Writing a STEM Design Brief
From Content Standards to Curriculum: Using Engineering Design to Deliver STEM Content

Why is "design" important? Design is regarded by many as the core problem-solving process of technological development. Design is as fundamental to technology as inquiry is to science and reading is to language arts. Becoming literate in the design process requires acquiring the cognitive and procedural knowledge needed to create a design, in addition to familiarity with the processes by which a design will be carried out to make a product or system. More broadly, problem solving is basic to technology. STEM teacher's regularly uses a number of design and problem solving techniques. Some of these include: troubleshooting, research & development, invention, innovation, and experimentation.

How are "design briefs" used to deliver STEM? Design briefs are typically used to guide and extend learning in STEM education. While completing design brief activities, students have the opportunity to prove that they understand the content, work as a member of a design team, demonstrate technological ability, and prove him/herself. Design briefs can be very open-ended or very structured, but the best design briefs allow for a culmination of previously learned content.

What strategies are used to solve "design briefs?" Technological design involves the use of the "design process" or the "design loop." The design process is a series of cognitive and manipulative steps that students use to arrive at the best possible solution to a given problem. The design loop usually includes the following procedures: 1) Define the problem, 2) Conduct research, 3) Brainstorm potential solutions, 4) Design, 5) Build prototype, 6) Test solution; and, 7) Modify the solution based on the results of testing and communicate the results or produce and market the product.

Challenge: Design briefs are created to cause students to demonstrate their understanding of a particular technological concept. Design briefs are derived from technological concepts or standards. At the conclusion of this lesson you are going to develop your own design brief that supports learning related to one or more standards. Please use the Getting Started questions below to begin your *rough draft* design brief.

Follow-up: After you have completed the rough draft of the design brief, it will be presented in a small group setting. The group will be responsible for assessing the design brief, comparing it to the standards and benchmarks, and for providing you with feedback and suggestions for improving the design-based lesson.

To get started – you may ask yourself the following rhetorical questions. Each answer will be further developed in the design brief and some items may need to be added as 'notes to the teacher'.

Standard(s): What is the grade level and what standards and/or local curriculum component is addressed?

Assessment: What evidence will be used to determine whether students have learned?

Prior Knowledge/Experiences: What prior content knowledge/skills will the students need?

Challenge: What will the students be required to do?

Results: What will students know, value, and be able to do as a result of this lesson? What's the big idea?

Classroom/Laboratory Preparation: Will special arrangements need to be made?

Materials/Equipment: What materials and equipment will students need to successfully complete this lesson/activity?

Summary/Connections: How will this design activity connect with future learning, other disciplines, work world, etc.?

Time: How much time is involved?

Writing the Final Design Brief

Directions: After completing the questions above, take the time to craft the final design brief. The final design brief should include each of the categories below. You will note that these categories are loosely based on the Understanding by Design curriculum model.

Title: Use a catchy title the will attract the attention of students and provide a hint at the task in front of the students.

Grade Level: Use standards and content knowledge to determine the appropriate grade level of the design brief.

STEM Content Standards: Identify content standards from each of the STEM fields, but don't try to deliver everything known to humankind in one design brief. Be sure to include one standard from the Arkansas Science Standards (Life, Earth/Space, or Physical Science), one Standard for Technological and Engineering Literacy (include both standard and benchmark), and one Arkansas Mathematics Standards. You may also consider an ETS standard from science, ELA, social studies, or other standards.

Big Ideas: Identify the major concepts that will be delivered through the design brief. It should be central to the STEM disciplines, hold the potential to engage students, include commonly misunderstood materials, and be important enough for the students to remember when they are 30 years old. Look at the standards that you have identified for the project – what are those big ideas?

Essential Question: What question or questions will the student be able to answer after completing the design challenge? Remember use **open-ended/open-response** types of questions.

Scenario: Write an engaging scenario that will capture the attention and possibly intrigue the students. Fictional scenarios are entirely appropriate. A good scenario will place the students into the story or challenge.

Challenge: In specific terms, identify exactly what the student teams are required to do to fully answer the challenge in the design brief (i.e., build a tower as tall as possible that will support the weight of a golf ball using only the materials available). Use a statement that says construct, build, make, etc.

Tools, Materials, and Resources: Identify all the tools, materials, and resources that will be available to the students as they attempt to solve the challenge. Try to keep the list small, students need to know that in the work world, unlimited supplies are rarely available and there are benefits to solving problems as efficiently as possible.

Content information: Provide any content information and/or research materials related to each of the identified STEM content standards that the students will need to adequately solve the design challenge.

Results: Identify what (exactly) the students need to deliver to the teacher upon completion of the design challenge (i.e., what product, notes, journal, etc.). Results are sometimes referred to as deliverables.

Limitations: Identify the boundaries for the students (maximum size, materials allowed, how fast/slow, etc.). Think about all of the ways that student creativity might take their solution beyond your boundaries. Limitations are sometimes referred to as parameters or constraints.

Assessment/Evaluation: List and describe, in specific terms, how the students will be evaluated. A rubric is a good choice. Also remember to evaluate the contributions of all team members so that one student isn't left doing all the work.