Bringing Dynamic Geometry to Three Dimensions:

The Use of SketchUp in Mathematics Education

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EXECUTIVE SUMMARY

Contemporary technologies have impacted the teaching and learning of mathematics in significant ways, particularly through the incorporation of dynamic software and applets. Interactive geometry software such as Geometers Sketchpad (GSP) and GeoGebra has transformed students' ability to interact with the geometry of plane figures, helping visualize and verify conjectures. Similar to what GSP and GeoGebra have done for two-dimensional geometry in mathematics education, SketchUp™ has the potential to do for aspects of three-dimensional geometry. This chapter provides example cases, aligned with the Common Core State Standards in mathematics, for how the dynamic and unique features of SketchUp™ can be integrated into the K-12 mathematics classroom to support and aid students' spatial reasoning and knowledge of three-dimensional figures.

BACKGROUND

In the past fifteen years, the available technologies for use in mathematics classrooms have expanded far beyond the handheld calculator. Many contemporary technologies have made an impact on the teaching and learning of mathematics. Interactive applets and virtual manipulatives in Web 2.0 and Smartboard tools can help elementary students understand the base ten number system and help secondary students visualize the algebraic process of completing the square (Moyer, Bolyard & Spikell, 2002); Dynamic geometry software such as Geometers Sketchpad (GSP) and GeoGebra can allow middle and secondary students to construct shapes and explore their properties with thousands of examples by dragging vertices, while also offering a concrete connection between varying quantities of shapes and algebraic functions (Jones, 2000; Wasserman & Arkan, 2011); Statistics packages such as Fathom and Excel spreadsheets can help middle school students visualize data and secondary students better understand sampling distributions and inferential statistics (Lock, 2002; Meletiou-Mavrotheris, 2003); And the incorporation of Computer Algebra Systems (CAS) into graphing calculators can make symbolic manipulation less burdensome and free secondary students to focus on deeper conceptual understandings and applications (Heid & Edwards, 2001). Each of these technologies have uniquely added to and altered the way K-12 mathematics content can be taught and accessed in school classrooms.

Many of these technologies allow students to interact dynamically with software, which produces real-time changes and modifications based on direct input from students. On GSP and GeoGebra platforms, students can construct, for example, a rectangle, and, by dragging one corner, produce thousands of different rectangles, providing a live interaction between the student and the two-dimensional object. The interface allows students to see, among others, what properties hold for these thousands of cases; in this situation, for example, students may notice that the lengths of the two diagonals of the rectangle are always congruent. The interactive features allow students to use inductive reasoning to help form and justify conclusions about two-dimensional figures. (However, this aspect may also become a limitation that causes students not to see a need for further evidence, confusing inductive reasoning with deductive proof (deVilliers, 2006).) The use of dynamic, two-dimensional geometry software, has proven to be an effective classroom tool; among many extant studies, for example, Saha, Ayub, & Tarmizi (2010) showed a statistically significant gain in students' performance on a visual-spatial reasoning test about coordinate geometry that used the GeoGebra platform as opposed to a traditional classroom.

This chapter will provide examples for how the use of one contemporary technology, SketchUp™ [1] (which will be referred to as GSU), can effectively support implementation of the Common Core State Standards for Mathematics (CCSSM,

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