

# Grades 9-12: Mathematical Modeling

Adopted 2019

## Mathematical Modeling

### Modeling

- A. Mathematical modeling and statistical problem-solving are extensive, cyclical processes that can be used to answer significant real-world problems. **MM.M.A**
  - 1. Use the full Mathematical Modeling Cycle or Statistical Problem-Solving Cycle to answer a real-world problem of particular student interest, incorporating standards from across the course. **MM.M.A.1**

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## Financial Planning and Management

- A. Mathematical models involving growth and decay are useful in solving real-world problems involving borrowing and investing; spreadsheets are a frequently-used and powerful tool to assist with modeling financial situations. **MM.FPM.A**
2. Use elements of the Mathematical Modeling Cycle to solve real-world problems involving finances. **MM.FPM.A.2**
3. Organize and display financial information using arithmetic sequences to represent simple interest and straight-line depreciation. **MM.FPM.A.3**
4. Organize and display financial information using geometric sequences to represent compound interest and proportional depreciation, including periodic (yearly, monthly, weekly) and continuous compounding. **MM.FPM.A.4**
  - a. Explain the relationship between annual percentage yield (APY) and annual percentage rate (APR) as values for  $r$  in the formulas  $A=P(1+r)t$  and  $A=Pert$ . **MM.FPM.A.4.A**
5. Compare simple and compound interest, and straight-line and proportional depreciation. **MM.FPM.A.5**
6. Investigate growth and reduction of credit card debt using spreadsheets, including variables such as beginning balance, payment structures, credits, interest rates, new purchases, finance charges, and fees. **MM.FPM.A.6**
7. Compare and contrast housing finance options including renting, leasing to purchase, purchasing with a mortgage, and purchasing with cash. **MM.FPM.A.7**
  - a. Research and evaluate various mortgage products available to consumers. **MM.FPM.A.7.A**
  - b. Compare monthly mortgage payments for different terms, interest rates, and down payments. **MM.FPM.A.7.B**
  - c. Analyze the financial consequence of buying a home (mortgage payments vs. potentially increasing resale value) versus investing the money saved when renting, assuming that renting is the less expensive option. **MM.FPM.A.7.C**
8. Investigate the advantages and disadvantages of various means of paying for an automobile, including leasing, purchasing by cash, and purchasing by loan. **MM.FPM.A.8**

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## Design in Three Dimensions

- A. Two- and three-dimensional representations, coordinates systems, geometric transformations, and scale models are useful tools in planning, designing, and constructing solutions to real-world problems. **MM.D3D.A**
9. Use the Mathematical Modeling Cycle to solve real-world problems involving the design of three-dimensional objects. **MM.D3D.A.9**
10. Construct a two-dimensional visual representation of a three-dimensional object or structure. **MM.D3D.A.10**
- a. Determine the level of precision and the appropriate tools for taking the measurements in constructing a two-dimensional visual representation of a three-dimensional object or structure. **MM.D3D.A.10.A**
  - b. Create an elevation drawing to represent a given solid structure, using technology where appropriate. **MM.D3D.A.10.B**
  - c. Determine which measurements cannot be taken directly and must be calculated based on other measurements when constructing a two-dimensional visual representation of a three-dimensional object or structure. **MM.D3D.A.10.C**
  - d. Determine an appropriate means to visually represent an object or structure, such as drawings on paper or graphics on computer screens. **MM.D3D.A.10.D**
11. Plot coordinates on a three-dimensional Cartesian coordinate system and use relationships between coordinates to solve design problems. **MM.D3D.A.11**
- a. Describe the features of a three-dimensional Cartesian coordinate system and use them to graph points. **MM.D3D.A.11.A**
  - b. Graph a point in space as the vertex of a right prism drawn in the appropriate octant with edges along the  $x$ ,  $y$ , and  $z$  axes. **MM.D3D.A.11.B**
  - c. Find the distance between two objects in space given the coordinates of each. **MM.D3D.A.11.C**
  - d. Find the midpoint between two objects in space given the coordinates of each. **MM.D3D.A.11.D**
12. Use technology and other tools to explore the results of simple transformations using three-dimensional coordinates, including translations in the  $x$ ,  $y$ , and/or  $z$  directions; rotations of  $90^\circ$ ,  $180^\circ$ , or  $270^\circ$  about the  $x$ ,  $y$ , and  $z$  axes; reflections over the  $xy$ ,  $yz$ , and  $xz$  planes; and dilations from the origin. **MM.D3D.A.12**
13. Create a scale model of a complex three-dimensional structure based on observed measurements and indirect measurements, using translations, reflections, rotations, and dilations of its components. **MM.D3D.A.13**

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## Creating Functions to Model Change in the Environment and Society

- B.** Functions can be used to represent general trends in conditions that change over time and to predict future conditions based on present observations. **MM.D3D.B**
- 14.** Use elements of the Mathematical Modeling Cycle to make predictions based on measurements that change over time, including motion, growth, decay, and cycling. **MM.D3D.B.14**
- 15.** Use regression with statistical graphing technology to determine an equation that best fits a set of bivariate data, including nonlinear patterns. **MM.D3D.B.15**
  - a.** Create a scatter plot with a sufficient number of data points to predict a pattern. **MM.D3D.B.15.A**
  - b.** Describe the overall relationship between two quantitative variables (increase, decrease, linearity, concavity, extrema, inflection) or pattern of change. **MM.D3D.B.15.B**
  - c.** Make a prediction based upon patterns. **MM.D3D.B.15.C**
- 16.** Create a linear representation of non-linear data and interpret solutions, using technology and the process of linearization with logarithms. **MM.D3D.B.16**

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## Modeling to Interpret Statistical Studies

- C. Statistical studies allow a conclusion to be drawn about a population that is too large to survey completely or about cause and effect in an experiment. [MM.D3D.C](#)
17. Use the Statistical Problem Solving Cycle to answer real-world questions. [MM.D3D.C.17](#)
  18. Construct a probability distribution based on empirical observations of a variable. [MM.D3D.C.18](#)
    - a. Estimate the probability of each value for a random variable based on empirical observations or simulations, using technology. [MM.D3D.C.18.A](#)
    - b. Represent a probability distribution by a relative frequency histogram and/or a cumulative relative frequency graph. [MM.D3D.C.18.B](#)
    - c. Find the mean, standard deviation, median, and interquartile range of a probability distribution and make long-term predictions about future possibilities. Determine which measures are most appropriate based upon the shape of the distribution. [MM.D3D.C.18.C](#)
  19. Construct a sampling distribution for a random event or random sample. [MM.D3D.C.19](#)
    - a. Use the binomial theorem to construct the sampling distribution for the number of successes in a binary event or the number of positive responses to a yes/no question in a random sample. [MM.D3D.C.19.A](#)
    - b. Use the normal approximation of a proportion from a random event or sample when conditions are met. [MM.D3D.C.19.B](#)
    - c. Use the central limit theorem to construct a normal sampling distribution for the sample mean when conditions are met. [MM.D3D.C.19.C](#)
    - d. Find the long-term probability of a given range of outcomes from a random event or random sample. [MM.D3D.C.19.D](#)
  20. Perform inference procedures based on the results of samples and experiments. [MM.D3D.C.20](#)
    - a. Use a point estimator and margin of error to construct a confidence interval for a proportion or mean. [MM.D3D.C.20.A](#)
    - b. Interpret a confidence interval in context and use it to make strategic decisions. [MM.D3D.C.20.B](#)
    - c. Perform a significance test for null and alternative hypotheses. [MM.D3D.C.20.C](#)
    - d. Interpret the significance level of a test in the context of error probabilities, and use the results to make strategic decisions. [MM.D3D.C.20.D](#)
  21. Critique the validity of reported conclusions from statistical studies in terms of bias and random error probabilities. [MM.D3D.C.21](#)
  22. Conduct a randomized study on a topic of student interest (sample or experiment) and draw conclusions based upon the results. [MM.D3D.C.22](#)