Apr 18th, 9:00 AM - 10:00 AM

Engaging HS Geometry Students Through Student-Centered Activities

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Research Question

How does hands-on exploration with physical and virtual manipulatives impact students' engagement in geometry?

Manipulatives are defined as concrete materials that students utilize in order to better comprehend abstract concepts (McNeil & Jarvin, 2007).

Engagement involves three key components: behavioral, emotional, and cognitive (Fredericks, Blumenfeld, & Paris, 2004).

Literature Review

- McNeil and Jarvin (2007) stress that manipulatives should be used as mathematical tools rather than toys.
- Steen, Brooks, and Lyon (2006) illustrated that students' retention of mathematical concepts can be improved through the careful implementation of both concrete and virtual manipulatives.
- Manipulatives on their own can act as a perceptually rich tool in order to develop students' conceptual understanding (Bhatia, Premadas, & Martin, 2014; Reimer & Moyer, 2005).
- According to Erkoc, Gecu, and Erkoc (2013), both concrete and virtual manipulatives were effective in improving students' spatial reasoning over time.
- Gaps in the research exist in how hands-on activities specifically impact cognitive, behavioral, and emotional engagement.

Methodology

- Participants included 30 high school students in 2 geometry classes in a small, rural public school.
- 23 hands-on activities were implemented throughout the semester.
- Data was collected from lesson plans, student work samples, student questionnaires, and teacher reflections.
- Data sources were content analyzed in order to identify themes related to mathematical proficiency and engagement.
- A conceptual framework was created in this research study.

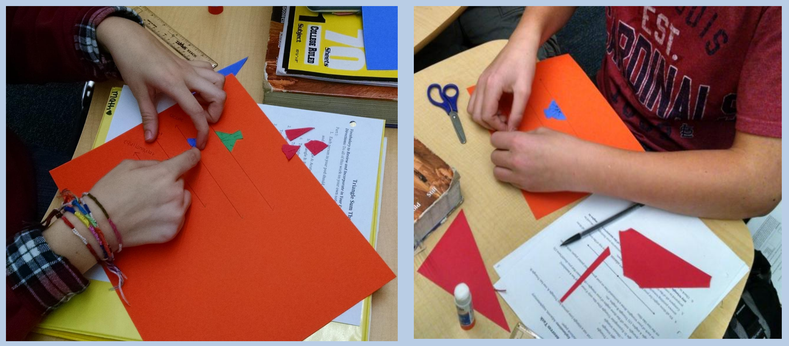

Figure 1. Students prove the triangle sum theorem by creating a line with the three interior angles of the triangle.

Figure 2. Students explore the basic properties of a circle using a compass .

Results and Data Analysis

- Analysis of lesson plans resulted in emerging themes of developing students' conceptual understanding and adaptive reasoning and students' engagement in investigative and exploratory learning.
  - Figure 1 and Figure 2 represent examples of exploratory hands-on activities.
- Thoughtfulness, effort, participation, and positive reactions were emergent themes in student work samples and student responses.
  - 89% of the students claimed to be either somewhat or very much engaged in activities involving physical manipulatives.
- Analyses of lesson plans, student work, and teacher reflections provided evidences that exploratory activities prompted deeper discussion and novel hands-on activities promoted greater student participation and positive reactions.
- Issues with functionality in manipulatives like problems operating compasses and confusions with performing tasks in geometer's sketchpad led to less student engagement.

Conclusion

- Findings support Puchner, Taylor, O'Donnel, and Fick's (2008) suggestion to utilize hands-on activities for exploration as it leads to increased cognitive engagement.
- Novel activities positively impact students' behavioral and emotional engagement.
- Further research in additional high school mathematics classes is needed to supplement findings in this research study.