HelioRoom: Problem-solving in a whole class visual simulation

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Abstract: HelioRoom simulates the orbital motion of the planets in the Solar system on a set of synchronized computer displays situated on the walls of the classroom, with planets "orbiting" around the periphery of the room. Third grade students used the application for a problem-solving activity requiring the collection of evidence in support of theories concerning the identity of planets whose size and surface characteristics were intentionally obscured.

Introduction

Classroom phenomenaria such as ant farms and moth hatcheries afford students access to phenomena whose rate of change requires observation and data collection ranging over extended courses of time, important skills in observational sciences such as astronomy and seismology. Phenomenaria of this kind have three important characteristics that arguably contribute to their value as learning artifacts, and that could inform the design of technology analogues. First, they are public, in that they are accessible to all members of the class. Second, they are persistent; phenomenaria are accessible continuously, during the whole school day. Finally, they involve the presentation of the phenomena over days and weeks instead of class periods. In this paper, we briefly describe an effort to construct a simulation of one phenomenon—the orbital motion of the planets in the Solar system—incorporating these three characteristics in our design, and our experience with its use in a third grade classroom to support an evidence-based learning activity.

HelioRoom

HelioRoom is a visual simulation of the orbital motion of the planets in the Solar system that explicitly attempts to adopt the public, persistent, and long term attributes of phenomenaria. In our implementation, a tablet computer is Velcroed to the middle of each of the four walls of a classroom. Adopting the pretense that the Sun is coincident with the center of the room, the tablet computers become synchronized viewports into the Solar system, with the planets revolving 360º around the periphery, temporarily entering a viewport, then leaving and becoming invisible for a while, then entering the next viewport, and so on. HelioRoom presents a greatly simplified model of the Solar system. The Solar system is reduced from ratio to ordinal scale; the order of the planets is maintained, but the distances among them are not proportional to their actual distances from the Sun. Orbital periods are reduced proportionately. Size and surface features are intentionally ignored; each planet is represented only as a uniform size sphere of a distinct color. The overall illusion is of colored discs traveling in a counter-clockwise fashion at different speeds, with some discs crossing in front of other discs as they overtake them (see Figure 1).

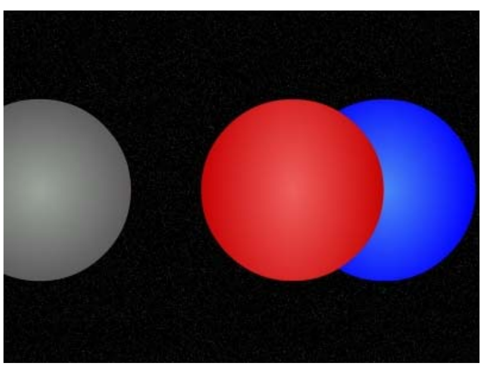

Figure 1. HelioRoom display.

Classroom Experience

HelioRoom was introduced to a third grade classroom of 25 children, with the cover story that our research lab had built the simulation, but now couldn't remember which color belonged to which planet. The students had just completed an introductory unit on the Solar system, focusing on the order and properties (e.g., size, orbital period) of the planets. Our goal was to leverage their nascent declarative astronomy knowledge in the performance of an ambitious evidence-based inquiry. The simulation ran continuously for nine class days (until the end of the school year). During that period, as students would make observations about the relative order of colored disks, they wrote their observations on index cards and posted them (and theories drawn from them) to a public “Idea Board” on the wall. Periodically, the students would come together as a whole class to propose theories about planet colors. As consensus was reached on the identity of a planet-color combination, it was written on the blackboard.

Not surprisingly, the task proved challenging for the third graders. As a group, after nine class days they had correctly identified six planets. The primary instructional design implication of the activity became evident after the first few group discussion sessions: the density and lack of organization of the observations on the Idea Wall made it extremely difficult for students to retrieve the evidence they needed to construct argument chains to support their theories. Rather than populating a data space with observations and then exploring the aggregate data set for a global solution, the students adopted an incremental “inside-out” strategy, first identifying (within seconds of the introduction of the activity) Mercury, and then building out planet by planet away from the Sun.

As individuals, students posted an average of 3.5 index cards (many with multiple observations or theories) and verbally presented an average of 3.3 theories over the course of the whole-class discussions. Some students “specialized” in certain planets; Pluto, for example, drew over 30% of references during class discussions and 20% of references on the index cards. Students supported written theories with evidence just over 50% of the time; support for theories was a procedural requirement during the group discussions. Interestingly, students favored the velocity evidence base over occlusion evidence by about a 2:1 ratio.

There was concern at the outset that the dynamism of the displays might raise problems of competing attention during other class activity. In practice, this proved not to be a problem, as the students quickly relegated the displays to the background of their attention as appropriate. The classroom teacher encouraged participation and devoted occasional class time for students to work on the task.

Conclusion

HelioRoom is an example of a broader class of applications that we call embedded phenomenon: simulations that map dynamic science phenomena to the physical space of classrooms, and allow students to act as scientists by using computers as simulated instruments for measuring or viewing those phenomena (Moher, et al., 2005). Inspired by the concepts of participatory simulations (Colella, 2000) and ambient devices (Wisneski, et al., 1998), embedded phenomena share important commonalities with other research-based classroom (Rogers, et al., 2002) and outdoor (Klopfer, Squire, & Jenkins, 2002) environments, including the use of distributed embedded technologies to represent simulation state to groups of learners. Embedded phenomena differ from these along the dimensions of persistence and duration; it is not used as a serial component of instruction, but rather runs concurrently and continuously as instruction proceeds. HelioRoom is currently undergoing a second classroom trial, augmented by a scaffolding application that provides a simple database where students can store and retrieve observation data.

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