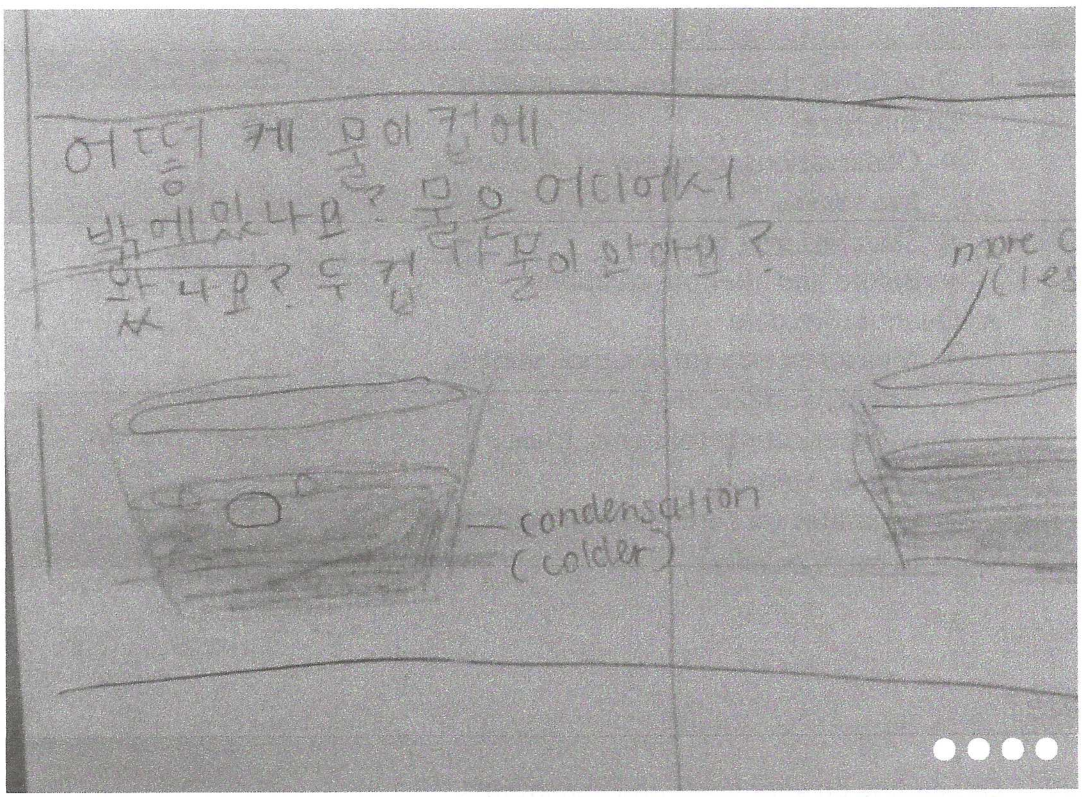
Search the Educators section Search

Collecting and Analyzing Data

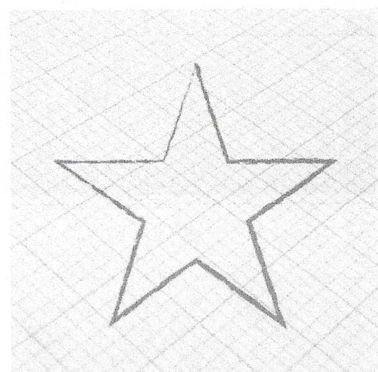


When we empower students to collect *and* evaluate data, they learn how to make scientific meaning out of concrete evidence. The science notebook is a useful tool for both data stages: collection and analysis.

About This Guide

Below, you'll find guidance related to **helping students collect and analyze data**, including:

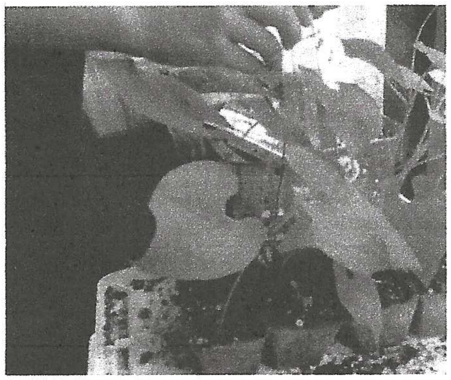
You Are Here: Investigations



Science Notebook Corner

Learn how notebooks can help your students think and act like scientists.

Introductory Activities

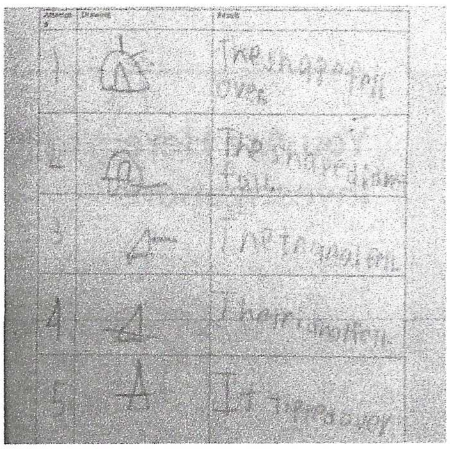


analyzing the data
- An example story from a real classroom

Because we know teachers appreciate seeing the results of using these strategies, we've also created an example gallery containing student work and photographs of scaffolds on the walls of classrooms.

Gallery of Examples

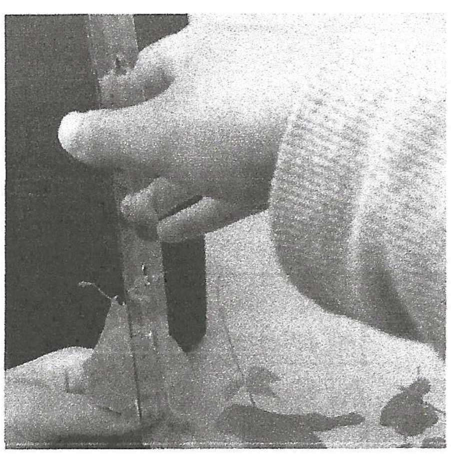
What kind of data will students collect?



Most kinds of data fall into two broad categories:

- *Qualitative observations* [*see more tips on this* **here**]
  - Observations using any or all of the five senses
  - Sketches over time
  - Before and after observations
- Quantitative data
  - Measurements (of distance, weight, height, wattage, etc.)
  - Number counts (of items, trials, swings, spins, etc.)
  - Estimates (of something too difficult to count exactly)

Who will collect the data?



Depending on your goals and constraints, you may choose one of these options:

- Everyone collects the same data
  - e.g. Each group performs the same mineral scratch test.
- Some groups collect different parts of the data that everyone needs
  - e.g. In a water quality test, some groups test for temperature and other groups test for pH. This data is then shared with everyone.

Strategies for Investigations

Strategies for Notetaking

Strategies for Reflection

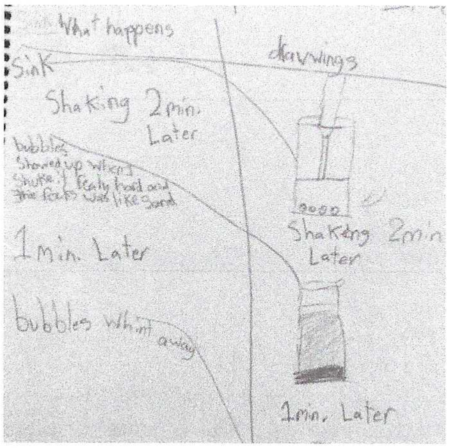
Notebook Galleries

Science Notebook Stories

Homepage

migration data collected by scientists over several years.

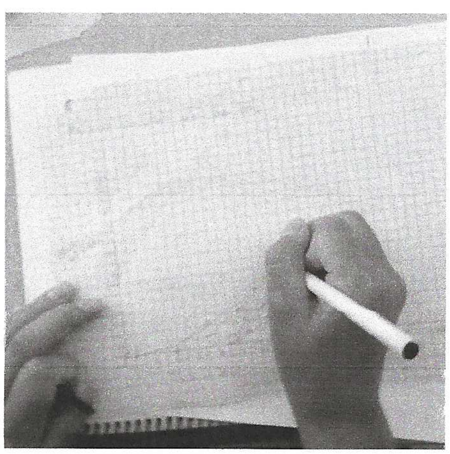
How will students organize the data?



Depending on your learning objectives, you can decide from several options:

- Students use pre-made data tables that students copy or glue into their notebooks.
- Students make their own data tables based on prior class experience.
- Students collect data as they choose. Making decisions about how to collect data is part of the learning.
- Teacher puts data into a class data table. This can be done in addition to students collecting their own data. A class data table can be a powerful tool so that everyone can look at the same data.
- Teacher makes an open data table at the front of the class. Students are responsible for filling out parts of the class data table. Students then can put the data they collected in their notebooks into the larger data table created by the teacher.

How will students analyze the data?



Again, your learning objectives will determine which option you choose:

- Students create graphs or other synthesis of the data in order to look for patterns and trends.
- Students make meaning of their own data in pairs or small groups.
- Students pool data as a class and consider it all together.
- Teacher provides scaffolding to help students go from organization of data to

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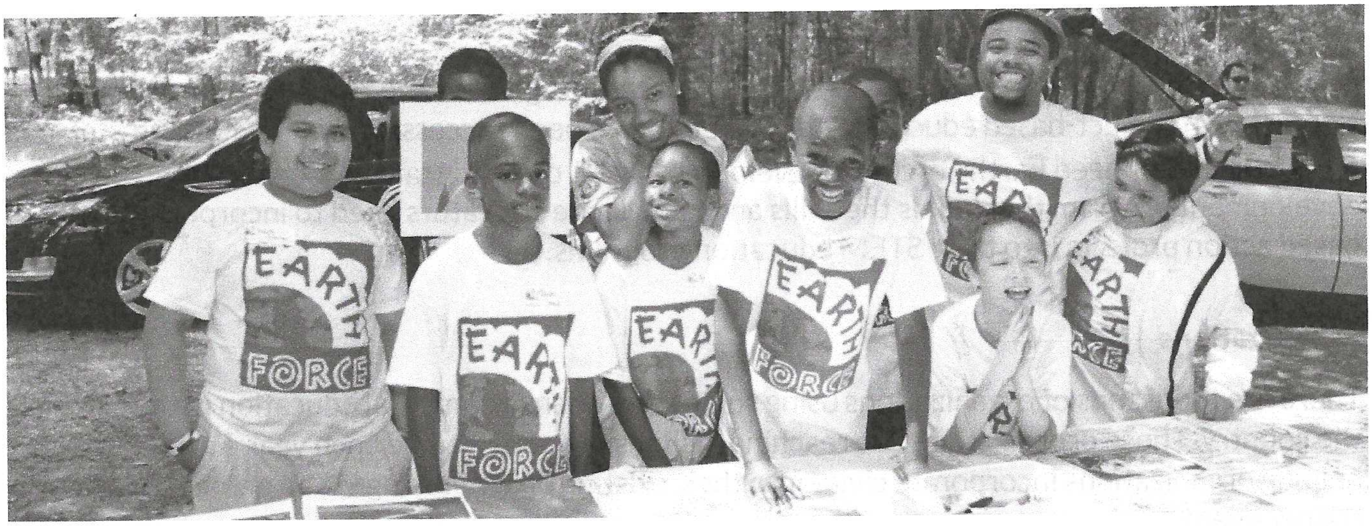
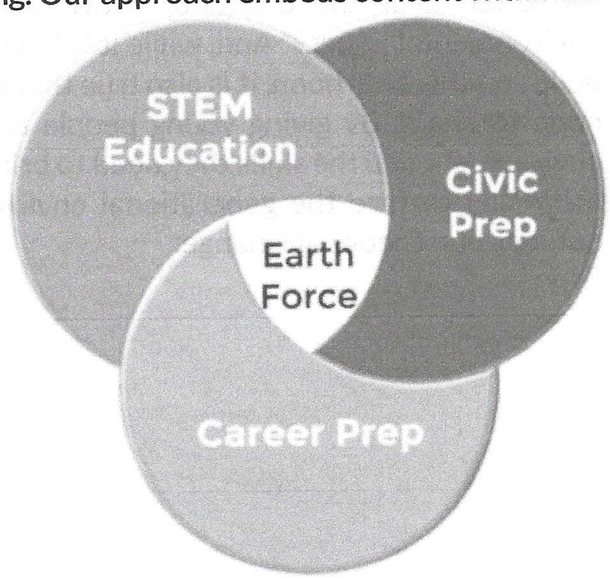
Strategy



Drawing from 25 years of experience and a wealth of research on effective STEM education, youth development, and civic engagement we have created a tool, the Community Action and Problem-Solving Process, that combines the hands-on education that young people need to understand environmental issues with the civic experience they need to engage in civic action.

Earth Force supports schools as they are working to meet the changing needs of their students. Earth Force programs support schools as they work to meet three needs:

STEM – Schools across the country are working to change how they teach middle school science. Gone are the days when science was taught as a recitation of facts and educators are working to adapt their methods to incorporate more active learning. Our approach embeds content within an active learning framework to help education make this transition. 72% of the educators we have worked with say the program helped them create more authentic, active learning experiences for students.



Civic Preparation – Through Earth Force students get a first-hand experience at being an active member of their community. Students study problems in their community, develop solutions, and work with local leaders to turn their ideas into real changes.

Career Preparation – Earth Force students develop the skills that are necessary for the jobs of tomorrow. Students learn to apply problem solving tools in situations where there is no simple answer. Businesses from a wide variety of areas have identified problem-solving skills as the number one attribute they are looking for in employees.

The result is young people who have experience apply STEM concepts to develop solutions to community problems. They then use that knowledge as they starting point for a civic action project. Our strategy is to focus on three levers of change:

Educator Professional Development

In 2017, Earth Force surveyed a broad range of education agencies and found that though are all interested in project-based education, few schools have been successful in implementing that model. To fill this need Earth Force has developed a world class educator professional development program that builds the skills and knowledge educators need to incorporate civic-based action projects into their STEM education programs.

Organizations

There are thousands of organizations using some form of environmental education in the across the country. Those organizations are reaching millions of young people each year. Earth Force is helping organizations incorporate civics into their existing programming via an annual train-the-trainer event.

Youth-Led Solutions

Each year thousands of young people are taking action to improve the environment. Earth Force is committed to increasing awareness of the positive environmental impact of projects driven by young people. To promote the achievements of young people Earth Force is the host for the Chesapeake Bay Caring for our Watersheds contest and the Colorado based Rocky Mountain Environmental Challenge.

Theory of Change

We often hear the question, "How can educating young people be the answer to global environmental issues?" And, while it is true that middle school students are not going to eliminate pollution this afternoon, it is also true that they are the key to any long-term solutions society may hope to enact. By giving young people the opportunity to develop their understanding of the environment and the skills they need to bring that into the civic realm we ensure that communities are ready to face the generational environmental challenges they face. The following graphic outlines our Theory of Change:

TOOLS TO IMPROVE YOUR EARTH FORCE EXPERIENCE

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RESOURCES FOR EACH STEP

Maximize the value of each step in the Community Action and Problem Solving Process

STEP 1: COMMUNITY ENVIRONMENTAL INVENTORY

STEP 2: ISSUE SELECTION

STEP 3: POLICY AND PRACTICE RESEARCH

STEP 4: GOAL & STRATEGY SELECTION

STEP 5: TAKING ACTION!

STEP 6: CELEBRATE & REFLECT

Can We Teach Environmental Problem Solving?

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If we were to ask participants at this conference to state the chief objective of environmental education. o doubt most responses would mention teaching environmental problem solving. Environmental problem olving has been the cornerstone of environmental education almost since its inception. Indeed the Tbilisi)eclaration on Environmental Education, the seminal document for this field, states that the basic aim of nvironmental education is to help "individuals acquire the knowledge, values, attitudes, and practical skills to articipate in a responsible and effective way in anticipating and solving environmental problems." (UNESCO 980).

Three variables distilled from this statement were investigated: problem solving skills, empowerment nd interest. Environmental problem solving skills are synonymous with the "practical skills" cited above. nterest can construed as a component of attitude about environmental problems, and empowerment is related to ffectiveness.

Action Research Community Problem Solving, a program developed at the University of Michigan chool of Natural Resources in collaboration with Deakin University in Geelong, Australia, was designed to meet hese same goals (Wals et. al. 1989, Bull et. al 1988, DiChiro and Stapp 1986). This study focuses on its mplementation in two junior high schools in the inner city of Detroit from October 1987 through June 1989.

Methods

A pilot study with an eighth grade class in one of the schools provided information about problems that vere of interest to inner city Detroit students. These, together with a list of "traditional" environmental problems generated by the author, formed the basis for the instrument used in this study. For empowerment and interest tudents were presented with a list of 46 problems and asked to rate each as to how much interest they had in hat problem and the degree to which they felt they could be effective in solving it ("empowerment"). Two limensions of problem solving skill, action strategy choice and information gathering were investigated by resenting students with several problem scenarios then asking them to choose which among a number of otential actions they would likely take in that situation, and from among a number of information sources which hey would most likely consult. All these questions were included on one instrument which was administered efore and after the project.

The study consisted of three experimental and four control classes; a total of 211 students. Control groups were selected so that they had the same teacher, similar academic ability and similar demographics as the experimental classes. Students in the experimental classes participated in an Action Research Community Problem Solving project, including choosing an environmental problem as a class and then working to solve it. Projects ranged in length from four to eight months. Control classes did not participate in action projects; their only participation in the study was to fill out the pre and post test surveys.

The Guttman-Lingoes Smallest Space Analysis ,SSA III (Lingoes 1972), a non-metric factor analysis was used to group the survey items into a smaller number of scales for further analysis. Pre-test responses of experimental and control groups were pooled for this analysis to ensure an adequate sample size. At this stage of the study neither the experimental or the control group would have been affected by the experimental manipulation. The scales then reflect the a *priori* world view of the inner city students in this study. The SSA III analysis yielded five empowerment scales, five interest scales and five problem solving scales. Answers to individual question were analyzed as well.

Results and Discussion

The empowerment scales were: Persistent Neighborhood Problems, Persistent Problems Beyond the Neighborhood, Neighborhood Appearance, Urban Nature, and Sexual Consequences. Interest scales were similar. Finally problem solving skill categories were: Find out everything about a problem and tell somebody about it, changing the cafeteria menu, call powerful others, consult newspapers and teachers, and seek expert advice about environmental problems.

In each case there were significant differences between the ratings of these scales strongly suggesting that empowerment, interest and problem solving skill are domain specific traits. While other studies have demonstrated domain specificity of these constructs (Paulhaus and Van Selst 1990, Voss et. al. 1983, and McGuire 1976), the domains in this study seem to be much more specific than has been previously reported. Lopez and Staskiewicz (1985), Lange and Tiggeman (1985), and Berndt (1978) have described personal and political problem domains, while Paulhaus and Van Selst (1990) have added a domain of interpersonal issues. This study demonstrated that the domain of "political problems" was much too broad. There were five domains of political problems in this study, all based on the kind of political problem. Simply put, students felt more empowered, more interested and more skilled with respect to some environmental problems than others. This finding calls into question the use of Locus of Control instruments which have traditionally been used to ascertain level of "empowerment."

The bad news is that it may not be possible to teach "environmental problem solving" except in the context of one kind of problem. There is no guarantee that learning problem solving in one environmental domain will transfer automatically to another one. The good news is that If other studies collaborate this finding we may find out that students are more empowered, interested and skilled in problem solving than we previously thought. Global measures, like locus of control which has traditionally been used to assess empowerment, may have masked these domain specific achievements. While we may not be able to teach "environmental problem solving" per se, it is clear that we can help students to become efficacious in solving specific environmental problems.

Secondly, working on an action project did not result in significant differences in empowerment, interest or problem solving skill with respect to the factor analysis derived scales. In finer grain analysis of individual items, there was a more disturbing result. On five items the control group increased in empowerment while the experimental group decreased in empowerment with respect to five different items. This raises the question of whether the experimental group was somehow impeded from feeling empowered on these problems as a result of this project.

Simmons and Parsons (1983) had similar results in a study of the effectiveness of an instructional program designed to increase feelings of empowerment in adolescent girls. "Underclass girls" significantly decreased in perceived competence after completing that program. It may be that some well intentioned instructional programs can be harmful. It is more likely that lack of success, lack of structure, lack of adequate information and lack of social support were not adequately addressed in our program. If one tries to take action and is unsuccessful, feeling less empowered should be expected (Bandura 1990). On the other hand, the control group's more hopeful view of their efficaciousness is not surprising considering that they had not yet been jaded by frustrations inherent in the actual problem solving experience itself.

Is there any hope that skills learned in the context of one problem can be of help to students in solving different problems later on? Is there hope that we can we help students to get over the hump of frustration that may result in decline in their sense of efficacy. Fortunately there is. Experience with more than one action project may help build a cognitive map to a wider problem space (Bull et. al. 1988). Monroe (1991) and Bardwell (1992) discussed the positive impact of vicarious problem solving experience through exposure to success stories of others involved in solving environmental problems. While skills, interest and empowerment do not automatically transfer from one problem to another, experience with a variety of problem spaces and explicit comparisons of similarities and differences to one's own problem solving experience seems to be key. These discussions enable students to store "problem solving" information in such a way that it can retrieved for use in more than one problem, because the relationships between these problems and approaches to dealing with them have been made clear.

Kaplan and Kaplan (1982) have discussed the importance of structure in building cognitive maps. Taylor (1989) and Gruber and Trickett (1987), Mohai (1985) and Brody (1982) have demonstrated the importance of information in developing feelings of efficacy and skill in problem solving. Because student choice was valued so highly, this study may have given students too much freedom while neglecting the structure and information resources which are necessary for the experience of success. Too often, when we over-emphasize process to the exclusion of content, we may draw too heavily upon what students already know without considering that with regard to taking action on some of these problems students may wrack their brains but find nothing there to help them. Information is power, and information that is structured is more easily assimilated. We may be forced to admit that process isn't enough. Maybe we do have some knowledge via experience that is worth imparting to the younger generation after all. This does not mean we disregard students' own valuable experience and perspectives, it's just that this may not be sufficient. A "both and" approach is needed.

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