

Data Analysis & Probability

Grades K-2

Ohio Benchmarks Grades K-2	Grade-Level Indicators Kindergarten	Grade-Level Indicators Grade 1	Grade-Level Indicators Grade 2
<p>A. Pose questions and gather data about everyday situations and familiar objects.</p>	<p>1. Gather and sort data in response to questions posed by teacher and students; e.g., how many sisters and brothers, what color shoes.</p>	<p>5. Construct a question that can be answered by using information from a graph.</p>	<p>1. Pose questions, use observations, interviews and surveys to collect data, and organize data in charts, picture graphs and bar graphs.</p> <p>6. Recognize that data may vary from one population to another; e.g., favorite TV shows of students and of parents.</p>

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<p>B. Sort and classify objects by attributes, and organize data into categories in a simple table or chart.</p>	<ol style="list-style-type: none"> 2. Arrange objects in a floor or table graph according to attributes, such as use, size, color, or shape. 3. Select the category or categories that have the most or fewest objects in a floor or table graph. 	<ol style="list-style-type: none"> 1. Identify multiple categories for sorting data. 2. Collect and organize data into charts using tally marks. 6. Arrange five objects by an attribute, such as size or weight, and identify the ordinal position of each object. 7. Answer questions about the number of objects represented in a picture graph, bar graph or table graph; e.g., category with most, how many more in a category compared to another, how many altogether in two categories. 	<ol style="list-style-type: none"> 1. Pose questions, use observations, interviews and surveys to collect data, and organize data in charts, picture graphs and bar graphs. 4. Write a few sentences to describe and compare categories of data represented in a chart or graph, and make statements about the data as a whole.

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<p>C. Represent data using objects, picture graphs and bar graphs.</p>		<ol style="list-style-type: none"> 3. Display data in picture graphs with units of 1 and bar graphs with intervals of 1. 4. Read and interpret charts, picture graphs and bar graphs as sources of information to identify main ideas, draw conclusions, and make predictions. 	<ol style="list-style-type: none"> 2. Read, interpret and make comparisons and predictions from data represented in charts, line plots, picture graphs and bar graphs. 3. Read and construct simple timelines to sequence events. 5. Identify untrue or inappropriate statements about a given set of data.

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D. Describe the probability of chance events as more, less or equally likely to occur.				8. Describe the likelihood of simple events as possible/impossible and more likely/less likely; e.g., when using spinners or number cubes in classroom activities.	
				7. List some of the possible outcomes of a simple experiment, and predict whether given outcomes are more, less or equally likely to occur.	
				8. Use physical models and pictures to represent possible arrangements of 2 or 3 objects.	
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Grades 3-4

Ohio Benchmarks Grades 3-4	Grade-Level Indicators Grade 3	Grade-Level Indicators Grade 4
A. Gather and organize data from surveys and classroom experiments, including data collected over a period of time.	1. Collect and organize data from an experiment, such as recording and classifying observations or measurements, in response to a question posed.	1. Create a plan for collecting data for a specific purpose.
B. Read and interpret tables, charts, graphs (bar, picture, line, line plot), and timelines as sources of information, identify main idea, draw conclusions, and make predictions.	4. Support a conclusion or prediction orally and in writing, using information in a table or graph. 5. Match a set of data with a graphical representation of the data. 7. Analyze and interpret information represented on a timeline.	2. Represent and interpret data using tables, bar graphs, line plots and line graphs. 5. Propose and explain interpretations and predictions based on data displayed in tables, charts and graphs.

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Grades 3-4

Ohio Benchmarks Grades 3-4	Grade-Level Indicators Grade 3	Grade-Level Indicators Grade 4
<p>C. Construct charts, tables and graphs to represent data, including picture graphs, bar graphs, line graphs, line plots and simple Venn diagrams.</p>	<p>6. Translate information freely among charts, tables, line plots, picture graphs and bar graphs; e.g., create a bar graph from the information in a chart.</p>	<p>2. Represent and interpret data using tables, bar graphs, line plots and line graphs.</p> <p>3. Interpret and construct Venn diagrams to sort and describe data.</p> <p>4. Compare different representations of the same data to evaluate how well each representation shows important aspects of the data, and identify appropriate ways to display the data.</p>
<p>D. Read, interpret and construct graphs in which icons represent more than a single unit or intervals greater than one; e.g., each  = 10 bicycles or the intervals on an axis are multiples of 10.</p>	<p>2. Draw and interpret picture graphs in which a symbol or picture represents more than one object.</p> <p>3. Read, interpret and construct bar graphs with intervals greater than one.</p>	

Data Analysis & Probability Grades 3-4		
Ohio Benchmarks Grades 3-4	Grade-Level Indicators Grade 3	Grade-Level Indicators Grade 4
<p>E. Describe data using mode, median and range.</p>	<p>8. Identify the mode of a data set and describe the information it gives about a data set.</p>	<p>6. Describe the characteristics of a set of data based on a graphical representation, such as range of the data, clumps of data, and holes in the data.</p> <p>7. Identify the median of a set of data and describe what it indicates about the data.</p> <p>8. Use range, median and mode to make comparisons among related sets of data.</p>

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Ohio Benchmarks Grades 3-4	Grade-Level Indicators Grade 3	Grade-Level Indicators Grade 4
<p>F. Conduct a simple probability experiment and draw conclusions about the likelihood of possible outcomes.</p>	<p>9. Conduct a simple experiment or simulation of a simple event, record the results in a chart, table or graph, and use the results to draw conclusions about the likelihood of possible outcomes.</p>	<p>9. Conduct simple probability experiments and draw conclusions from the results; e.g., rolling number cubes or drawing marbles from a bag.</p> <p>10. Represent the likelihood of possible outcomes for chance situations; e.g., probability of selecting a red marble from a bag containing 3 red and 5 white marbles.</p> <p>11. Relate the concepts of impossible and certain-to-happen events to the numerical values of 0 (impossible) and 1 (certain).</p> <p>12. Place events in order of likelihood and use a diagram or appropriate language to compare the chance of each event occurring; e.g. impossible, unlikely, equal, likely, certain.</p>

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G. Identify and represent possible outcomes, such as arrangements of a set of up to four members and possible combinations from several sets, each containing 2 or 3 members.	10. Use physical models, pictures, diagrams and lists to solve problems involving possible arrangements or combinations of two to four objects.	13. List and count all possible combinations using one member from each of several sets, each containing 2 or 3 members; e.g., the number of possible outfits from 3 shirts, 2 shorts, and 2 pairs of shoes.
H. Use the set of possible outcomes to describe and predict events.		<p>10. Represent the likelihood of possible outcomes for chance situations; e.g., probability of selecting a red marble from a bag containing 3 red and 5 white marbles.</p> <p>11. Relate the concepts of impossible and certain-to-happen events to the numerical values of 0 (impossible) and 1 (certain).</p>
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Grades 5-7

Ohio Benchmarks Grades 5-7	Grade-Level Indicators Grade 5	Grade-Level Indicators Grade 6	Grade-Level Indicators Grade 7
<p>A. Read, create and use line graphs, histograms, circle graphs, box-and-whisker plots, stem-and-leaf plots, and other representations when appropriate.</p>	<p>1. Read, construct and interpret frequency tables, circle graphs and line graphs.</p>	<p>1. Read, construct and interpret line graphs, circle graphs and histograms.</p>	<p>1. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate.</p>
<p>B. Interpret data by looking for patterns and relationships, draw and justify conclusions, and answer related questions.</p>		<p>5. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance or shape; e.g., number of modes, middle of data and level of symmetry, outliers.</p>	<p>4. Construct opposing arguments based on analysis of the same data, using different graphical representations.</p>
<p>C. Evaluate interpretations and conclusions as additional data are collected, modify conclusions and predictions, and justify new findings.</p>	<p>5. Modify initial conclusions, propose and justify new interpretations and predictions as additional data are collected.</p>		

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Grades 5-7

Ohio Benchmarks Grades 5-7	Grade-Level Indicators Grade 5	Grade-Level Indicators Grade 6	Grade-Level Indicators Grade 7
<p>D. Compare increasingly complex displays of data, such as multiple sets of data on the same graph.</p>	<p>3. Read and interpret increasingly complex displays of data, such as double bar graphs.</p>	<p>3. Compare representations of the same data in different types of graphs, such as a bar graph and circle graph.</p>	<p>5. Compare data from two or more samples to determine how sample selection can influence results.</p>
<p>E. Collect, organize, display, and interpret data for a specific purpose or need.</p>	<p>2. Select and use a graph that is appropriate for the type of data to be displayed; e.g., numerical vs. categorical data, discrete vs. continuous data.</p> <p>4. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings.</p>	<p>2. Select, create and use graphical representations that are appropriate for the type of data collected.</p>	<p>2. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.</p>

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Grades 5-7

Ohio Benchmarks Grades 5-7	Grade-Level Indicators Grade 5	Grade-Level Indicators Grade 6	Grade-Level Indicators Grade 7
<p>F. Determine and use the range, mean, median and mode to analyze and compare data, and explain what each indicates about the data.</p>	<p>6. Determine and use the range, mean, median and mode, and explain what each does and does not indicate about the set of data.</p>	<p>4. Understand the different information provided by measures of center (mean, mode and median) and measures of spread (range).</p>	<p>3. Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures.</p>
<p>G. Evaluate conjectures and predictions based upon data presented in tables and graphs, and identify misuses of statistical data and displays.</p>		<p>6. Make logical inferences from statistical data.</p>	<p>2. Analyze how decisions about graphing affect the graphical representation; e.g., scale, size of classes in a histogram, number of categories in a circle graph.</p> <p>6. Identify misuses of statistical data in articles, advertisements, and other media.</p>

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Grades 5-7

Ohio Benchmarks Grades 5-7	Grade-Level Indicators Grade 5	Grade-Level Indicators Grade 6	Grade-Level Indicators Grade 7
<p>H. Find all possible outcomes of simple experiments or problem situations, using methods such as lists, arrays and tree diagrams.</p>	<p>7. List and explain all possible outcomes in a given situation.</p>		
<p>I. Describe the probability of an event using ratios, including fractional notation.</p>	<p>8. Identify the probability of events within a simple experiment, such as three chances out of eight.</p> <p>9. Use 0,1 and ratios between 0 and 1 to represent the probability of outcomes for an event, and associate the ratio with the likelihood of the outcome.</p>		<p>7. Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models.</p>

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Ohio Benchmarks Grades 5-7	Grade-Level Indicators Grade 5	Grade-Level Indicators Grade 6	Grade-Level Indicators Grade 7		
J. Compare experimental and theoretical results for a variety of simple experiments.	10. Compare what should happen (theoretical/expected results) with what did happen (experimental/actual results) in a simple experiment.				
K. Make and justify predictions based on experimental and theoretical probabilities.	11. Make predictions based on experimental and theoretical probabilities.	7. Design an experiment to test a theoretical probability and explain how the results may vary.	8. Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences.		
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Grades 8-10

Ohio Benchmarks Grades 8-10	Grade-Level Indicators Grade 8	Grade-Level Indicators Grade 9	Grade-Level Indicators Grade 10
<p>A. Create, interpret and use graphical displays and statistical measures to describe data; e.g., box-and-whisker plots, histograms, scatter plots, measures of center and variability.</p>	<p>1. Use, create and interpret scatterplots and other types of graphs as appropriate.</p>	<p>1. Classify data as univariate (single variable) or bivariate (two variables) and as quantitative (measurement) or qualitative (categorical) data.</p> <p>2. Create a scatterplot for a set of bivariate data, sketch the line of best fit, and interpret the slope of the line of best fit.</p> <p>3. Analyze and interpret frequency distributions based on spread, symmetry, skewness, clusters and outliers.</p>	<p>2. Represent and analyze bivariate data using appropriate graphical displays (scatterplots, parallel box-and-whisker plots, histograms with more than one set of data, tables, charts, spreadsheets) with and without technology.</p> <p>3. Display bivariate data where at least one variable is categorical.</p> <p>4. Identify outliers on a data display; e.g., use the interquartile range to identify outliers on a box-and-whisker plot.</p> <p>6. Interpret the relationship between two variables using multiple graphical displays and statistical measures; e.g., scatterplots, parallel box-and-whisker plots, and measures of center and spread.</p>

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Ohio Benchmarks Grades 8-10	Grade-Level Indicators Grade 8	Grade-Level Indicators Grade 9	Grade-Level Indicators Grade 10
<p>B. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose.</p>	<p>2. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose; e.g., line graph for change over time, circle graph for part-to-whole comparison, scatterplot for relationship between two variants.</p> <p>3. Differentiate between discrete and continuous data and appropriate ways to represent each.</p>		
<p>C. Compare the characteristics of the mean, median and mode for a given set of data, and explain which measure of center best represents the data.</p>	<p>5. Explain the mean's sensitivity to extremes and its use in comparison with the median and mode.</p>		<p>1. Describe measures of center and the range verbally, graphically and algebraically.</p>

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Ohio Benchmarks Grades 8-10	Grade-Level Indicators Grade 8	Grade-Level Indicators Grade 9	Grade-Level Indicators Grade 10
D. Find, use and interpret measures of center and spread, such as mean and quartiles, and use those measures to compare and draw conclusions about sets of data.	4. Compare two sets of data using measures of center (mean, mode, median) and measures of spread (range, quartiles, interquartile range, percentiles).		6. Interpret the relationship between two variables using multiple graphical displays and statistical measures; e.g., scatterplots, parallel box-and-whisker plots, and measures of center and spread.
E. Evaluate the validity of claims and predictions that are based on data by examining the appropriateness of the data collection and analysis.	8. Describe how the relative size of a sample compared to the target population affects the validity of predictions.	4. Describe and compare various types of studies (survey, observation, experiment), and identify possible misuses of statistical data.	

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Ohio Benchmarks Grades 8-10	Grade-Level Indicators Grade 8	Grade-Level Indicators Grade 9	Grade-Level Indicators Grade 10
<p>F. Construct convincing arguments based on analysis of data and interpretation of graphs.</p>	<p>6. Make conjectures about possible relationship in a scatterplot and approximate line of best fit.</p> <p>9. Construct convincing arguments based on analysis of data and interpretation of graphs.</p>	<p>6. Make inferences about relationships in bivariate data, and recognize the difference between evidence of relationship (correlation) and causation.</p>	
<p>G. Describe sampling methods and analyze the effects of method chosen on how well the resulting sample represents the population.</p>	<p>7. Identify different ways of selecting samples, such as survey response, random sample, representative sample and convenience sample.</p>	<p>5. Describe characteristics and limitations of sampling methods, and analyze the effects of random versus biased sampling; e.g., determine and justify whether the sample is likely to be representative of the population.</p>	<p>5. Provide examples and explain how a statistic may or may not be an attribute of the entire population; e.g., intentional or unintentional bias may be present.</p>

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Ohio Benchmarks Grades 8-10	Grade-Level Indicators Grade 8	Grade-Level Indicators Grade 9	Grade-Level Indicators Grade 10
<p>H. Use counting techniques, such as permutations and combinations, to determine the total number of options and possible outcomes.</p>	<p>10. Calculate the number of possible outcomes for a situation, recognizing and accounting for when items may occur more than once or when order is important.</p>	<p>7. Use counting techniques and the Fundamental Counting principle to determine the total number of possible outcomes for mathematical situations.</p>	
<p>I. Design an experiment to test a theoretical probability, and record and explain results.</p>	<p>7. <i>Design an experiment to test a theoretical probability and explain how the results may vary. (Grade 6)</i></p> <p>8. <i>Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences. (Grade 7)</i></p>	<p>8. Describe, create and analyze a sample space and use it to calculate probability.</p>	

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Ohio Benchmarks Grades 8-10	Grade-Level Indicators Grade 8	Grade-Level Indicators Grade 9	Grade-Level Indicators Grade 10		
<p>J. Compute probabilities of compound events, independent events, and simple dependent events.</p>	<p>11. Demonstrate an understanding that the probability of either of two disjoint events occurring can be found by adding the probabilities for each and that the probability of one independent event following another can be found by multiplying the probabilities.</p>	<p>9. Identify situations involving independent and dependent events, and explain differences between and common misconceptions about probabilities associated with those events.</p>	<p>7. Model problems dealing with uncertainty with area models (geometric probability).</p>		
<p>K. Make predictions based on theoretical probabilities and experimental results.</p>		<p>10. Use theoretical and experimental probability, including simulations or random numbers, to estimate probabilities and to solve problems dealing with uncertainty; e.g., compound events, independent events, simple dependent events.</p>	<p>8. Differentiate and explain the relationships between the probability of an event and the odds of an event, and compute one given the other.</p>		
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Grades 11-12

Ohio Benchmarks Grades 11-12	Grade-Level Indicators Grade 11	Grade-Level Indicators Grade 12
<p>A. Create and analyze tabular and graphical displays of data using appropriate tools, including spreadsheets and graphing calculators.</p>	<p>4. Create a scatterplot of bivariate data, identify trends, and find a function to model the data.</p> <p>5. Use technology to find the Least Squares Regression Line, the regression coefficient, and the correlation coefficient for bivariate data with a linear trend, and interpret each of these statistics in the context of the problem situation.</p> <p>7. Describe the standard normal curve and its general properties, and answer questions dealing with data assumed to be normal.</p> <p>8. Analyze and interpret univariate and bivariate data to identify patterns, note trends, draw conclusions, and make predictions.</p> <p>10. Understand and use the concept of random variable, and compute and interpret the expected value for a random variable in simple cases.</p>	<p>2. Transform bivariate data so it can be modeled by a function; e.g., use logarithms to allow nonlinear relationship to be modeled by linear function.</p> <p>4. Apply the concept of a random variable to generate and interpret probability distributions, including binomial, normal and uniform.</p>

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Grades 11-12

Ohio Benchmarks Grades 11-12	Grade-Level Indicators Grade 11	Grade-Level Indicators Grade 12
<p>B. Use descriptive statistics to analyze and summarize data, including measures of center, dispersion, correlation and variability.</p>	<p>3. Describe how a linear transformation of univariate data affects range, mean, mode, and median.</p> <p>5. Use technology to find the Least Squares Regression Line, the regression coefficient, and the correlation coefficient for bivariate data with a linear trend, and interpret each of these statistics in the context of the problem situation.</p> <p>6. Use technology to compute the standard deviation for a set of data, and interpret standard deviation in relation to the context or problem situation.</p> <p>8. Analyze and interpret univariate and bivariate data to identify patterns, note trends, draw conclusions, and make predictions.</p>	<p>3. Describe the shape and find all summary statistics for a set of univariate data, and describe how a linear transformation affects shape, center and spread.</p>

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Grades 11-12

Ohio Benchmarks Grades 11-12	Grade-Level Indicators Grade 11	Grade-Level Indicators Grade 12
<p>C. Design and perform a statistical experiment, simulation or study; collect and interpret data; and use descriptive statistics to communicate and support predictions and conclusions.</p>	<ol style="list-style-type: none"> 1. Design a statistical experiment, survey or study for a problem; collect data for the problem; and interpret the data with appropriate graphical displays, descriptive statistics, concepts of variability, causation, correlation and standard deviation. 2. Describe the role of randomization in a well-designed study, especially as compared to a convenience sample, and the generalization of results from each. 9. Evaluate validity of results of a study based on characteristics of the study design, including sampling method, summary statistics and data analysis techniques. 	<ol style="list-style-type: none"> 1. Identify and use various sampling methods (voluntary response, convenience sample, random sample, stratified random sample, census) in a study. 5. Use sampling distributions as the basis for informal inference.

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Grades 11-12

Ohio Benchmarks Grades 11-12	Grade-Level Indicators Grade 11	Grade-Level Indicators Grade 12			
<p>D. Connect statistical techniques to applications in workplace and consumer situations.</p>	<ol style="list-style-type: none"> 1. Design a statistical experiment, survey or study for a problem; collect data for the problem; and interpret the data with appropriate graphical displays, descriptive statistics, concepts of variability, causation, correlation and standard deviation. 2. Describe the role of randomization in a well-designed study, especially as compared to a convenience sample, and the generalization of results from each. 9. Evaluate validity of results of a study based on characteristics of the study design, including sampling method, summary statistics and data analysis techniques. 11. Examine statements and decisions involving risk; e.g., insurance rates and medical decisions. 	<ol style="list-style-type: none"> 6. Use theoretical or experimental probability, including simulations, to determine probabilities in real-world problem situations involving uncertainty, such as mutually exclusive events, complementary events and conditional probability. 			
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