6th Graders "doin' science" - Collecting Data and Looking for Patterns in a Virtual Field

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1. Introduction

Kevin Harris' sixth grade class has a mission; they need to find out why there are more red flowers in certain areas of a large field. Mr. Harris breaks up the class into groups to explore different parts of the field. When the children come upon a flower, they place a flag in the ground to mark the spot and record its position and colour using a Pocket PC that doubles as a Global Positioning System (GPS) receiver. They do all of this at an ImmersaDesk™ in their school. Once all of the data is collected, the students meet as a group in their classroom to integrate and visualize it. Patterns that are not visible while collecting the data suddenly appear when that data is visualized as a whole. Using MyWorld, a geographic information system for high-school students, filters are applied to the data to make the patterns more obvious.

This collaboration combines the VR educational work at the University of Illinois at Chicago with the desktop educational work at Northwestern University. It is part of a larger NSF funded project including the University of Michigan and Georgia Tech developing guidelines and an engineering process to support software developers in building effective computer-based learning environments. We have been focusing our efforts on young learners and science inquiry skills. Combining the virtual environments work with MyWorld allows us to help children learn these skills in a controlled environment. At the same time we learn how to provide appropriate aide to the children engaged in these activities. In this pilot study we wanted to see if the children could articulate hypothesis, take measurements, and use the resulting visualizations to explain phenomena in this virtual environment. Further, even if the children could do the work, we wanted to know if they would they be engaged in doing the work, especially during the rather tedious task of data collection.

2. Doin' Science

Teachers have always relied on local environments to give students something to observe and measure. Local environments have the advantage of being local, and being real. However they may emphasize activity over learning, limit the domain of inquiry, and constrain teachers' ability to reduce complexity.

Conducting an investigation in a virtual world can help prepare students for these sorts of investigations in the real world. The students can explore environments that are not locally accessible and measure exotic phenomena. Most importantly, the teacher can simplify the environment to focus on particular features.

Wherever the students collect their data, they need to be able to effectively visualize and analyze that data. Pencil, paper, and the ever-present blackboard are the typical tools available. They are valuable for small data-sets but quickly become cumbersome with large amounts of data. Scientists use computers for this job and we would like to expose the students to this. However the tools that work well for scientists won't work well for schoolchildren. As with using VR to simplify the exploration, MyWorld allows us to simplify the visualization.

3. The Field

The Field is a square patch of flat ground 3000 feet on a side. Picket fences divide the space into a 3x3 grid. The field is big enough that you can not just stand in the center and see all of the important details, but not so big that you couldn't survey the space within a reasonable time.

The Field has limited affordances. The students can move around and plant flags at points of interest. Nothing that the children do in the Field will affect the underlying simulation. We imposed this constraint to reduce the cognitive burden of exploring the space and limiting the students to familiar activities. This still allows the students to articulate and investigate hypothesis, but like Astronomy, the students can't manipulate the variables of the study.

We have used variations of the Field on the ImmersaDesk at Lincoln since spring 2000. Jarvia Thomas' 2nd graders investigated issues of similarity and difference; Victor Baez's 4th graders learned about interpolation and extrapolation; Marilyn Rothstein's 6th graders learned to develop co-occurrence rules, and Joanna Peterson's 6th graders learned how to estimate population distributions.

4. The Activity

The sixth graders play a team of scientists in an ink company that gets their ink from fields of red plants; the students are to give recommendations for increasing the

yield of red plants. We introduce this scenario in their classroom and give them a brief tour of the Field on a PC-based 50-inch plasma panel with a PC bird tracker. The students notice that there are both red and white flowers in the Field. We talk about how to systematically search such a space; the students suggest several different 'lawnmower' algorithms. We then introduce the students to the GPS receiver and data collection tool that they will use. Mr. Harris, their teacher, then breaks them into groups and over the next two days groups of two or three are pulled out of class to survey their part of the Field.

The students use several displays while collecting data. The ImmersaDesk shows the Field. One student holds a Pocket PC showing the position and orientation of the group as well as acting as a data entry tool. One laptop shows a top-down view of the path they have taken; a second laptop runs MyWorld showing the locations of the plants they have found. We could have placed all of these displays onto the ImmersaDesk screen but didn't for two reasons. First, we wanted to strengthen the illusion of being in the Field by only showing the Field on the ImmersaDesk screen. Second, the multiple displays give the multiple students different tools to 'possess' as part of their 'job.' All of the students could see all the displays but each had to focus on one to complete the task. See Figure 1.

Each group spent 20 to 60 minutes exploring their sector; there was no time limit. The children had no trouble using the technology or integrating the different views presented by the multiple displays, and found roughly 90% of the flowers. The children were enthusiastic both during the in-class discussion and during their exploration of the field – one group continued exploring through recess. Each of the groups wanted to be the 'best' at collecting data. The children were also very good about switching roles on their own without prompting.

The next day the students met in their classroom to look at their data. We used MyWorld to integrate the collected data into a single display showing the positions of the red and white plants. The students noticed that the red and white plants were evenly distributed except for a circular cluster of red flowers. The children decided to go back and take a look at the center of the circle. Switching over to the Field on the plasma display we found a beehive there. The students concluded that the bees were pollinating the red flowers and helping them take over that area. The students also noticed that there are more flowers in the southern end of the field. We focused on two possibilities – moisture content and salinity of the soil. Ideally the children would mount a second expedition to take moisture and salinity readings at regular intervals. In this case we showed them what the collected data would look like. The soil moisture had a gradient that was orthogonal to the plant density, while the salinity matched.

The students' final recommendations were to buy more beehives to plant around the Field, and if possible trade the land in the north for more land in the south.

5. Conclusions

We believe that this study had several benefits for the children. It made the math concepts real and gave them a purpose in the real world. The children developed confidence they could perform a real science research project and gained an appreciation for the importance of careful observation. The study also engaged children who were ordinarily less reluctant to participate. Our next study will focus on assessing the effectiveness of this experience.

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Figure 1: The left image shows the class getting their first look at the field on the plasma display. The center image shows their data collection/GPS device. The right image shows Kevin Harris and one of his groups collecting data.