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Statistics in Preschool

Statistics education has become established in the elementary school curriculum. Because the principles of statistics underlie many basic learning concepts, it is not surprising to discover statistics principles in the preschool curriculum as well. This article describes how statistical tools and concepts are included in the Brigham Young University (BYU) Child and Family Studies Laboratory preschool curriculum. At BYU, children study topics as long as they are interested, and teachers use projects to create a rich learning environment. This article describes how statistical projects—such as the “Question of the Day,” survey work, and experiments—are used to teach young children to pose questions, make operational definitions, summarize data, understand variation, gather data, construct bar charts, and apply the scientific method. BYU teachers also use statistical projects to teach many other important preschool skills.

KEY WORDS: Early childhood development; Experiments; Quantitative literacy; Surveys.

1. INTRODUCTION

Basic statistical concepts are commonly found in the K–12 curricula; in fact, the National Council of Teachers of Mathematics (NCTM) provides content standards for measurement, data analysis, and probability for the pre-kindergarten through 12 curricula (NCTM 2000). It is common for kindergarten children to collect data, such as daily weather conditions or shapes of Halloween candy, and to construct frequency bar charts using these data. Therefore, it is natural, albeit less common, for statistical topics and tools to be taught in early childhood education programs. Teachers at the Brigham Young University (BYU) Child and Family Studies Laboratory recognize that children are naturally curious and incorporate statistical projects in their preschool curriculum to help children learn to pose and explore their questions.

The BYU early childhood research lab is a practicum experience for undergraduate and graduate education students. Classes for children turning five are held four days a week during fall and winter semesters. Two morning and two afternoon classes of approximately 20 children each are taught by one graduate and five undergraduate students under the direction of an early childhood specialist.

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2. QUESTION OF THE DAY

The “Question of the Day” is a one-question survey at the start of each class and is possibly the most popular activity in the BYU preschool. After children find their name tags and hang up their jackets, they move to the table with the Question of the Day. The head teacher greets the children and poses the question. The question is written on a large sheet of paper and usually has a binary response; for example, “Do you prefer chocolate or vanilla ice cream?” or “Have you ever seen a lion?” The children respond to the question by writing their names in the appropriate column. The children enjoy expressing their opinion and comparing their responses to the rest of the class. During large group time later in the day, the teachers and children tabulate and interpret the results from that day’s question. Many statistical skills are learned and reinforced through this simple activity. Such skills include posing a question, defining operational terms, tabulating the responses, and observing variation in the responses.

First, through the consistent routine of being asked questions and responding to them, children begin to understand and use the unique format of the language pattern labeled “question.” They also begin to appropriately apply it to extend their knowl-
edge. Most adults forget how abstract the term question really is. Consider the following scenario: A guest presenter asks a group of four-year-olds if they have any questions, and a child says, "My aunt has a dog," or "My brother found a snake in the grass." By answering a question daily, preschool children begin to form and reinforce the pattern of the structure of a question in their schema and test this new "knowing" by verbalizing questions that seem to fit. For example, as the school year progressed, one child who just discovered he had a wiggly tooth was able to ask his teacher, "Do you have a loose tooth?"

Statisticians understand the importance of developing operational definitions, and the Question of the Day teaches children the importance of defining the terms in a question. For example, during a unit on pets the Question of the Day was "Do you have a pet?" Some children wrote their name under "yes" if they had a dog, cat, or lizard; others said "yes" if they had a virtual or electronic pet; still others affirmed they had stuffed animals or animals that were imaginary friends. Some children answered "no" even if the family had a fish tank full of fish or if other family members had pets or if the family kept horses and cows. During the review for this question, the teacher explained the varied interpretations of the term "pet" and helped the children appreciate that the same word means different things to different people. Discussion also centered around the idea that being more specific about the definition of "pet" during the data collection phase of the activity would have changed the results of the survey.

During large group time, the children and teacher tabulate and interpret the results from the Question of the Day. At the beginning of the school year, the class counts the responses together, with the teacher pointing to each child's answer. As the children learn the routine through the year, one child is chosen to lead the count and record the numeral total. Children learn to associate the number sequence with counting. They also recognize that the numeral associated with the tally for each response summarizes the class opinion. The result is each child being able to report, "The Question of the Day was about pets, and 13 people have pets and 7 don't."

In the large group discussion, the teacher can point out the variation in responses. Piaget (1962) pointed out that the four-year-old perspective is one of "What I'm thinking, you are thinking." Children see that others responded differently to the question and are curious why. The teacher and class discuss reasons for variation in responses to the Question of the Day. Instead of using the words most or least likely to describe frequency, many children talk about the "winning" or "losing" response. Some children compare their answer to the class. Some may be proud for picking the "winner" and others see that not everyone is like them. Some children take a step toward statistical inference by generalizing the most frequent class response to be the response for most children. One child used the results of the "Do you have a pet?" question to indicate to his father that most other children have pets, so he should have one too!

3. SURVEY WORK

Although the children provide data for the Question of the Day, they collect the data during survey work. Surveys are a data collection activity easily mastered by children. Children are divided into small groups of four or five with a teacher for each group. After each child is armed with the question, a clipboard, a tally sheet, and a pencil, the group goes onto the BYU campus where each child approaches university students to ask the question and record their responses. Figure 1 shows four children ready to survey university students about hats. Although the NCTM 2000 recommends survey work for grades 3–6, teachers at the BYU preschool have found survey work to be applicable to preschool age children. Children learn skills that include posing questions to increase knowledge, developing interview skills, testing a survey, representing a survey subject’s response, and learning to appropriately represent data with bar charts.

Children are naturally curious, and survey work develops children’s ability to pose questions. Frequent repetition of survey work with new topics gives children confidence in designing and seeking ways of finding answers to their questions. Questions are chosen from the topic under study. For example, when studying bases, children may ask, "Have you ever ridden a bus?" or before touring the campus flower store, "Do you like a sunflower or rose best?" At the beginning of the year, the teacher suggests a question and writes it on the survey tally sheet, but many children identify a related question closer to their understanding. As the year progresses, the children begin to pose their own questions.

Just as survey interviewers are trained in how to greet survey participants, children are taught how to stop someone and politely ask a question in different ways. Before gathering data, the children practice by surveying one another, and they will often provide encouragement to those children with less confidence. When familiar with the procedure, the children take their questions to BYU students. The survey of university students takes between 5 and 15 minutes, and each child stops between 1 and 20 students depending on their enthusiasm and speed in questioning. Children learn the process of survey research, but important issues such as probability sampling and making valid inference should be overlooked. University students are willing
research subjects for the young researchers, so there is no reason to introduce the idea of "nonresponse" to the children!

The lessons of testing a survey instrument are not lost on the children. For example, as the children studied food preferences of their class pets, the teacher suggested that each child choose two foods they thought the class gerbil would like best and then ask the university students which one they thought would be the gerbil's favorite. These instructions were fine in the abstract, but during the actual survey respondents offered answers that were not included in the question. Since a child does not have to worry about peer review, no harm was done when a quick-thinking child merely began to draw pictures of the new responses on the bottom of his sheet and then included the new foods to his survey question.

Learning how to represent their knowledge and learning that the printed marks have meaning are significant steps for a preschool age child. In BYU survey work, the children are instructed to make a mark in the appropriate column for each response. Children use different mechanisms to record survey responses. Some will use a tally, an "X," a cross, or write the words "yes" or "no." Sometimes a child chooses to draw the response, such as drawing an ice cream cone or a piece of pie when asking about favorite foods. Figure 2 is an example of one child's tally sheet for the question, "What color are your shoes?" Each response is marked by an "X."

When the data collection phase of the survey work is completed, the children learn to summarize the data with a bar chart. The children count their tallies and try to write the numeral to match their count. To make bar charts that fairly represent their tallies, the children use graph paper to keep the categories distinct and use colored stickers for each count so that the display is not misleading. When looking at their charts, children again see variation by noticing that people respond differently to the survey questions. However, some children have very strong priors. One boy remained convinced that the class gerbil would like carrots despite the fact that not a single university student responded positively to the category.

4. EXPERIMENTS

As stewards of the scientific method, statisticians can appreciate the use of experiments as a preschool tool to help children collect data to answer their questions. Teachers design experiments the children can safely and successfully perform with as much independence as possible. Appropriately designed experiments give children experience in asking questions, forming hypotheses, and collecting relevant data. Having collected data, teachers can help children use their data to reconsider their hypotheses and answer their questions. Ideal experiments for the preschool age child begin with exploring the known and then
asking a simple question to encourage the child to extend their current understanding (Piaget 1962). Bredekamp and Copple (1997) found that allowing children to choose the context of their learning assures high interest and attention to task while increasing the probability of the new information being assimilated into long-term memory.

For example, during a project on water animals, the teacher could prepare a table with different colors and types of plastic snakes and fish in water, asking, “What is in the water?” The children’s curiosity has them exploring the objects they touch in the water. To organize their discovery, the children begin to sort and classify the objects according to obvious differences and attributes; for example, the fish are separated from the snakes. While this simple activity is not an experiment, the teacher can seamlessly move into an experiment phase. After the children’s attention is focused on the activity, the teacher can continue to engage the children around the water table by building boats out of tin foil. Each child builds a boat and floats it on the water. The teacher doesn’t use the word “hypothesis,” but prompts the children to ask the first step of the scientific method by asking, “How many water animals can ride on your boat?” Each child chooses a number. Some children will be conservative, estimating one or two, and others will boast their boat will hold the most by announcing the largest number they know, like a hundred or a kazillion. The children then perform the experiment, as shown in Figure 3, and collect data by putting animals on his/her boat one at a time until it sinks. When the children see their boats sink before or after their initial guess, the teacher might ask, “Did you guess too many or not enough?” in order to help the children compare their original hypothesis with their data. Some children may revise their hypothesis by choosing a new number and repeating the experiment. Not surprisingly, repeated trials result in variable outcomes that teach children, among other things, the concept of variability. Other children will determine their boat sank because it got water in it, not because there were too many animals. The teacher encourages these children to modify their boat design and test the hypothesis that the new boat holds more animals than the old boat through more data collection.

As the children place animals on their boat and tally the number before the boat sinks, the most important thing they learn is that they can answer the question. The teacher provides the materials and the catalyst, stimulating the child’s curiosity to explore using the scientific method. Empowering preschool age children to formulate a question and explore their question with an experiment is exciting and powerful.

5. STATISTICS PROJECTS ARE A SCAFFOLD FOR ACQUIRING OTHER SKILLS

The BYU preschool curriculum is designed to support and scaffold the development and learning of young children. Vygotsky (1978) described how the curriculum should support a child’s learning by providing an interim scaffold that can eventually be taken away as the child is able to do the behavior on his/her own. BYU preschool teachers use statistical projects as the scaffold to support the acquisition of many other important skills, such as literacy, socialization, communication, and mathematics.

The primary vehicle for teaching literacy is to provide multiple opportunities for the children to use reading and writing in the natural course of their exploring. The Question of the Day teaches both reading and writing skills. The Question of the Day is written and complemented with pictures related to the question. For example, pictures of ice cream cones provide clues to help the children read the question “Do you like ice cream?” Eventually, some children are able to recognize the frequently used words by sight and use beginning letters to help decode new words. Writing skills are practiced daily as the children represent their response to the Question of the Day with a written representation of their name. Under the teacher’s guidance and using their nametags as a model, the children “write” their name from the start. With the daily repetition, many children progress from squiggles, disconnected letters, or a dominant letter at the beginning of the year to a full representation of their name with all the letters by the year’s end.

Socialization and communication are major curriculum goals for the preschool-age child, and survey work creates opportunities for children to practice and extend their oral language and their group entry skills. For example, survey work provides the opportunity to learn the social skills of stopping someone and politely asking a question. As the children perform surveys and experiments, they explain what they see and know, which develops their communication skills. Many of the mathematics skills that are learned through the statistical projects are obvious. Counting and one-to-one correspondence are practiced and learned as the children count the responses to the Question of the Day and the tallies from their survey work. As children make guesses about the outcome of an experiment and then compare their results with the original guess, they learn and practice the mathematical concept of relative size: “more than,” “less than,” and “about the same.”

Figure 3. BYU Child and Family Studies Laboratory Child Performing Experiments with Boats.
6. SUMMARY

Teachers at the BYU Child and Family Studies Laboratory have used the Question of the Day, survey work, and experiments to teach preschool age children statistical skills. These statistical tools capitalize on children’s natural curiosity and teach them not only to pose questions, but also to find answers to their questions. Preschool children are able to construct bar charts and draw conclusions from their tallies. It may surprise some readers to learn that statistical activities are also used by innovative early childhood specialists to foster socialization, literacy, communication and mathematical skills. However, in a child’s world, all learning is intertwined, and statistics is naturally one of the key strands that supports other learning.

REFERENCES


