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| **Title** | **Creating Catapults using Schema of the Human Body** |
| **Introduction** | Students love to plan, design and create things with their learning. Catapults have been around for centuries, yet students love to still learn and build them. This lesson will have the students build two different catapults. The first will be a rather basic catapult and the second will be made using the LEGO® WeDo pieces and software program. Reasoning behind the creation of catapults is to reinforce, enrich and extend the students schema that was built using the human body. The catapult mimics and acts much like one of our joints. The engineering design process will be used with each task. Students will be using concepts of science, technology, engineering, and math (STEM) as they complete this lesson.  |
| **Learning Outcomes** | Students will be able to:1. Work as an effective member of a team
2. Use the engineering design process to complete a given task
3. Accurately estimate and measure correctly on objects that are launched
4. Collect data and use it to solve problems
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| **Curriculum Alignment** | Grade 3 NCSCOSMathematicsGoal 1 Number and Operations1.06: develop flexibility in solving problems by selecting strategies and using mental computation, estimation, calculators or computers, and paper and pencilGoal 4 Data Analysis & Probability4.01: Collect, organize, analyze, and display data to solve problemsTechnology1.07 Recognize spreadsheets as a tool to organize, calculate, and graph information to make predictions.2.06 Enter/edit data in a prepared spreadsheet to perform calculations. Identify and discuss the changes that occur as a class/group.\*knowledge and application of the LEGO® WeDo softwareScience Goal 4: The learner will conduct investigations and use appropriate technology to build an understanding of the form and function of the skeletal and muscles system of the human body.4.3 Describe the function of different types of joints: hinge, ball and socket, gliding.4.4 Describe how different kinds of joints allow movement and compare this to the movement of mechanical devices.Engineering connection1. Engineering design process (Ask, Imagine, Plan, Create, Improve)
2. Form and Function of design

Framework for 21st Century Learning components1.Core subjects (Mathematics, science)3. Learning and Innovation Skills (creativity and innovation skills, critical thinking and problem solving, communication and collaboration skills)5. Life and Career Skills (initiative and self direction, leadership and responsibility, flexibility and adaptability)6. 21st Century Support Systems (standards and assessment, curriculum and instruction, learning environments) |
| **Classroom Time Needed** | 3-4 Class Periods (Each class 45 minutes – 1 hour) |
| **Materials Needed** | Each student:Dixie cupPlastic spoonClear tapeBean (any type that fits into the spoon)STEM notebook pages providedCatapult assessmentSafety GogglesEach group:Tape measureLEGO® WeDo kits\*additional kits or materials available to students allow for greater imagination to be used (LEGO® Mindstorm/Robotics pieces work with the WeDo software and pieces) |
| **Technology Resources** | SMART BoardSMART Board lesson plan providedLaptop for each group of students (desktops would work, but limit students mobility)LEGO® WeDo software installed on each laptopMicrosoft Excel installed on each laptop |
| **Pre-Activities** | 1. Students need to be familiar Microsoft Excel. In this lesson, students are working from the point where they already have been taught how to import numbers into cells, make simple formulas and create graphs of their data. If your students are not familiar with these three elements, they have to be taught this prior to this lesson. (If not using Microsoft Excel portion and using classic graphs and numbers using paper and pencil, ignore this step)
2. Students have built all the LEGO® WeDo pre-created builds that are on the software. In turn, they are very familiar with the programming involved and how the different parts work and fit together. Students would not be able to do this lesson without this prior knowledge.
3. Unit on Science Goal 4: Human Body is being taught as this lesson is being used. Bones, muscles, and joints have to be either previously taught (like used in this plan) or Day 1 of the lesson plan has to go further into the content compared to what is written below
4. Students have already been introduced and worked through the engineering design process (ask, imagine, plan, create, improve) used by Boston Museum of Science
5. Estimation and measurement should have covered with students
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| **Activities** | Day 11. Student discussion: identify different joints and where they are located on the body (focus of discussion is to generate ball and socket, hinge and gliding)
2. Show a picture(s) of a catapult and discuss the function and how it works.
3. Create a discussion around how a catapult relates to a hinge joint and not like the other two joints
4. Brief lesson on estimation and actual measurement: throw a bean across the room. Ask students how far it went in inches, feet, etc. Discuss how they just estimated the distance. Then ask how they would actually know? This should lead to actually measuring from where I was standing to the object. Be sure students know the difference between estimated and actual distance and how to properly measure before moving on. If not, data can be altered the different tests
5. Closing activity: Pass out safety goggles to everyone and explain how we do not try to hit each other with the catapults and to make sure to wear the goggles even if done building. Any student that doesn’t follow these instructions is not allowed to continue with the other activities.

Pass out a Dixie cup, plastic spoon, tape and a bean to each student. The goals if for the students to build a catapult that can launch the bean the furthest. Day 2 1. Starting with the “Ask” stage of the engineering design process: present the engineering design challenge: “build a catapult solely powered by the LEGO® WeDo software that can launch an object the furthest
2. Have students get into groups of 2-3. I believe 2 is perfect because it allows for one to build and one to program, but three can also work.
3. Give each group a LEGO® WeDo kit, STEM Notebook handouts/masters and briefly overview the additional WeDo pieces you have available to them.
4. Students complete the “Imagine” stage in their notebooks. Have them draw designs for what they think would work
5. Students then complete the “Plan” stage together. They have to blend their ideas into a workable drawing. This drawing does not have to be exact or pretty, but it has to be functional for them to build from
6. In conclusion, have students create an Excel document that will collect their estimate and actual distance data they will track in their experiment. (sample Excel spreadsheet included)

Day 31. Students start the “Create” step in the process. They will build their catapult from their design. In addition, they have to create an original program on the LEGO® WeDo software because the catapult has to be solely powered by the computer.
2. As students complete their initial builds, they have to make estimation before they launch their object and then actually measure it when they try it. These numbers have to be tracked in their Excel spreadsheet.
3. Before each group tests, have the entire class watch the test. This will allow for other students to see what other groups are doing and possibly use, share, manipulate others designs for their own design.
4. Each group should at least test once this day

Day 41. Students work into the “Improve” step in the process. After each improvement and test, they will include that in their Excel sheet (i.e. improvement/modification #1 trial #1)
2. When groups have improved their design at least 3 times, have them print out a graph of their results.
3. Using their graphs, they will complete Catapult Assessment provided
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| **Assessment** | 1. Math 1.06, Science 4.3 & 4.4 all formally assessed in catapult assessment attached. Science 4.3 & 4.4 informal through classroom discussions
2. Math 1.06 & 4.01, Technology 1.07 & 2.06 all formally assessed through creation and application of the Excel documents made throughout the lessons.
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| **Modifications** | 1. This task is meant for any style of learner. The SMART Board template or PowerPoint of same material supports learners with ELL, LD restrictions because it provides visual representation of material being covered.
2. Working in teams, allows for different levels of learners to share and understand together. With grouping students, make sure to create heterogeneous groupings to allow for students to help teach and learn from each other.
3. Using different ways of responding to the discussions questions is a modification to be used to meet various IEP or ELL needs. If students struggle with written responses, use a version of the webcam or oral discussion of answers to questions.
4. This is a real world activity that is built upon 21st century learning format and environment which enables for modifications to be built within and tailored to each learning style
5. If groups really struggle: assistance could be made by showing how other builds (The Giant for example in the WeDo software mimics a catapult)
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| **Alternative Assessments** | 1. The format of this lesson does not allot for the need for an alternative assessment. There are plenty of opportunities for students to show you what they learn as they are working in small groups. If they struggle with written documentation, modeling expected results could help.
2. Verbal questioning groups and students in particular with questions that are aligned with the standards covered could also be used as a supplement
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| **Supplemental Information** | Use of LEGO® as an educational resource: <http://www.lego.com/education/default.asp>Engineering in the classroom: <http://teachengineering.com/> Importance on Engineering in Education: <http://www.todaysengineer.org/2009/Oct/STEM-education.asp>EiE (Engineering is Elementary) website: <http://www.mos.org/eie/> |
| **Critical Vocabulary** | Joints (hinge, ball and socket, gliding)Engineering design processCatapultLEGO® WeDo software and pieces vocabularyEstimationMicrosoft Excel (cell, formula, graph)Distance |
| **Websites** | 1. Boston Museum of Science EiE website <http://www.mos.org/eie/index.php>
2. Teach Engineering multiple excellent resources <http://teachengineering.org/>
3. LEGO® website for products, etc. <http://www.lego.com/en-US/default.aspx>
4. SMART Board free download of software: <http://www2.smarttech.com/st/en-US/Support/Downloads/SBS/Windows/SBSv97Win.htm>
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| **Comments** | 1. This lesson was done after the Human Body kit was taught. It can be done as it is being taught, but after the bones, muscles and joints are introduced. This lesson builds from that previous knowledge and will make connections easier for students
2. Take the time to let students build all of the LEGO® WeDo pre-created builds, it is both valuable learning the different designs and purposes of the different pieces in the kits. In addition, students better understand how they can manipulate different builds to serve different purposes. These lessons were done with groups that did not have the extensive background and they were far less creative and successful in their learning.
3. In creation of groups, I have always allowed students to pick their own group when it comes to engineering tasks. Unlike in reading and math, engineering is a field where “high” and “low” students are not easily identified. The idea of heterogeneously grouping students becomes impossible because of the lens you have to look through.
4. Groups should not be over 3, more than three allows for down time for students which is ineffective and inefficient use of both student and teacher instructional time.
5. The implementations of engineering tasks, in my opinion, are most successful after the science foundation has been taught. Due to this view, I complete this lesson after the solids liquids and gases unit is completed in the NCSCOS.
6. If completing an engineering challenge using the 5 step process, please do not skip steps to cut time. Each step is equally important in students learning. Remember, during the imagine step, do not limit their ideas by constraints or restrictions. Introduce constraints, restrictions, or criteria after the imagine step.
7. Engineering is a field where there are so many standards being addressed at once. They are perfect opportunities to support, enrich or remediate students at all levels.
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