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**Analysis of peer learning behaviors using multiple representations in virtual reality and their impacts on geometry problem solving.**

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Summary: Learning geometry emphasizes the importance of exploring different representations such as virtual manipulatives, written math formulas, and verbal explanations, which help students build math concepts and develop critical thinking. Besides helping individuals construct math knowledge, peer interaction also plays a crucial role in promoting an understanding of mathematics and geometric problem solving. In this research, an interactive future mathematics classroom (IFMC) based on the Collaborative Virtual Reality Learning Environment (CVRLE) was proposed to facilitate three-dimensional (3-D) geometric problem solving. Two representational tools, the virtual manipulative and a white board, were integrated into the IFMC to help students with the following activities: to synchronously review peers' solving processes; to individually or collaboratively manipulate 3-D objects using the virtual manipulative; and to give comments on peers' white boards for future queries and discussions. One eight-week experiment was conducted and the results showed that the experimental group using the IFMC performed significantly better than the control group on geometric learning achievement. Further analysis showed that the peer learning behaviors of the experimental group in the two kinds of geometric problems, volume and surface area calculation, were different due to the problems' varying difficulty levels. Moreover, various peer learning behaviors with multiple representations lead to different types of strategies for geometric problem solving in the IFMC. Therefore, peer learning behaviors in the IFMC were found useful to facilitate geometric problem solving by sharing ideas and exploring multiple representations.

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