Lesson: Civil Engineering: Design Process and Drawings

Grade Level: 8-9 – Time Required: 45 minutes – Lesson Dependency: None

Subject Areas:

- Science
- Technology

Summary

Students will learn about the thought and innovative process called the Engineering Design Process. The Design Process is used in the manufacturing, designing, and implementation of every idea brought to life. They will first discover the steps and reasoning behind the process. Then, through an educational video, they will analyze and reflect on possible explanations for a bridge collapse. After, students will dive into technical and detailed drawings, which help bring communication between engineers and their ideas. Finally, through an interactive and competitive activity, the students will test their knowledge and grasp of the given learning material.

Engineering Connection

Every idea and concept starts somewhere. The development of that idea into a physical and substantial solution to a problem is where the importance of the design process and drawings shine. Engineers in every field deal with the process and whether the conflict is as simple as a new app or as complicated as rocket science, the design process aids in the nurturing of each possible solution. All the steps included such as identifying the problem, research, brainstorming, testing a prototype, etc., are all realistic steps used in the real world. In addition to the development of an idea through the engineering design process, technical drawings are the main method for communicating ideas, solutions, and courses of action. In the same way that a picture represents 1,000 words, a technical drawing can transmit countless amounts of information from one engineer to another.

Learning Objectives

After this lesson, students should be able to:

- Explain and list the steps of the Engineering Design Process.
- Identify and analyze possible solutions to a problem.
- Identify the purpose behind drawings.
- Be able to define a floor plan and its contents.
- Be able to define a site plan and its contents.
- Differentiate the difference between both site and floor plans.

Educational Standards

- International Technology and Engineering Educators Association- Technology
    - The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others. (Grades K - 2)
    - The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results. (Grades 3 - 5)
- CTE-TECED.68.ENTECH.11.01
    - Identify the design process involving a set of steps, which can be performed in different sequences and repeated as needed.

- CTE-TECED.68.ENTECH.10.01
    - Use design as a creative planning process that leads to useful products and systems.

Attachments

- Presentation Slides (Slides 1-8)

Materials

- Each student will need a device or computer to participate in the Quizizz activity.

Lesson Background and Concepts for Teachers

The text and lessons that follow coordinate with the attached Google Slides Presentation. Starting from slides 1 to 8. Each will break down the key objectives in each slide and the points/ideas supporting them and leading to their discussion. You may modify and adapt the examples and explanations to suit your classroom's needs.

Slide 1-

To begin, introduce the topic of the design process and drawings. You may do this by asking a pre-assessment question or by talking about how ideas and concepts are cultivated into real and tangible results through the process. Perhaps you can even take some words or ideas from the "Engineering Connection" section.

Slide 2-

After introducing the topic, explain and introduce the steps of the Engineering Design process.

To begin, everything must start with a question. Whether it is a need, want, or convenience, it all starts with a problem. One example of this is the t.v remote. We wanted the convenience of not having to stand up to change the channel so they invented the remote to do it from our seats. Without a conflict or problem, nothing new would arise.

After you receive a problem, the next step is to do research. Using a book, library, studies, or the internet, investigate if another person has had the same problem as you. If so, what did they do? How did they solve it or what method did they use? Use their information, data, and conclusions to help you in the next section which is brainstorming.

Brainstorming, whether it is with a group or by yourself, is the process of coming up with ideas. This is the time to be creative. Think of every possible way to fix the problem and use your research to enhance your ideas. At the end, choose a possible and *tangible* concept; meaning it has to be feasible.

The next step is to make a prototype. Make your idea a reality! Once you have created it, test out your prototype and investigate if it accomplishes its purpose. In other words: Does it work? Whether or not it works, there will always be ways to improve and fix it. Which is step 6, identify and record the flaws in your design.

The flaws will then become a new problem to fix therefore leading you to step 7. Repeat the process again with your new problem. Remember that the Engineering Design Process is continuous and always being

performed to perfect things. The entire point of the design process is to improve. Examples of this being done are everywhere. Phone companies such as Apple Inc. are constantly improving their devices using this process.

Slide 3-

Now that we know how the process works and what it is, display the video "6 Construction Failures and What We Learned From Them". This video gives numerous examples of failed bridges and construction plans. This ties into the design process because if something goes wrong, that means that a step in the design process was not done properly. Either it was not tested sufficiently, there wasn't a proper prototype beforehand, or no improvements were made, something went wrong in the process. The lecturer can pause the video whenever they see fit and ask questions based upon the content or examples given.

Slide 4-

Moving deeper into the design process, technical drawings and architectural drawings are very important parts of the design process. It takes part in the brainstorm and prototype steps. The purpose of these drawings is to communicate ideas. It is a way to display information in an easy to read format and it can be made by hand or electronically. Architects and planners make the drawings and then engineers make sure it is safe and able to be built. In civil engineering, architects have to use these drawings and plans all the time.

Slide 5-

One of the main types of drawings is the floor plan. Like any other plan it displays information, but it is more specific in certain parts. As you can see, it shows information from above. It specializes in the relationships between space, furniture, rooms, and other physical features by giving dimensions and lengths. In the end, it shows all the information of a single floor in a building, but is limited to that floor.

Slide 6-

Another type of drawing is the site plan, which contrasts the floor plan. It is a much broader plan, but still gives a great deal of information. Like the floor plan, it shows information from above, but instead of the relationships between spaces on a floor, it shows the relationships between buildings on the entire property. It can display the whole property, boundaries, entrances, and it can be used to display new construction projects alongside old ones already on the property. Since it is much broader in the information it gives, it does not go into specific and minor details, which is why it is often paired with other drawings and plans.

Slide 7-

Now that we have finished going over the curriculum and learning material, a quizizz is a fun way to review the students' intake of knowledge and retention of what they learned. After a quiz is chosen or made, simply share the code or link with students and they will compete against each other in real time with the objective to see who can get the best score. As they go through the quiz, the presenter can go over missed questions and reinforce the lesson. For a 15-20 question quiz, the activity should take around 20 minutes.

Slide 8-

To end, ask the students if there was anything that caught their attention or something they learned. This quick activity will hopefully inspire participation and sharing. The lecturer may also choose to further this into a discussion or wrap up the lesson as soon as they want.

Associated Activities

Past Mistakes- While displaying the video titled "6 Construction Failures and What We Learned From Them", students will learn about historic faults and errors made in the construction of several bridges and the teacher will have opportunities to ask critical thinking questions as well as time to recapture students' attention.

Quizizz- Quizizz is a site similar to Kahoot, where after a pre-prepared quiz is made to review certain content and topics, students can compete and engage in an activity that encourages them to review what they have learned.

Lesson Closure

Lesson closure begins after the Quizizz class activity ends. Using slide 8, the lecturer can transition into a closing, participating atmosphere where students are asked to share 1 thing they learned or enjoyed from the lesson. Now that they have learned the design process and the basics of technical drawings, the students will be more prepared for future engineering classes and related topics.

Vocabulary/Definitions

Brainstorm **-** *A group discussion to generate ideas or to solve problems*

Prototype **-** *A first, typical, or preliminary model of something, especially a machine, from which other forms are developed or copied.*

Architectural Drawing **-** *A technical drawing of a building or project with the main purposes of bringing ideas to fruition and communicating ideas or concepts.*

Floor Plan **-** *A scale diagram of the arrangement of rooms in one story of a building.*

Site Plan **-** *an architectural plan, landscape architecture document, and a detailed engineering drawing of proposed improvements to a given lot. It includes the entire property, buildings, entrances, and more if necessary.*

Assessment

Pre-lesson Assessment

As a pre-lesson assessment to gauge the level of knowledge of the students attending the instruction, the lecturer may start the lesson with a question (slide 1). For example, "Does anyone know what the design process is?" is a simple way to encourage participation and at the same time serve as an indicator for their level of familiarity with the topic.

During the Lesson

During the lesson, there are many instances where a quick question or poll would be a good idea to motivate their analytical sides. During the video activity, there are many occasions where one can stop the video and inquire about a certain comment the narrator spoke. For example, one of the named bridge examples (at 2:40) had its supports bending. A good question to start the discussion is to ask for any hypothesis' or ideas for the cause of the bending.

Post-Lesson Assessment

The final slide, slide 8, is a good post-lesson assessment. The idea behind it is not really to encourage them to think, but just to motivate the students to share something they liked or to just recall something new they encountered or found interesting throughout the presentation.

Lesson Extension

One way to extend the lesson is to include a hands-on activity that the students could partake in. For instance, after discussing and learning of the design process, an assignment could be introduced where the students have to think of a new invention or improved model of a household appliance, and then create a simple drawing or sketch of how it would look like.

Another way to extend their application of what they learned is to give them an example of a technical or engineering drawing and ask what information they can extrapolate from it. This will help reinforce the lesson that the goal of each drawing and plan is to communicate that information.

References

All of the references towards the pictures used during the lesson presentation have the credits in the slide notes.

Dictionary.com. Lexico Publishing Group, LLC.. (Source of most vocabulary definitions, most of which were done in my own words) http://www.dictionary.com

CPALMS Standards and Achievement Standards Network (Source of educational standards) https://www.cpalms.org/Public/search/Standard http://asn.jesandco.org/resources/ASNJurisdiction

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