

Design Your Own Dream Home!

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Grade Levels: 9-12

Subject: Mathematics

Project Summary: Using Free CAD, a computer aided drafting software program, students design and draw a two dimensional layout of their dream home. In five lessons, students draw a sketch, by hand, of their dream home, learn how to use Free CAD to create a computer drawing of their home, do a peer review of each other's dream home, make corrections to that project, and submit the project. The major standards being addressed are in the areas of mathematics (Algebra & Geometry) and career technical education (Engineering and Design Industry & Building Trades & Construction Industry), but also include standards from Visual & Performing Arts, History-Social Science, and Science. Students are assessed in a formative fashion using rubric scoring on the design project that they submit.

Introduction:

Project Description: In five lessons, students will learn to design their dream home on paper and learn to use a Computer Aided Drafting (CAD) program to produce a scaled drawing of their dream home. Students will submit a portfolio of their work for assessment, which will include the dimensioned sketch and CAD drawing.

This project works because it incorporates many modalities of learning, thus engaging all learners. This project also works because it is exciting for all students to take a step toward realizing a dream by putting it on paper. This project also addresses many standards across the high school curriculum; including standards in the following strands: English Language Arts, Mathematics, Career Technical Education, Science, History-Social Science, and Visual and Performing Arts. This project also works because students are able to apply what they have learned in mathematics and career technical education classes to a project that has meaning to their lives.

Educational Value: Students are able to apply what they have learned in traditional classes, such as math and science, to a project that interests them. Students also learn how to use new tools, such as CAD software, that could be a pathway for a future career. Most importantly, students tap into their imagination to create a project that many students and families equate with success, home ownership.

Lesson Plans:

Lesson 1 - Tools of Geometry and Design

Objective: Students will learn how to use a protractor, straightedge, and compass to design their dream home. Students will use the Internet to research design ideas for their dream home.

Lecture: Ex 1: Students will learn how to use a straightedge, protractor, and compass to draw various geometric figures that will be used in designing their dream home.

- a) Students will draw a rectangle 4" long by 2.25" wide.
- b) Students will draw an equilateral triangle with length $3 \frac{1}{8}$ " long.
- c) Students will draw a regular hexagon with length 4.625" long.
- d) Students will draw a circle of radius 1.0625".

The teacher will show how to draw these geometric figures with a compass, straightedge, and protractor using tools made for the dry erase board. Students will then practice using their instruments in their notebook.

In class assignment: Students will begin to design their own dream home using the tools given to them. Students will research websites like homeportfolio.com, doityourself.com, homeanddesign.com, and others for ideas. Students will be given three pieces of 24" X 36" paper, protractor, straightedge, compass, colored pencils, and a mechanical pencil to complete the assignment.

Home assignment: Students will finish in class assignment for the next class period, which is 5 days away.

Lesson 2 - Peer review & Basic Tools of Free CAD

Objective: Students will give feedback to their fellow students on their dream home, including areas for improvement and good ideas for each other's homes. Students will learn about the x-y plane in Free CAD. Students will also learn how to draw basic geometric figures in Free CAD, such as circles and polygons.

Lecture: Students will spend the first fifteen minutes of the class period with their partners from the class trading their sketch of their dream home.

Each one will answer the following questions:

1. What are the positive attributes of the home? What is the one thing that you like the best?
2. What do you think can be improved upon for the home? Name one thing that you think could be better.
3. What do you think of the overall sketch? Write five complete sentences summarizing your feelings on it, make sure you include question 1 & 2 in your summary.

With the remaining 30 minutes of class, students will be at their assigned computer with their partner and take turns drawing geometric shapes in Free CAD.

Ex 1: On the overhead projector, the teacher will teach students how to graph points and draw geometric figures, such as polygons and circles.

In class assignment & student practice:

- a) Students will graph the points $(1.25,3);(-.0625,-3.625);(12.5,-7.46)$
- b) Students will draw a rectangle with a corner at $(0,0)$ and length of 5.5 and width of 2.875.
- c) Students will draw a circle centered at $(-2.5, 1.75)$ with radius of 3.75.
- d) Students will draw a regular hexagon centered at $(0,-1.5)$ and side length 1.25.

Out of Class Assignment: Students will make corrections to their sketch and start drawing their dream house on Free CAD. Students will draw the shape of the lot, the outer wall of the house, and all pathways and driveways.

Lesson 3 - More tools of Free CAD: Snaps, Chamfer/Fillet, Cut

Objective: Students will learn more functions on Free CAD that will help them complete their dream home, such as how to use Snaps in drawing lines & figures, how to Chamfer and Fillet lines & figures, and how to cut lines & figures.

Lecture: Ex 1: The teacher will show students how to snap to ends of line segments, snap to the midpoint of a segment, and snap to make a line perpendicular to another line. The teacher will show students how to cut a circle, line, and polygon. The teacher will show students how to chamfer and fillet a polygon.

Student Practice:

- a) Draw a rectangle that has one point at (3.75,-1), a length of 2.25, and a width of 4.0.
- b) Draw a line 3.5" in length from the midpoint of the length of the rectangle perpendicular to the rectangle's length.
- c) Cut that line in half.
- d) Fillet the corners of the rectangle to a radius of 1.5.

In class assignment: Students will continue working on their dream home CAD project, while the teacher roams the class answering questions. Students will begin working on the interior of the house, dividing the house into rooms, showing stairwells, doors, and windows, and showing attached appliances.

Out of class assignment: Students will continue to work on dream home CAD project. First submittal will be the next class period.

Lesson 4 - Dimensioning & Text Boxes

Objective: Students will learn how to dimension CAD drawings and learn how to insert text boxes into CAD drawings.

Due: Students will submit a copy of their dream home CAD project on CD for the teacher to review and mark up.

Lecture: Ex 1: The teacher will show students examples of how to dimension a drawing and insert text boxes.

Student Practice:

- a) Students will dimension the longest wall of their dream home and the shortest wall of their dream home.
- b) Students will insert a text box containing their address on the bottom right corner of the page.

In class assignment: Continue to work on dream home CAD project, by incorporating newly learned knowledge of dimensioning and text boxes.

Out of class assignment: Continue to work on dream home CAD project.

Lesson 5: Students will receive back their marked up plans for their dream home and make the appropriate changes. Students will continue working on their dream home CAD project, which will be due the next time the class meets.

Peer Review Sketch Questions

Directions: Review your partner's sketch of his/her dream home. Answer the questions on this paper.

1. What are the positive attributes of the home? What is the one thing that you like the best?
2. What do you think can be improved upon for the home? Name one thing that you think could be better.
3. What do you think of the overall sketch? Write five complete sentences summarizing your feelings on it, make sure you include question 1 & 2 in your summary.

Student Impact:

Students will be able to apply what they have learned in core and arts classes in high school to a project that has meaning to their lives. Students will learn how to use a new tool, CAD, which could lead to interest in many new career paths in science and engineering. Students will learn new curriculum standards from the areas of Mathematics, History-Social Sciences, Science, and Visual & Performing Arts. Most importantly, students will learn to use their imagination to create a representation of what they want to achieve.

Students will benefit from this project because they will reinforce what has been learned in the classroom on a project that excites them. Students will also benefit from this project because they will learn a new skill and explore a new career path that may interest them. Students will also be exposed to new curriculum standards that they may have not been exposed to before, and that will give some knowledge of the standards for courses taken later in high school.

Assessment:

Students will be submitting for assessment a formative project that will be mainly graded by a rubric created by the teacher. The rubric will consist of five levels: Exemplary (4),

Good (3), Proficient (2), Needs Improvement (1), and Did not Complete/Answer (0). Students will be assessed on the areas of imagination/creativity, notes from lessons, CAD drawing, CAD dimensioning, sketch drawing, sketch dimensioning, and total project. I will also be informally assessing students' study skills and effort.

Standards:

ELA

Grade 8: Writing:

2.6 Write technical documents:

- a. Identify the sequence of activities needed to design a system, operate a tool, or explain the bylaws of an organization.

Grade 9 & 10: Writing:

2.6 Write technical documents:

- a. Report information and convey ideas logically and correctly.
- b. Offer detailed and accurate specifications.
- c. Include scenarios, definitions, and examples to aid comprehension.
- d. Anticipate readers' problems, mistakes, and misunderstandings.

Mathematics

Grades 8-12: Algebra 1:

1.0 Students identify and use the arithmetic properties of subsets of integers and rational, irrational, and real numbers, including closure properties for the four basic arithmetic operations where applicable.

2.0 Students understand and use such operations as taking the opposite, finding the reciprocal, taking a root, and raising to a fractional power. They understand and use the rules of exponents.

3.0 Students solve equations and inequalities involving absolute values.

4.0 Students simplify expressions before solving linear equations and inequalities in one variable, such as $3(2x-5) + 4(x-2) = 12$.

6.0 Students graph a linear equation and compute the x - and y -intercepts (e.g., graph $2x + 6y = 4$). They are also able to sketch the region defined by linear inequality (e.g., they sketch the region defined by $2x + 6y < 4$).

7.0 Students verify that a point lies on a line, given an equation of the line. Students are able to derive linear equations by using the point-slope formula.

8.0 Students understand the concepts of parallel lines and perpendicular lines and how those slopes are related. Students are able to find the equation of a line perpendicular to a given line that passes through a given point.

9.0 Students solve a system of two linear equations in two variables algebraically and are able to interpret the answer graphically. Students are able to solve a system of two linear inequalities in two variables and to sketch the solution sets.

10.0 Students add, subtract, multiply, and divide monomials and polynomials. Students solve multistep problems, including word problems, by using these techniques.

13.0 Students add, subtract, multiply, and divide rational expressions and functions. Students solve both computationally and conceptually challenging problems by using these techniques.

16.0 Students understand the concepts of a relation and a function, determine whether a given relation defines a function, and give pertinent information about given relations and functions.

21.0 Students graph quadratic functions and know that their roots are the x -intercepts.

23.0 Students apply quadratic equations to physical problems, such as the motion of an object under the force of gravity.

Grades 8-12: Geometry:

1.0 Students demonstrate understanding by identifying and giving examples of undefined terms, axioms, theorems, and inductive and deductive reasoning.

4.0 Students prove basic theorems involving congruence and similarity.

5.0 Students prove that triangles are congruent or similar, and they are able to use the concept of corresponding parts of congruent triangles.

7.0 Students prove and use theorems involving the properties of parallel lines cut by a transversal, the properties of quadrilaterals, and the properties of circles.

8.0 Students know, derive, and solve problems involving the perimeter, circumference, area, volume, lateral area, and surface area of common geometric figures.

9.0 Students compute the volumes and surface areas of prisms, pyramids, cylinders, cones, and spheres; and students commit to memory the formulas for prisms, pyramids, and cylinders.

10.0 Students compute areas of polygons, including rectangles, scalene triangles, equilateral triangles, rhombi, parallelograms, and trapezoids.

11.0 Students determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids.

12.0 Students find and use measures of sides and of interior and exterior angles of triangles and polygons to classify figures and solve problems.

13.0 Students prove relationships between angles in polygons by using properties of complementary, supplementary, vertical, and exterior angles.

15.0 Students use the Pythagorean theorem to determine distance and find missing lengths of sides of right triangles.

16.0 Students perform basic constructions with a straightedge and compass, such as angle bisectors, perpendicular bisectors, and the line parallel to a given line through a point off the line.

17.0 Students prove theorems by using coordinate geometry, including the midpoint of a line segment, the distance formula, and various forms of equations of lines and circles.

18.0 Students know the definitions of the basic trigonometric functions defined by the angles of a right triangle. They also know and are able to use elementary relationships between them. For example, $\tan(x) = \sin(x)/\cos(x)$, $(\sin(x))^2 + (\cos(x))^2 = 1$.

19.0 Students use trigonometric functions to solve for an unknown length of a side of a right triangle, given an angle and a length of a side.

20.0 Students know and are able to use angle and side relationships in problems with special right triangles, such as 30° , 60° , and 90° triangles and 45° , 45° , and 90° triangles.

21.0 Students prove and solve problems regarding relationships among chords, secants, tangents, inscribed angles, and inscribed and circumscribed polygons of circles.

22.0 Students know the effect of rigid motions on figures in the coordinate plane and space, including rotations, translations, and reflections.

Grades 7-12: Career Technical Education: Foundation Standards:

1.1 Mathematics

Specific applications of Number Sense standards (grade seven):

- (1.2) Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.
- (1.3) Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.
- (1.4) Differentiate between rational and irrational numbers.
- (1.5) Know that every rational number is either a terminating or a repeating decimal and be able to convert terminating decimals into reduced fractions.
- (1.6) Calculate the percentage of increases and decreases of a quantity.
- (2.1) Use estimation to verify the reasonableness of calculated results.
- (2.2) Apply strategies and results from simpler problems to more complex problems.
- (2.3) Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques.
- (2.5) Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
- (2.6) Express the solution clearly and logically by using the appropriate mathematical notation and terms and clear language; support solutions with evidence in both verbal and symbolic work.
- (2.8) Make precise calculations and check the validity of the results from the context of the problem.
- (3.1) Evaluate the reasonableness of the solution in the context of the original situation.
- (3.2) Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
- (3.3) Develop generalizations of the results obtained and the strategies used and apply them to new problem situations.

1.2 Science

Specific applications of Investigation and Experimentation standards (grades nine through twelve):

- (1.a) Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- (1.d) Formulate explanations by using logic and evidence.
- (1.1) Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

1.3 History–Social Science

- (10.3.5) Understand the connections among natural resources, entrepreneurship, labor, and capital in an industrial economy.
- (11.5.7) Discuss the rise of mass production techniques, the growth of cities, the impact of new technologies (e.g., the automobile, electricity), and the resulting prosperity and effect on the American landscape.

(11.8.7) Describe the effects on society and the economy of technological developments since 1945, including the computer revolution, changes in communication, advances in medicine, and improvements in agricultural technology.

(12.2.2) Discuss the effects of changes in supply and/or demand on the relative scarcity, price, and quantity of particular products.

(12.2.4) Explain how prices reflect the relative scarcity of goods and services and perform the allocative function in a market economy.

1.4 Visual and Performing Arts

(2.3) Assemble and display objects or works of art as a part of a public exhibition.

(2.6) Present a universal concept in a multimedia work of art that demonstrates knowledge of technology skills.

(3.1) Identify contemporary styles and discuss the diverse social, economic, and political developments reflected in the works of art examined.

(3.2) Identify contemporary artists worldwide who have achieved regional, national, or international recognition and discuss ways in which their work reflects, plays a role in, and influences present-day culture.

(5.3) Prepare portfolios of their original works of art for a variety of purposes

Architectural and Structural Engineering Pathway:

A6.0 Students understand the use of computer-aided drafting and design (CADD) in developing architectural designs:

A6.1 Know various CADD programs that are commonly used in architectural design.

A6.2 Use CADD software to develop a preliminary architectural proposal.

A7.0 Students understand how to systematically complete an architectural project:

A7.1 Develop, read, and understand architectural and construction plans, drawings, diagrams, and specifications.

A8.0 Students understand the methods of creating both written and digital portfolios:

A8.1 Develop a binder of representative student work for presentation.

A8.2 Produce a compact disc, Web site, or other digital-media portfolio.

A8.3 Give an effective oral presentation of a portfolio.

Engineering & Design Pathway:

C4.0 Students use proper projection techniques to develop orthographic drawings:

C4.1 Understand the commands and concepts necessary for producing drawings through traditional or computer-aided means.

C4.2 Understand the orthographic projection process for developing multi-view drawings.

C5.0 Students know various object-editing techniques and CADD programs:

C5.1 Understand the commands and concepts necessary for editing engineering drawings.

C5.2 Know the various object-altering techniques.

C5.3 Know the CADD components and the operational functions of CADD systems.

C6.0 Students understand and apply proper dimensioning to drawings:

C6.1 Know a variety of drafting applications and understand the proper dimensioning styles for each.

- C6.2 Apply dimensioning to various objects and features.
- C6.3 Edit a dimension by using various editing methods.
- C9.0 Students understand the methods of inserting text into a drawing:*
- C9.1 Understand the processes of lettering and text editing.
- C9.2 Develop drawings using notes and specifications.

Materials/Budget:

1 Elmo Doc-Tor Classroom Bundle	\$1190.00
15 Compasses, Straightedges, & Protractors	\$150.00
1 Roll of 24" Paper	Donated
15 sets of Colored Pencils, Markers, & Mechanical Pencils	Donated
8 Computers	Already have or donated
Free CAD	Free download
Student Supplies (Pencils, Notebooks, etc.)	Already have