

Discrete Mathematics Standards

The DoDEA high school mathematics program centers around six courses which are grounded by rigorous standards. Two of the courses, AP Calculus and AP Statistics, are defined by a course syllabus that is reviewed and revised on an annual basis. The other 5 courses, Algebra 1, Algebra 2, Geometry, Discrete Mathematics and PreCalculus/Mathematical Analysis, have established standards designed to provide a sequence of offerings that will prepare students for their future goals. These standards serve as the foundation of a comprehensive effort to realize the vision for mathematics education of the students enrolled in DoDEA schools.

Vision: DoDEA students will become mathematically literate world citizens empowered with the necessary skills to prosper in our changing world. DoDEA educators' extensive content knowledge and skillful use of effective instructional practices will create a learning community committed to success for all. Through collaboration, communication, and innovation within a standards-driven, rigorous mathematics curriculum, DoDEA students will reach their maximum potential.

Guiding Principals

Standards:

- Clear and concise standards provide specific content for the design and delivery of instruction.
- Standards provide details that ensure rigor, consistency, and high expectation for all students.
- Standards identify the criteria for the selection of materials/resources and are the basis for summative assessment.

Instruction:

- The curriculum focuses on developing mathematical proficiency for all students.
- The instructional program includes opportunities for students to build mathematical power and balances procedural understanding with conceptual understanding.
- Effective teachers are well versed in mathematical content knowledge and instructional strategies.
- Classroom environments reflect high expectations for student achievement and actively engage students throughout the learning process.
- Technology is meaningfully integrated throughout instruction and assists students in achieving/exceeding the standards.

Assessment/Accountability

- Assessment practices provide feedback to guide instruction and ascertain the degree to which learning targets are mastered.
- Assessments are used to make instructional decisions in support of the standards and measure standards-based student performance.
- All teachers of mathematics and administrators providing curriculum leadership should be held accountable for a cohesive, consistent, and standards-based instructional program that leads to high student achievement.

Mathematics Process Standards

The DoDEA PK-12 mathematics program includes the process standards: problem solving, reasoning and proof, communication, connections, and representation. Instruction in mathematics must focus on process standards in conjunction with all PK-12 content standards throughout the grade levels.

Problem Solving	Reasoning and Proof	Communication	Connections	Representation
<p>Instructional programs from Pre-Kindergarten through Grade 12 should enable all students to:</p> <ul style="list-style-type: none"> • build new mathematical knowledge through problem solving; • solve problems that arise in mathematics and in other contexts; • apply and adapt a variety of appropriate strategies to solve problems; • monitor and reflect on the process of mathematical problem solving. 	<p>Instructional programs from Pre-Kindergarten through Grade 12 should enable all students to:</p> <ul style="list-style-type: none"> • recognize reasoning and proof as fundamental aspects of mathematics; • make and investigate mathematical conjectures; • develop and evaluate mathematical arguments and proofs; • select and use various types of reasoning and methods of proof. 	<p>Instructional programs from Pre-Kindergarten through Grade 12 should enable all students to:</p> <ul style="list-style-type: none"> • organize and consolidate their mathematical thinking through communication; • communicate their mathematical thinking coherently and clearly to peers, teachers, and others; • analyze and evaluate the mathematical thinking and strategies of others; • use the language of mathematics to express mathematical ideas precisely. 	<p>Instructional programs from Pre-Kindergarten through Grade 12 should enable all students to:</p> <ul style="list-style-type: none"> • recognize and use connections among mathematical ideas; • understand how mathematical ideas interconnect and build on one another to produce a coherent whole; • recognize and apply mathematics in contexts outside of mathematics. 	<p>Instructional programs from Pre-Kindergarten through Grade 12 should enable all students to:</p> <ul style="list-style-type: none"> • create and use representations to organize, record, and communicate mathematical ideas; • select, apply, and translate among mathematical representations to solve problems; • use representations to model and interpret physical, social, and mathematical phenomena.

DISCRETE MATHEMATICS

Strand: DM.1 Students use counting techniques to solve problems.

Standards: Students in Discrete Mathematics will:

DM.1.1 Use Tree diagrams, Venn diagrams and other pictorial representations to determine the number of outcomes in a problem situation;

Example: In a motel there are 4 different elevators that go from Joan's room to the pool and 3 different doors to the pool area. Use a tree diagram to show how many different ways Joan can get from her room to the pool.

DM.1.2 Apply the fundamental counting principle to determine the number of outcomes in a problem situation and solve problems using combinatorial reasoning;

Example: You are getting dressed one morning when you realize that you have far too many choices. You have 6 shirts to choose from, 4 pairs of jeans, and 3 pairs of shoes. Ignoring color coordination, construct a tree diagram or other pictorial representation to show how many different outfits you could assemble.

DM.1.3 Use probability to make predictions and solve problems;

Example: You know that your locker combination contains the numbers 2, 4, 6, and 8, but you have forgotten the order in which they occur. What is the probability that your locker opens with the first combination you try?

DM.1.4 Use simulations to solve counting and probability problems;

Example: A panel of 12 jurors was selected from a large pool that was 70% male and 30% female. The jury turned out to be 11 men and 1 woman. Suspecting gender bias, the defense attorneys asked how likely is it that this situation, or worse, would occur purely by chance. Simulate this situation using a random number generator to select 12 numbers, letting 0, 1, and 2 represent women and 3, 4, 5, 6, 7, 8, and 9 represent men. Note the number of times that 11 or 12 men are chosen.

DISCRETE MATHEMATICS

Strand: DM.2 Students use matrices to solve problems.

Standards: Students in Discrete Mathematics will:

DM.2.1 Model problems using matrices and apply matrix operations (including row reduction and inverses) to solve them;

Example: Suppose the rings in the previous problem cost \$90, \$120, and \$135 for the girls' rings and \$110, \$140, and \$165 for the boys' rings. Display this information in a matrix and use matrix multiplication to find the total revenue from the sale of girls' rings and boys' rings.

DM.2.2 Use matrix representation to model polygons, and transformations;

Example: Transform the following matrix, which represents the points on a triangle, to reflect across the y -axis to resemble a spinning effect.

Vertices of Triangle ABC

$$\begin{bmatrix} -2 & 2 & 0 \\ 1 & 1 & 5 \end{bmatrix}$$

Strand: DM.3: Students use recursive techniques to solve problems.

Standards: Students in Discrete Mathematics will:

DM.3.1 Use Recursive Thinking to solve problems;

Example: How many handshakes would occur in this room if everyone shook hands with everyone else? Create a spreadsheet that will find the number of handshakes starting with one person and increasing the number to 15.

DM.3.2 Use finite differences to solve problems;

Example: Add two columns to the spreadsheet from the previous example and create appropriate formulas for each to calculate first and second differences.

DISCRETE MATHEMATICS

Strand: DM.4: Students use graph theory to solve problems.

Standards: Students in Discrete Mathematics will:

- DM.4.1** Use vertex-edge graphs to model and solve problems;
Example: There are two islands in the River Seine in Paris. The city wants to construct four bridges that connect each island to each side of the riverbank and one bridge that connects the two islands directly. The city planners want to know if it is possible to start at one point, cross all five bridges, and end up at the same point without crossing a bridge twice. Use a graph to help solve this problem.
- DM.4.2** Use critical path analysis to solve scheduling problems;
Example: Write a critical task list for redecorating your room. Some tasks depend on the completion of others and some may be carried out at any time. Use a graph to find the least amount of time needed to complete your project.
- DM.4.3** Use graph coloring techniques to solve problems;
Example: Color a map of the Midwestern states of the United States so that no adjacent states are the same color. What is the minimum number of colors needed?
- DM.4.4** Use minimal spanning trees to solve problems;
Example: The telephone company wants to connect cities with new telephone lines. They calculate the cost of connecting each pair of cities, but want to reduce costs by connecting cities through others. Given a graph showing the cost of connecting each pair of cities, find the minimum cost for connecting all the cities with new telephone lines.
- DM.4.5** Use Bin-packing techniques to solve problems;
Example: Six large crates of electronic equipment are to be shipped to a warehouse. The crates weigh 2,800, 6,000, 5,400, 1,600, 6,800, and 5,000 pounds. Each delivery truck has a capacity of 10,000 pounds. What is the minimum number of trucks needed to send all the crates?

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DM.4.6 Use fair division techniques to divide continuous objects;
Example: Find a method for dividing a piece of cake among three people so that each person feels they have received a fair share.

DM.4.7 Use fair division techniques to solve apportionment problems;
Example: Find the enrollment of seniors, juniors, sophomores, and freshmen at your high school. If there are 20 seats on the Student Council, how should the representatives be apportioned so that the voting power of each class is proportional to its size?

DM.4.8 Use Linear Programming to minimize or maximize a variable subject to constraints;
Example: A company produces two varieties of widgets — standard and deluxe. A standard widget takes 3 hours to assemble and 6 hours to finish. A deluxe widget takes 5 hours to assemble and 5 hours to finish. The assemblers can work no more than 45 hours per week and the finishers can work no more than 60 hours per week. The profit is \$32 on a standard widget and \$40 on a deluxe widget. Use a graph to find how many of each model should be produced each week to maximize profit.

Strand: **DM.5** Students use game theory and election theory to solve problems.

Standard: Students in Discrete Mathematics will:

DM.5.1 Use game theory to analyze situations and select strategies which obtain preferred outcomes for players;
Example: In the game “Two-Finger Morra,” each of two players shows either one or two fingers. If the total number of fingers shown is even, Player A collects a dollar for each finger shown from Player B. If the total number of fingers is odd, Player A pays \$3 to Player B. Set up the game matrix and find the optimal strategy and the value of the game.

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- DM.5.2** Use election theory techniques to analyze election data;
Example: Each student in your class ranks four kinds of pop from the most preferred to least preferred. Discuss the merits of various methods for deciding on the overall ranking by the class.
- DM.5.3** Use weighted voting techniques to decide voting power within a group.
Example: Company stockholders have different numbers of votes according to their holdings. For given holdings, find the power index of each stockholder.