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| **Fellow Name: Temiloluwa Adeniyi** | **Contact Info: adeniyta@mail.uc.edu** | **Date: 1/27/16** |
| **Teacher Name: Gina Rider** | **School Name: Seton High School** | **Grade and Class: 12th Grade, Pre- Calculus** |

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| **Activity Title:** | **Applications of Trigonometry with Animated 2 Link Robotic Arm** |
| **Estimated Activity Duration:** | **50 minutes** |

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| **Setting:** | **Seton High School** |

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| **Activity Objectives:** |

The student will be able to:

1. Applications of Trigonometry with Animated 2 Link Robotic Arm
2. Determine the domain of a system of equations that describe a real life system.
3. Apply fundamental trigonometric concepts to engineering design scenarios in creation of individual systems that meet design parameters.

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| **Activity Guiding Questions:** |

1. Identify the Pythagorean Theorem, as it relates to the unit circle.
2. How does the formula look when used in the diagram for the 2 link diagram?
3. How can the Pythagorean formula be used to describe the maximum length the robotic arm can be, which is also the domain for the system of equations for the robotic arm?
4. Co- Terminal angles share a beginning and end position. They have a difference of 360 degrees. How would the robotic arm look that has initial angles that are co-terminal to the final angles the links have with the positive, horizontal axes? What happens when co-terminal angles are compared in Matlab?
5. Using this constraint of possible values, as well as an additional constraint that L\_2 can’t be shorter than L\_1, what possible values can be used to create your own system?

| **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):** |

1. Asking questions.
2. Using mathematics and computational thinking.
3. Obtaining, evaluating and communicating information.
4. Systems and system models.
5. Designing technological/engineering solutions using science concepts.
6. Make use of problems and persevere in solving them.
7. Reason abstractly and quantitatively.
8. Model with mathematics.
9. Use appropriate tools strategically.

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

1. My laptop
2. HDMI cord
3. Projector
4. Projection screen
5. Robotic Arms (follow up activity)

6. [Prezi Presentation](http://prezi.com/3npuwod6frdf/?utm_campaign=share&utm_medium=copy)

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| **Teacher Advance Preparation:** |

* Co-terminal angle lesson
* Technology check

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| **Activity Procedures:** |

1. Open link for pre- assessment from email and complete.
2. Connect to Prezi.
3. Open Prezi presentation.
4. Complete introduction and give context for activity with unit circle and Pythagorean Theorem.
5. Complete example with one link robotic arm problem.
6. Show applications of trigonometry and video.
7. Follow along for user inputs for desired initial and final position.
8. Determine maximum length for robotic arm, using Pythagorean Theorem.
9. Design individual system and test robotic arm with individual values.
10. Ask student for the dimensions of their design from manual calculations.
11. Ask students what pattern do they see?
12. What do you observe when co-terminal angles of the robotic arm are compared side by side?
13. Open link for post- assessment from email and ask students to complete it.

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

The students will be assessed during the activity through dialogue and a Socratic approach.

**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.

[Pre- Assessment](http://goo.gl/forms/RSVUUPo45U)

[Post- Assessment](http://goo.gl/forms/HeVFLv0ZqP)

**Bar Graph 1: Evaluation Student Learning**

The students completed the pre-assessment together and the post- assessment individually. Despite this difference, there student was demonstrated from the pre- assessment to the post- assessment in the above bar graph 1.

Questions 1- 5 evaluated the student learning. Question 6 evaluated the student interest in S.T.E.M. There was a measureable difference between student interest before the activity and after the activity.

**Bar Graph 2: Evaluation Student Interest in S.T.E.M.**

I think the activity was successful, there was an increase in understanding for each question and overall there was an average of **34.22%** increase for the overall activity. The items where the students showed the most increase in understanding in calculating co-terminal angles (question 3) and designing systems (question 4). There was also an increase in the students’ interest in S.T.E.M. **67%** of students who expressed no interest in S.T.E.M. before the activity expressed interest after completing the activity.

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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. |

The activity can potentially reach different learning types through the hook, dialogue and visuals. With these elements visual and audio learners can be potentially targeted.

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

The primary strengths of the activity and the follow up activity with the 3D printed technology were the focus on real life applications of trigonometric concepts in engineering and incorporation of technology into the lesson. The primary shortcomings were not explaining the design question very well and having an unclear diagram. Although there was a significant increase in understanding in designing systems with defined constraints, there were still a large number of students who did not answer the question. There may not have been enough time for them to answer the question or the question was not presented to them in a clear way. If given the opportunity to modify the lesson, I would rephrase question 4 and also focus on the design aspect in the class discussion. Additionally, I would have the students to complete the pre- assessment individually.