Collecting Data Outdoors: Making Connections to the Real World

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The most enjoyable experiences that I have had with young children are those that occur outdoors. Taking children on walks in the woods, at our local park, or simply around the school yard can prompt many discoveries about the natural world. As we walk, children gain knowledge and skills by using their senses to collect information about the world around them. Traditionally, we think of providing these experiences as part of children's scientific learning. However, direct observation is also an important piece of mathematical learning that is essential for identifying patterns, promoting problem solving, and developing spatial sense and reasoning.

Why Data Collection?

How can observations be used to learn mathematics? One way is through collecting data outdoors. Data collection is a process in which children can make connections between mathematical concepts, in a variety of content areas, and in the real world. In addition, it is possible to embellish this process with children's natural curiosity about the outdoors by offering experiences that are challenging and engaging and that support learning.

When working with children outdoors, it is interesting to note their perceptions about the world around them. Often these perceptions are misconceptions. Children will ask such questions as, "Why are all birds black?" and inquire, "What are those rats with the fuzzy tails?" when they see squirrels. Children commonly make such comments as, "Trees are only alive when the wind blows, because then they move" or "We should clean up the forest and get rid of all these leaves."

Simply telling children that their perceptions are incorrect will not change these misconceptions. However, when children become data collectors, they look for patterns and develop reasoning skills that allow them to draw conclusions on the basis of information that they have not only collected but also observed with their own eyes. If they observe and collect information about where they find squirrels (e.g., on the ground, in a tree, on the fence), they learn about the behavior of squirrels. If children begin to observe and record the animals living in leaf litter, they soon realize the diversity of life that uses the "messy" forest floor as its home.

As children collect data, they see how prior knowledge about number, size, shape, and pattern relates to things around them. For example, they may use numbers to help them count and record the number of petals found on different flowers, they may use nonstandard measurement devices to examine the circumference of trees and compare sizes, or they may simply collect data about all the outdoor things they find that have ABAB patterns.

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Edited by **Kate Kline,** *kate.kline@wmich.edu, Western Michigan University, Kalamazoo, MI 49008. This column addresses the early childhood teacher's need to support young children's emerging mathematics understandings and skills in a context that conforms with current knowledge about the way that young children—pre-K–K—learn mathematics. Readers are encouraged to send manuscripts for this section to the editor.*

Data collection builds beliefs about what mathematics is and about what it means to know and do mathematics, and it supports children's view that they are mathematicians. Children who collect data can portray themselves as mathematicians and begin to see how mathematics can be used to solve real problems.

In the Classroom

A group of kindergarten students began their investigation of data with the following question from the teacher: "One thing mathematicians do is collect data. Does anyone know what data can be?" No one knew. One boy asked if it was like collecting bugs. The teacher wrote "data" on the chalkboard and then walked around the room pointing out data that the children had already collected, like the information on their weather chart, children's birthdays, and their favorite foods. Then she explained that collecting information, or data, helps you to learn something that you might not have known before.

The teacher then asked the children if they would like to know anything about the animals in their school yard that they did not know before. Their responses included how caterpillars grow, how big is an anthill, how much do animals weigh, how big are the animals, what animals can we see, and what animals can we hear. The teacher wrote all the ideas on chart paper, and as a group, the children decided which idea to investigate. They decided that they would use their senses to see which animals they could see and hear.

Once the children had made this decision, the teacher encouraged them to think about how they would keep track of the data. They decided to use their journals. One child suggested writing everything down in a list; another said that she could remember it in her head; and a third suggested using two pages, one for what they would see and one for what they would hear. In the end, the third idea was modified; they chose to draw a line down the middle of their papers and write or draw the animals that they could see on one side and those that they could hear on the other side. At the top of one column, they drew an ear; at the top of the other column, they drew an eye (see **fig. 1**).

Deciding what kind of data to collect and how to record the information can be difficult for inexperienced children. The more often that students get an opportunity to ask the questions themselves, the better they become at recognizing data that they want to collect in the future. NCTM (1992) states that as students are involved in generating questions and collecting data, they will be able to make more sense of data.

FIGURE 1

The "ear" and "eye" columns helped organize the data.

Sorting Data

Sorting is an excellent way to encourage children to think about important features of data that lead to classifications that make sense. Two important questions concern sorting data: (1) Do we think about sorting data before or after they are collected? and (2) Which sort gives us the best answer to our original research question?

In the example described previously, the kindergarten children decided to sort their data *before* collection into "animals they saw" and "animals they heard." These categories helped them think about the questions that they wanted to answer and how to organize their record keeping of the collection. When they returned to the classroom, however, they realized that the data could have been sorted into "animals they saw," "animals they heard," and "animals they saw and heard." This recategorization of the data was valuable because it helped the children understand that classification systems can grow and evolve as data are collected.

It is also possible to collect data as separate pieces of information, without any categorization decided on beforehand. Children could be given small sheets of paper stapled at the top, and each time they use their senses to observe an animal, they could draw a picture or write the name. When they return to the classroom, they could pull their "books" apart and decide how to sort the data into groups according to a common characteristic. This more open-ended approach would also be beneficial in helping chil-

dren understand the various ways that data can be categorized. It would also help them think carefully about the question they are researching.

For example, another class decided to measure and record the size of the animals that they saw. The class had been learning nonstandard measurement and saw this task as being an opportunity to use their new skill outside. Many suggestions were made about what they could use for a measuring device, but they finally decided on Unifix cubes. Before they collected the data, the children talked about data-collection procedures and identified those that would not harm any of the animals that they were measuring. The following recommendations were listed on the chalkboard: "Don't touch the animal with your hands or with the Unifix cubes"; "If an animal is too far to reach, just estimate"; "If an animal might hurt you (like a bumble bee), just estimate"; and "We all do not have to measure the same animal. One person in the group can measure while the rest record the information." (See **fig. 2.**) Once the procedures were agreed on, the children decided to collect the data by designing a chart in their notebooks and by recording a picture of the animal and the number of cubes needed to measure it.

In this example, the children's data-collection charts were not organized in any particular way. Therefore, the children were placed in small groups and asked to think about how they might sort their data to represent them to others. One group sorted by the type of animal they saw (mammals, reptiles, insects, and so on). They had forgotten about the original purpose for collecting the data. The teacher then referred them to their initial question and asked, "Does this grouping help us answer what size the animals are that we found outside?" At the end of the lesson, each group presented its groupings, and the class members discussed which sorting method they thought best answered their research question.

Representing Data

When the students returned to the kindergarten classroom with their journals, the teacher posed the following problem:

> I have a friend who studies animals and would like to know what we found in our school yard. We have collected a lot of data. How can we display it on one piece of paper so that she might be able to see what we found?

The children said that they could write small and that each person could write one thing that they found. When the teacher demonstrated to them that some of them saw the same things while others saw or heard different things, she asked whether they could find a way to get all the information on the chart without repeating any information. One student said, "Make a chart like our journals." The student was then asked to show the group what he meant. He drew a line down the middle of the chart and drew an eye and an ear at the top, just like in the students' journals. Once the data from the entire class were compiled on the chart, the students discussed what the graph illustrated. They talked about how many animals they saw and heard and why more animals were in one category than in another.

To help the students think about other ways to represent their data, the teacher gave students Unifix cubes and asked them to choose two colors, using one color to represent the animals that they heard and the other to represent the animals that they saw. A student's representation is shown in **figure 3.**

Davis and Maher (1997) explain that everyday experiences can provide children with the building blocks for learning mathematical ideas. Further, when children can represent these ideas—whether on paper, with manipulatives, or mentally—learning is extended. Therefore, after data are collected, children need to explore ways to represent those

Thinking about Classification

Giving children the opportunity to think about whether their classification helps them answer their research questions is essential for developing a deeper understanding of data analysis. Encouraging children to create different ways of sorting data helps them recognize the variety of possibilities for collecting and categorizing data. One can find numerous examples of scientists and social scientists who must think about how to sort the data that they want to collect before and after collection. For example, public relations firms that develop questionnaires, marketing assessments, and opinion polls must think about the information that they want before they design an instrument to collect the data. In a survey, they might use such demographic information as age range, salary range, and level of education. The questions might also be categorized by such factors as knowledge, preferences, and practices. In contrast, social scientists who collect qualitative data might organize or categorize their data *after* they have collected it. Researchers might want to know people's opinions about a particular program and then ask an open-ended question, such as, "What do you see as the benefits of this program?" They would then sort, categorize, and quantify the responses after they were collected.

data. The events described here show that children can think in various ways to organize the data that they have collected. This task of organizing data allows children the opportunity to sort and classify real data for a real purpose.

Asking Questions

The questions that the teacher asks about data throughout the process of formulating a question, collecting data, representing data, and interpreting data are crucial. They help children think about the important mathematical understanding involved in data collection as well as clarify their own perceptions of the natural world.

The following list represents the kind of questions that the kindergarten teacher asked that fostered mathematical thinking. Her questions helped students—

- formulate research questions: "What kinds of animals do you think we could find in our school yard? What do you want to know about them?"
- think about sorting by important features and record keeping: "How can we keep track of what we see and what we hear without getting them mixed up?" "How will we remember what we saw and what we heard?"
- think about reclassifying: "What else is the same or different about some of the animals we saw? If we were to make a new chart with only the animals we saw, and we had to put some in one column and some in the other column, how could we do that so that all the animals in one column would have something the same?"
- represent the data: "If we wanted to draw a picture of our data to show another class what we found, how could we do that?"
- describe what the representation tells us and why we think it has occurred: "Which side has more animals? Why do you think we saw more animals than we heard? If we collected these data at night, what do you think the results would be?"
- clarify ideas about the natural world: "Which of these animals are insects? How do you know? Why do you think we found more insects than any other animal? Why do you think we did not see any frogs? Where could we find more information about the songs of birds and frogs?"

Using the Data Later

One rule is important about collecting and compiling data: never throw anything out. The information collected by your students can be used again to compare data sets and see change over time. By documenting such variables as weather conditions, time of day, study area, or date, children can observe differences in data sets from one day to the next or from one area of the school to another. For example, one teacher placed bird feeders in the back of the school and none in the front of the school. The children decided to collect data to see whether they saw more birds in the front or the

FIGURE 2

"This is a caterpillar, I think."

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FIGURE 3

Blue and red cubes represent data in the "ears" and "eyes" column.

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back. They recorded the data by using pictographs for each location. For the data collection in front of the school, the children decided on the following four categories: in the air, high in the trees, low in the bushes, and on the ground. For the back of the school, the students decided that they should add one more category: on the feeders.

By displaying one data set next to another data set, the children were able to make comparisons and see similarities and differences between the two sets of data. They offered the following observations: "There are more birds in the back of the school than in the front," "There are more birds at the birdfeeders than any location in the front of the school," and "There are more birds on the ground in the back of the school." When they were asked to think about why these differences existed, the children excitedly offered possible explanations, such as, "The birds are hungry; that's why we see so many at the birdfeeder" and "There are a lot of birds on the ground in the back of the school, because a lot of the seeds have fallen to the ground from the birdfeeder!" Making comparisons among data sets prepares young children to think like statisticians as they discuss possible interpretations for the similarities and differences that have occurred.

Conclusion

The process of data collection gives young children a wealth of opportunity to think like mathematicians and apply their reasoning about data to the real world. It also introduces children to ideas of more abstract mathematics as they sort and classify data, create graphs, compare data sets, examine patterns, and interpret graphical representations.

It is crucial that educators create meaningful mathematical environments by providing real-life contexts and setting the foundation for more abstract mathematics. Both the National Council of Teachers of Mathematics and the National Association for the Education of Young Children call for young children to learn in realistic contexts and to study the world in which they live. Taking children outdoors gives them real experiences that they might otherwise not have had, especially those in urban areas where green space is limited or unsafe. The more we can integrate real-life activities into classroom learning, the more students will be able to recognize the importance of what they are learning.

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