Blanchard Memorial School Boxborough, MA Course Dates: July 20-21, 2011

The Missing Link: Engineering Design Process and Thinking Skills

Lesson Plan	
Outline	**Description**
Introduction	The book, *The Cricket in Times* Square, was selected because it is a core piece of literature used in our school's English Language Arts 5th grade curriculum. It is a Newberry Award Honor and is well-liked by our students. It is a prequel to the subsequent book, *Tucker's Countryside* which we also read within our fantasy genre. These books are used to teach a variety of reading skills, strategies, and literary elements in a unit approach.
Story Title & Description	*The Cricket in Times Square* by George Selden (144 pages) After Chester, a cricket, arrives in the Times Square subway station via a picnic basket from his native Connecticut, he takes up residence in the Bellinis' newsstand. There, the tiny creature is lucky enough to find three good friends: a little boy named Mario whose parents run the unsuccessful newsstand, a fast-talking Broadway mouse named Tucker and his pal, Harry the Cat. Throughout their escapades and their ups and downs in New York City, together they somehow manage to bring success to the almost bankrupt newsstand when Chester reveals his unique musical chirping talent. The humans in the story are oblivious to the fact that the animals that dwell among them are able to communicate with one another. Grades 4 – 6 (This lesson is designed for 5th grade students.)
Learning Goals/Outcomes ***Students will know…*** ***Students will be able to…***	KNOW: • The students will know that science, technology, engineering. math, and art can be applied to literature. • The students will know that learning can be interdisciplinary and span various subjects. DO: • The students will be able to apply reading strategies to comprehend an appropriate grade-level text. • The students will be able to complete a story map. • The students will be able to work cooperatively and collaboratively to use the engineering design process to create a solution to a defined problem. • The students will be able to self-assess their individual contributions as well as the success of their group.
Prior Knowledge	Prior to introducing the series of lessons outlined below, I would facilitate an activity similar to what we partook in during our training. I would have my students brainstorm what they think engineering is and

	what engineers do. I would also have them illustrate what they think an engineer looks like. Both their lists and illustrations would be shared in small groups and whole class. Together we would define what engineering means and the various forms of engineers. They need this conceptual background knowledge in their schemas before moving forward with any engineering design challenges. Fifth grade students will love the idea that they, too, are engineers! In order to be successful with the series of activities outlined in this plan, students will need to have had prior experience with: • Discussions and presenting to the class • Working in cooperative groups • Teacher-modeled thinking skills and engineering design processes; The intent is for a "gradual release of responsibility" in which students will have multiple engineering experiences each time with less teacher-led direct teaching and modeling and more student ownership, responsibility, and initiative for their learning. Ultimately the goal is for teacher facilitation of the learning experience with little control and input where students are able to identify possible design challenges within a given text. • Reading chapter books • Completing story maps • Sketching/drawing • Building/creating with various materials
Vocabulary	• Brainstorming • Problem solving • Brain writing • Gallery sketches • Convergent thinking • Divergent thinking • Critical thinking • Creative thinking • Requirements/Constraints • Engineering Design Process • Process • Product
Design Challenges (problems identified in the story)	• Chester Cricket gets trapped in the picnic basket • The Bellinis need a new newsstand which is more attractive and functional (must be able to secure it at night) • The cash register draw cannot be closed tightly • Mario needs a cage to house his new pet cricket • The Bellinis need to increase business and draw customers to their stand • The animals need to put out the fire they accidentally started

	• Chester needs to replace the $2.00 bill he accidentally ate during a dream thinking it was a Mulberry leaf • Tucker Mouse needs to protect his "life savings" and all the treasures he has scrounged up as well as store the bits of food he collects (pantry)
Requirements (science and/or math constraints; any other requirements)	Utilization of at least one simple machine in each group's design solution.
Selected design challenge to solve	Enticed by the delicious aroma of liverwurst, Chester Cricket climbed into a picnic basket, but he had more than a taste. In fact, he ate so much that with being tired from all his previous jumping and now a full stomach, he couldn't keep his eyes open. He fell asleep right there in the picnic basket in a Connecticut meadow. Before he knew it, he was trapped under a bag of roast beef sandwiches. The little cricket worked furiously to try to free himself. The students will design and build a contraption using at least one simple machine to successfully free Chester from be pinned under the weight of the sandwiches and thus, he will be able to freely climb out of the picnic basket before being accidentally transported all the way to New York City.
Teacher's Strategy (How will you introduce the project?)	Once we read to the end of chapter 3, I will present the class with a wicker picnic basket filled with roast beef sandwiches and other picnic foods (possibly using faux food as not to spoil over the course of a few days). Pinned under the bulk of the food will be a fake, toy cricket (Chester). I will introduce the selected design challenge. I am anticipating that this visual will pique curiosity for my students and motivate them to seek solutions to free Chester Cricket. I hope the visual representation will stimulate creative thinking solutions. The students and I will discuss expectations for various steps of the design process and create a rubric/checklist to be used for assessment (see Assessment section below). A logical time for this to occur would be after step 2 below once students are privy to the challenge.
Procedure: Series of Lessons	1. PRIMING: Read the book through Chapter 3 (pp. 1-26). Complete a Story Map template with information gained thus far. Have students work with a partner to add information to their charts, then regroup as a whole class and share responses. Create a classroom Story Map on the overhead projector or electronically on the interactive whiteboard (EnoBoard/Smartboard). Revisit throughout the duration of the book as we encounter new information related to characters, setting, problem, main events, and resolution. This portion of the lesson will take 2-3 language arts blocks to complete.

2. PRIMING: See the "Teacher's Strategy" section above regarding how I will introduce the engineering design project.

3. DIVERGENT THINKING/GENERATIVE: Students will generate possible solutions to free Chester. They will "Brain Write" one idea on each Post-It note with the goal of 3-4 ideas generated per group member. Sitting at round tables of 4 is perfect for students to pass their ideas to their partner. Once they receive their neighbor's idea, they should generate a new idea that was somehow inspired by it, "piggy-backing" on the proposed solution. This activity will take 5th graders about 15-20 minutes to complete; therefore, it can be combined with the next activity.

4. CONVERGENT THINKING: In this "shaping" activity, teams will sort and narrow down their possible solutions which may lead to the creation of new ideas. Discussion will ensue about which ideas belong in one of three categories: ordinary, innovative, or magical. Students should work together to sort each idea and physically move them to the appropriate location on their table. Students may wish to label each pile with a contrasting sticky-note color as not to confuse the process. Students will be encouraged to reshape their ordinary and magical ideas into innovative solutions. This activity will take approximately 15-20 minutes to complete. During this process, the group members should narrow down their possible solutions and make a decision about which idea to pursue during the building process.

5. DEFINING: The four members of each group will break up in teams of two to create "Gallery Sketches." They will work together to visually represent their design solution. Approximately 10-15 minutes will be allotted for this task. Then the two partnered groups will share their illustrations with the table group, comparing and contrasting elements of each design. The group members may decide to use one particular design in which to build their prototype, or they may choose to incorporate features from the two sketches creating a third sketch as part of the iterative process. The second step of this lesson will take an additional 10-15 minutes, thus these two activities together will require approximately 30 – 40 minutes of class time.

6. DEFINING: This lesson will most-likely take a few days to complete since students will be involved in executing their gallery sketches as they construct their solution to free Chester from the picnic basket. Students may wish to assess what materials are available to them in the classroom, and discuss as a group which materials they may

	want to gather from other areas of the school as well as bring in from home. Students will be encouraged to utilize provided materials in creative, novel ways and to "think outside the box" as the build their models. (2-3 class periods) 7. SHARING: Once the groups have completed their models, we will have a whole class sharing of gallery sketches and completed 3-D designs. We will hold a discussion regarding unique approaches groups took and similarities and differences among each group's design. During each group's presentation, they will need to define which simple machines they incorporated into their model and how it contributes to helping free Chester from the picnic basket. 8. ASSESSMENT/REFLECTION: At the end of each class time working with the engineering design process, the students will be asked to write a reflection in their Science Notebooks sharing successes, failures, frustrations, celebrations, questions, etc. for the day. At the culmination of the above activities, they will complete a self-assessment using the rubric/checklist we initially created as a class. They will be evaluating their individual contributions to the group as well as reflect on other group members assessing the overall dynamics of the group.
Curriculum Framework Standards	***MA Science & Technology/Engineering Curriculum Framework Standards*** **Technology/Engineering Grades 3-5** 1.1 Identify materials used to accomplish a design task based on specific property, e.g. strength, hardness, and flexibility. 1.2 Identify and explain the appropriate materials and tools to construct a given prototype safely. 1.3 Identify and explain the difference between simple and complex machines, e.g. hand can opener that includes multiple gears, wheel, wedge, gear, and lever. 2.1 Identify a problem that reflects the need for shelter, storage, or convenience. 2.2 Describe different ways in which a problem can be represented, e.g. sketches, diagrams, graphic organizers, and lists. 2.3 Identify relevant design features (e.g. size, shape, weight) for building a prototype of a solution to a given problem. ***MA English Language Arts & Literacy Framework incorporating Common Core Standards*** **Grade 5 Reading Standards for Literature:** 1. Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. 2. Determine a theme of a story, drama, or poem from details in the

	text, including how characters in a story or drama respond to challenges or how the speaker in a poem reflects upon a topic; summarize the text. 10. By the end of the year, read and comprehend literature, including stories, dramas, and poetry, at the high end of the grades 4–5 text complexity band independently and proficiently. **Foundational Skills:** 4. Read with sufficient accuracy and fluency to support comprehension. a. Read grade-level text with purpose and understanding. b. Read grade-level prose and poetry orally with accuracy, appropriate rate, and expression on successive readings. c. Use context to confirm or self-correct word recognition and understanding, rereading as necessary. **Speaking & Listening Standards:** 1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions and carry out assigned roles. c. Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others. d. Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions. 2. Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence. 4. Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. 6. Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation. (See grade 5 Language standards 1 and 3 on page 39 for specific expectations.)
Thinking Skills	• Critical thinking • Creative thinking • Higher order thinking skills (all levels of Bloom's Taxonomy are represented in various steps within the sequence of lessons – knowledge, comprehension, application, analysis, synthesis, evaluation)

	• Priming • Generative • Convergent • Divergent • Defining • Metacognition (especially applied to reading comprehension and self-assessment)
Safety	• Students should wear safety goggles when cutting, breaking, or snapping any materials (i.e. wooden tongue depressors, sticks). • Students should be cautioned about potential finger burns when using a hot glue gun (teacher should model appropriate use).
Materials	A wide-variety of materials should to be available for students in order for them to exercise creativity and ingenuity. They will be encouraged to use materials and supplies in novel ways. I welcome the opportunity for them to bring in any additional supplies and materials from home that they may choose to use to complete their challenge. I would highly recommend that they not purchase new materials rather use "found items," "beautiful junk" and recycled materials from home and school as well as items found in nature. Some suggested materials are: • Glue gun and sticks • Styrofoam meat trays • Yarn/string • Clay • Milk jug caps • Popsicle sticks/tongue depressors • Straws • Toothpicks • Pipe cleaners • Cardboard • Fabric scraps/felt • Empty film containers • Empty thread spools • Shoe boxes or empty food containers • Elastics/rubber bands • Fasteners: glue, tape, brass brads, staples
Assessment Method	The students and I will construct a checklist of Criteria for Success that will be used to assess their individual contributions using the defined Learning Goals/Objectives as our focus. The checklist will be used to assess individual student effort and contributions during the process as well as to assess their final product. Students will self-assess themselves, assess members of their group, and receive a teacher

	assessment and written feedback based on multiple observations.
Extensions	• Students continue to add to the Story Map as they encounter more characters, the story problem, main events, and finally the resolution as they continue to read the selected chapter book. • Students write an additional chapter to the book extending the story predicting what Chester Cricket might do now that he is back in Connecticut. They should include what Harry Cat and Tucker Mouse are doing back in New York City now that their new friend has departed. • Students continue reading about these fictional animal characters in the sequel, *Tucker's Countryside*. While they are reading, they complete a City/Country chart comparing and contrasting the settings of each book (urban vs. rural). • Students record examples of personification, similes, and metaphors in their reading response journals to notice how these elements of figurative language are used to enhance literature. • Students respond to literature response questions to improve their writing skills and ability to answer open-response questions using specific details and literary evidence for support. • Students use their visualization reading strategy to transform abstract to concrete by creating a diorama of their favorite book scene using the author's description. • As a science extension, students can research the common cricket on the Internet. They may gather information on a cricket's body, habitat, what it eats, life cycle, etc. They may also draw a cricket and label its main body parts, i.e. head, antennae, thorax, abdomen, etc. An interesting topic to research is the anatomy of a cricket's wings and how it produces chirps using the friction of its wings. This would be a great science tie-in to vibration and sound energy.
Additional Information (Considerations & Modifications)	Even students who are unable to independently read the selected text can still successfully participate in these activities. A student's reading skills need not be a barrier to creativity through the application of the engineering design process. The text can be shared whole class through a teacher read aloud or through partner reading, guided reading, or further supported with a text on tape to expose less-capable readers. It is activities such as these where learning styles and various areas of multiple intelligences emerge and are celebrated within the classroom.