SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Stronger Together	Grade 7 – Form, Function, and Design of Structures

Lesson Plan

Learning Outcomes

A1. STEM Investigation and Communication Skills: use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

A3. Applications, Connections, and Contributions: demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology from people with diverse lived experiences

D1. Relating Science and Technology to Our Changing World: analyse personal, social, economic, and environmental factors that should be considered when designing and building structures

D2. Exploring and Understanding Concepts: demonstrate an understanding of the relationship between structural forms and the forces acting on them

Specific Expectations

A1.2 use a scientific experimentation process and associated skills to conduct investigations

A1.3 use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems

A3.1 describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

Form, Function and Design of Structures

D1.1 evaluate environmental, social, and economic factors that should be considered when designing and building structures to meet specific needs for individuals and communities

D2.5 describe factors that can cause a structure to fail

D2.6 identify the factors that determine the suitability of materials for use in manufacturing a product or constructing a structure

Description

In this activity, students will investigate composite materials. They will compare the relative strength of composite and non-composite materials to understand why composite materials are used in construction and manufacturing.

Materials

- Paper
- White Glue
- Cheesecloth
- Scissors

Introduction

Composite Material: A composite material is a material used for construction which is made of two or more components, each with different chemical and physical properties. When combined, they are more effective at doing a specific job.

Composite Material vs Alloys

Composite materials are generally heterogeneous mixtures, whereas alloys are bound together and become homogeneous. For example, a sheet of carbon steel with a stainless-steel coating is a composite material, because it still has two distinct materials, whereas both carbon steel and stainless steel are alloys of different metals, bonded to each other to form one material.

Examples of Composite Materials

Reinforced concrete – Concrete itself is a composite material, but it alone has low tensile strength – it does not hold up to force well – but it is an easily affordable building material, compared to materials with greater tensile strength. However, when reinforced with steel bars (rebar), the tensile strength of the structure increases significantly.

Plywood – Plywood is made of several thin layers of wood glued together. Each layer has grain going in a different direction, increasing its resilience to force in all those directions. Plywood is, as a result, more flexible and cheaper than solid wood, while using layering to retain strength.

Ceramics – For millennia, Indigenous Peoples have traded knowledge, including the making of tools such as pots and jugs from clay. The preparation of the clay involves the addition of inclusions, usually sand, shards of pottery, or shells. Those inclusions temper the clay, allowing it to be baked and used without shattering, cracking, or drying, making the pot stronger and more durable.

Action

This activity may be done individually or in groups.

1. Make Materials

- Students will start with three sheets of paper, a bottle of white glue, and a sheet of cheese cloth.
- Leave one sheet of paper as it is.
- Coat the second sheet of paper in white glue and let it dry.
- Coat one side of the third sheet of paper in a thin layer of white glue and add the cheese cloth.
- Your students should now have one non-composite material (a sheet of paper), and two composite materials (Glue-Paper and Cheesecloth-Glue-Paper).

2. Test Materials

Put the materials through stress tests. For each test, make a prediction and then test it.

- Attempt to tear each material (shear force). Which tears most and least easily?
- Attempt to crumple each material (compression force). Which is hardest to crush? Which returns best to form?
- Pull on either side of each material (tension force). Which resists best?
- What other forces can you test on your material?

3. Build

Having tested all three materials, have students build a structure with a flat roof. They may use any existing knowledge of structures to help them, such as strong shapes. They must choose which of their three materials to use where in their structure. They may use their materials in any combination.

When all structures are complete, test how much weight they can hold by stacking first small items such as coins, up to heave items such as textbooks, on the structures.

Ask students to identify the failure points in their structure when it does finally fall and ask how it might be reinforced.

Consolidation/Extension

Create your own composite material! Have students decide what purpose they are designing their material for (ex., flexibility and strength, resistance to shear force, etc.). Then, have them choose two or more materials to combine to achieve the desired effect. Let them create their composite and design a test for it against both original materials to see if it is indeed more effective at the desired effect.

Additional Resources

EN:

https://www.youtube.com/watch?v=hRI0ymx_6aw -> The future of concrete in a green future

https://www.youtube.com/watch?v=az6oYcd-SfU -> New and cool materials

An Illustrated guide RZS 2018 (1).pdf -> an illustrated guide to the creation of Iroquois pottery

FR:

https://www.youtube.com/watch?v=_GV35WRH23E -> les matériaux vert de la future

https://www.quebecscience.qc.ca/14-17-ans/encyclo/quand-lunion-des-materiaux-fait-la-force/

Bilingual:

https://letstalkscience.ca/educational-resources/backgrounders/types-materials

https://letstalkscience.ca/educational-resources/stem-explained/testing-spacesuit-material