Changes to Mathematical Understanding as Influenced by Learning in a Collaborative Dynamic Geometry Setting

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Abstract

Web 2.0 environments provide infrastructure for synchronous access to communication and shared dynamic mathematical tools.

Scant literature in mathematics education examines how, with Web 2.0 tools, learners can coordinate both content and social resources as they discuss their mathematical ideas and problem solve.

This case study aimed to understand how small teams of learners problem solve using mathematical, tool-enabled, and collaborative resources in a computer supported, collaborative learning environment.

Our analysis revealed the importance of chat roles in facilitating productive collaboration, including the exchange of individual knowledge and the construction of group knowledge.

Theoretical Framework

Oner's (2013) framework- students draw on content-related and social resources to develop joint attention, mutuality, and shared task alignment.

Social resources include: ***chat roles*** such as questioning, clarification, elaboration, and rejection; ***repair*** as in when individuals initiate and correct themselves and others; and ***turn-taking*** which speaks to group members taking turns speaking, one at a time, with little gap or overlap between turns.

Content-related resources include: ***the mathematical reference fields*** comprised of the theoretical and spatio-graphical levels, along with interactions between these levels (Oner, 2013); and ***content-based tools*** such as dragging in GeoGebra.

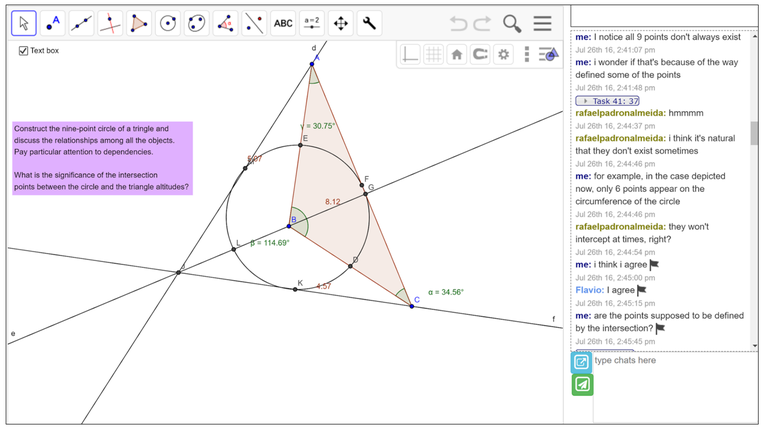
Methodology

Analysis followed directed content analysis (Hsieh & Shannon, 2005), focusing on identifying similar patterns of resource use among the teacher learners. Interactions with various levels of collaboration were analyzed.

Development of initial codes were based on Oner (2013) and initial review of the data, with Coding of a selection of task chat logs using Dedoose.

After the initial coding stage, refinement, definition, and organization of codes to reveal patterns in use of the resources.

Virtual Math Teams with Geogebra



Data collected using Virtual Math Teams with GeoGebra (VMTwG), a CSCL environment.

VMTwG is a product of a collaborative research project among investigators at the Math Forum, Rutgers University and Drexel University. The current study uses an updated version.

Integrates multi-user GeoGebra, a dynamic geometry environment, with a chat forum and other collaborative features.

Data collected during a Summer 2016. A group of three graduate students conducted collaborative problem solving sessions focusing on Dynamic Geometry.

Results

Chat roles that include noticing, questioning, and facilitating, support the development of mathematical understanding.

These chat roles have the greatest influence on the development of mathematical understanding when they are assumed by multiple group members during an exchange, as opposed to being undertaken by a single member.

Additionally, the use of each mathematical field proportionally supports greater collaboration and understanding than reliance on one field.

Conclusions and Implications

Collaborative problem solving should be structured in a way that encourages group members to assume multiple chat roles.

Our results contribute to literature on how to establish a productive collaborative environment as well as how collaboration focuses learners' attention on mathematical relations.

References

Hsieh, H., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277-1288.

Oner, D. (2013). Analyzing group coordination when solving geometry problems with dynamic geometry software. *International Journal of Computer-Supported Collaborative Learning, 8*(1), 13-39.

Resnick, L. B. (1989). Developing Mathematical Knowledge. *American Psychologist, 44*(2), 162-169. doi:10.1037/0003-066X.44.2.162