Best Practices of Technology Integration

Title: *Sensing Science - Elementary Probes and Interfaces*

Subjects: Math and Science

Intended Grade Levels: K-5

Description:
Data collection, graphing, and drawing conclusions from the graphed data are tasks that students at all levels struggle with. As students progress through school, their knowledge of graphing, data collection, and their ability to make inferences becomes more sophisticated. The challenge for early elementary teachers is to provide meaningful experiences that teach these skills. The activities in these lessons are designed to expose students to data collecting techniques, as well as using the collected data to create graphs. In addition, this lesson will allow the students to practice viewing graphs and drawing conclusions from them. Interfaces and probes are quite commonly used in high school and middle school science courses, but their use in the elementary grades is not very frequent. Our experiences show that this is an under-utilized resource.

Narrative:
Making and interpreting observations is a lifelong skill. Students need much practice and timely feedback when first introduced to these skills in the elementary grades. One useful tool is to graph the data collected and look for patterns and trends on the graph. Though graphing is a skill that all students should master, elementary-aged students can learn to read a graph before they learn to create one from data.

Students need to collect data and somehow display it in graphical format, yet at this age they lack the skills to graph their data by hand. Using probes to assist in data collection, interfaces to feed the data into the computer, and finally the computer itself to assist in plotting the graph, eliminates this difficulty. Furthermore, the computer can plot a variety of different types of graphs, so different learning styles can be accommodated. In addition, using probes to collect data permits young students to conduct experiments that might otherwise be too complicated, (e.g.: measuring oxygen or carbon dioxide levels in the air or water).

The end product of all of this is that in every aspect of the activity students have the opportunity to utilize critical thinking skills. They get the chance to reflect on their results, and make suggestions for further investigations and even make predictions of the outcomes of these experiments. All of this is done in a timely fashion, since setting up the probes, data collection parameters, and graphs is a rapid and simple process. Time can therefore be used more productively in the classroom.

Curriculum Benchmarks:
MI.MAT.I - Patterns, relationships and functions.
MI.MAT.III - Data analysis and statistics.
MI.MAT.V- Analytical Thinking
MI.MAT.I.2.E - Variability and Change

MI.MAT.III.3.E.2
Inference and Prediction

MI.MAT.III.3.MS.2
Design experiments to model and solve problems using sampling, simulations and controlled investigations.

MI.MAT.III.3.HS.2
Design investigations to model and solve problems

MI.SCI.I - Constructing New Scientific Knowledge.
MI.SCI.I.E.6 - Construct charts and graphs and prepare summaries of observations.

MI.SCI.I.1MS.2
Design and conduct simple investigations.

MI.SCI.I.1MS.5
Use measurement devices to provide consistency in an investigation.

MI.SCI.I.1.HS.3
Design and conduct scientific investigations.

Detailed Timeline:
These investigations can range from single lessons, where much is directed by the teacher, to projects covering several weeks. In all cases students would begin by trying to answer a question. They would need to design and conduct an investigation to help them to answer the question. After class discussion concerning the results, further investigations would normally be proposed and then designed. The time needed is a reflection on the variety of skills and amount of reinforcement desired by the teacher.

Materials/Hardware/Software:
Ecolog, Vernier, or Pasco Interfaces and sensors
Graphing Plus, Data Studio or LoggerPro Software
Computer
Graph Paper
LCD Projection unit if desired
Individual experiments: Equipment will vary depending on the topic.

Activities/Procedure:

There are a variety of interfaces available. For grades K-3 we chose a simple device due to the age of the students. The device is called the Ecolog. For other grades, both Vernier and Pasco interfaces were deemed to be suitable. The instructions given here refer to experiments that 1st, 3rd, and 5th graders conducted. First graders investigated similarities and differences when fresh water and salt water was boiled. Third graders investigated how light intensity changed as a function of distance. Fifth graders investigated how the level of carbon dioxide (fizziness) varied in different soft drinks. The instructions can be adapted for a variety of other science topics. Science content and process skills are both developed at the same time in all of these investigations.

First Graders: First introduce the Ecolog. Have students discuss their prior knowledge of what happens when a liquid is heated. Discuss salt water, (oceans) and fresh water (lakes). Ask whether they think each will heat up differently. Have students suggest how this can be tested. Teacher should set up the experiment that the group agrees on. Use a temperature probe to investigate how the temperature of each type of water varies with time when being heated to boiling. Do they both heat at the same rate? Do they both boil at the same temperature? If there is a difference, is there any implication for how lakes and oceans might behave? Have students predict whether both liquids will freeze at the same temperature. Test their predictions.

Third graders: First introduce the Ecolog. Have students discuss their prior knowledge of the light. Discuss when a light is the brightest and when it is not very bright. Tell the class that you are going to be measuring the intensity of light from a flashlight. Tell them that the Ecolog will measure the light. Students should predict what will happen as the light source is moved closer and further from the sensor. Record their predictions on the board. The graphing plus software allows you to predict the graph before the data is collected. Choose a student to draw in what he/she predicts the graph will look like as the light source is moved away from the sensor. Conduct the experiment by moving the sensor away from the sensor at predetermined intervals. Discuss their predictions and results. Have students replicate predictions for moving the light source closer to the sensor. Collect data. Discuss. Teacher should present some pre-created graphs. Have students interpret the graphs and tell what they think caused the results. Have students make predictions on what the graphs would look like for other types of light e.g.: fluorescent, halogen, sunlight, etc. Design experiments to test predictions.

Fifth graders: First introduce the interface and probes and explain the concepts behind them and their use. Students need to hypothesize about the "fizziness" of different carbonated products and then test their hypotheses. Measuring CO_2 levels is not an easy task, but a CO_2 sensor can do the job quickly and accurately. Students use the sensor to test different soft drinks. They can test how the fizziness changes once the can/bottle is opened. Do some drinks retain their fizziness better than others? Students make predictions then test them. Does the temperature of the drink make a difference? For example, does a cold drink fizz more than a warm drink? Again, students predict and investigate. There are numerous other extensions to this investigation. Throughout, students gain experience in hypothesizing, designing experiments, collecting and interpreting data, and using graphs.

Teacher Preparation:
Make sure that the interface and probes are connected to the computer and working **prior** to the start of class. You really don't want to be messing around with equipment when the students are waiting. You will need to get other equipment ready as required by the experiment you are conducting. It may be helpful to have a projector connected to the computer if access to computers is limited in the classroom.

Prerequisite student skills: None

Assessment/Evaluation:
Students can create graphs based on a teacher-demonstrated experiment related to the topic under study. Students will be assessed on the accuracy of their graph and the accompanying explanation. Students can also be asked to make predictions related to extensions of the investigations.

Follow-up Activities:
The interfaces and probes can be used to graph temperature, sound, humidity, pressure, motion, magnetic field, gas concentrations, etc. You may decide to conduct similar experiments using these other options. The number of investigations that can be done using probes and interfaces is limited only by the equipment available, the imagination of the teacher, and the time that can be allotted to the activities.

Submitted By:

Names: John Howarth, Martha LaVoie, Michael Hodges, Marc Lester, Kelli Leep
School District: Thornapple-Kellogg
Address: 3885 Bender Road, Middleville, MI 49333