Utilizing Literature and Science to Teach Probability in the Elementary Classroom

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Overview

Probability can be an abstract and confusing concept to teach 7 and 8 year-old learners. The idea of predicting the likelihood of a certain event based on only a small amount of information can cause feelings of hesitation and uncertainty within young students. When limited amounts of solution strategies are presented many children tend to fall behind under the weight of the common sentiment that "I'll never be able to understand so I should just give up!" Today's students need to be approached in a variety of ways in order to retain and synthesize information. All learning modalities must be engaged so that visual, auditory, and kinesthetic learners alike can achieve success in the classroom. With the addition of a variety of strategies, as well as various subject areas used to teach probability, the likelihood that students will acquire and retain information is greater than if only one strategy were presented. This unit will look at the variety of ways that probability can be taught in today's elementary classroom.

In this unit I will address various aspects of teaching the foundations for probability and I will discuss ways in which a teacher can utilize literature and science to reinforce the mathematical concepts related to probability. The Core Curriculum of the School District of Philadelphia does not put much emphasis on teaching probability in the primary grades. This unit will offer additional ways to introduce and prepare students for developing an understanding of probability while simultaneously fulfilling the curriculum concepts of the School District of Philadelphia. The lessons included in this curriculum unit will best be implemented in a first, second, or third grade classroom. The literature that will be utilized offers many extensions and suggested activities that this unit will develop and discuss. The purpose for utilizing literature and science as pathways to introduce probability to young students is simple. In my experience when students are

exposed to the same topics in a variety of different ways and at different times of the day retention of this information is greater than when only experienced sporadically. When concepts are reinforced and revisited frequently, my students experience an "a-ha!" moment; they connect their prior knowledge with their current experience and everything begins to synchronize smoothly.

Rationale

My students have a tendency to shut down emotionally when they are unsuccessful at grasping a math concept. Because of this, I often try to incorporate different strategies and approaches to solving certain math equations and questions in order to boost student success rates. As a teacher I battle continually with "math-damaged" children, a term I learned in college to describe students who feel they rarely experience success with mathematics in the classroom. It is a struggle and challenge to motivate students who are so used to giving up after their first experience with failure. In an effort to increase the amount of success that my students experience with understanding math concepts I have researched ways to incorporate literature and science, specifically meteorology, to teach my students about probability. I will explore children's literature as a tool for my students to analyze data and information and to make predictions based on that information. I'd like for my students to experience this literature as an opportunity to make connections across the core curriculum. Additionally, I will explore weather predicting as a tool and real-life relatable experience for my students to examine for occurrences of probability.

Unfortunately, the School District of Philadelphia's Core Curriculum does not include many lessons regarding probability. This is another reason I have created this curriculum unit so that there can be more emphasis on a mathematics subject that is rarely talked about in the primary grades. I feel that if probability were more widely discussed in the younger grades our children would not struggle as much with this topic. The lessons provided later in this unit enrich the standards addressed in the Core Curriculum and also continue to take it one step further. Time will be taken to conduct two week-long prediction activities where students will interact with the concept they are learning about. At the conclusion of these activities students will analyze their collected information using some of the probability terms they have learned to provide a summary of the information.

In order for students to successfully complete the activities included later in this unit the children will need to have mastered a variety of basic fundamental mathematics skills. Students will need to be able to add, subtract, tally numerical information, and record observable data. Students will also have to become familiar with resources used to conduct basic research. The resources they will be responsible for consulting are pre-screened weather websites and the weather section of a local newspaper. The students will then examine these resources for specific information listed on a teacher-created worksheet. An additional skill needed by students will be the ability to locate and record

specific information. A variety of vocabulary terms and definitions will also need to be discussed prior to beginning this unit on probability. Students who are ages seven through nine should find the activities challenging yet achievable. The lessons are aligned to the Pennsylvania State Standards and the Core Curriculum of the School District of Philadelphia and meet the requirements for teaching probability in grade two.

Building Vocabulary

There are a variety of vocabulary words that are recommended within our mathematics curriculum to help explain the concept of probability. In my experience I find it most useful to introduce the concept of probability by introducing the terms *possible* and *impossible*. I describe possible as an event or occurrence that can and might happen. Impossible is described as an event that cannot and will never happen. I like to utilize the examples from a reproducible page from a data analysis and probability workbook to help my students understand these vocabulary words. Students will answer "possible" or "impossible" to the following statements: "You will see a rainbow tomorrow," "August is the month after May," "You will find a penny."[1] After introducing impossible and possible it is appropriate to then introduce students to the word *certain*. Explain that when an event is certain to occur it will definitely happen. One statement that can be verified for certainty is, "Tuesday is the day after Monday."[1]

After students demonstrate a sound understanding of possible, impossible and certain I continue with the introduction of more probability related vocabulary. The next words to introduce are *likely* and *unlikely*. Once students have an understanding of the level of possibility of an event they are now able to identify whether or not an event is likely to occur. If an event is likely to occur, than there is a very good chance that the event will happen. If an event is unlikely to occur, then there is only a small chance that the event will happen. Some statements that I find useful to help students demonstrate their understanding of these vocabulary words are: "You will brush your teeth today," "A movie star will visit your house today," "You will work on math today," and "You will see a car drive by your school."[1] Each of these statements can be discussed individually with students to help solidify their understanding of likely and unlikely events.

Concepts of Probability

While attending our weekly fellowship class at the University of Pennsylvania I was introduced to various concepts and ideas related to probability. Throughout the semester I tried very hard to connect the multiplication principle and permutations to concepts that could be discussed in my elementary classroom. I later learned that many of the probability concepts that we were learning were meant for us as adults to develop a deeper understanding of probability. This understanding then allows us as educators to go forward and teach our students with a well-rounded grasp on these various mathematical concepts.

Probability Rules

It is stated that there are three basic rules of probability. The rules are as follows:

> 1. Any probability assigned must be a nonnegative number.
> 2. The probability of the sample space (the collection of all possible outcomes) is equal to 1.
> 3. If you have two outcomes that can't happen at the same time, then the probability that either outcome occurs is the sum of the probabilities of the individual outcomes.[2]

These rules can be looked at and broken down from an elementary viewpoint. Rule number one can be restated as if something never happens then the probability of it occurring is zero and an event cannot occur less often than never. This means that the probability cannot be a negative number. Rule two can be restated that the probability of any possible event occurring is one. An example of this could be if there are five different colored t-shirts in your drawer. For example: red, green, blue, yellow, and orange. If you pick one at random the probability of the t-shirt you picked being red, green, blue, yellow, or orange is one. Rule three can be demonstrated by an example. It can be explained to students that the odds of rolling a one on a six-sided die is one in six. The odds of rolling a two are also one in six. Since these events cannot occur at the same time the odds of rolling a one or a two is two in six. This could then be reinforced by physically demonstrating this concept using a six-sided die.

Predictions

In the lesson plans to follow I utilize the action of predicting quite frequently. I feel that prediction is a strong and prevalent part of the basics of probability. Making predictions, also known as determining the odds of a situation, is a fairly complex term to explain to elementary students. First, students need to understand ratios. A ratio is "the number of things that you are not looking for to the number of things that you are looking for. So the odds against flipping a coin and it coming up heads are 1:1."[3] Once students understand how to create a ratio they will then understand that the "odds" of something occurring is what you are looking to occur compared to what you do not want to occur. Once the odds of a situation are determined then a prediction can be made about the outcome of an event based on the ratio created. In the lessons below we will experiment with making predictions based on information that we are already familiar with. We will also look at how meteorologists make predictions about the weather and if those predictions are valid.

Weather Predicting

There are many different elements that contribute to meteorologists being able to accurately predict future weather occurrences. Meteorologists use different types of technology to track air masses. Most air masses act in a "relatively predictable way"[4] which make predicting the ways in which the air masses move simple and foreseeable. Meteorologists can track the ways in which warm and cold fronts move across the earth and then make a prediction as to what types of weather events will result depending on what type of front is moving in to an area. Some of the tools that are used to identify this information are barometers and anemometers. The geography of the land also plays an important role in weather prediction. There are five different rules to remember when utilizing geography as a weather predictor:

> 1. Coastal areas have more moderate temperatures than inland areas, and are generally warmer in the winter and cooler in the summer.
> 2. In hilly areas, hot air moves up the slopes during the day and down the slopes at night.
> 3. High altitude areas are usually colder and receive more precipitation than low altitude areas.
> 4. The air above cities is often warmer than the surrounding area. In certain situations, this can create an artificial low pressure system.
> 5. In coastal areas, cool air usually blows inland during the day and out to sea at night.[4]

There are many ways in which these prediction factors relate to probability. Meteorologists utilize probability on a daily basis. There is rarely ever an occurrence where a meteorologist predicts a weather event with 100% probability because there is always the possibility that it may not occur. There is always some level of uncertainty when predicting events. This brings us back to the rules of probability which reinforce these concepts.

Weather Resources

Within my lesson plan on analyzing accuracy in weather predictions I will be utilizing a variety of different resources. Students will be asked to log on to a variety of different weather websites that have been pre-screened for inappropriate content. Most local news stations all have weather sections on their websites that are updated frequently by a team of meteorologists. Usually, these meteorologists are the same group of reporters that the students are familiar with seeing on television. The news station websites that the students will be analyzing are ABC 6 Action News Accuweather, CBS Philly Weather, NBC Philadelphia Weather, My Fox Philly Weather, The Weather Channel local weather, and PhillyWeather.net. Another resource that the students will be looking at is *The Philadelphia Inquirer*. The Weather Report can be found in the local section of this

newspaper. It includes that day's forecast as well as a 7-day forecast, a national forecast, and a Philadelphia Almanac section.

I will ask the students to pay close attention to the almanac and history portions of the weather report pages. They will be asked to predict why a meteorologist might find this information useful for future reporting purposes. Ideally, students will deduce that one way to predict weather is to look at the weather at this same time of year in years prior. Weather generally behaves in the same fashion as it did the year before with minor, usually insignificant differences. This can lead to a discussion about why we are familiar with the types of weather that the four seasons bring each year. Students could then discuss the general seasonal attributes of spring, summer, fall, and winter. For those students who are assigned an internet based resource that does not include a history or almanac section, they will be asked to meet with a group who did analyze one of these sections and partake in the discussion about the importance history can play in future weather predicting.

Objectives

This unit is intended for second grade students. These students are in an all-inclusive regular education classroom. Our allotted math subject area time is 90 minutes daily. The students will be expected to master a variety of objectives. Students will be able to predict what the next most likely event is in a story. Students will answer probability questions about a story. Students will keep track of school lunches for one week and then make predictions about what the lunches will be the next week. Students will identify whether an event is likely, possible, or unlikely. Students will observe weather prediction reports for one week using the internet or television and track the weather reporting accuracy. Students will analyze collected data about weather predictions for accuracy and patterns.

Students will be expected to participate fully in each discussion. There will be various discussions in each lesson focusing on what the students learned from the probability story, lunch tracking, and weather prediction tracking. Students will be graded on the level of completion of each teacher made tracking sheet. Students will not be penalized for incorrect predictions but will be asked to justify the predictions that they made.

Strategies

Incorporating Literature

This unit will utilize age-appropriate children's literature that contains math messages about probability. The stories will be used to present students with a different way of

experiencing probability. They will experience probability through a character in a story not a word problem in a math workbook. Children will make predictions while listening to literature being read aloud to them. The books will also be available for student viewing at their seats during free time. Children will analyze data presented in the story and make the next possible predictions. After practicing analyzing and predicting the students will then have a more thorough understanding of the concepts of probability that were introduced and reinforced throughout the stories.

Incorporating Science

Students will enjoy utilizing science as a pathway for learning about the mathematics topic of probability. It is beneficial for students to experience multiple subjects at the same time throughout the day so that cross-curricular learning can take place. Cross-curricular learning has been shown to better reinforce concepts as multiple subjects are being utilized at multiple times during the school day. Students will study some basic elements of meteorology and weather predicting. They will become familiar with some of the tools that meteorologists use to help them make their weather predictions. They will consult reference sources to gather information.

Newspaper and Internet Resources

This unit will utilize the internet and newspaper as resources for students to consult and analyze. The teacher will guide and assist students on proper webpage and newspaper navigation, providing searching tips and techniques. Students will become familiar with webpage and newspaper navigation and will be able to independently locate needed information regarding weather forecasts and weather history.

Graphic Organizers

I have created a few different graphic organizers for two of the lessons that I produced. These graphic organizers will help students organize the information that I am looking for them to collect. The charts will also help students keep track of the information that they have collected and help them to see what information they still need to document.

Activities

Sample Lesson Plan One

Title: Probably Pistachio
Grade: Second
Duration of Lesson: 30 minutes

Standards Utilized: 1.2.2.A, 1.3.2.B, 1.3.2.F, 2.2.2.F, 2.5.2.A, 2.5.2.B

Lesson Goals: Students will be able to successfully predict the next possible event in a story by utilizing information given in the children's story *Probably Pistachio*. Students will learn to analyze information so that they can make informed decisions and they will realize that these skills can be applied to many different areas of learning.

Materials Needed: *Probably Pistachio* by Stuart J. Murphy

Opening Lesson Discussion: Ask students about a time they can recall when they seemed to have a bad day where nothing seemed to go as planned. Make sure students discuss the events that did not go as planned and why they think their plans ended up changing. Also make sure to discuss the feelings that go along with a series of events not going as planned.

After discussion, tell students that they are going to listen to a story about a boy named Jack who experiences a day where nothing goes as planned. Inform the students that they will be making predictions throughout the story where they must use information from previous pages to make an educated guess as to what they think will happen next in Jack's day.

The author of *Probably Pistachio* recommends asking the following questions during the reading of the story:
> *Do you think Emma will have pastrami for lunch?*
> *Why do you think that?*
> *Why did Jack's prediction come true?*
> *What question could Jack have asked Emma so that he might have made a better prediction?*

After reading the story the author of *Probably Pistachio* recommends asking the question:
> *If Emma had a pastrami sandwich only once a week, would Jack expect pastrami when he traded with her?*

After the teacher has asked each of the author recommended questions, other questions can be added in based on students' interest in the story and any questions that may be posed by the children. After all questions have been discussed and answered the teacher will then instruct students to turn to a partner and utilize the pair and share discussion model. Students will be asked to discuss events that are likely to happen today. They will then be prompted to discuss events that are not likely to happen today. Lastly, the students will be asked to come up with events that may or may not happen today. Ask students to share as a whole group a few examples that they and their partners discussed while sharing.

Lesson Closure: Summarize the story read as well as the scenarios discussed by students. Close lesson by reiterating the idea of probability and how different events can be categorized and predicted based on the information that has been analyzed.

Sample Lesson Plan Two
Title: School Lunch Tracking
Grade: Second
Duration of Lesson: 30 minutes for initial lesson, followed by 5 minutes a day for one week

Standards Utilized: 2.2.2.F, 2.5.2.A, 2.5.2.B, 2.6.2.C, 2.6.2.C.1, 2.6.2.D, 2.7.2.A, 2.7.2.A.1

Lesson Goals: Students will successfully keep track of school lunch items that are served for a school week of five days. Students will then analyze the information they recorded to make predictions about the possible lunch selections for the following school week.

Materials Needed: Teacher made school lunch sheet

Opening Lesson Discussion: Remind children of the story they listened to involving making predictions about the probability of an event. Ask students for an example of each type of probability scenario: a likely event, and unlikely event, and an impossible event. After reviewing the three types of possibilities, move into the main idea of the lesson.

Inform students that they will be keeping track of the school lunch choices for an entire school week of five days. Explain that each student will be given a School Lunch Tracking Sheet and they will be responsible for recording the following: drinks offered, main meal offered, sides to meal offered, and any extra offerings. After they have successfully recorded each lunch item offered each day for a week they students will then be asked to compare their recordings with other students in the class. Next, the children will be asked to analyze the information they collected and make predictions for next week's lunch choices. Encourage children to also use previous knowledge of lunch patterns to help in forming predictions for next week's lunches. For example, ask students, "What lunch item is usually served on Fridays?" Students are then expected to respond, "Pizza!" Students will then complete the Student Lunch Prediction Sheet.

After students have successfully completed their Student Lunch Prediction Sheet they will be asked to take their sheet to lunch each day of the following week. Tell students to record if their predictions are accurate or inaccurate for the duration of the school week. Students should also be encouraged to record when their incorrect predictions surprise them and why they feel that their prediction should have been correct.

Lesson Closure: Ask students to bring their prediction sheets to the carpet for discussion. Begin a small discussion about the accuracy of students' predictions. Encourage students to think about what made them choose a possible outcome and analyze a specific choice when a prediction was incorrect. Were there any instances where an outcome was unusually surprising, such as a Friday without pizza? Possible questions to ask:

> *Was there any time during the week where you were surprised about your prediction?*
> *Were there any times when you felt that your prediction should have been correct but was not?*
> *Why did you feel that way?*
> *Were your predictions correct most of the time?*
> *Were your predictions incorrect most of the time?*
> *Were any of the school lunches served on the same day as the previous week?*
> *What surprised you most about this activity?*
> *What did you like the most/least about this activity?*

<u>Sample Lesson Plan Three</u>
Title: Weather Prediction Comparison
Grade: Second
Duration of Lesson: 30 minutes for initial lesson, followed by 5 minutes a day for one week

Standards Utilized: 2.6.2.C.1, 2.6.2.D, 2.7.2.A, 2.7.2.C, 2.7.2.D, 1.3.2.F, 3.3.3.A, 3.4.3.A

Lesson Goals: Students will successfully keep track of anticipated precipitation predictions from various weather prediction sources for a 5-day school week. Students will then analyze the information they recorded and they will compare sources to see which source was the most accurate. They will also look for any inconsistencies or abnormalities and come to a personal conclusion deciding if precipitation prediction percentages are necessary within weather reports.

Materials Needed: Teacher made weather tracking sheet, computers, a current copy of The Philadelphia Inquirer

Opening Lesson Discussion: Ask children to talk about a time when they watched/heard a weather forecast on the television, internet, or radio. Encourage students to discuss the different aspects of a meteorologist's forecast. After reviewing the different forecast components such as radar, temperatures, wind speeds, humidity, and the extended forecast, move on to the main idea of the lesson.

Inform students that they will each be assigned a different weather forecasting source to observe and analyze for the duration of one school week. The weather forecast sources will be as follows: ABC 6 Action News Accuweather, CBS Philly Weather, NBC Philadelphia Weather, My Fox Philly Weather, The Weather Channel Weather, PhillyWeather.net, and The Philadelphia Inquirer Weather Section. Under supervision on the teacher the students will log on to the weather websites provided by the teacher. Those assigned The Philadelphia Inquirer will be given a copy of that day's newspaper. Students will be broken up into small groups and given a weather prediction information recording sheet. The students will fill out the predicted temperature, chance of precipitation, and overall weather conditions. As the week goes on the students will compare the predicted weather conditions with the actual weather conditions and record and differences on their prediction worksheets. At the end of the week we will come together as a class and discuss the students' findings. Students will compare data collected with one another to see which weather prediction source was most accurate during the course of the week. Students will be instructed to look over their information carefully and try and analyze areas where the predictions were incorrect and they will be encouraged to create a reason as to why they believe the prediction may have been incorrect.

Lesson Closure: After analyzing all of the recorded data, students will then share which weather prediction source they feel is the most accurate and why. Discussion will be concluded by reiterating the purpose for making predictions in everyday life and stating that predictions play a large role in the way people live their lives from day to day.

Annotated Bibliography / Resources

Teacher Resources

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"Clear Standards - Pennsylvania Academic Standards." SAS - Pennsylvania Department of Education Standards Aligned System. 2011. Web. 6 Apr. 2011. <http://www.pdesas.org/Standard/StandardsDownloads>. This website contains all of Pennsylvania's State Standards that curriculum and lesson plans must be aligned to.

"Highline Advanced Math Program." *Definition and Explanations of Math Terms*. 15 Jan. 2008. Web. 24 May 2011. <http://home.blarg.net/~math/index.html>. This website was created as a resource for an advanced math program and contains child-friendly math definitions as well as other probability information.

Murphy, Stuart J., and Marsha Winborn. *Probably Pistachio*. New York: HarperCollins, 2001. Print. This is a children's book specifically written to teach children about the basic principles and vocabulary of probability. This is a great story to share with students in grades 1 through 3.

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Students' Bibliography

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Thunstrom, Tom. "Forecast." *Phillyweather.net.* 2011. Web. 6 Apr. 2011. <http://phillyweather.net/>. Phillyweather.net website containing forecast information.

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"Weather Report." The Philadelphia Inquirer 2011. Print. This is the newspaper students will use to examine the daily local weather report.

Appendix 1

Standards: The Philadelphia Public Schools Core Curriculum is aligned to the Pennsylvania State Standards. The following second grade standards within the mathematics, literacy, and science branches will be utilized:

Mathematics:

2.2.2: Computation and Estimation
       2.2.2.F: Determine the reasonableness of calculated answers.
- 2.2.2.F.1: Compare estimation with calculated answers.

2.5.2: Mathematical Problem Solving and Communication
       2.5.2.A: Use appropriate problem-solving strategies (e.g., guess and check, working backwards).
- 2.5.2.A.1: Select appropriate problem solving strategy (e.g., guess and check, working backwards) to solve problems.

       2.5.2.B: Determine when sufficient information is present to solve a problem and explain how to solve a problem.
- 2.5.2.B.1: Choose and explain the correct strategy to solve a problem.

2.6.2: Statistics and Data Analysis
       2.6.2.C: Predict the likely number of times a condition will occur based on analyzed data.
- 2.6.2.C.1: Collect and display data over time and predict what conditions will change the data.

       2.6.2.D: Form and justify an opinion on whether a given statement is reasonable based on a comparison to data.

2.7.2: Probability and Predictions
       2.7.2.A: Predict and measure the likelihood of events and recognize that the results of an experiment may not match predicted outcomes.
- 2.7.2.A.1: Predict the likelihood of an event and verify the prediction.

       2.7.2.C: List or graph the possible results of an experiment.
       2.7.2.D: Analyze data using the concepts of largest, smallest, most often, least often and middle.
- 2.7.2.D.1: Collect and describe data using concepts of largest, smallest, most often, least often, and middle.

Literacy:

1.2.2: Reading Critically In All Content Areas
- 1.2.2.A: Read and understand essential content of informational texts.

1.3.2: Reading, Analyzing and Interpreting Literature
       1.3.2.B: Identify literary elements in stories including characters, setting, and plot.

1.3.2.F: Read and comprehend both nonfiction and fiction.

Science:

3.3.A: Earth Structure, Processes and Cycles
- 3.3.3.A: Explain how air temperature, moisture, wind speed and direction, and precipitation make up the weather in a particular place and time.

3.4.A: The Scope of Technology
- 3.4.3.A: Identify how the study of technology uses many of the same ideas and skills as many other subjects.

Teacher Created Worksheets

School Lunch Sheet

Monday __/__/__	Tuesday __/__/__	Wednesday __/__/__	Thursday __/__/__	Friday __/__/__
Drinks Offered:	Drinks Offered:	Drinks Offered:	Drinks Offered:	Drinks Offered:
Main Meal:	Main Meal:	Main Meal:	Main Meal:	Main Meal:
Sides to Main Meal:	Sides to Main Meal:	Sides to Main Meal:	Sides to Main Meal:	Sides to Main Meal:
Extras Offered:	Extras Offered:	Extras Offered:	Extras Offered:	Extras Offered:

<u>Weather Prediction Sheet</u>

Monday __/__/__	Tuesday __/__/__	Wednesday __/__/__	Thursday __/__/__	Friday __/__/__
Predicted Temperature:	Predicted Temperature:	Predicted Temperature:	Predicted Temperature:	Predicted Temperature:
Chance of Precipitation:	Chance of Precipitation:	Chance of Precipitation:	Chance of Precipitation:	Chance of Precipitation:
Predicted Overall Weather Condition:	Predicted Overall Weather Condition:	Predicted Overall Weather Condition:	Predicted Overall Weather Condition:	Predicted Overall Weather Condition:

Actual Temperature:	Actual Temperature:	Actual Temperature:	Actual Temperature:	Actual Temperature:
Was there precipitation?	Was there precipitation?	Was there precipitation?	Was there precipitation?	Was there precipitation?
Actual Weather Conditions:	Actual Weather Conditions:	Actual Weather Conditions:	Actual Weather Conditions:	Actual Weather Conditions:

Works Referenced

[1] (Using the Standards Data Analysis and Probability 2005)

[2] (Albert 1996)

[3] (Highline Advanced math Program 2008)

[4] (Predicting Weather 2000)