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| **Fellow Name: Chirau J. Patel** | **Contact Info:** [**patelcj@mail.uc.edu**](mailto:patelcj@mail.uc.edu) | **Date: January 11 and 12th, 2017** |
| **Teacher Name: James Prugh** | **School Name: Indian Hill High School** | **Grade and Class: 10th/11th Grade for Advanced Pre-Calculus** |

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| **Activity Title:** | **Starjumpers: Trigonometric Explorers in Space** |
| **Estimated Activity Duration:** | **90 minutes**   * **15 min introduction (Space and the Project)** * **25 min construction and refinement of rocket to reach target zone of 5 to 8 feet** * **15 min calculation for each planetary zone** * **15 min launch for each planetary zone** * **10 min conclusion questions** * **10 min activity end discussion** |

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| **Setting:** | **Classroom (“Outer Space”)** |

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| **Activity Objectives:** |

The student will be able to:

1. Perform trigonometric calculations to determine where a rocket should land within a target planet zone.
2. Build a straw rocket with preallocated materials through an iterative process.
3. Successfully launch a straw rocket within a target zone distance of 5 to 8 feet.
4. Document their design iterations during the activity.
5. Be able to discuss future suggestions based of their experience through the activity.

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| **Activity Guiding Questions:** |

1. How could trigonometry be applicable in space?
2. What are some variables that could affect the design of straw rockets?
3. How could I make a straw rocket that will land between the target zone?
4. What are important ideas and observations I should keep in mind?
5. What purpose do our group roles play?
6. What is real-life engineering design driven by?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| * Developing and using models | * Cause and effect |
| * Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| * Analyzing and interpreting data | ☐ Systems and system models |
| * Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| * Constructing explanations (for science) and designing solutions (for engineering) | * Structure and function. |
| ☐ Engaging in argument from evidence | ☐ Stability and change. |
| * Obtaining, evaluating, and communicating information |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| * Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| * Make sense of problems and persevere in solving them | * Useappropriate tools strategically |
| * Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| * Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

**Common Core for High School Geometry:**

* Define trigonometric ratios and solve problems involving right triangles

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

* A PowerPoint outlining an introduction to travel in space (gravity assist maneuvers, traveling from Earth to Mars and back, etc.)
* Attached handout, “Starjumpers” presents intro, overview, and procedure for overall activity.
* Supplies for the Activity itself—Targeted for 100 students in groups of 4
  + “Starjumpers” shows the designation of supplies as well as the launching apparatus
* Extra supplies will be ordered
* Students’ assistance will be needed to clean up the activity once finished.

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| **Teacher Advance Preparation:** |

* Teacher will have advance copies of all activity materials so students can come to class having read what the activity entails and what will be expected of them.
* Supplies will be designated for each class with kits. Replenishments will need to prepared to save time for the incoming classes.
* Pre/Post Assessments will be conducted prior to the activity and then afterwards.
* Have prebuilt straw rockets in different stages (so students quickly see the steps) and a simple trigonometric calculation on the board.

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| **Activity Procedures:** |

1. Pre-Assessment and the Starjumpers document need to be distributed before this activity begins. Just as well, make sure there are pre-built straw rockets in different build stages, this will help keep better management of time.
2. Introduce the topic of space travel with PowerPoint from materials-10 minutes
   1. This should provide a general overview on traveling in space. Begin with gravity assist maneuvers and introduce if an astronaut crew traveled to mars and back, what type of mission durations they may have, things they may have to account for, and what is being planned for the future in terms of long distance missions.
   2. Briefly go over “Starjumpers” just to refresh the students’ minds before starting the activity.
3. Give students 5 minutes to form groups and assign team roles as well as a team name.
   1. Once all students have done so, this item can be checked off.
4. Give students 25 minutes to build and refine their designs to reach the target zone of 5 to 8 feet.
   1. Briefly show the construction of a straw rocket with variables that effect the design. However, make sure to not tell students directly that these variables will influence their flight, this should come from their own understanding. These three will be the key variables to “demonstrate:”
      * 1. Nosecone
        2. Fins
        3. Straw length
   2. Present a simple trigonometric calculation on the whiteboard
   3. Teacher has to monitor the students using the datasheet during this time so the design iterations are drawn/written down.
   4. The teacher will have to also manage with time and groups as some groups will quickly figure out a successful design and will want to launch and other groups will need some help.
      1. If students are falling behind, make sure they address why, and help them come to the understanding of what to fix.
   5. Students may not be experts at modeling clay or shaping fins, help them in this aspect if they need it. Keep an eye out because sometimes students may not ask for help even though they would like it.
   6. Launch accordingly, at least give each group 2 successful attempts for the target zone distance before letting them move onto the next phase: calculations for the planet zones.
5. Students should not need more than 15 minutes for Planet Zone calculations.
   1. There will be some groups that are advancing to this stage quickly so let them go ahead and verify their results of x and y locations, angle to orient the launcher, and hypotenuse length for both zones.
   2. It will be important to make sure any questions by the students are addressed. The formative assessment sheet will serve a good place holder to see if any groups are falling behind.
6. Launching for the Two Planets; this should take 15 minutes.
   1. Let students launch in the order groups with finished calculations. It will be easier to do one group at a time for both zones.
      1. If a group does have an incorrect first or second launch, let them double check their calculations, their rocket to make sure it isn’t damaged, and then as the teacher, verify their calculations.
   2. Make sure all groups have launched for both zones.
   3. Groups that finish early can move onto the conclusion questions
   4. Use the formative assessment to keep track of anyone falling behind.
7. Conclusion Questions and Post Assessment which both should take 10 minutes
   1. Make sure students have answered conclusion questions.
   2. Once all the groups have finished their questions, let them move onto the Post Assessment.
   3. If there are, and there’s a good chance, some groups may be completely finished early. Have them help other groups, this way other groups have a helping hand, and students are not just sitting around waiting.
   4. Make sure they’ve cleaned up their work areas and all waste is properly disposed.
8. Discussion should take 10 minutes
   1. Address the conclusion questions, they will entail good sources for discussion: student thoughts on the activity, things that worked them and things that did not, improvements, and overall what they learned out of the experience.
   2. At the same time, go over the post assessment with the students and explain the solution. No one likes a test with no explanation of why the answers are the answers.
   3. Thank the students for their time and let them know to reach you with any questions that weren’t cleared up or potential resources if they would like to learn the subject matter further.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

The attached file, “Formative Assessment Checklist” covers: a timer for the teacher conducting the activity to track with the timeline, pre/post-assessment, construction phases, planet zone calculations, whether the students reach their calculated locations, clean-up, if conclusion questions have been answered, and the group discussion.

Just as well, the students will be documenting the design process, answering questions, and solving calculations in the “Starjumper Datasheet.”

**Summative Assessments:** Prepare a Pre-Test and Post-Test with the input of the RET Teacher. This should be a simple 10-12 question assessment tool. These questions will cover the content related to the Standards. The Pre and Post Test will be identical. There may be several summative assessments at the end of this Activity. Besides the Pre and Post Tests, the students might create a product for which this is a rubric developed. The rubric is also a summative assessment tool. Link the assessment tools.

The attached “Starjumper Pre-and Post-Assessment Teacher Copy” file covers the summative assessments.

Summary for Summative Assessment

Things that could have affected the score:

* Students forgot to answer a question
* Students accidently took the sheet home
* Students developed rockets that proved questions on the assessment incorrect
* Students may have needed longer time to finish the assessment
* Students forgot to write their names on the assessment

Below is a table outlining the general data for the formative assessment as well as four bar graphs outlining: pre vs. post assessment scores for 55 students, improvement of scores on the overall assessment, the number of the three key trigonometry questions incorrect both before and after, and lastly the number of students that were able to get all three key trigonometry questions correct during both assessments.

Upon further examination of the assessment, I realized afterwards there were rockets that defied the correct answers on the assessment, for this reason, questions 3 and 5 should not be used in the future, and question 7 requires more time and testing to fully correctly answer. Nonetheless, the assessments were scored out of all 9 questions. The most important questions, and ones unaffected by the activity, were the ones about trigonometry (Q6, Q8, and Q9), and for that reason those questions were further analyzed.



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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.Refer to Activity Template for details. |

* I eliminated the launch for the second planet zone because there was confusion about the projectile launcher angle and the trig calculations. This was observed with the first class that did the activity. Instead, I spent several extra minutes at the beginning of each class to walk through an example, and then once again when the students reached the calculations part. I realized, that it wasn’t wise to overload them too much at the beginning, but to build more information and teaching it at several different checkpoints.
* Students felt much more encouraged in the activity with a competition component. As a result, we saved 10 minutes at the end for furthest distance competitions.
* For the last class, in order to promote more creativity, we ended up not showing a prebuilt model of the rocket and instead had students develop rockets from scratch with no prior knowledge. This ended up taking a little more time than expected however as a result, rockets were very different in design in comparison to previous classes. One design even reached the furthest distance amongst all the classes.

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| **Reflection:** Reflect upon the successes and shortcomings of the Activity. This is done after the Activity is implemented. |

Students gave great feedback, which will really help if this activity is implemented again in the future. Their recommendations included:

* sturdier material for the nosecone such as modeling clay
* more accurate angle measurement in both directions
* open spaces so the rocket does not hit the ceiling
* different competitions
* more trials
* more time
* more materials
* having more rocket launching apparatuses
* more information about the aerodynamics properties of the straw rocket

In terms of factors that I should fix for the future, I personally found:

* I need more time for the activity
* I need to clear up the trig questions more in-depth
* Eliminate the second planet zone because we did not launch for it as often
* Make more trig problems at the beginning to get students into the groove of what they will be doing
* Leave more time for clean-up
* Not show a straw rocket model\*\*\* Not doing this for the last class allowed the students to make the most creative and unseen designs. It also promoted multiple rockets, testing, and really the engineering design process much better.

In terms of personal successes, I found:

* Every single group was excited, engaged, and participating.
* They were able to apply trig, understand how the problems worked, and see practical application of it with their rockets.
* When the students launched their rockets with near-perfect accuracy to the planet zone coordinates they calculated.
* They seemed to thoroughly enjoy the activity and the change in pace.
* Jim was pretty happy with the outcome and application to trig. He trusted me enough through all the classes to teach all his students.
* I felt like I knew what I was doing and was able to successfully apply principles of engineering and the philosophy of COFSP.