THE ART AND DESIGN OF THE HIGH ROLLER OBSERVATION WHEEL

Teacher Guide
Grades 6-8
“HOW CAN YOU DESIGN A SAFE AND ENJOYABLE FERRIS WHEEL THAT CONTINUALLY MOVES?”

LESSON:

BACKGROUND AND PLANNING INFO:

This lesson guides students through a design process that will help them create a model that describes the sum forces acting upon a Ferris wheel that meets the criteria and constraints true to the needs of the High Roller Observation Wheel. Students will participate in drawing designs, testing forces, as well as have the opportunity to take a trip to collect data and make observations at the High Roller to propose answers to the question, “How can you design a safe and enjoyable Ferris wheel that continually moves?”
Students will express their understanding by asking questions, brainstorming solutions, creating a draft of their solution, critiquing their peers, revising their models and recording their ideas in their design notebooks.

These activities are designed for a student to have an actual wheel to work on and create a design to make it continually move. Old bicycle wheel on a wooden spindle, clamped to tables, or something similar, is suggested for each group of 3-4 students.

**SUMMARY OF ACTIVITIES**

A. **ASK QUESTIONS TO DEFINE THE PROJECT:**
   Students will use the guidance provided by the teacher and their design notebooks to describe the goal of their design that will help them understand the sum forces acting upon the Ferris wheel, while at the same time using the materials provided to describe their findings. *(50 Minutes)*

B. **IMAGINE THE POSSIBILITIES:**
   Students will work in groups of three or four to express and evaluate their initial ideas that address the design problem of how to make a Ferris wheel move continuously. Students will create diagrams to share their ideas with each other. Students will also take this time to evaluate their ideas according to the criteria and constraints that they defined in the last section. *(50 Minutes)*

C. **PLAN YOUR DESIGN:**
   Students will work in their groups to plan and record the solution they select from the ideas they brainstorm in the last section. *(30 Minutes)*
D. CREATE A DRAFT:
Working in their groups, students use provided materials to create a model that will make their ideas about a solution to the proposed problem explicit within their group so that they can communicate their ideas to other groups. *(120 Minutes)*

E. IMPROVE YOUR DESIGN:
Using the results of the testing phase, as well as the date they collected and observations during the field trip, students will revise their design solution, justifying each change or revision with data from testing or field trip. *(60 Minutes+ Field Trip)*
Students who demonstrate understanding can:

Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object. [Clarification statement: Emphasis is on balanced (Newton’s First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton’s Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry]

A. ASK QUESTIONS TO DEFINE THE PROJECT

Teachers will divide students into groups of 3 or 4. Provide them with video clips that will spark their initial thinking about the lesson’s Big Question. In each task, teachers may employ “Big Paper” activity, graffiti wall participation, etc. for students to share their ideas and then students should record their constraints and criteria in their field notebooks.

**TASK #1: IDENTIFYING CRITERIA FOR SUCCESS**

Teacher will guide students to consider the video of the moving wheel as they think about potential design solutions that address the problem of making a wheel that continuously moves. In their small groups, students will work to brainstorm the criteria to make their project successful. How will they know that their solution is a good one for the challenge set forth? Students should use their design notebooks to record their ideas.

**TASK #2: IDENTIFYING CONSTRAINTS**

Students should use the guidance of their design notebooks to brainstorm any limitations to the project. These might include money, time, numbers of visitors, artistic limitations and more.
TASK #3: NEGOTIATION WITH TEACHER GUIDANCE-
As a class and guided by the teacher, discuss the criteria and constraints developed by separate groups. Record the groups’ ideas on the board and help students negotiate to an agreement for which criteria and constraints are the priority. In this case, students create their own criteria and contraints that they will work toward for the rest of the project.

Another option is to guide students to express their ideas, record them on the board and then present the students with a pre-determined list that is true to the design needs of the High Roller. Students and teachers can take time to compare and contrast what the group came up with and what the adopted criteria and constraints will be.

The goal for Task #3 is to devise a list of both criteria and constraints common to the whole class, that each group will work to acheive with the design they create. Students use filed notebook to record the resulting criteria and constraints for the project.
Teachers will guide students to be creative and communicate all of the ideas that they have that will address the problem of creating a continuously moving wheel. Students will work in their small groups to describe three ideas, select the best option and communicate their idea to the whole class.

**TASK #1: BRAINSTORM IDEAS-**
Teachers should guide students to brainstorm their ideas that are design solutions that answer the Big Question posed in the beginning of the activity. In groups of 3 or 4 students should use the guidance in their design notebooks and brainstorming sheet to get their ideas on paper. Students should keep their criteria and constraints in mind, but for this activity, be creative and get at least three design ideas out in their design notebooks.

**TASK #2: EVALUATE IDEAS THROUGH THE CONSTRAINTS AND CRITERIA-**
Instruct students to evaluate each of their three design ideas through the lens of their criteria and constraints for the project’s result. Students can share the design that they select as their best solution with the whole class.
C. PLAN YOUR DESIGN: Teachers should guide students to use their design notebooks to plan what they need to do and materials they will need to implement their design. This might include a plan for materials, time, money, information resources, expertise, etc. that will be required in order to complete a draft. The second activity is designed for students to make their design plan explicit.

TASK #1: DESCRIBE WHAT YOU WILL NEED (15 MINUTES):
Prior to articulating their work or design plan, students can be guided to describe the materials, the amount of time, any additional information they might need to research on their own or ask an expert, etc. Students will use the questions and prompts in their design notebooks to inspire them to consider each of these important needs and communicate them to the other students in their group.

TASK #2: DESCRIBE THE PLAN (15 MINUTES):
In their design notebooks, they will work as a group to decide upon tasks to be completed and an order of operations so that they can successfully complete a draft/prototype of their idea.
D. CREATE A DRAFT: (120 MINUTES)
In this section, students create a prototype or draft that they understand to best satisfy the criteria and constraints laid out in the first section. It is up to the design of the lesson whether this draft is a written piece, a blueprint, a physical model, or whatever design that students can use to make their ideas concrete. This section should contain three parts. First, students will create their draft. Second, they will test their draft and their ideas for how it achieves the goals of the project with the whole class.

TASK #1: CREATE YOUR DRAFT:
Students are given access to materials for the development of their draft. Direct students to use the questions and answer prompts to journal their development process, including the challenges and the things that work well. They should have a space for sketching and revising.

TASK #2: TEST YOUR DRAFT:
Students will test their draft based on the criteria for success established in the beginning of the lesson. All students should have the same criteria for success in mind and each idea should undergo the same testing. Design notebooks include tables for recording testing data and space and prompts for students to record any additional observations or ideas during the testing process. The teacher should also provide a data sheet on the board for students to contribute to, so that they can benefit from the tests and design solution implemented by others.

E. IMPROVE YOUR DRAFT: (60 MINUTES)
In this section, students will incorporate the ideas of their peers and the things that they learned on their trip to the High Roller to improve their draft. This section contains two parts. First students will propose their changes and use a scaffold provided by the lesson design to justify each of those changes using evidence from class resources (including their peers) and from the field trip. Then, they will make the changes to their draft and complete their design.

TASK #1: PROPOSE CHANGES TO THE PROTOTYPE:
Students should be provided with a mechanism (table questions, etc.) to record each change they might make to their original design/draft. With each proposed change, they should record a justification, based on information they obtained through testing, observation, the ideas of their peers, or things they learned on their trip to the High Roller.

TASK #2: MAKE FINAL CHANGES:
Finally, students will make changes to the prototype based on that they learned. A final step might be to present their final design as a whole class and discuss the changes in the forum.