Can 3D Visualization Assist in Young Children’s Understanding of Sun-Earth-Moon System?

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ABSTRACT

This research-in-progress investigates how the usage of technology, specifically three dimensional (3D) stereoscopic vision, might support astronomy learning in primary grades. 3D stereoscopic vision might be an effective means to observe the relationships among space objects through simulations. In order to explore this presumption, this pilot study examines how 3D stereoscopic vision might enhance urban second graders’ understanding of (a) the shape of Sun, Moon, and Earth, (b) how day and night alternate, and (c) how Moon appears in different shapes. Currently, Indiana state standards for science do not suggest the teaching of these astronomical concepts explicitly before fourth grade. The authors project that students can learn these concepts earlier in their educational lives with the implementation of these new technologies. These technologies might challenge the views of when astronomical concepts could be taught to children and expand the ways the authors think about children’s cognitive capacities in understanding scientific concepts.

Keywords: Astronomy, Elementary Science Education, Stereoscopic Vision, Virtual Environments, Young Children and Technology

1. INTRODUCTION AND THEORETICAL BACKGROUND

Maturationist views often position young children as incapable of comprehending many scientific concepts due to their limited reasoning abilities (Kuhn & Dean, 2004; Kuhn, 1989; Zimmerman, 2007). Other researchers often found that young children are unable to explain astronomical ideas (Klein, 1982; Jones, Lynch, & Reesink, 1987; Baxter, 1989; Osborne, Wadsorth, Black, & Meadows, 1994; Vosniadou & Brewer, 1994; Sharp, 1996), and that even fewer children can explain the scientifically correct relationship among Sun, Earth, and Moon (Jones et al., 1987; Klein, 1982).
On the other hand, there is a big push for increased science and math learning in elementary schools as outlined in national and state standards for science, math, and technology. Moreover, taking a social constructivist perspective to curriculum, several researchers have pointed out that children as young as preschool age may be able to reason around scientific concepts with adult scaffolding, modeling, and peer collaboration (Kamii & DeVries, 1978; Russell, Harlen, & Watt, 1989; Ravanis, 1994). Photos, videos, and software are often used to support young children’s understanding of the relationship among Earth, Sun, and Moon.

One hesitation for teaching young children about the universe and objects in the sky has been the idea that there is no possibility for children to fully understand that these objects are 3D because in the videos or photos, children do not see the depth of the objects. The use of small scale 3D models could also be problematic due to similar representation issues. For instance, in some concrete small scale models that represent Earth’s orbit around Sun, children might be confused by the strings or rods attached to Earth and Sun, and might assume these are real. Sometimes, even after instruction, young children might gain new misconceptions about Moon, Sun, and Earth, particularly related to their shapes, orbits, and relationships relative to one another. Therefore, teaching these children about the relationships among Sun, Earth, and Moon without perpetuating misconceptions that might be introduced through current models and lesson plans is a challenge that requires alternative pedagogies.

Perhaps due to these constraints, the Indiana State Standards for astronomy learning in second grade (Hicks, 2010) suggest that the scope of learning about astronomy in second grade be limited as rationalized by the following statements on the standards website: “During these years, learning about objects in the sky should be entirely observational and qualitative, for the children are far from ready to understand the magnitudes involved or to make sense out of explanations. The priority is to get the students noticing and describing what the sky looks like to them at different times. They should, for example, observe how the moon appears to change its shape. But it is too soon to name all the moon’s phases and much too soon to explain them” (Hicks, 2010).

The following learning standards related to astronomy are offered for second grade in the state of Indiana:

“We by the end of the 2nd grade, students should:

2.2.7. Investigate how the sun appears to move through the sky during the day by observing and drawing the length and direction of shadows;
2.2.8. Investigate how the moon appears to move through the sky during the day by observing and drawing its location at different times;
2.2.9. Investigate how the shape of the moon changes from day to day in a repeating cycle that lasts about a month” (Hicks, 2010).

Second grade standards suggest that teachers utilize moon observations and help students recognize patterns in sky objects in addition to helping them understand that those change. At the same time, the standards at this grade level caution that gravity and shadows are difficult for second grade students to understand and are problematic topics to address when introducing students to astronomical concepts (Hicks, 2010). The science standards do not suggest revisiting these topics before fourth grade, which is when teachers are expected to teach how day and night occurs, how seasons occur, and what patterns Moon and Earth follow as they move.

2. THE STUDY

Is it possible to support young children in their understanding of Earth, Sun, and Moon using technology, particularly 3D visualization? 3D technologies already captivate young students’ attention in entertainment contexts such as movies and video games. We wonder what the potentials of 3D technologies could be for students in their school curriculum, particularly
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