

# PLANES OF SYMMETRY IN REGULAR POLYHEDRONS WITH VIRTUAL REALITY AND MANIPULATIVE MATERIALS

Silvia-Natividad Moral-Sánchez<sup>1,2</sup>, Isabel M. Romero<sup>2</sup>, M. Teresa Sánchez-Compañía<sup>1</sup>, José L. Rodríguez<sup>2</sup>

<sup>1</sup>University of Málaga, <sup>2</sup>University of Almería

Visualization difficulties are a source of errors in spatial geometry, where conceptual images are usually very poor, in spite of their importance (Gutiérrez & Jaime, 2015). Physical manipulation of objects and the recognition of properties in geometric solids requires specific spatial skills (e.g., Ramírez et al., 2018), which are not spontaneous in many students, but can be trained. Virtual reality has the potential to enrich these conceptual images and help students to overcome errors and limitations (Rodríguez et al., 2019). This poster presents the analysis of secondary students' errors and limitations when locating the planes of symmetry in regular polyhedrons, comparing the work with manipulative materials and with virtual reality.

The sample comprises 30 students of third year of secondary education (age 14-15). In a one-hour session, the class was divided into two groups: Group 1 of 10 students working with virtual reality, and Group 2, with 20 students carrying out the activity with manipulative materials. The students who used manipulative material only managed to point out correctly the planes of symmetry of the tetrahedron and the hexahedron, while all the students who worked with the immersive virtual reality NeoTrie VR software completed correctly the planes of symmetry of the five regular polyhedrons. Most frequent errors made during the activity were: 95% of Group 2 students did not correctly indicate the midpoint necessary to do some planes of symmetry, while all the Group 1 student did so, by using the tool provided by the virtual reality interface. Similarly, 80% of the Group 2 students failed to place the diagonal planes in the hexahedron properly, compared to 10% of those who used virtual reality. Finally, none of Group 1 students made mistakes in checking planes of symmetry, while the Group 2 students were unable to do this check. All this will be detailed in the presentation.

## References

- Gutiérrez, A., & Jaime, A. (2015). Análisis del aprendizaje de geometría espacial en un entorno de geometría dinámica 3-dimensional. *PNA*, 9(2), 53–83.
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