çakir, et al, 2009) and how they construct and reason about their joint problem space (Sarmiento & Stahl, 2008).

The Math Forum plans to release the new system for worldwide usage, providing a convenient online venue for students to engage in synchronous collaborative learning within a rich environment for mathematical inquiry and knowledge-building interaction. We also plan to release VMT to the open source communities.

## References

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