Housing Design Technology
(10-12 hours)

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Authors

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Level I: Green, Alexandria

SUBJECT/GRADE LEVEL

Subject Area(s): Applied Engineering Design
Grade Level(s): Middle school

Materials

- Laptop
- Architectural triangular scale
- Back Saw
- 3D printer
- Wood glue, 8 oz bottle
- Home furnishings template, Dimensional furniture for kitchen, dining, bedroom and living room
- Self-healing cutting mat
- Styrofoam cutter, Table top
- Poster Board, White, 22 x 28 inch
- Masking tape, 1 in x 60 yd, 9 pack
- Transparent tape, 3/4 in x 500 in, 3 pack
- Quick Dry Tacky Glue
- Balsa wood, 1/8" x 3/8" x 36" Strips, 50 pack
- Balsa wood, 1/8" x 1/4" x 36" Strips, 50 pack
- Graph paper

STANDARDS

Next Generation Science Standards

- **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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- **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Mathematics Standards | Common Core State Standards

- **7.RP.A.2** Recognize and represent proportional relationships between quantities.
- **7.RP.A.3** Use proportional relationships to solve multi-step ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.
- **7.G.A.1** Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
- **G.MG.A.2** Apply geometric methods to solve real world problems.

English Language Arts Standards | Common Core State

- **RST.6-8.5** Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
- **RST.6-8.6** Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- **RST.6-8.8** Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

LESSON OBJECTIVE(S)

Students will be able to

1. Use Realtor.com to find an example of a single family that fits the criteria of the project.
2. Demonstrate an understanding of the Engineering Design Process while utilizing each stage to successfully complete a team challenge.
3. Use the engineering design process to create a 2D blueprint and 3D design for a single family

residential house.
4. Use a computer aided design (CAD) program that allows them to design their homes to be 3D printed.
5. Convert full size measurements to scale size and scale size measurements to full size using proportions.
6. Recognize scaled drawings of items as a similar figure to the original item.
7. Create a physical model of home using balsa wood and glue.

CAREER CONNECTION(S)

Mentor Background: Dr. Benjamin D. Nye is the Director of Learning Sciences at the University of Southern California, Institute for Creative Technologies. Ben's major research interest is to identify best-practices in advanced learning technology, particularly for frontiers such as distributed learning technologies (e.g., cloud-based, device-agnostic) and socially-situated learning (e.g., face-to-face mobile use). His research interests include modular intelligent tutoring system (ITS) designs, modeling social learning and memes, cognitive agents, and educational tools for the developing world and low-resource/low-income contexts. He received his Ph.D. in Systems Engineering from the University of Pennsylvania in 2011. Ben currently leads projects focused on areas such as mobile adaptive learning ecosystems (Personal Assistant for Life-Long Learning), open-source and user-authorable tutoring chat dialogs (OpenTutor), a studio for career mentors to self-record their own virtual mentors (CareerFair.ai), and augmented reality experiences with the La Brea Tar Pits to understand complex concepts (Re-Living Paleontology) In his prior work as a Research Professor at the University of Memphis, Ben led work on the Shareable Knowledge Objects (SKO) framework integrating ITS services such as AutoTutor for the ONR ITS Grand Challenge, helped data mine effort a corpus of 250k human-to-human online tutoring dialogs (part of the ADL PAL initiative), collaborated on ONR's PAL3 tutoring architecture for supporting life-long learning, and is an advisor and book editor for the ARL Generalized Intelligent Framework for Tutoring (GIFT) advisory panel. Ben's research tries to remove barriers to development and adoption of ITS so that they can reach larger numbers of learners, which has traditionally been a major roadblock for these highly-effective interventions.

STEM Careers: Computer science, software engineer, civil engineer, industrial engineer

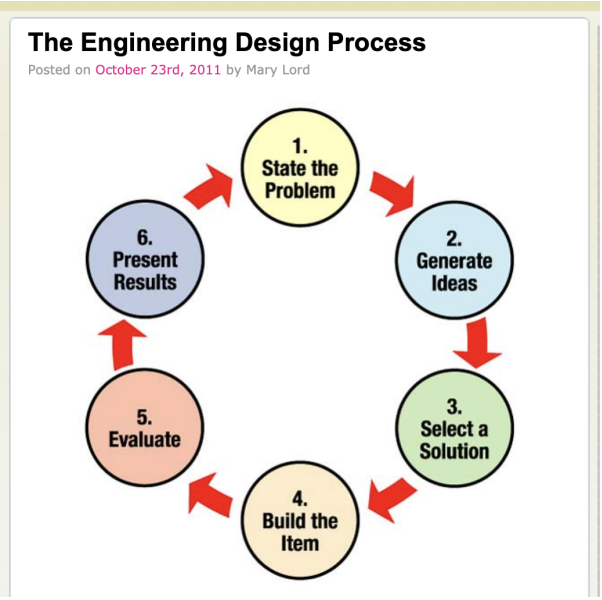
ENGAGEMENT

Brief Description: Students are introduced to one real-life problem that can be solved by using the Engineering Design Process (EDP). First, the students will review the stages of the EDP with a slide presentation. Then, each student will design a vegetable garden and share their findings with the class.

Procedures:

1. Watch the Engineering process video to review the EDP steps.

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2. Each student will sketch a vegetable garden plan.
3. The teacher will have the students fill out the Vegetable Garden Design Quiz.
4. Next, students will share their drawings with the class and discuss the Vegetable Garden Design Quiz.

EXPLORATION

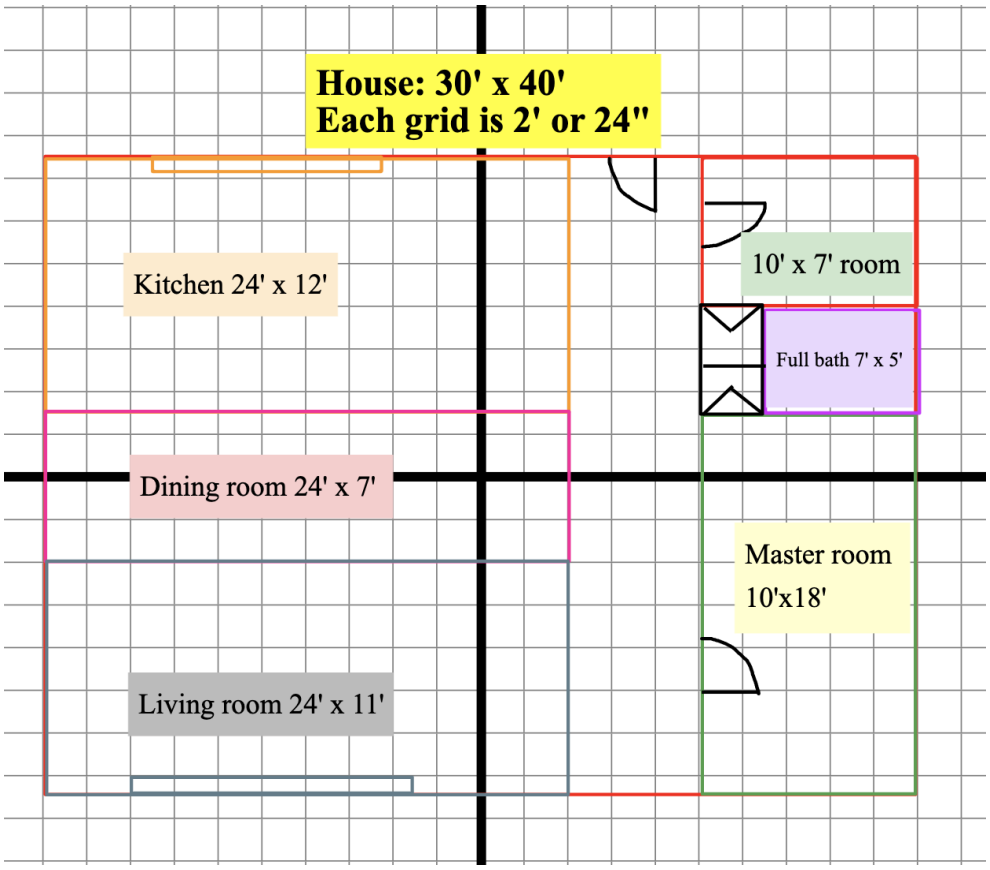
Brief Description: Students begin EDP Stage 2: Generate Ideas by working individually to draw a blueprint of a one story house. Then in discussion groups, the students will read through a scenario together, stopping and discussing at key points to share ideas and consider the requirements, and constraints as they move through the engineering design cycle to design and implement a solution (EDP Stage 3: Select a Solution).

Procedures:

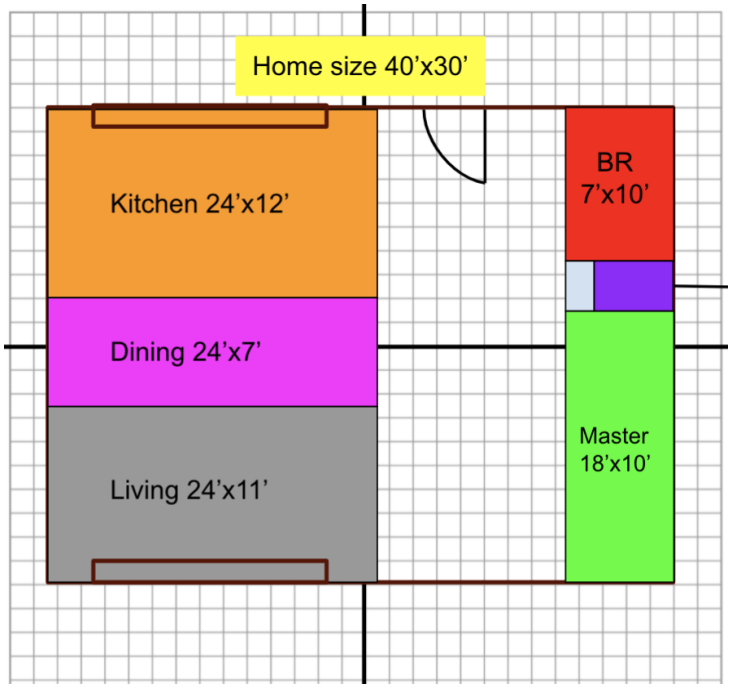
1. **Start with Simple Sketches**
    a. Each student must draw floor plans as simple sketches using Kami or Google doc.

    See Kami example or screenshot below. (Student copy)

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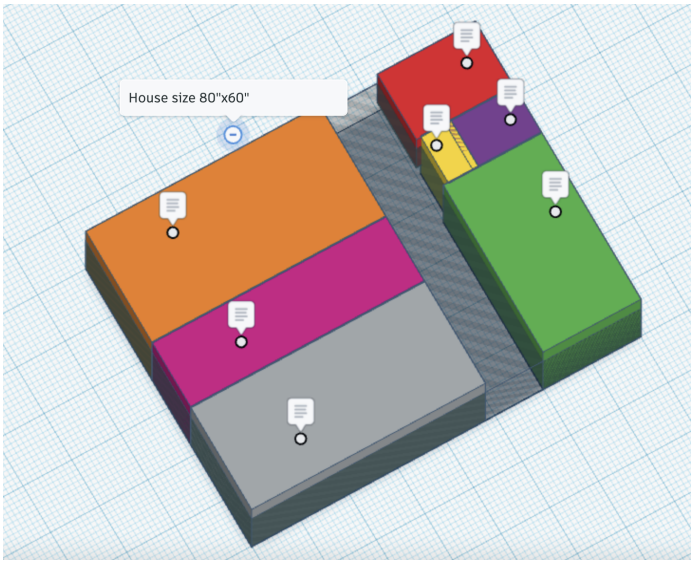
See [Google doc example] or screenshot below. (Students need to make a copy of the [graph in Google doc])



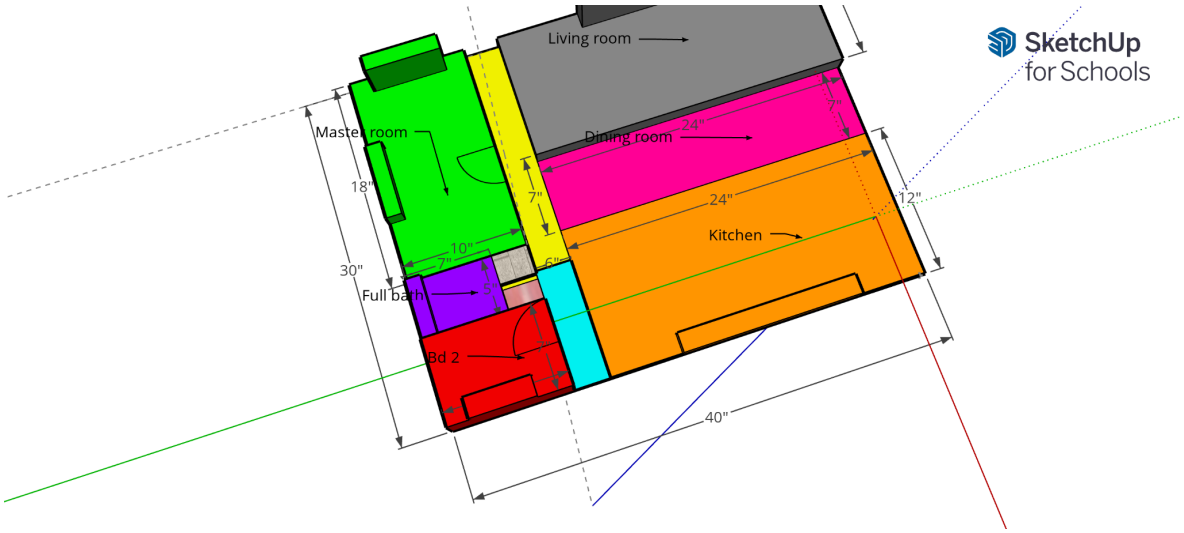
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2. Then the students will design their 3D house by either Tinkercad or SketchUp. Use the Housing Design Measurements Worksheet.

   See example for Tinkercad or screenshot below. (Video)



   See example for SketchUp or screenshot below. (Video)



EXPLANATION

Brief Description: As a class, the students will discuss the Engineering Design Process Stage 2:

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Generate Ideas and Stage 3: Select a Solution of the project. Each group will get some feedback from their classmates about their sketch to plan to protype before they start to build.

Procedures:

Discuss these questions with the class: (Think, pair and share worksheet)

1. Follow up by asking, "What was the most difficult part while you were working together?"
2. What designs did the students think of initially? Did anyone have similar ideas during the brainstorming process? Did anyone have a totally unique idea that no one else came up with?
3. What problems did students encounter during the design and prototype-building process? Did everyone's design work exactly like they thought it would on the first try? Why or why not?
4. What did they discover during the testing and redesign process? What changes did they make to their designs? Why?
5. What were the results of the final testing?

ELABORATION

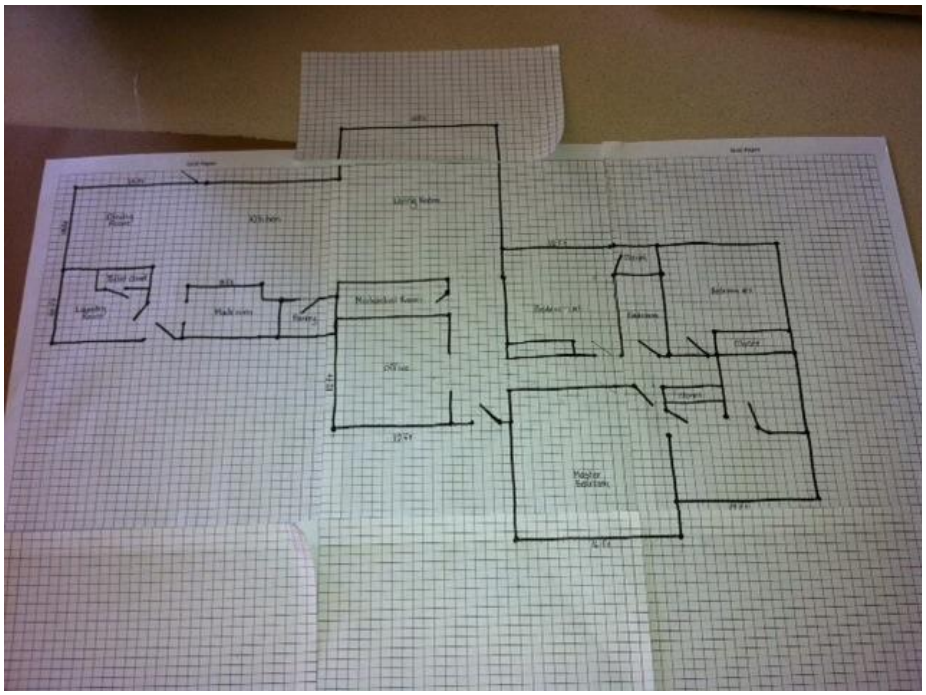
Brief Description: Using EDP Stage 4: Build the Item, each group will have 35-45 minutes to sketch, build, and regain the attention of the class and ask them how each group will know who has built the most effective 3D homes. The students will come up with the idea to test each room in different locations as long as they keep the scale in place.

Procedures:

Final Rubric: Develop a prototype

1. The students will choose the design that they will be working on and will draw the sketch on a graph paper. See example below. Housing Design Measurements Worksheet

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2. Show students materials they can choose from to build their 3D one story home.
3. Students will create a physical model of their homes using balsa wood and tacky glue. See example of physical model and the video on how to frame a scale model house. See example below.



Extension: The students will use the 3D printer and print their design as part of their final presentation.

EVALUATION

Brief Description: Using the EDP Stage 5: Evaluate and Stage 6: Present Results, provide a concise overview of the proposed activity. Make sure students have basic understanding of key concepts of today's lesson using OpenTutor: Housing Design Technology (Create an account).

Procedures:

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Formative Assessment: The students will be assessed through peer feedback after the first design process. The students will receive both positive and negative feedback on their house, which will allow the students to make necessary modifications to their final product.

Summative Assessment: Use the attached rubric to assess the students' houses.

REFERENCES

- Better Lesson: https://betterlesson.com/lesson/512266/constructing-a-house-plan-day-1
- eGFI Dream Up the Future: http://teachers.egfi-k12.org/design-process/
- Mr. Fleming Science: https://www.mrflemingscience.com/engineering-design-process.html
- Science buddies: https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps
- Teach Engineering: https://www.teachengineering.org/activities/view/cub_creative_activity5
- Try engineerings: https://tryengineering.org/teacher/design-dome/
- VistaThink: https://www.vistathink.com/engineering-design-process-example/