Arizona Mathematic Standards

Mathematics Curriculum Map

Introduction to Statistics

ARIZONA DEPARTMENT OF EDUCATION
HIGH ACADEMIC STANDARDS

Chandler Unified School District Standards

Introduction to Statistics– At a Glance

Introduction to Statistics Curriculum Map

Semester 1					Semester 2				
Unit 1 Analyzing One-Variable Data	**Unit 2 Analyzing Two-Variable Data**	**Unit 3 Collecting Data**	**Unit 4 Probability**	**Unit 5 Random Variables**	**Unit 6 Sampling Distributions**	**Unit 7 Estimating a Parameter**	**Unit 8 Testing a Claim**	**Unit 9 Comparing Two Populations or Treatments**	**Unit 10 Inference for Distributions and Relationships**
A1.S-ID.A.1 **A1.S-ID.A.2** **A1.S-ID.A.3**	**A1.S-ID.B.5** **A1.S-ID.B.6** **A1.S-ID.B.6a** **A1.S-ID.B.6b** **A1.S-ID.C.8** **A1.S-ID.C.9**	**A2.S-IC.A.1** **A2.S-IC.B.3** **P.S-IC** **P-S-IC.B.3** **P-S-IC.B.4**	**A2.S-CP.A.3** **A2.S-CP.A.4** **A2.S-CP.A.5** **A2.S-CP.A.7** **A2.S-CP.A.8** **P.S-CP.B.0** **P.S-IC.B.5**	**A2.S-ID.A.4** **P.S-MD.A.1** **P.S-MD.A.2**	**A2.S-IC.A.1** **A2.S-ID.A.4** **P.S-IC.B** **P.S-MD.A.3**	**A2.S-IC.B** **A2.S-IC.B.4** **P.S-IC.B.4** **P.S-IC.B.6** **P.S-MD.B.7**	**A1.S-ID.A.1** **A1.S-ID.A.2** **A1.S-ID.A.3** **A2.S-ID.A.4**	**A2.S-IC.B** **A2.S-IC.B.4** **P.S-IC.B.4** **P.S-IC.B.5**	**A1.S-ID.A.3** **A1.S-ID.B.6** **A2.S-IC.A.2** **A2.S-ID.A.3** **A2.S-ID.B** **A2.S-ID.C**

Mathematical Practices *:* All units will include the Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

NOTE: Mathematical standards are interwoven and should be addressed throughout the year in as many different units and tasks as possible in order to stress the natural connections that exist among mathematical topics.

Introduction to Statistics Overview

Analyzing One-Variable Data
- Statistics: The Science and Art of Data?
- Displaying Categorical Data
- Displaying Quantitative Data: Dotplots
- Displaying Quantitative Data: Stemplots
- Displaying Quantitative Data: Histograms
- Measuring Center
- Measuring Variability
- Summarizing Quantitative Data: Boxplots and Outliers
- Describing Location in a Distribution

Analyzing Two-Variable Data
- Relationships between Two Categorical Variables
- Relationships between Two Quantitative Variables
- Correlation
- Calculating the Correlation
- Regression Lines
- The Least-Squares Regression Line
- Assessing a Regression Model
- Fitting Models to Curved Relationships

Collecting Data
- Introduction to Data Collection
- Sampling: Good and Bad
- Simple Random Samples
- Estimating a Margin of Error
- Sampling and Surveys
- Observational Studies and Experiments
- How to Experiment Well
- Inference for Experiments
- Using Studies Wisely

Probability
- Randomness, Probability, and Simulation
- Basic Probability Rules
- Two-Way Tables and Venn Diagrams
- Conditional Probability and Independence
- The General Multiplication Rule and Tree Diagrams
- The Multiplication Rule for Independent Events
- The Multiplication Counting Principle and Permutations
- Combinations and Probability

Random Variables
- Introduction to Random Variables
- Analyzing Discrete Random Variables
- Binomial Random Variables
- Analyzing Binomial Random Variables
- Continuous Random Variables
- The Standard Normal Distribution
- Normal Distribution Calculations

Sampling Distributions
- What Is a Sampling Distribution?
- Sampling Distributions: Center and Variability
- The Sampling Distribution of a Sample Count (The Normal Approximation to the Binomial)
- The Sampling Distribution of a Sample Proportion
- The Sampling Distribution of a Sample Mean
- The Central Limit Theorem

Estimating a Parameter
- The Idea of a Confidence Interval
- What Affects the Margin of Error?
- Estimating a Proportion
- Confidence Intervals for a Proportion
- Estimating a Mean
- Confidence Intervals for a Mean

Testing a Claim
- The Idea of a Significance Test
- Significance Tests and Decision Making
- Testing a Claim about a Proportion
- Significance Tests for a Proportion
- Testing a Claim about a Mean
- Significance Tests for a Mean

Comparing Two Populations or Treatments
- Estimating a Difference between Two Proportions
- Testing a Claim about a Difference between Two Proportions
- Estimating a Difference between Two Means
- Testing a Claim about a Difference between Two Means
- Analyzing Paired Data: Estimating a Mean Difference
- Testing a Claim about a Mean Difference

Inference for Distributions and Relationships
- Testing the Distribution of a Categorical Variable
- Chi-Square Test for Goodness of Fit
- Testing the Relationship between Two Categorical Variables
- Chi-Square Tests for Association
- Testing the Relationship between Two Quantitative Variables
- Inference for the Slope of a Least-Squares Regression Line

Semester 1

Unit 1 – Analyzing One-Variable Data

Essential Question(s):

- **How do you identify the individuals and variables in a data set, then classify the variables as categorical or quantitative?**
- **How do you summarize the distribution of a variable with a frequency table or a relative frequency table?**
- **How do you make, interpret, and compare data using bar charts, pie charts, dotplots, stemplots, and histograms?**
- **How do you make comparisons of quantitative data using mean, median, range, and standard deviation?**
- **How do you calculate and interpret a standardized score (z-score) in a distribution of quantitative data?**

Topic	AZ State Mathematical Standards	Mathematical Practices	Resources
Statistics: the science and art of data		MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 1.1
Displaying categorical data	**A1.S-ID.A.1:** Represent real-value data with plots for the purpose of comparing two or more data sets.		Starnes &Tabor 1.2
Displaying quantitative data: dotplots, stemplots, and histograms	**A1.S-ID.A.1:** Represent real-value data with plots for the purpose of comparing two or more data sets.		Starnes & Tabor 1.3,1.4,1.5
Measuring center and variability	**A1.S-ID.A.2**: se statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets **A1.S-ID.A.3:** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present		Starnes & Tabor 1.6,1.7
Summarizing quantitative data: boxplots and outliers	**A1.S-ID.A.1**: Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present. **A1.S-ID.A.2:** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.		Starnes & Tabor 1.8
Describing location in a distribution			Starnes & Tabor 1.9

Semester 1

Unit 2 – Analyzing Two-Variable Data
Essential Question(s):

- **How can you use relationships in two variables to solve real-world problems?**

Topic	Arizona Mathematics Standards	Mathematical Practices	Resources
Relationships Between Two Variables	**A1.S-ID.B.5:** Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data, including joint, marginal, and conditional relative frequencies. Recognize possible associations and trends in the data.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 2.1, 2.2
Correlation	**A1.S-ID.B.6:** Represent data on two quantitative variables on a scatter plot, and describe how the quantities are related. **A1.S-ID.C.8:** Compute and interpret the correlation coefficient of a linear relationship. **A1.S-ID.C.9:** Distinguish between correlation and causation.		Starnes & Tabor 2.3, 2.4
Linear Regression	**A1.S-ID.B.6a:** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Focus on linear models. **A1.S-ID.B.6b:** Informally assess the fit of a function by plotting and analyzing residuals.		Starnes & Tabor 2.5, 2.6, 2.7
Fitting Models to Curved Data	**A2.S-ID.B.6:** Represent data of two quantitative variables on a scatter plot, and describe how the quantities are related. Extend to polynomial and exponential models. **A1.S-ID.B.6a:** Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or chooses a function suggested by the context.		Starnes & Tabor 2.8

Semester 1

Unit 3 – Collecting Data
Essential Question(s):

- **How do you collect data in appropriate ways?**
- **When can you make inferences about a population?**
- **When can you say cause and effect relationships exist?**

Topic	Arizona Mathematic Standards	Mathematical Practices	Resources
Sampling Methods	**A2.S-IC.B.3:** Recognize the purposes of and differences between designed experiments, sample surveys and observational studies. **P.S-IC:** Make inferences and justify conclusions from sample surveys, experiments, and observational studies. **P.S-IC.B.3:** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 3.1, 3.2, 3.3, 3.5, 3.9
Margin of Error	**P.S-IC.B.4:** Use data from a random sample to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.		Starnes & Tabor 3.4
Surveys	**A2.S-IC.A.1:** Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **P.S-IC:** Make inferences and justify conclusions from sample surveys, experiments, and observational studies. **P.S-IC.B.3:** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.		Starnes & Tabor 3.5, 3.9
Observational Studies and Experiments	**P.S-IC:** Make inferences and justify conclusions from sample surveys, experiments, and observational studies. **P.S-IC.B.3:** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.		Starnes & Tabor 3.6, 3.7, 3.8, 3.9

Semester 1

Unit 4 - Probability
Essential Question(s):

- **How do you calculate probability of multiple events?**
- **How do you organize data to find a probability of an event?**
- **How do you determine if events are independent?**

Topic	Arizona Mathematics Standards	Mathematical Practices	Resources
Simulations	**P.S-IC.B.5:** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 4.1
Probability Rules	**A2.S-CP.A.3:** Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P(B)*, and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of A, and the conditional probability of *B* given *A* is the same as the probability of *B*. **A2.S-CP.B.7:** Apply the Addition Rule, *P*(*A* or *B*) = *P(A)* + *P(B)* – *P*(*A* and *B*), and interpret the answer in terms of the model. **A2.S-CP.B.8:** Apply the general Multiplication Rule in a uniform probability model, *P*(*A* and *B*) = *P(A)P(B|A)* = *P(B)P(A|B)*, and interpret the answer in terms of the model.		Starnes & Tabor 4.2, 4.4, 4.5, 4.6, 4.7
Two-Way Tables, Venn Diagrams, and Tree Diagrams	**A2.S-CP.A.4:** Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.		Starnes & Tabor 4.3, 4.4, 4.5
Conditional Probability	**A2.S-CP.A.3:** Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P(B)*, and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of A, and the conditional probability of *B* given *A* is the same as the probability of *B*. **A2.S-CP.A.5:** Recognize and explain the concepts of conditional probability and independence utilizing real-world context.		Starnes & Tabor 4.4, 4.5

Independent and Dependent events	**A2.S-CP.A.3:** Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P(B)*, and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of A, and the conditional probability of *B* given *A* is the same as the probability of *B*. **A2.S-CP.A.5:** Recognize and explain the concepts of conditional probability and independence utilizing real-world context. **A2.S-CP.B.8**: Apply the general Multiplication Rule in a uniform probability model, *P*(*A* and *B*) = *P(A)P(B*|*A) = P(B)P(A*|*B)*, and interpret the answer in terms of the model.		Starnes & Tabor 4.4, 4.6, 4.7
Combinations and Permutations	**P.S-CP.B.9:** Use permutations and combinations to compute probabilities of compound events and solve problems.		Starnes & Tabor 4.7, 4.8

Semester 1

Unit 5 – Random Variables

Essential Question(s):

- **How do you classify a random variable as discrete or continuous?**
- **How do you calculate and interpret the mean (expected value) of a discrete random variable?**
- **How do you calculate and interpret the mean and standard deviation of a binomial random variable?**
- **How do you use the 68-95-99.7 rule to find approximate probabilities?**
- **How do you find a probability (area) from a z-score in the standard normal distribution?**

Topic	AZ State Mathematical Standards	Mathematical Practices	Resources
Two types of random variables	**P.S-MD.A.1:** Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 5.1
Discrete random variables	**P.S-MD.A.1:** Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions. **P.S-MD.A.2:** Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.		Starnes & Tabor 5.2
Binomial random variables	**P.S-MD.A.1:** Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions. **P.S-MD.A.2:** Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.		Starnes & Tabor 5.3, 5.4
Continuous random variables	**P.S-MD.A.1:** Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions. **P.S-MD.A.2:** Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.		Starnes & Tabor 5.5
Normal distribution, Standard normal distribution	**A2.S-ID.A.4:** Use the mean and standard deviation of a data set to fit it to a normal curve, and use properties of the normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, or tables to estimate areas under the normal curve.		Starnes & Tabor 5.6, 5.7

Semester 2

Unit 6 – Sampling Distributions
Essential Question(s):

- **How is the mean of a sampling distribution related to the population mean or proportion?**

Topic	Arizona Mathematics Standards	Mathematical Practices	Resources
Proportions	**A2.S-IC.A.1:** Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **P.S-IC.B:** Make inferences and justify conclusions from sample surveys, experiments, and observational studies. **P.S-MD.A.3:** Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated. Find the expected value.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 6.1, 6.3, 6.4
Means	**A2.S-IC.A.1**: Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **A2.S-ID.A.4:** Use the mean and standard deviation of a data set to fit it to a normal curve, and use properties of the normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, or tables to estimate areas under the normal curve. **P.S-MD.A.3:** Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated. Find the expected value. **P.S-IC.B**: Make inferences and justify conclusions from sample surveys, experiments, and observational studies.		Starnes & Tabor 6.1, 6.2, 6.5
The Central Limit Theorem	**P.S-IC.B**: Make inferences and justify conclusions from sample surveys, experiments, and observational studies. **P.S-MD.A.3:** Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated. Find the expected value.		Starnes & Tabor 6.6

Semester 2

Unit 7 – Estimating a Parameter
Essential Question(s):

- **How do you use confidence intervals to make decisions?**
- **How do you estimate a population proportion?**
- **How do you estimate a population mean?**
- **What conditions must be met to construct confidence intervals?**

Topic	Arizona Mathematics Standards	Mathematical Practices	Resources
Confidence Interval	**A2.S-IC.B:** Make inferences and justify conclusions from experiments, and observational studies. **P.S-IC.B.4:** Use data from a random sample to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. **P.S-IC.B.6:** Evaluate reports based on data. **P.S-MD.B.7**: Analyze decisions and strategies using probability concepts.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 7.1, 7.2, 7.4, 7.5, 7.6
Proportions	**A2.S-IC.B.4:** Use data from a sample survey to estimate a population mean or proportion; recognize that estimates are unlikely to be correct and the estimates will be more precise with larger sample sizes. **P.S-IC.B.4:** Use data from a random sample to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.		Starnes & Tabor 7.3, 7.4
Means	**A2.S-IC.B.4:** Use data from a sample survey to estimate a population mean or proportion; recognize that estimates are unlikely to be correct and the estimates will be more precise with larger sample sizes. **P.S-IC.B.4:** Use data from a random sample to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.		Starnes & Tabor 7.5, 7.6

Semester 2

Unit 8 – Testing a Claim
Essential Question(s):
How do you develop an appropriate hypothesis for a significance test?
How do you test a claim about a parameter?
How do you interpret the p-value correctly and in context?
How do you distinguish between Type I and Type II errors?

Topic	Arizona Mathematics Standards	Mathematical Practices	Resources
Significance test	**A1.S-ID.A.1:** Represent real-value data with plots for the purpose of comparing two or more data sets. **A1.S-ID.A.2:** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. **A1.S-ID.A.3:** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 8.1, 8.2
Testing a claim/ Significance test for a proportion	**A1.S-ID.A.1:** Represent real-value data with plots for the purpose of comparing two or more data sets. **A1.S-ID.A.2:** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. **A1.S-ID.A.3:** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present. Use the mean and standard deviation of a data set to fit it to a normal curve, and use properties of the normal distribution and to estimate population percentages. **A2.S-ID.A.4:** Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, or tables to estimate areas under the normal curve.		Starnes & Tabor 8.3, 8.4

Testing a claim/ Significance test for a mean	**A1.S-ID.A.1:** Represent real-value data with plots for the purpose of comparing two or more data sets. **A1.S-ID.A.2:** Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. **A1.S-ID.A.3:** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present. **A2.S-ID.A.4:** Use the mean and standard deviation of a data set to fit it to a normal curve, and use properties of the normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, or tables to estimate areas under the normal curve.		Starnes & Tabor 8.5, 8.6

Semester 2

Unit 9 – Comparing Two Populations or Treatments

Essential Question(s):

- **When can procedures for comparing two means be used and what are those procedures?**

Topic	Arizona Mathematic Standards	Mathematical Practices	Resources
Difference Between Two Proportions	**A2.S-IC.B:** Make inferences and justify conclusions from experiments, and observational studies. **A2.S-IC.B.4:** Use data from a sample survey to estimate a population mean or proportion; recognize that estimates are unlikely to be correct and the estimates will be more precise with larger sample sizes. **P.S-IC.B.4:** Use data from a random sample to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. **P.S-IC.B.5:** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 9.1, 9.2
Difference Between Two Means	**A2.S-IC.B:** Make inferences and justify conclusions from experiments, and observational studies. **A2.S-IC.B.4:** Use data from a sample survey to estimate a population mean or proportion; recognize that estimates are unlikely to be correct and the estimates will be more precise with larger sample sizes. **P.S-IC.B.4:** Use data from a random sample to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. **P.S-IC.B.5:** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.		Starnes & Tabor 9.3, 9.4
Mean Difference	**A2.S-IC.B:** Make inferences and justify conclusions from experiments, and observational studies. **P.S-IC.B.5:** Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.		Starnes & Tabor 9.5, 9.6

Semester 2

Unit 10 – inference for Distributions and Relationships

Essential Question(s):

- **What conditions must be met to run a test about the distribution of a categorical or quantitative variable?**
- **How do you run a chi-squared test for goodness of fit?**
- **How do you run a chi-squared test for association?**
- **How do you calculate and interpret a confidence interval for the slope of a least-squares regression line?**

Topic	Arizona Mathematic Standards	Mathematical Practices	Resources
Chi-Square	**A1.S-ID.A.3:** Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present. **A2.S-IC.A.2:** Explain whether a specified model is consistent with results from a given data-generating process. **A2.S-ID.B:** Summarize, represent, and interpret data on two categorical and quantitative variables.	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	Starnes & Tabor 10.1, 10.2, 10.3, 10.4
Two Categorical Variables	**A2.S-ID.B:** Summarize, represent, and interpret data on two categorical and quantitative variables. **A2.S-ID.C:** Interpret models.		Starnes & Tabor 10.3, 10.4
Two Quantitative Variables	**A2.S-ID.B:** Summarize, represent, and interpret data on two categorical and quantitative variables. **A2.S-ID.C:** Interpret models.		Starnes & Tabor 10.5, 10.6
Least-Squares Regression Line	**A1.S-ID.B.6:** Represent data on two quantitative variables on a scatter plot, and describe how the quantities are related. a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Focus on linear models. b. Informally assess the fit of a function by plotting and analyzing residuals **A2.S-ID.C:** Interpret models. **A2.S-IC.A.2:** Explain whether a specified model is consistent with results from a given data-generating process.		Starnes & Tabor 10.6

Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Overarching habits of mind of a productive math thinker	**MP.1 Make sense of problems and persevere in solving them**	Mathematically proficient students explain to themselves the meaning of a problem, look for entry points to begin work on the problem, and plan and choose a solution pathway. While engaging in productive struggle to solve a problem, they continually ask themselves, “Does this make sense?" to monitor and evaluate their progress and change course if necessary. Once they have a solution, they look back at the problem to determine if the solution is reasonable and accurate. Mathematically proficient students check their solutions to problems using different methods, approaches, or representations. They also compare and understand different representations of problems and different solution pathways, both their own and those of others.	• How would you describe the problem in your own words? • How would you describe what you are trying to find? • What do you notice about...? • What information is given in the problem? • Describe the relationship between the quantities. • Describe what you have already tried. What might you change? • Talk me through the steps you’ve used to this point. • What steps in the process are you most confident about? • What are some other strategies you might try? • What are some other problems that are similar to this one? • How might you use one of your previous problems to help you begin? • How else might you organize...represent... show...?
	MP.6 Attend to precision	Mathematically proficient students clearly communicate to others using appropriate mathematical terminology, and craft explanations that convey their reasoning. When making mathematical arguments about a solution, strategy, or conjecture, they describe mathematical relationships and connect their words clearly to their representations. Mathematically proficient students understand meanings of symbols used in mathematics, calculate accurately and efficiently, label quantities appropriately, and record their work clearly and concisely.	• What mathematical terms apply in this situation? • How did you know your solution was reasonable? • Explain how you might show that your solution answers the problem. • What would be a more efficient strategy? • How are you showing the meaning of the quantities? • What symbols or mathematical notations are important in this problem? • What mathematical language...,definitions..., properties can you use to explain...? • How could you test your solution to see if it answers the problem?

Actions and dispositions from NCSM Summer Leadership Academy, Atlanta, GA • Draft, June 22, 2011)
Most questions from all Grades Common Core State Standards Flip Book

The Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Reasoning and Explaining	**MP.2 Reason abstractly and quantitatively**	Mathematically proficient students make sense of quantities and their relationships in problem situations. Students can contextualize and decontextualize problems involving quantitative relationships. They contextualize quantities, operations, and expressions by describing a corresponding situation. They decontextualize a situation by representing it symbolically. As they manipulate the symbols, they can pause as needed to access the meaning of the numbers, the units, and the operations that the symbols represent. Mathematically proficient students know and flexibly use different properties of operations, numbers, and geometric objects and when appropriate they interpret their solution in terms of the context.	• What do the numbers used in the problem represent? • What is the relationship of the quantities? • How is _____ related to _____? • What is the relationship between _____and _____? • What does_____mean to you? (e.g. symbol, quantity, diagram) • What properties might we use to find a solution? • How did you decide in this task that you needed to use...? • Could we have used another operation or property to solve this task? Why or why not?
	MP.3 Construct viable arguments and critique the reasoning of others	Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents. Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.	• What mathematical evidence would support your solution? • How can we be sure that...? / How could you prove that...? • Will it still work if...? • What were you considering when...? • How did you decide to try that strategy? • How did you test whether your approach worked? • How did you decide what the problem was asking you to find? • Did you try a method that did not work? Why didn't it work? Could it work? • What is the same and what is different about...? • How could you demonstrate a counter-example?

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The Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Modeling and Using Tools	**MP.4 Model with mathematics**	Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. When given a problem in a contextual situation, they identify the mathematical elements of a situation and create a mathematical model that represents those mathematical elements and the relationships among them. Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.	• What number model could you construct to represent the problem? • What are some ways to represent the quantities? • What is an equation or expression that matches the diagram, number line, chart, table, and your actions with the manipulatives? • Where did you see one of the quantities in the task in your equation or expression? What does each number in the equation mean? • How would it help to create a diagram, graph, table...? • What are some ways to visually represent...? • What formula might apply in this situation?
	MP.5 Use appropriate tools strategically	Mathematically proficient students consider available tools when solving a mathematical problem. They choose tools that are relevant and useful to the problem at hand. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful; recognizing both the insight to be gained and their limitations. Students deepen their understanding of mathematical concepts when using tools to visualize, explore, compare, communicate, make and test predictions, and understand the thinking of others.	• What mathematical tools can we use to visualize and represent the situation? • Which tool is more efficient? Why do you think so? • What information do you have? • What do you know that is not stated in the problem? • What approach are you considering trying first? • What estimate did you make for the solution? • In this situation would it be helpful to use...a graph..., number line..., ruler..., diagram..., calculator..., manipulative? • Why was it helpful to use...? • What can using a _____ show us that _____may not? • In what situations might it be more informative or helpful to use...?

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Mathematics Practices		Narratives	Related Questions
Seeing structure and generalizing	**MP.7 Look for and make use of structure**	Mathematically proficient students use structure and patterns to assist in making connections among mathematical ideas or concepts when making sense of mathematics. Students recognize and apply general mathematical rules to complex situations. They are able to compose and decompose mathematical ideas and notations into familiar relationships. Mathematically proficient students manage their own progress, stepping back for an overview and shifting perspective when needed.	• What observations do you make about...? • What do you notice when...? • What parts of the problem might you eliminate..., simplify...? • What patterns do you find in...? • How do you know if something is a pattern? • What ideas that we have learned before were useful in solving this problem? • What are some other problems that are similar to this one? • How does this relate to...? • In what ways does this problem connect to other mathematical concepts?
	MP.8 Look for and express regularity in repeated reasoning	Mathematically proficient students look for and describe regularities as they solve multiple related problems. They formulate conjectures about what they notice and communicate observations with precision. While solving problems, students maintain oversight of the process and continually evaluate the reasonableness of their results. This informs and strengthens their understanding of the structure of mathematics which leads to fluency.	• Explain how this strategy works in other situations? • Is this always true, sometimes true or never true? • How would we prove that...? • What do you notice about...? • What is happening in this situation? • What would happen if...? • Is there a mathematical rule for...? • What predictions or generalizations can this pattern support? • What mathematical consistencies do you notice?

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