Chapter	Problem Context	Chapter Objectives	Common Core Standards
1 Making Hard Decisions—Multi-Criteria Decision Making	1.1 Choosing a Cell Phone Plan 1.2 Enrique Ramirez Chooses a College 1.3 Judy Purchases a Used Car	▪ Identify the steps required to employ Multi-Criteria Decision Making. ▪ Use MCDM to make a decision. ▪ Analyze and interpret results; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.
2 Finding Optimal Solutions—Linear Programming (Maximization)	2.0 An Introductory Problem, Furniture Building 2.1 Computer Flips, a Junior Achievement Company 2.2 SK8MAN, Inc. 2.3 The Pallas Sport Shoe Company	▪ Given a contextual two-variable linear programming problem, develop the linear programming formulation, solve by graphing the feasible region and evaluating corner points to obtain the optimal solution. ▪ Given a contextual linear programming problem with two or more variables, develop the linear programming formulation, construct a spreadsheet in Excel, and use Solver to obtain the optimal solution. ▪ Analyze and interpret the optimal solution using Answer Reports. ▪ Analyze and interpret the optimal solution; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • A-SSE.1. Interpret expressions that represent a quantity in terms of its context. • A-CED.1. Create equations and inequalities in one variable and use them to solve problems. • A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. • A-REI.12. Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
3 Analyzing Optimal Solutions—Sensitivity Analysis	3.1 Computer Flips, a Junior Achievement Company 3.2 SK8MAN, Inc. 3.3 The Pallas Sport Shoe Company	▪ Given a contextual linear programming problem with two or more variables, use Solver to find the optimal solution and generate Answer and Sensitivity Reports. ▪ Given a contextual linear programming problem with two or more variables, investigate and define the different parts of Answer and Sensitivity Reports. ▪ Analyze and interpret the optimal solution using the Answer and Sensitivity Reports; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • A-SSE.1. Interpret expressions that represent a quantity in terms of its context. • A-CED.1. Create equations and inequalities in one variable and use them to solve problems. • A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
4 Finding Optimal Solutions—Linear Programming (Minimization)	4.1 Nutrition in Malawi 4.2 Minimizing Costs to Reduce Phosphorus in Wisconsin Watersheds 4.3 Disk Gasoline Distributors, Inc.	▪ Given a contextual linear programming problem with two or more variables, develop the linear programming formulation, construct a spreadsheet in Excel, and use Solver to obtain the optimal solution. ▪ Analyze and interpret the optimal solution using the Answer and Sensitivity Reports. ▪ Analyze and interpret the optimal solution; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • A-SSE.1. Interpret expressions that represent a quantity in terms of its context. • A-CED.1. Create equations and inequalities in one variable and use them to solve problems. • A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
5 Finding Optimal Solutions—Integer Programming	5.1 An Advertising Problem 5.2 Effectiveness of Political Advertising 5.3 Opening and Operating the Pizza Palace 5.4 Transporting Oranges to Midwest Markets	▪ Explain the need for and use the kernel to solve two-variable integer programming problems. ▪ Given a contextual integer programming problem with two or more variables, develop the integer programming formulation, construct a spreadsheet in Excel, and use Solver to obtain optimal solution. ▪ Given a contextual transportation problem with two or more variables, develop the integer programming formulation, construct a spreadsheet in Excel, and use Solver to obtain optimal solution. ▪ Analyze and interpret the optimal solution using the Answer Report. ▪ Analyze and interpret the optimal solution of a transportation problem using the Answer and Sensitivity Reports. ▪ Analyze and interpret the optimal solution; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • A-SSE.1. Interpret expressions that represent a quantity in terms of its context. • A-CED.1. Create equations and inequalities in one variable and use them to solve problems. • A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
6 Finding Optimal Solutions—Binary Programming	6.1 Jarvis selects a Project 6.2 Flipping Houses—A Detailed Example 6.3 Sam Johnson Makes a Hard Decision, Choosing which University to Apply to	▪ Investigate and explain the purpose of binary variables. ▪ Given a contextual binary programming problem with two or more variables, develop the binary programming formulation, construct a spreadsheet in Excel, and use Solver to obtain optimal solution. ▪ Analyze and interpret the optimal solution; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • A-SSE.1. Interpret expressions that represent a quantity in terms of its context. • A-CED.1. Create equations and inequalities in one variable and use them to solve problems. • A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
7 Finding Optimal Solutions—Assignment Problems	7.1 Coach Bass's Problem 7.2 Homecoming Events at State U. 7.3 Ms. Newman Assigns Students to Teams	▪ Given a contextual assignment problem with two or more variables, develop the binary programming formulation, construct a spreadsheet in Excel, and use Solver to obtain optimal assignment. ▪ Analyze and interpret the optimal assignment; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • A-SSE.1. Interpret expressions that represent a quantity in terms of its context. • A-CED.1. Create equations and inequalities in one variable and use them to solve problems. • A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
8 Finding Optimal Locations—Location Problems	8.1 Stadium Hot Dog Stands 8.2 The Smoothie Industry 8.3 Disaster Response Agency	▪ Given a contextual location problem (1-D or 2-D), define the cost and weight of a system. ▪ Given a contextual location problem (1-D or 2-D), calculate and find the optimal solution by calculating the median weight and determining which location's cumulative sum of weights exceeds the median weight. ▪ Use the geometric circumcenter of equally weighted, non-collinear points to find the optimal location. ▪ Given a contextual location problem (1-D or 2-D), develop the binary programming formulation, construct a spreadsheet in Excel, and use Solver to obtain optimal location. ▪ Analyze and interpret the optimal location; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. • G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). • G-MG.3. Apply geometric methods to solve design problems.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
9 Minimum Spanning Trees & Shortest Path — Graph Theory	9.0 Six Degrees of Separation 9.1 Road Reconstruction 9.2 Medical Supplies 9.3 How Quickly do Rumors Spread?	▪ Investigate and define graphs, arcs, nodes, networks, spanning trees, and weights and be able to identify them in a contextual problem. ▪ Given a contextual problem, find the minimum spanning tree using Kruskal's algorithm, analyze the results, and make decisions based on results. ▪ Given a contextual problem, find the shortest path using Dijkstra's algorithm, analyze the results, and make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.
10 Planning Projects —Critical Path Method (CPM)	10.1 Getting Ready for School 10.2 Preparing a Taco Dinner 10.3 Scheduling with CPM for a Flight Propulsion System	▪ Given a contextual problem, find the critical path of a project using the critical path method (via order-requirement digraph or Gantt chart). ▪ Analyze and interpret results; make decisions based on results.	• N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.
11 Making Complex Decisions— Decision Trees	11.1 Planning a Wedding, How many people should be invited? 11.2 Investment in Automation 11.3 Green Tree Energy— Location a New Plant 11.4 Purchasing collision Insurance	▪ Given a contextual problem, draw a tree diagram illustrating the probabilities. ▪ Given a contextual problem, calculate the expected cost associated with the tree diagram. ▪ Analyze and interpret results; make decisions based on results.	• S-CP.2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. • S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
12 Probabilistic Modeling—The Basics	12.1 The Super Bowl—Conference Dominance? 12.3 Customer Service at Koala Foods 12.4 Getting *The Lancer* to Press 12.5 Worker Absenteeism at BT Auto Industries	▪ Investigate and explain the concept of randomness. ▪ Simulate a probability using various methods (e.g., flipping a coin, RANDINT function on the calculator, Excel) and interpret results. ▪ Connect the results of a simulation with the theoretical probability of a contextual problem. ▪ Given a contextual problem, recognize when the multiplication principle is appropriate and apply it to independent events. ▪ Given a contextual problem, recognize when events are mutually exclusive and collectively exhaustive; then calculate probabilities of complementary events. ▪ Analyze and interpret results; make decisions based on results.	• S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. • S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). • S-CP.2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. • S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. • S-CP.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. • S-MD.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. • S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. • S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. • S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
12 Probabilistic Modeling—The Basics	12.1 The Super Bowl—Conference Dominance? 12.3 Customer Service at Koala Foods 12.4 Getting *The Lancer* to Press 12.5 Worker Absenteeism at BT Auto Industries	▪ Investigate and explain the concept of randomness. ▪ Simulate a probability using various methods (e.g., flipping a coin, RANDINT function on the calculator, Excel) and interpret results. ▪ Connect the results of a simulation with the theoretical probability of a contextual problem. ▪ Given a contextual problem, recognize when the multiplication principle is appropriate and apply it to independent events. ▪ Given a contextual problem, recognize when events are mutually exclusive and collectively exhaustive; then calculate probabilities of complementary events. ▪ Analyze and interpret results; make decisions based on results.	*Continued* • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
13 Using Probability Distributions—Binomial and Geometric	13.1 Customer Service at Koala Foods—Binomial Distribution of Successes 13.3 *The Lancer*—What if We Publish an Incomplete Paper? 13.4 Worker Absenteeism and Spare Workers at BT Auto Industries 13.5 First Time Something Happens: Geometric Distribution—Koala Foods at 8:10am 13.6 Geometric Distribution—NASA Shuttle Catastrophic Failure	▪ Explain what the Binomial Distribution is and when it is appropriate to use. ▪ Explain what the Geometric Distribution is and when it is appropriate to use. ▪ Given the probability of a success in a contextual problem, calculate theoretical probability of *r* successes in *n* trials using the Binomial Distribution. ▪ Given the probability of a success in a contextual problem, calculate the theoretical probability of the first success occurring in the *n*th trial using the Geometric Distribution. ▪ Given a contextual scenario, calculate combinations, conditional probabilities, and expected values. ▪ Recognize mutually exclusive and collectively exhaustive events; then use complementary events to calculate probabilities. ▪ Distinguish and investigate the difference between theoretical probabilities and experimental probabilities as well as their connections to the law of large numbers. ▪ Analyze and interpret results; make decisions based on results.	• S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”). • S-CP.2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. • S-CP.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*. • S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. • S-CP.6. Find the conditional probability of *A* given *B* as the fraction of *B*’s outcomes that also belong to *A*, and interpret the answer in terms of the model. • S-CP.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. • S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems. • S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
13 Using Probability Distributions—Binomial and Geometric	13.1 Customer Service at Koala Foods—Binomial Distribution of Successes 13.3 *The Lancer*—What if We Publish an Incomplete Paper? 13.4 Worker Absenteeism and Spare Workers at BT Auto Industries 13.5 First Time Something Happens: Geometric Distribution—Koala Foods at 8:10am 13.6 Geometric Distribution—NASA Shuttle Catastrophic Failure	▪ Explain what the Binomial Distribution is and when it is appropriate to use. ▪ Explain what the Geometric Distribution is and when it is appropriate to use. ▪ Given the probability of a success in a contextual problem, calculate theoretical probability of *r* successes in *n* trials using the Binomial Distribution. ▪ Given the probability of a success in a contextual problem, calculate the theoretical probability of the first success occurring in the *n*th trial using the Geometric Distribution. ▪ Given a contextual scenario, calculate combinations, conditional probabilities, and expected values. ▪ Recognize mutually exclusive and collectively exhaustive events; then use complementary events to calculate probabilities. ▪ Distinguish and investigate the difference between theoretical probabilities and experimental probabilities as well as their connections to the law of large numbers. ▪ Analyze and interpret results; make decisions based on results.	*Continued* • S-MD.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. • S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
14 Using Probability Distributions—Poisson	14.1 The CSI Team 14.2 Scheduled and Urgent Patients at a Health Care Clinic	▪ Explain what the Poisson Distribution is and when it is appropriate to use. ▪ Given in a contextual problem, calculate theoretical probabilities using the Poisson Distribution. ▪ Analyze and interpret results; make decisions based on results.	• S-CP.2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. • S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. • S-MD.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. • S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
15 Using Probability Distributions—Normal	15.1 Cutting Fabric for Parachutes 15.2 Automobile Battery Warranties 15.3 *Rappin' Skoop Dogg*—Seasonal Demand	▪ Explain what the Normal Distribution is and when it is appropriate to use. ▪ Given a contextual problem, calculate probabilities using the Normal Distribution. ▪ Given a contextual problem, calculate expected value using probabilities based on the Normal Distribution. ▪ Analyze and interpret results; make decisions based on results.	• S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots). • S-ID.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. • S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). • S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. • S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. • S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. • S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). • S-CP.2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. • S-MD.1. (+) Define a random variable

Chapter	Problem Context	Chapter Objectives	Common Core Standards
			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.
15 Using Probability Distributions—Normal	15.1 Cutting Fabric for Parachutes 15.2 Automobile Battery Warranties 15.3 *Rappin' Skoop Dogg*—Seasonal Demand	▪ Explain what the Normal Distribution is and when it is appropriate to use. ▪ Given a contextual problem, calculate probabilities using the Normal Distribution. ▪ Given a contextual problem, calculate expected value using probabilities based on the Normal Distribution. ▪ Analyze and interpret results; make decisions based on results.	*Continued* • S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. • S-MD.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. • S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. • S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. • S-MD.6. (+) Use probabilities to make fair decisions • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
16 Managing Randomness—Quality Control	16.1 Assembly of the Fuselage of a Boeing 787 16.2 Monitoring the Quality of Boeing 787 Fuselage Assembly 16.3 Compiling data to Create Quality Control Charts for the Assembly of Boeing 787 Fuselages	▪ Explain what quality control is and why we use quality control. ▪ Understand the differences between natural variability and unnatural variability as well as variability between samples and variability within a sample. ▪ Given a contextual problem, graph data on quality control charts and analyze whether or not the process is in statistical control. ▪ Given a contextual problem, plot data in Excel. ▪ Given a contextual problem, calculate/graph control limits and the average of the averages. Create quality control charts based upon these limits. ▪ Analyze and interpret results; make decisions based on results.	• S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots). • S-ID.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. • S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). • S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. • S-MD.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. • S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
17 Detecting and Interpreting False Positives and False Negatives	17.1 Spam Email 17.2 Lyme Disease 17.3 Identifying Credit Card Fraud	▪ Explain what are False Positive and False Negative Results and their implications. ▪ Given a contextual problem, use conditional probabilities to calculate the likelihood of false positive and false negative results. ▪ Analyze and interpret results; make decisions based on results.	• S-CP.2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. • S-CP.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*. • S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. • S-CP.6. Find the conditional probability of *A* given *B* as the fraction of *B*'s outcomes that also belong to *A*, and interpret the answer in terms of the model. • S-CP.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. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

Chapter	Problem Context	Chapter Objectives	Common Core Standards
18 Waiting in Line — Queuing Theory	18.1 Post Office in Britton, MI —Single Server 18.2 Airport Security Screening 18.3 Customer Complaints about the Front and Center Ticket Sales	▪ Investigate and explain queues and why we use queuing theory. ▪ Given a contextual problem, describe state transitions. ▪ Given a contextual problem, calculate average waiting time in a queue. ▪ Given a contextual problem, calculate: - Average arrival rate - Average service rate for one server - Proportion of arrival to service rates - Average number of people waiting in line - Average time in the system - Average time spent waiting in line - The probability of the system being in State *n* during any random observation of the system ▪ Analyze and interpret results; make decisions based on results.	• S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.
19 Project Planning —Program Evaluation Review Technique (PERT)	19.1 Preparing a Taco Dinner 19.2 Relocating CHEM-PACK Containers for the Super Bowl 19.3 Construction of a TV Tower	▪ Given a contextual problem, estimate the optimistic/pessimistic/most probable activity completion times and calculate the expected activity completion time. ▪ Given a contextual problem, find the critical path of a project using the critical path method (via order-requirement digraph or Excel spreadsheet). ▪ Investigate expected total project completion time using the Normal Distribution. ▪ Analyze and interpret results; make decisions based on results.	• S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.
20 Making Predictions— Markov Chains	20.1 Using Markov Chains to Make Predictions about Total Cholesterol Levels 20.2 Using Markov Chains to Predict about Medication Adherence 20.3 Video Game	▪ Given the probabilities of a contextual problem, develop a transition diagram and a transition matrix. ▪ Given the probabilities of a contextual problem, make predictions using Markov chains. ▪ Analyze and interpret results; make decisions based on results.	• N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. • N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions. • S-MD.6. (+) Use probabilities to make fair decisions. • S-MD.7. (+) Analyze decisions and strategies using probability concepts.

