Using Augmented Reality to Assist Elementary School Students Developing Spatial Ability

Chih-Hung Yu
National Taiwan Normal University, Taiwan
chihung@ntnu.edu.tw

Abstract

Spatial ability refers to the ability to manipulate mental images. It plays an important role in assisting students learning math and science concepts, improving creativity, and achieving success in STEM (Science, Technology, Engineering, and Mathematics) fields. Providing young students with geometry learning activities had been proven a good way to develop their spatial ability. However, students usually find difficult in learning spatial geometry concepts, such as the volume of an object or the cubic nets of a cubic. By applying augmented reality (AR) techniques, we were able to attach virtual imagery on top of physical objects, and in turn, help students understand the target concepts.

We designed three AR tools to assist students' learning geometry and develop spatial ability. The first one is to help students learning enumeration strategies in volume concepts. It detects a 3D object constructed with physical cubes and display its spatial structuring by layers, and provides moving hints that help students to better regrouping cubes and adopt the volume formula. The second tool helps students visualize the folding process of a cubic net to facilitate them constructing and manipulating their mental imagines. The third tool helps students visualize the three-dimensional (i.e. front, right, or top) views of a physical object, and construct a virtual object from its three-dimensional (front, right, and top) views. We adopted Unity3D with Vuforia AR extension to build the AR tools, and a 7-inch Android tablet was used as the display devices. Three AR tools were developed to assist students learning the concepts of volume, cubic nets, and three-dimensional views, respectively.

We field-tested the effects of these AR tools and found that they improved students' achievement, motivated their learning, and helped them construct and manipulate mental images of objects.