

The Development of Statistics and Data Analysis in Grades K-5

*Maureen Ellis
Mifflin Elementary School*

Overview

In our ever changing and fast paced society, decisions to be made using data, probability, and statistics are appearing at an increasing pace. A well informed adult needs to be able to know how to interpret the data and be able to judge whether it is fair and make decisions about how to use the data to make correct and informed choices.

Children at an early age are comfortable about talking about chance. They hear the words predict, forecast, 50-50, not likely, impossible, probable and outcome. They flip coins, draw cards from a deck, throw dice and spin spinners.

As adults we understand that some things are more likely to happen than others. For example, from a daily simple decision, the weather forecast tells us the chance of whether an umbrella will be needed, to the more complex, the number of successful operations a certain surgeon has done helps decide whether or not that doctor should perform your back surgery. Also employers and employees in the work force need to know how to gather, display and analyze data in order to do their jobs effectively. Thus understanding probability and data analysis is a daily part of how we conduct our lives.

This concept is not innate to humans. Children begin at an early age to develop the skills necessary to make informative decisions. The Everyday Mathematics Program had developed a sequence of learning these skills, which expands upon previous acquired knowledge and builds upon it. The process begins as simply as informally collecting data and making decisions on methods of representing this data and explaining it. As the curriculum progresses the children are introduced to bar and line graphs to represent their data and use of statistical landmarks to help them answer questions and communicate their findings.

This project will present an overview of concepts taught and classroom activities presented as to how to develop these concepts.

For my project I am going to analyze two Academic Standards for Mathematics from the Pennsylvania Department of Education using the Everyday Mathematics Curriculum. The purpose of this project will be to analyze Standard 2.6 Statistics and Data Analysis and Standard 2.7 – Probability and Predictions, across

the grade levels kindergarten through fifth grade. These standards include collecting and reporting data (e.g. charts, graphs) and analyzing that data. I will present how these concepts are developed over the grade levels. The project will describe what students should know and be able to do at mastery level at completion at each of the levels. I will reflect upon the increasing complexity that the students achieve these goals as they progress through the grades.

Rationale

During our weekly seminars we have been learning about topics such as scientific method, probability, joint probability, quantitative and qualitative data, arithmetic mean, standard deviation, binomial distribution, cosmic inflation, Gudel's Theorem, luminosity and flux. We discussed and read about the use of bar charts, histograms and the use of variables to interpret data. We read about controlled, randomized, and observational studies on topics such as "Vitamins and the Common Cold," "Amiloride for Cystic Fibrosis," "Marriage, Sex and Mental Health," "Parkinson's Disease and Country Living," and "Caffeine and Miscarriage." We discussed different forms of samples, i.e. random, systemic, stratified and cluster.

Although many of these topics go far beyond my level of mathematical understanding, I have been pleasantly surprised to see how these concepts relate to what we are teaching at the elementary school level. Their beginnings are with us. So it is our responsibility to present them effectively and with enthusiasm so students will be interested in finding out more. So although these topics are much advanced when compared to the topics taught in the Everyday Mathematics Program, their roots are here. Students need to learn the basics of data collection, analysis, and statistics before they can begin to tackle these higher level mathematical concepts. As we discussed in our seminars, what we teach in elementary school are the stepping stones to higher level mathematics and the basis for functioning as adults in an ever changing, fast paced mathematical world.

Mathematics is most appropriately used as a tool to organize and understand information from other academic areas. Thus by using effective tools the students will be able to accomplish this goal. I will show how the multiple exposure approach used in the Everyday Mathematics program tries to build on early, relatively informal exposure to skills and concepts that are constantly built upon in the grade levels. The children will gain a better understanding of the skill or concept being developed when it is taught in a new format or application.

From the strand of exploring data in kindergarten to data collection, analysis and chance in fifth grade the children build on previously taught material to gain a better understanding of the concept being taught.

Children begin school with knowledge and intuition to be built on. In the Everyday Mathematics Program data collection, analysis, and statistics are taught as part of ongoing routines in the classroom and dialog between teacher and pupils concerning their results.

The philosophy of the program helps children work as partners and in small groups to share their thinking and ideas with peers. By using some of the highlights of the Everyday Mathematics Program in teaching data analysis and statistics the results should be inviting to children and offer a better chance for success. These highlights include establishing links between past experiences and explorations of new concepts, sharing ideas through instruction by building on each others' findings, cooperative learning, practice through games and using daily routines.

I hope to show how the presentation of these concepts in the Everyday Mathematics Program from kindergarten through grade five encourages mathematical thinking, provides challenging activities for the more skilled children without intimidating less skilled ones and how the mathematics taught at these levels serve as a stepping stone for higher education and for life.

By using the information from the topics presented in our seminars, such as understanding statistics and designing experiments I will be able to apply this knowledge to the project. These topics explore how you use statistics as a tool to plan and carry out experiments and then analyze and interpret the results. In elementary school children learn how to gather data rather easily but also need to understand what to do with that data in order to make a conclusion. I will present how these important mathematical ideas are developed in the kindergarten through grade five Pittsburgh Public Schools mathematics curriculum.

Objectives

Throughout the development of the project I will be addressing the following objectives through the Academic Standards of Mathematics from the Pennsylvania Department of Education.

The students will be able to compute, measure, and estimate to solve theoretical and practical problems, using appropriate tools. Students will formulate and solve problems and communicate the mathematical reasons for using them.

Students will evaluate, infer, and draw appropriate conclusions from charts, tables, and graphs using data they have collected and from data given to them in sample problems. Students will make decisions and predictions based upon their collection, organization, analysis, and interpretation of data and probability.

Throughout these development students need to learn that the more they repeat an experiment the more reliable their predictions will be. The probability of something happening is based on the data that has been collected.

For example, if they toss a coin twenty times it is possible, but not certain, that it will land on heads ten times. However, if it is tossed one hundred times, it is more likely to land on heads about half the time than if it is tossed twenty times. If it is tossed one thousand times the correct outcome is even more likely.

Also during the development of the lessons many social skills are learned. During data collection and interpretation of statistics children will learn respect for others, develop positive character traits, engage in cooperative learning and teamwork, learn how to communicate with their peers and gain confidence in their ideas when interpreting and presenting their results.

The main objective is for children to understand what data exploration is, i.e. that it is sensible and rational and if this is true then they can make wise and educated choices in interpreting the results of their data.

Strategies

The strategies to be used in assisting the students to achieve the standards are many. Throughout grades kindergarten through fifth the teachers should use a variety of methods to keep the students actively engaged in the data collection and analysis. Teachers and students alike must use accountable talk and common mathematical terminology. Teachers should allow students to use brainstorming and encourage discussion when they are collecting data and creating the tables and graphs to interpret the data.

Strategies should include opportunities for more capable students to extend their ideas and express them to the class.

Data collection should involve many sources of data such as counting and measuring in the classroom, observing and measuring at home, taking surveys at home, in the classroom and throughout the school. Also students should use television, newspapers, magazines, and other multi-media as sources for information.

Using a real problem that can be solved in the class is more meaningful to students than an abstract idea that has no connection to the students. For example, a kindergarten class could take a survey as to who could not zipper their own coats when the children went out to recess. The class could see who needed help and who could be the helpers. This could get the process done faster and leave more recess time! The children could then ask questions as to why some of the children are having difficulty – maybe the cloth from the jacket gets stuck easily on the zipper, maybe the bottom of the jacket has pulled away from the zipper, etc. The children could then see there are many reasons why something may occur.

Another strategy is organizing and displaying the data that is collected efficiently. The children must organize the data in the best way for them to see it. They should learn strategies such as smallest to largest, use of bar graphs to show how many, line graphs for ordered pairs and pie graphs to compare parts of a whole. Step graphs are useful when the horizontal axis represents time. Stem and leaf plot graphs distinguish between larger and smaller place value digits and are good for finding the median of a data set.

Tables are an important strategy in displaying tallies and lists. When discussing the spread of data, students need to be familiar with the terms maximum, minimum and range.

Data collection is never to be used as an end in itself. Students need to know that the data is to be used to describe a situation, solve a problem, make a decision, or make a prediction. The students should always be given time to discuss, summarize, and report findings for their problem. This is more important than the collection of data and should be the end result.

Grade Level Concept Development and Activities

The multiple exposure rule which is the foundation of the Everyday Mathematics Program builds on early and informal exposure to skills and concepts that are constantly reinforced and solidified in years to come. The strategy is that children may not get everything the first time around but with multiple exposures and with the understanding that they do not need to “get in all” the first time, they will be more relaxed in their learning and with appropriate reminders will be able to recall and recognize the skill when it is reintroduced in a new application or format.

I will highlight the concept development of statistics and data analysis through grades kindergarten through fifth in the Everyday Mathematics Program and follow with highlights of activities to support these concepts.

Kindergarten Concepts

- >measure, collect and record data
- >create graphs
- >use coordinates on a grid
- >increase weather awareness through symbols and data collection
- >use tally marks
- >make a pictograph
- >introduce probability

Kindergarten Activities

For kindergarten students the most meaningful discussions are those that are concrete and are connected to real problems in the classroom that concern the students directly.

Survey activities will include asking questions such as: Are you afraid of the dark?, What is your favorite color?, What is your eye color?, etc. The students can be put in charge of a certain survey and walk around the room with a clipboard and pencil. The survey should be done in tally form and then presented to the class for graphing the results. The results should be displayed in a bar graph – varying between horizontal and vertical designs.

The graph should lead to a discussion with questions generated for the teacher such as what did we find out, who has the most, the least, how many altogether, how many more, etc. The concrete representation of the graph can generate many questions and kindergarten students can easily analyze data from it.

Weather graphs are used throughout the year to analyze change in conditions. Each day the “weather person” puts the appropriate weather condition on the chart. Each month, totals are counted and discussion follows about the kinds of weather during the month.

A birthday bar in the room lists the months of the year and the students who have birthdays in each month. An age changing chart is a movable record of ages that is displayed in the room. The chart changes as the children have birthdays and move from five years old to six. This chart generates discussion throughout the year.

A height chart compares the heights of the children in the room. This activity extends as the heights of the children are compared to heights of things in the room and the heights of animals.

Another activity is comparing the heights of animals in relation to each other.

A favorite animal chart stimulates discussion about how many of the animals have tails, are mammals, is class favorite, smallest, largest, longest, etc.

Tally marks are used to tie science to math when discussing floating and sinking. The children test various objects and tally which float and which sink.

Health lessons are used to include discussion about heart rate. The children chart the number of heartbeats they have at rest and after various exercises. Questions such as which are higher and why, stimulate much discussion.

Venn diagrams are introduced when children talk about how they travel from home to school.

Time is introduced when children use a stop watch to calculate how long it takes to do things such as walk across the playground, walk to music class, eat lunch, etc. These times are charted and compared.

First Grade Concepts

- >data collection and analysis
- >use of tallies
- >sorting and graphing
- >frequency of numbers
- >range, middle value, most frequent
- >rounding of data
- >concept of chance

First Grade Activities

Data collection includes many topics in the first grade curriculum by building on what was presented in kindergarten.

During daily routines children chart the attendance and weather conditions. They use a thermometer to read the daily temperatures and color code the temperature

on a monthly weather chart. That collection leads to many questions about temperature change and monthly highs and lows.

Data collection also includes tallying different area codes collected by the children, recording game wins and losses between partners and in small groups, collecting coins with different dates, heads or tails in coin throwing, frequency a number is rolled on a dice roll, frequency of sums on a dice throw, number of two dimensional shapes on a picture, and how we get to and from school

Sorting and graphing activities include varieties and number of leaves found by students. This science activity opens many questions to the class such as the number of leaves found, vein patterns of leaves, symmetry and size of leaves compared to the size of the trees they come from. Other sorting activities include comparing tallest, shortest, most frequent and typical height of the class, organizing and counting pattern blocks, order, ranges and most frequent weight of the class and typical weights and heights of various animals.

Changing graphing activities include the growth of an amaryllis plant, and a bar graph of changing height growth.

A tally activity that includes a reading lesson is to assign various passages (approximately fifty to one hundred words) to groups and after the children read let them count and chart the number of different vowels in the words. After the groups total their tallies they report them to the class and various conclusions can be made such as what vowels were the most frequent, how that compares to other selections, etc.

Using the “Numbers About Me” section of the book, students will record data about themselves. Topics include personal height and weight records. This data can be rounded off and middle values as well as range of heights and weights can be found. The difference in height and weight gain can be charted also. In this section children will also record the people living with them, hand and foot spans, a timeline if their life so far, and lost tooth record. Time activities include how many times various activities can be done, such as blinking eyes in ten seconds, jumping rope in a minute etc, or how long an activity can be done such as standing on one foot , holding your breath, etc

The concept of chance is discussed by graphing wins and losses in the game counts the children tallied during the year. The chances of winning in a group compared to with a partner are debated. Since the chance of winning games is governed by events during the games and not just by skill, many students will have different opinions about how those variables effect the results.

Second Grade Concepts

- >data collection and analysis
- >use of tallies
- >estimating and analyzing median value
- >data comparison
- >bar, line and frequency graphing
- >making predictions about data
- >finding range
- >finding mode

Second Grade Activities

In second grade many of the concepts are, of course, repeated and expanded upon, however, new concepts are also introduced.

Early in the year each of the children are given an “Everyday Math Deck” of cards. The students are put in pairs to explore and make their own discoveries about what they find out about the cards. After they record their observations they discuss, as a group, the data they have found.

They continue work with tallying by recording how many tally marks (grouping by 5’s) that they can make in thirty seconds. They compare this number to the number they had estimated they would mark.

The children use data collection with a science lesson when they make a weather station, recording data about it for one week. They make a graph and record the various elements of the weather such as wind, strong wind, light breeze, etc. At the end of the week comparisons about the conditions are made.

As an ongoing project the students keep a height and weight record. They are weighed and measured three times during the year. Predictions and comparisons of change are discussed at the conclusion. They learn frequency when they compare heights and discuss the results. They compare the difference between most frequent and middle and discuss their own frequency graphs.

Estimation is introduced when children are asked to estimate the time on a clock. The use “estimation language” such as about, just before, between, and approximately.

Sequence is taught when the children collect data about their birth dates and those of their families and then order them from oldest to most recent. They learn that you must look past the month order when sequencing. They discuss middle birth dates and years between generation births.

Estimation is also taught when children record data about the time they go to bed and how many hours of sleep they get. The children find the middle value of going to bed and getting up times as well as the approximate hours of sleep the class gets.

The children learn that in many situations estimation is all you need when solving a math problem. They learn a close answer is estimation and is easier to work with. They discuss various situations when this kind of answer is sufficient, such as how much paint is needed for a room, how many pages you can read and understand in a half hour, or if you have enough money to purchase items at a store. They play the shopping game to see if they can estimate if they will have enough money to purchase items at a school store. This includes estimating the correct amount of change they will receive.

Comparisons are discussed when children study an animal poster of heights and weights. They are many activities that can be generated from the poster including ordering from smallest to tallest and finding the differences.

A good activity that can lead to much discussion is a comparison of weather forecast data prediction to actual weather data. Comparison of AM to PM temperatures also leads itself to discussion of variables in weather that make it change and why it is difficult to predict a seven day forecast.

The students learn about surveys and data collection when they make a group data table of their favorite foods. This links health to math because they divide their survey into food groups. They compare their favorite foods to that of adults. During discussion the class makes a table and talks about the most popular food group among children and adults and if it is different. If some children don't know what group a certain food falls into, more discussion follows. This information is translated into a bar graph that the children construct.

Students find the median length of a jump when they play the "How Far Can I Jump" game. They record jump lengths, find the median jump, and compare this data to their heights to see if there is any correlation. They also estimate their stride distances from starting point to ending point and use these stride lengths to compare lengths of other things. There is also a lesson comparing speeds of animals to humans and comparing how far and fast humans can go by various modes of travel.

A very useful lesson in estimation is figuring out how much of a tip to leave at a restaurant. The children discuss why at times you would leave a higher tip than other times, what constitutes good service and how to estimate ten percent, fifteen percent and so on. They then compare their results to finding the tip using a calculator.

Finally in second grade, children are introduced to mode and its comparison to median. They use their data collection throughout the year to find the total weight of the class and the weight changes of children over the year. They tally the weight changes of each student in pounds and make a bar graph with the data. They learn that the most often-occurring weight change is the mode, which is not always the same as the median.

Third Grade Concepts

- >tallying, collection, and recording of data
- >range
- >frequency distribution
- >averages
- >random sampling
- >pie graphs, line graphs, and bar graphs
- >comparison of mean, median, and mode
- >ordering of numbers

Third Grade Activities

In the first and second grade programs the children are exposed to mean, median and mode through a variety of lessons. Throughout the third grade program there are lessons that teach relevant data skills and allow children to organize and analyze the data. They make bar graphs to compare mean and median using pre-determined sets of data such as the number of children in a family, ostrich egg clutches, and length of shoes in a class. At the end of third grade the children learn the standard method of computing mean. (by finding the sum and dividing by the number of pieces of data) The data they use includes finding median and mean of their own and family members' height and arm span. This data is made into a frequency table using tallies. The mode can also be easily seen using this method.

A yearlong project in third grade is recording of high and low temperatures. This includes graphing the difference between the two temperatures on a line graph and discovering patterns, such as the most frequent temperature difference. Children

graph temperature ranges during certain intervals and chart the mean temperatures for those intervals.

Another yearlong project is finding the sunrise and sunset time each day and recording the length of day. Many probability questions arise from this collection of data.

Children discuss chance and probability by listing things that for sure will happen during a week and things that they are not sure of, and what effects whether those things happen or not. This introduces them to “ events” and why certain things are more or less likely to occur.

Other activities concerning probability include a block tossing experiment using various shapes, to see how many times the shapes will land on edge. They compare results and summarize findings. This is extended to taping blocks together to make rectangular prisms. Since the areas of the edge would be doubled while the areas of the bases would remain the same, would the new block be more likely to land on edge than a single block?

A coin tossing experiment should confirm students’ intuitions that nearly equal numbers of heads and tails occur when tossing.

Spinner experiments should also result in fairly even distribution when half of the spinner area is white and half is shaded. Children account for variables such as what constitutes a fair spin and importance of using of level surfaces. They then extend this activity to more colors choices of spinning area and discuss “equal, chance, and more likely than.”

Students collect data of number of right and left handed people in a survey and make predictions about outcomes when repeating this experiment with other samples and comparing results.

An end of the year project that is fun is a watermelon seed-spitting contest. The children record their individual distances and arrange the data in ascending order to find the median. They design and display their own graphs.

Fourth Grade Concepts

- >collect, organize, display and analyze data
- >minimum, maximum, range, mode, median
- >predictions, estimates, guesses, chance

- >comparing actual results to expected results
- >comparing data
- >evaluating reliability of data
- >tabulating and analyzing surveys

Fourth Grade Activities

Work with data is often taught artificially or in isolation. In Everyday Math, data work provides a context and motivation for developing number skills while having fun and learning interesting information.

During the World Tour Project, which lasts the entire year, the children gather and record information they collect by travelling around the world. They begin in Washington D.C. and go to various countries in Europe, Africa and South America, logging data about distances from place to place, total distance traveled and facts about the places they visit. They realize all the ways we use numbers such as for counting, measuring, expressing ratios and identification, for codes and used to specify locations in reference frames. They compare data about countries such as elevation, average barometric pressure, latitude, and distance from the equator.

When playing the raisin game the children determine median, mode, maximum and minimum and range of a data set. They display data with a line plot, bar graph and a tally chart. The students must estimate how many raisins are in a box with the lid on and then seeing the raisins, count them and organize as a class how to display the data. They then make a prediction about how many total raisins there will be before counting them.

The children make a class line plot of family size and answer questions by looking at the line plot as to the minimum number of people in a family, maximum number, range, mode and median family size for the class. They must take into account variables and make sure everyone is following the same guidelines such as siblings in college, divorced parents not living with them, cousins who live in their house, etc. The ground rules are important for accurate counting.

Two other data collections are determining the values of the ages of the children in the class and making a line plot, and making a bar graph to show head sizes of classmates. Children measure with string and then measure to the nearest one half centimeter. The median head size for the class is determined as well as the smallest and largest.

In both collections of data the class talks about the bumps, holes, clusters and far out numbers represented on the graphs.

In collecting data about favorite foods, favorite writing utensils and favorite cookies, the class makes grids to help them organize their data to solve more complicated problems containing more information.

They also do a fifty facts test at various times during the year, though not for grading purposes and with the anonymity of the students, and record and graph their test scores on a line graph. They discuss the group data as percentage scores to figure class maximum, minimum, range, mode, and median. Then they compare these landmarks to those of previous tests.

In the fourth grade curriculum the students are formally taught how to make predictions and check their predictions by doing experiments. They use the phrases of probability such as fifty - fifty chance, more likely, probably, and certainty. Their experiment involves making spinners for a game. They discuss what a fair spinner is and then use the spinner for an experiment to see the number of times a paper clip falls on a certain color. A similar experiment is dropping coins on a grid of different colors. The chances depend on how many squares of each color there are and the accuracy of the experiment increases the more times the experiment is done.

Another probability experiment involves inventing a carnival game of chance. The students figure out how much the prizes should be and what profit could be expected depending on the chance a coin should land on a certain color. By collecting and analyzing the data they need to find out if the game is fair and what the chances of winning will be.

During the study of fractions the students compare the results of a survey they take. They ask several people various questions about themselves and after discussing the results of the survey they make educated guesses about people's behavior based on the results. In the process they need to work out the best way to tabulate the information and discuss how naming the results in fractions with the same denominator (100) is easier for them to then rename the fractions as decimals and percents.

In a unit about mammals students make predictions, draw conclusions, compare, and speculate about mammal measurements. These results of height, weight, speed, and heart rate are then compared to humans. The children use ratio comparisons using math phrases such as "times as fast" and "a fraction of" when making the comparisons. Of course during all this comparison of facts many new things are learned about mammals. This is an interesting unit which incorporates addition, subtraction, percentages, and fractions into a topic that children enjoy learning about.

Another project that is relevant to students is the soft drink collection. The students collect soft drink cups from various places and record data about sizes of containers and prices. They then analyze their data to see which place offers the best drink value.

The term rate is introduced during a whole class activity on the collection of eye blinking data. One half of the class records the eye blinking of the other half according to a specific set of data and then the children compare results. They discuss variables that might influence the outcomes such as if the child becomes aware of what is taking place he might not blink in a natural way, or does a person blink more when reading or how tired a person is or if he wears contacts.

At the end of the year the students wrap up the world tour by plying *Patolli* from their world tour guidebook. They experiment with chance and probability as they try to be the first to get around the gameboard.

Fifth Grade Concepts

- >collect, organize, analyze data
- >chance events
- >estimation
- >landmarks: minimum, maximum. Mode, median, range
- >bar graphs, circle graphs, line graphs, tables, contour maps
- >frequency
- >probability
- >predictions from graphs and tables

Fifth Grade Activities

By fifth grade students act as consumers and critics of data and data displays. They learn to develop common sense, good judgment, and healthy skepticism.

There are many opportunities in the fifth grade curriculum for collecting and analyzing data and discovering landmarks. One of these activities is testing reaction time in reaching a stimulus. By comparing results with left and right hands, the students find the statistical landmarks for the data and speculate as to if a relationship exists between left and right handedness and reaction time.

Various ideas are presented to children to try to determine probability. Probability is taught by doing a “point up or point down” thumbtack experiment, chances of getting a busy signal when dialing a phone, the chance of one’s home

catching one fire and the chance of an adult knowing how to swim. Chance is determined when the answers to these questions are discussed. The children are encouraged to use mathematical vocabulary and describe chance events such as “one out of four chance, 25% of the time, highly unlikely, and very likely.”

The students construct bar graphs based on class data by first simply counting the number of boys and girls in the room and then taking a bar graph snack survey and dominant eye survey. The children construct their own graphs making either a horizontal or vertical graph. They then translate this data to circle graphs and discuss the features that this kind of graph must contain.

During an activity to find out how many states in the United States the students and adults they know have visited, the class determines that organizing the data helps people understand what is being presented. A graph, picture table, or list is easier to interpret than an unorganized set of data. In groups, the children decide which method they will use to present their information. They then interpret results such as why adults have a larger median and why some states are more traveled than others.

Other activities where the fifth graders organize and interpret data are the following: making a stem and leaf plot about hand span, finding landmark spans, and discussing why hand spans are important to know such as in playing a piano or how big a baseball glove to buy. The questions about why data is useful always are a great topic of discussion.

Students learn about sample size when they try to guess how many of each color candy is in a bag. They learn that looking at a sample of the bag the candy is in will give them useful information to predict percentages of colors. They also discuss whether a certain card game is fair by playing it many times and tallying the winners. The larger amount of sample games they play, the more accurate their conclusions will be.

A project the students do to interpret results is to conduct their own survey of students in another classroom, designing their own questions and determining the way to conduct the survey. Using their survey results they find medians, make graphs, display data, and analyze results.

The yearlong American Tour project gives students the chance to organize, analyze, and interpret data throughout the year. For example, they try to predict when Old Faithful will erupt next. They read color-coded data maps to compare land elevation, population totals, population density, temperature, and age group change over time. At the end of the year the students display their data and communicate their findings.

In studying circles and area, the students estimate the value of π by calculating the ratio of circumference to diameter for a number of circular objects. They enter their ratios on a stem and leaf plot and calculate the median ratio. They compare class estimates for the value of π to various values of π calculated since ancient times.

As a whole class activity the students estimate the ground area of the school. In pairs, they plan, gather data and estimate the results. These results are discussed and recorded on the chalkboard. Again, a median estimate is calculated. These results are compared with blueprints of the school to see how accurate their estimate was.

There are many lessons devoted to reading, drawing, and interpreting line graphs. The students discuss graphs that describe a variety of situations and they use “mystery graphs” to match graph slopes with described situations.

In an experiment with pendulums the students collect and record data to see if the length of a pendulum effects the time that it takes the pendulum to make a complete swing. They use their data to find averages, graph and draw conclusions.

In three explorations the students analyze data from videotapes of everyday situations. The topics include the following:

1. When do drivers turn their headlights on? The students convert the raw data gathered from the videotape sample to fractions and percents, graph the data, either by a line or bar graph, and use the graph to answer questions.
2. The mathematics of bicycle pedaling - By counting the number of times the pedal of a bicycle makes a complete turn and the ratio of wheel turns to pedal turns, children use this data to see how it is related to the difficulty or easiness of pedaling a bike. They can interpret data and make conclusions such as which kind of bicycles are better to ride on a hill or against the wind and which are good to ride on a flat surface with the wind at your back.
3. How fast do people walk and what is their step length? By gathering data on timing and pacing they solve rate problems and convert this to miles per hour and feet per step.

Venn diagrams are used when children compare likenesses and differences in prisms, pyramids, cylinders, and cones. Summarizing results from this type of display is another way children interpret data.

By integrating a health lesson with math the students find their heart rates after increasing strenuous exercise, graph their data and make line plots of the class heart rate data and line graphs of their personal data. They see that minimum,

maximum and median all increase as the amount of exercise increases. They can calculate their cardiac output from their data and using a formula, compare output at rest and after exercising.

Conclusions

After looking through the topics in the Everyday Mathematics curriculum I chose exploring data and chance because I felt it to be a relevant topic that children need to develop at an early age to be useful to them for the rest of their lives. In our seminars, Dr. Holman spent considerable time focusing on probability and chance, exploring its beginnings from the noblemen in France hiring mathematicians to figure out the probability of winning at gambling to the applications of data collection in higher education, in formulating the outcomes of medical studies and for use by adults to make informed decisions.

This is the math that will help you in the real world in our culture. Probability and statistics will help us analyze data, make good judgments, be skeptical and ask questions and be informed consumers in adult life.

In explaining the development of this topic in the Everyday Mathematics Curriculum from grades K-5, I was overwhelmed with the amount of information that is presented to the students. I feel that at times there is too much new information for the students to absorb at one given time. But after reviewing the progression of the whole curriculum, I feel that the kind of information presented and its applications is very relevant to the students and can help them understand the concepts easier than the minimal attention that is given to this topic in a traditional mathematics curriculum. I especially like the way the program focuses on vocabulary development that is built upon and repeated in book after book. I have found, from talking with math teachers in my building that this vocabulary becomes a part of the everyday language of students through repeated use. In my first grade classroom, the daily routines involving attendance, weather, the calendar and gathering data are first steps in using mathematical language.

On a daily basis in our school, children are using terms such as predict, average, probability, etc. Comparisons are easy for them to make and teachers say that much discussion about topics using data collection in all subject areas is an everyday occurrence.

Accountable talk is a huge component of the program. The children do learn to listen attentively to one another and build on each other's ideas. They discuss and provide evidence for their arguments and challenge each other before drawing

conclusions. These behaviors are building blocks that all of us need to learn to be successful adults.

So although, as in any program, in any subject area, there is room for improvement, I feel that the way this topic is developed in the Everyday Mathematics Program throughout the K-5 curriculum will be a useful tool to students as they grow into adults who need to make informed decisions in life.

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Mathematics Content Standards

1. All students use numbers, number systems, and equivalent forms (including numbers, words, objects and graphics) to represent theoretical and practical situations.
2. All students compute, measure and estimate to solve theoretical and practical problems, using appropriate tools, including modern technology such as calculators and computers.
3. All students apply the concepts of patterns, functions and relations to solve theoretical and practical problems.
4. All students formulate and solve problems and communicate the mathematical processes used and the reasons for using them.
5. All students understand and apply basic concepts of algebra, geometry, probability and statistics to solve theoretical and practical problems.
6. All students evaluate, infer and draw appropriate conclusions from charts, tables and graphs, showing the relationships between data and real-world situations.
7. All students make decisions and predictions based upon the collection, organization, analysis and interpretation of statistical data and the application of probability.

Appendix A

This is a glossary of mathematical language that is introduced in the Everyday Mathematics Curriculum that pertains to the teaching of probability and chance.

average - a central, or typical, value of a set of numbers

ball park estimate - a check on the reasonableness of an answer

bar graph – a drawing that shows the relationships among data by the use of bars to represent numbers

circumference – the distance around a circle or sphere

clutch – a nest of eggs

data – a collection of information that is gathered by observation or measurement

estimate – a calculation of a general, rather than an exact, answer: an approximation of a number

event – a happening or occurrence

exploration – an independent or small group activity. Explorations include concept development with manipulatives, links to more abstract levels, data collection, classification and ordering, problem solving, games, and skill reviews.

frequency – the number of times an event or value occurs in a set of data

frequency table – a chart on which data is tallied to find the frequency of given events or values

landmark – a distinguishing feature of a data set. Landmarks include median, mode, maximum, minimum, and range.

line graph – a drawing that shows the relationships among data by using a set of points connected by line segments; often to show trends

line plot – a sketch of data in which check marks, X's, or self-stick notes above a number line show the frequency of each value

maximum – the greatest amount or number in a set of data

mean – the average of a set of data found by adding the numbers in the set and dividing the sum by the number of numbers

median – the middle value in a set of data when the data are listed in order from smallest to largest

mode – the number (or value) that occurs most often within a set of data

outcome – the result of an event

pie graph – a drawing that represents data using a circle divided into parts to show the relationships of the parts to the whole

random sampling – taking a sample from a population in a manner that allows all members of the population the same chance of being selected

range – the difference between the greatest and least values in a set of data

rate – a comparison of two quantities with unlike units

ratio – a comparison of two quantities with like units. Ratios can be expressed with fractions, decimals, percents, or words; or they can be written with a colon between the two numbers being compared.

stem and leaf plot – a display of data in which digits with larger place values are named as stems and digits with smaller place values are named as leaves

survey – a study that collects data from human respondents

Venn diagram – a picture that uses circles to show relationships between sets

Appendix B

Pennsylvania Department of Education Academic Standards for Mathematics

2.6. Statistics and Data Analysis

2.6.3. GRADE 3	2.6.5. GRADE 5
<p><i>Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to...</i></p>	
<p>A. Gather, organize and display data using pictures, tallies, charts, bar graphs and pictographs.</p> <p>B. Formulate and answer questions based on data shown on graphs.</p> <p>C. Predict the likely number of times a condition will occur based on analyzed data.</p> <p>D. Form and justify an opinion on whether a given statement is reasonable based on a comparison to data.</p>	<p>A. Organize and display data using pictures, tallies, tables, charts, bar graphs and circle graphs.</p> <p>B. Describe data sets using mean, median, mode and range.</p> <p>C. Sort data using Venn diagrams.</p> <p>D. Predict the likely number of times a condition will occur based on analyzed data.</p> <p>E. Construct and defend simple conclusions based on data.</p>

***On April 9, 1998, the State Board of Education voted its intention to adopt these standards. The standards are currently in the Regulatory Review Process with an anticipated adoption date of Fall 1998.**

Pennsylvania Department of Education Academic Standards for Mathematics

2.7. Probability and Predictions

2.7.3. GRADE 3	2.7.5. GRADE 5
<p><i>Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to...</i></p>	
<p>A. Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes.</p> <p>B. Design a fair and an unfair spinner.</p> <p>C. List or graph the possible results of an experiment.</p> <p>D. Analyze data using the concepts of largest, smallest, most often, least often and middle.</p>	<p>A. Perform simulations with concrete devices (e.g., dice, spinner, etc.) to predict the chance of an event occurring.</p> <p>B. Determine the fairness of the design of a spinner.</p> <p>C. Express probabilities as fractions and decimals.</p> <p>D. Compare predictions based on theoretical probability and experimental results.</p> <p>E. Calculate the probability of a simple event.</p> <p>F. Determine patterns generated as a result of an experiment.</p> <p>G. Determine the probability of an event involving "and", "or" or "not".</p> <p>H. Predict and determine why some outcomes are certain, more likely, less likely, equally likely or impossible.</p> <p>I. Find all possible combinations and arrangements involving a limited number of variables.</p>

***On April 9, 1998, the State Board of Education voted its intention to adopt these standards. The standards are currently in the Regulatory Review Process with an anticipated adoption date of Fall 1998.**