

Capstone Challenge

2025-2026

Grade 10 Semester 1

Challenge Title:

Harnessing Local Natural Materials for Building Climate-Resilient Structures

Theme

Matter, Form, and Function

Egypt Grand Challenges

- **Improve the use of arid areas**
- **Deal with urban congestion and its consequences**
- **Deal with population growth and its consequences**
- **Reduce and adapt to the effects of climate change**

Note: any other suitable grand challenges are permitted.

Capstone Big Idea

The importance of relying on **natural and locally available resources** in construction lies in their vital role in reducing environmental impact and strengthening community sustainability. Sustainability is no longer a secondary option, but rather a necessity to address environmental, economic, and social challenges. Equally, the pursuit of **new architectural designs** that can adapt to climate change has become essential for building a more resilient future in the face of extreme heat, flooding, strong winds, and desertification.

Within this context, a clear need arises to **rethink both the form of residential buildings and the materials used in their construction**. This rethinking requires

combining the wisdom of traditional methods of utilizing natural resources with modern building techniques, thereby ensuring long-term environmental and economic efficiency.

Building on these foundations, the challenge presented to students is envisioned as a **journey of innovation and discovery**. They are invited to design a sustainable residential building that embodies these principles and translates them into practical solutions. The goal is not merely to produce an architectural model, but to **reimagine the future of construction** through creative use of local natural resources, making buildings more climate-adaptive and environmentally harmonious.

Essential Question

How can we exploit materials characteristics knowledge to transform a local natural material into a functional building component that enhances a building's resistance to a climate-related hazard?"

Design Challenge

Students will research arid areas in Egypt that are suitable for development (e.g., Eastern desert, Western desert, Sinai Peninsula, ...etc.) and identify at least **three design requirements** for their prototype structure (one must address safety, e.g., fire, theft, or weather). The structure must be designed to withstand environmental forces such as wind and temperature extremes while remaining aesthetically appealing. Students will then **select two design requirements** from the list below to be tested and graded. Additional features may be included, but only the chosen two will count toward evaluation.

Design Requirements

- The team should first search for the characteristics of a locally grown natural material (e.g., flax shives, corn cobs, Plant fibers, cotton stalks, wheat straw,

banana plant waste, Sugar cane bagasse, Rice husk, etc.) and then select one or more materials that are available in the school region to be utilized as the building component.

- The team must clearly justify their material choices based on the matter properties analyses (e.g., type of matter, elasticity properties, thermal properties, rigidity, ... etc.). Besides, the hazard they address, and the specific application of their prototype in a structure.
- The project dimensions must not exceed **80 cm in length, 60 cm in width, and 30 cm in height**, and the prototype should be of a manageable weight that allows students to transport it easily from one place to another.
- The team will identify at least three design problems for arid-area housing (one must be safety-related).
 - Static Load – Demonstrate that your structure model can hold a specified weight distributed across a defined roof surface area of at least 5 kg at the center of mass of the structure's ceiling with the least bending.
 - Lateral Load – Demonstrate that your structure model can withstand a lateral pressure equivalent to at least 2 kg of force, simulating the impact of wind or the collision of an animal against the external walls, without compromising its overall stability.
 - Thermal Management – Show that the structure can maintain an internal temperature at least 4 degrees less than the outside when exposed to direct sunlight.
 - Fire resistance – The material should **not catch fire easily** (i.e., following up the deformation of material such as its shape, color, ...etc.) within a given time frame (e.g., 30 seconds of controlled heat exposure).

Constraints

- Use only materials available in your region,
- **Only two design requirements** from the approved list may be selected for testing and grading.
- It is not allowed to use clay or manufactured construction materials (e.g., gypsum, cement, epoxy, ...etc.). However, you may use glue materials to assemble the final prototype, not exceeding 5% by weight.
- The prototype must be **testable, workable, and portable** at any time and place.
- **All processes** should be conducted **within the school grounds**.
- No equipment or materials that belong to the laboratories can be removed from the laboratories at any time. You must conduct those tests that require this equipment in the labs. Failure to do so will result in a reduced grade.
- **You are responsible for all that you need during the exhibition.**