Lesson Plans

Isaiah A.J. Walters • Designer • Educator

Subject: Science
Topic: Bridges – The 1st Annual Prince Edward Bridge Builders Convention
(Predicting, Testing and Reflecting on Student Bridge Construction)
GRADE: Five

Curriculum Expectations:

Structures & Mechanisms: Grade 5 - Forces Acting on Structures & Mechanisms (The Ontario Curriculum Grades 1-8: Science and Technology pg 81)

UNDERSTANDING BASIC CONCEPTS

1. Identify the parts of a structure that are under tension and those that are under compression when subjected to a load;

DEVELOPING SKILLS IN INQUIRY, DESIGN, AND COMMUNICATION

1. Use appropriate vocabulary, including correct science and technology terminology, in describing their investigations and observations;
2. Design and make a frame structure that can support a load;
3. Compile data gathered through investigation in order to record and present results using tally charts, tables and labelled graphs…

RELATING SCIENCE AND TECHNOLOGY TO THE WORLD OUTSIDE THE SCHOOL

1. Identify problems that arose in the designing and making of a product, and indicate how these could have been avoided or how they were solved;
2. Describe the consequences of having limited time and materials when making a product;

Links to Previous Learning Contexts:

Students will have synthesized learning from previous lessons about bridge types and forces acting on bridges. This knowledge has been applied to the construction of their own bridges. The design strategy employed should have reflected a degree of comprehension relating to bridge structure and the forces of compression and tension.

Anticipated Learner Outcomes:

Students will present their constructions to the class and provide reasons for the type of bridge they choose to build. They will share their predictions about how much of a load their bridge will hold and where they anticipate structural weakness. All students will record data including their own predictions and the actual outcomes. Once testing is finished students will be required to complete a self-reflection and evaluation of their bridge building strategy. This will be assigned and completed as homework.

Resources:

1. A selection of varying weights 50g – 2KG
2. Weigh Scale
3. Bridge Builder's Convention Poster & Invitations
4. Student name cards
5. Camera- photos to be taken during recess
6. Load Test Worksheet

Learning Based on Multiple Intelligences

(The following types of intelligences have been stimulated during the mini-unit on Bridges)

Linguistic:
- Write descriptions and responses to questions
- Present their bridge to an audience

Logical – Mathematics:
- Use thinking skills to apply knowledge of bridge structures to their own designs

Visual – Spatial:
- Draw diagrams of proposed and final bridge structures
- Chart load test results

Bodily Kinesthetic:
- Building and constructing a bridge using common household materials

Intrapersonal:
- Self-assessment of bridge
- Self-reflection on the design of the bridge
- Self-reflection on the bridge building process and experience

Interpersonal:
- Participating in a team environment to accomplish a mutual goal
- Collaborative work and planning

Introductory Activity: Welcome the students as engineers attending the 1st Annual Bridge Builders Convention.

Developmental Strategies:

	Component Time	Teaching Learning Strategy
1.	<5 minutes	Distribute measuring tapes, and Load Test Worksheet. Have students measure the length and the span of their bridges. Inform students that if they will be placing their bridge on books that the span will be roughly the space between the books (roughly the entire length of the bridge).
2.	<3 minutes	Two tables at a time will place their bridges on the back counter.
3.	2-3 minutes	Model the load testing as adding weights in increments. Students may wish to start out with lighter weights. When the bridge is reaching a critical load they may wish to add smaller weights. Model the appropriate information to provide to the class about their bridge. (see below)
4.	Approx 5 minutes per bridge. X13	Invite one bridge building team at a time to present their bridge. Shake hands with the 'young engineers'. Students will: • State the name, length, span, type and location of the bridge. • Summarize what technique or strategy they used to strengthen their deck. • Predict the maximum load and where they think their bridge is most likely to break. • Proceed to test their bridge's load capacity. • List how much weight they are adding so that a volunteer recorder can tabulate this on the black board. • Thank each student team when finished. The remainder of the class will record this information as well as their own prediction of the maximum load.

Concluding Activity: When finished, hopefully time will permit a general class discussion about what the students have learned from the testing. The students will be encouraged to draw conclusions about the structural stability of various bridge building strategies and make judgements as to what they think worked the best. Ask students if this experiment was a fair test? Try to get them to realize that the varying styles and materials made it difficult to properly compare these

structures. Have students reflect on what they have learned about bridges in general. Allow students to evaluate their own bridge building experience. What did they learn? What problems did they encounter? How will they improve their bridges? These questions will also be part of the Load Testing Worksheet and will be assigned as homework.

Methods of Evaluation: Anecdotal Observations of student bridges and responses during the presentations and class discussion. Student's Load Testing Worksheet will be collected once completed and assessed along with the Bridge Builder's Checklist, Bridge Summary Worksheet and the Bridge itself based on the Bridge Building Rubric (see attached).

Self-Reflection: As this lesson is the completion of a series of six lessons I feel it is appropriate to comment on my own experience. Overall I am satisfied with my approach to this subject. The bridge building activity has been an excellent means of meeting several curriculum expectations in a manner that catered to the needs of six different intelligences. I am pleased at the variety of work the students were engaged in during this mini-unit. I was able to incorporate authentic examples to model the forces of tension and compression as well as multi-media resources including videos, and an Internet webquest. I believe my approach of taking time to thoroughly teach the students about the types of bridges and how the forces of tension and compression work in these structures was correct. I felt it was necessary to develop a sufficient level of knowledge and comprehension in the students prior to allowing construction of their bridges. On the other hand I feel I made a serious scientific error in permitting too many materials to be used in the construction of these bridges. By allowing materials such as Popsicle sticks and cardboard not all students were sufficiently challenged to use their materials strategically. Furthermore this exception also destroyed all 'control' of the actual scientific load testing experiment. Overall, I have come to terms with my errors and hope that the students will still assimilate the factual, technical and scientific knowledge I taught them. Judging from the intrigue and enthusiasm from the majority of the students I must have done something right.

Bridge Building -- Rubric

Student Name: _____

		CRITERIA	Level 1	Level 2	Level 3	Level 4
KNOW	Understanding of Concepts	**Concepts** Demonstrates Forces of: Tension Compression	**Few**	**Some**	**Most**	**All/Almost All**
		Misconceptions Reinforcement: Bridge strength through strength of material alone	**Significant**	**Some**	**Minor**	**None/Almost None**
		Explanations Structural Details Forces in action	**Limited**	**Partial**	**Usually Complete**	**Complete**
DO	Inquiry and Design Skills	**Skills and Strategies** Good pre-planning Kept to original ideas Good Time Management Good Team-work	**Rarely**	**Sometimes**	**Mostly**	**Always**
		Use of Tools and Materials Construction of a truss cable stay or suspension bridge	**With Assistance**	**Some Assistance**	**Occasional Assistance**	**Little or no assistance**
	Communication	**Clarity and Precision** Writing is clear, concise and contains details	**Little**	**Some**	**Usually**	**Consistently**
		Use of Terminology Span, Length, Load (live and dead loads), Tension, Compression, truss, pier, tower, deck, arch, cable, anchorage, abutment	**Few / None**	**Some**	**Most**	**All (where appropriate)**

Bridge Builder's Checklist

Engineer's Name:

Bridge Type:	**Location & Function:**

Quantity	**Materials Required:**
	1.
	2.
	3.
	4.
	5.
	6.

Bridge Description (Describe in detail how you will use your materials to create the type of bridge you have chosen.)

Draw a diagram of your bridge. (Using arrows label where you will find compression and tension in your structure.)

Detail #1 (draw a close-up here)	**Detail #2 (draw a close-up here)**

***Note: Use the back of this sheet for your rough sketches.**

Bridge Summary and Analysis

Engineer's Name:

Name Of Your Bridge:

Bridge Type:	**Location & Function** (who/what will use it):

1. What type of bridge did you build? What were your reasons for choosing this type of bridge?

2. What force (tension or compression) do you think your bridge will be better able to handle? Why? Make sure to include parts of your bridge that you estimate are the strongest and best at dealing with this force.

3. Predict how much weight your bridge can hold? Specify this in grams or kilograms. Where are the weakest part(s) of your bridge?

4. Draw a diagram of your bridge. (Using arrows label where you will find compression and tension in your structure. Label the main parts of your bridge using the correct terms.)

Load Test Worksheet

Engineer's Names	Bridge Name	Bridge Type	Length (Cm.)	Span (Cm.)	Predicted Max. Load	Tested Max. Load

Engineer's Name: _____

Bridge Name: _____

Length: _____ **Span:** _____

What was the outcome of your own test? Was it different than your prediction?

_____

_____

How could you improve your bridge? What would you do differently when you make your next bridge?

_____

_____

_____

_____

Describe the problems and challenges you faced when building your bridge. (Was there enough time? Was it difficult to work with a partner? Did the materials provided pose a problem?)

_____

_____

_____

_____

What was the most interesting or important thing you learned about bridges? Did you enjoy this subject?

_____

_____

_____

_____