Science Classroom Design

Unit: Introduction to Science and Engineering

Time: four 50 minute periods

Key Concepts:

Oregon Department of Education Career and Technical Education Standards:

AC02 - Use architecture and construction skills to create and manage a project.
AC05 - Understand the roles and responsibilities among trades and professions, including labor/management relationships.
AC06 - Read, interpret, and use technical drawings, documents, and specifications to plan a project.
AC07 - Evaluate a wide range of career pathway opportunities for success in architecture and construction careers.

Next Generation Science Standards - Engineering and Design

ETS1.A: Defining and Delimiting Engineering Problems
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution

Summary: Students will learn the value of clear and effective communication and job roles while problem-solving a creative new design for a science classroom.

Objectives:

- Students will create a blueprint/building plan of a science classroom that meets the required criteria including the time limit.
- Students will construct a 1:10 scale model based on proposed blueprint/building plan using provided material and within the time limit.
- Students will recognize design problems and work to correct them for an optimal final product.
- Students will reflect over multiple career pathways in the construction trades industry and how those careers use science, math, and critical thinking skills to be successful.

Career Technical Skills and Knowledge:

AC02 - Use architecture and construction skills to create and manage a project.
AC05 - Understand the roles and responsibilities among trades and professions, including labor/management relationships.
AC06 - Read, interpret, and use technical drawings, documents, and specifications to plan a project.
AC07 - Evaluate a wide range of career pathway opportunities for success in architecture and construction careers.

Academic Knowledge and Skills:

Science and Engineering Practice: Constructing explanations and designing solutions
Disciplinary Core Ideas:

ETS1.A: Defining and Delimiting Engineering Problems
ETS1.B: Developing Possible Solutions

ETS1.C: Optimizing the Design Solution
Crosscutting Concept: Systems and system models

Integration Possibilities: This lesson includes the cultivation of skills that are necessary for success in the 21st century. Problem recognition and design of solutions while thinking creatively and working in a team are cornerstones of the career/college-ready student. Using different criteria this lesson could be suited to many subjects or units of study both inside and outside of the science curricula.

Project-Based Learning Opportunities: This lesson is effectively a large project that students will use to showcase critical thinking and communications skills.

Resources/Materials Needed: For this project students will need peanut butter, jelly, spreading utensils (plastic knives, spoons, etc.), bread, napkins, cutting boards, timers, construction paper, white glue, glue sticks, tape, rulers, pens, pencils, markers, large butcher paper (no particular color), sticky notes

Motivational Opener:

Class will begin with an informal survey asking students if they have ever made a peanut butter and jelly sandwich - the expectation is that they all have, and any few who may not have are likely familiar with the process. Next students are asked how long it takes to make a single PB&J, and as a class we would agree on an average time or time range (with readied supplies, one to two minutes seems like a reasonable range). This could be done as elbow partners or in groups, but should be limited to only one minute or so of class time. Finally students are asked to generate a list of all of the materials that would be needed to make a PB&J (partners again and this task should take only one to two minutes). The class will then use the answers to generate a list of materials on the board that would be needed to make the sandwich. The teacher will reiterate to the class: "with these materials I should be able to make a peanut butter and jelly sandwich in this amount of time? Well, let's see!"

Learning Activities:

Day 1:

First the class will attempt to make peanut butter and jelly sandwiches by following instructions given by classmates. The class will split into groups of three (depending on class size) and will determine roles: one instructor, one builder, and one timer. The following instructions will be given by the teacher:

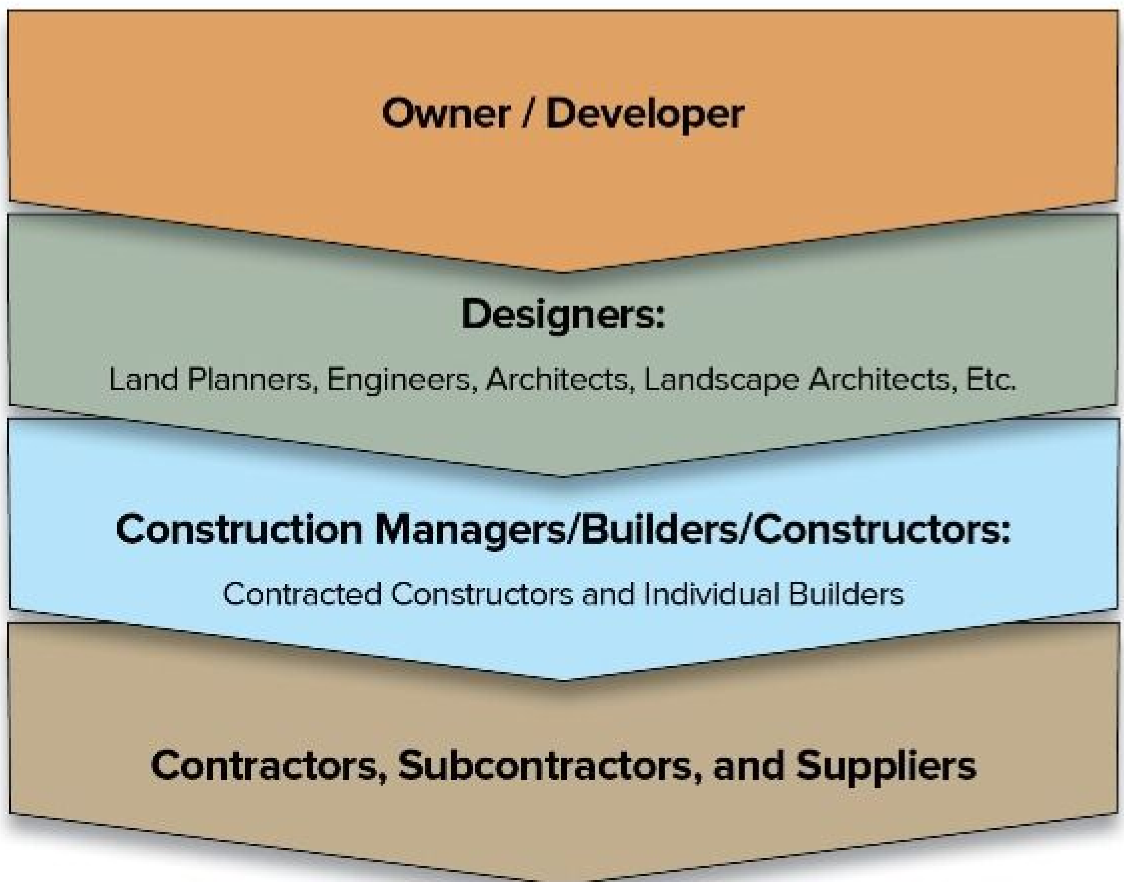
1. The timer-student will give the instructor-student three-five minutes to write down directions for how to make a peanut butter and jelly sandwich.
2. While this is going on the other students are gathering provided supplies.
3. When that time is up, the builder-student will be given materials (preferably matching those listed by the class) and instructions written by the instructor-student, and will be asked to follow the directions as closely (and literally) as possible. The teacher may want to speak with the builders to make sure they know that their role in following directions *literally* is clear.
4. The instructor-student may not speak to the builder except to answer questions.
5. The timer-student should time how long the sandwich making takes, taking particular note of the time that the class agreed on as an average sandwich making time.

During this process students should begin to value the importance of clear and efficient instruction, problem-solving, and the pressure of working under a deadline. After the sandwich making (no more than 3 minutes), students should 3-2-1 reflect on **three** challenges they noticed to making a sandwich this way, **two** things that they think are most important in writing instructions for others to follow, and **one** job where reading/interpreting instructions correctly is necessary for success. Student groups and/or the whole class should share their reflections with each other. This should be about the end of the first day of this unit of study.

Assessment/Culminating Project/Evaluation:

Day 2:

The teacher will start class by reminding students of the important role of good communication (output and input) and ask students to brainstorm how they might use communication in other classes or jobs. Then he will announce to the class that the classroom is no longer a classroom, but instead is the planning room for a developer who is interested in building a construction project. Here the teacher shows students an image (or draws on the board) of a typical construction project hierarchy (attached) and briefly explains some of the roles of each position. The students then get into groups of nine and count off by 9s (adjusted by class size), after which the teacher announces that all 1s and 2s will be designers, 3s and 4s will be construction managers, and 5s-9s will be trade laborers (if students are able to choose their roles on their own they can do so, as long as the ratios of the positions stay about the same). The teacher will have the position of developer/owner.



After students meet their group members and decide on a team name, the teacher-developer/owner will announce the construction project guidelines: students have been hired to design and build a physical science classroom for up to 30 students. Information about requirements such as number of chairs/desks, doors, windows, electrical, lighting, computer, projector, and other things will be provided and will need to be addressed in the group's final designs. Sample building plans and blueprints will be available as models.

Throughout the project direct designer-laborer contact will be very limited, and at this time designer team members will move to a separate lab room where they will have 10 minutes to design and create a blueprint for their group (the time limit is somewhat arbitrary, but should create some pressure for students to work quickly). This blueprint will be on large paper and is what their builder team members will have to work from to create the classroom, so clear and efficient instruction is highly recommended. Designers will also be encouraged to look forward to potential problems and questions that laborers might run into with these plans and finding solutions for them.

While that is happening, the construction manager-students and trade labor-students will be introduced to a visiting guest laborer. This guest could be from any number of trades or positions, but should be willing to talk about their job, their pathway to their job including education and developing skills, and how they use science and math in their field. I personally know of laborers that would make wonderful and willing guests, and many schools and businesses around the area are willing to volunteer their students. While students are speaking and listening to the speaker(s) they should be taking cornell notes about what is being shared and making sure to write down questions that come along.

Designers will work hard on their blueprint designs and the teacher will circulate for support and to answer questions. After 10-15 minutes (again, arbitrary) the students will switch rooms with the designers hearing from the trade worker guests (and taking cornell notes), and the laborers reading the blueprints and creating a 1:10th scale paper model of the new classroom plan. Any time laborers have any sort of question about the design they will write a request for information (RFI) on a sticky note to the design team that will be submitted at the beginning of next period. Again, the teacher will circulate with the labor teams to answer and ask questions.

After another 10-15 minutes, all students will meet up in the classroom with the guests to ask any other questions and thank them for their time. This should be the end to the 2nd period of work.

Day 3:

This period will start quickly with designers and trade laborers separating and laborers submitting their RFIs to the design teams for answers to any questions. The design teams begin to work on resolving and submitting those answers while also addressing the work that has been done on the scale models so far. The labor team will be meeting with another trade professional guest visitor (preferably someone with a significantly different job and/or pathway as the previous guest) and taking cornell notes. Once the design team is finished (10 minutes or so), the groups will switch again and the design team will be in the classroom interviewing the guest speaker(s).

After around 15 minutes (more added if necessary, though having a time limiting factor can push students to work in a high-pressure environment), the projects (including all RFIs) are submitted for the teacher-developer/owner for evaluation. Here students can do a gallery walk of their projects and should leave sticky note comments and suggestions on other's projects. Based on the criteria, the owner will select one project to fund, and that team will get a prize and congratulations. The teacher will graded based on completeness, scale accuracy, neatness/professionalism, creativity, level of communication between teams, and reflection practices.

Closure:

Day 4:

Students will spend this period doing a student-led socratic seminar about the project (if necessary prompts may be provided: the importance of clear directions, effective communication, and teamwork; how these skills can be used in other classes; how scientists use these skills; etc.). As a final review, students will do a one-page quick write of their reflections of the project. If necessary prompts and/or sentence stems may be provided here as well or instead.

Lesson Plan Reflection:

This is a relatively ambitious lesson, so the length of work times might be off. Differentiation can be achieved in many ways including making the tasks easier by giving all students a blueprint to work from, giving more time to complete tasks, and/or having more group members in teams; or more challenging by letting students come up with their own instructable project ideas, requiring more rooms like a science lab or bathroom, including separate systems like plumbing or electrical, limiting students in different "trades" to different systems or materials, creating budgets, and/or looking up state building codes to follow.

In order to prevent guest speakers from falling flat, questions for the guests be prepared by students beforehand, or possibly after they had done some research.