

Out of this World Engineering!
Let NASA Help Engage your Students

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SCED 545: STEM Leadership Seminar

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Who, What, and Where?

The goal of this project was to create a professional development session to share classroom STEM activities and increase teacher knowledge of elementary engineering. The one hour session took place at Springer Elementary School in Mountain View, California on March 16, 2022 from 3:30 to 4:30. It was during a staff meeting so attendees were required to be there as part of their work day. The audience included 16 TK-6th grade teachers, 1 instructional support teacher (our district STEM coach) and 1 principal. The specific breakdown of the number of teachers at each grade level was one TK, two kindergarten, two first grade, one second grade, two third grade, three fourth grade, two fifth grade, and three sixth grade teachers. All participants were female. Specifically, four educators who attended the presentation and gave and/or are willing to give additional feedback were:

Denise Khalid, principal - dkhalid@lasdschools.org
Allison White, TK teacher - awhite@lasdschools.org
Jill Williams, 3rd grade teacher - jwilliams@lasdschools.org
Judi Hultberg, 4th grade teacher - jhultberg@lasdschools.org

Project Summary

The objective of this project was to increase the number of experiences classroom teachers are giving their students to engage in engineering. The Next Generation Science Standards for engineering in grades kindergarten through middle school are listed in the appendix. Engineering standards involve giving students the opportunity to design solutions to problems and compare strengths and weaknesses of those ideas. At each grade level band, the expectations increase for student performance. Teachers are responsible for teaching these standards without a specific curriculum. Utilizing free, high quality curriculum created by NASA is an excellent way to increase student engagement and save teacher preparation time.

Pre-Survey Questions

Before beginning the professional development session, participants were asked to complete the following survey.

Survey Questions	Summary of Responses (17 total)
On a scale of 1-5, how confident do you feel teaching engineering to your students?	Five at 2 One at 2.5 Seven at 3 One at 3.5 One at 4 Three at 5 See Graph 1 to compare pre and post survey data side by side.

<p>Approximately how many engineering challenges have you given your students this school year? Circle the number (range)</p> <ul style="list-style-type: none"> ○ 0 ○ 1-3 ○ 4-7 ○ 8 or more 	<p>One does not have a class so the question is not applicable. Two answered 0 challenges. Nine answered 1-3 challenges. Five answered 4-7 challenges. NO ONE answered 8 or more... That means my class is the only one on campus that is teaching engineering more than once a month. This makes me so sad.</p>
<p>Can you name the steps to the engineering design process?</p>	<p>Six either left it blank or wrote “No”. The other eleven had some idea but no one wrote it as a cycle with multiple iterations.</p>
<p>Aside from lack of time, what are some obstacles that detour you from teaching engineering?</p>	<p>Obstacles included lack of knowledge, unsure how to integrate with other curricular areas, access to materials, need more (adult) hands, aligned curriculum rather than additional lessons</p>

Brief Description of the Actual PD

For my professional development presentation, I chose to focus on incorporating engineering into the classroom. My principal requested that I share this presentation at a staff meeting because our STEM program has taken a major hit with budget cuts and the pandemic. In previous years, each school in our district had a dedicated STEM teacher who co-taught weekly STEM lessons with each classroom teacher. Now the classroom teachers are expected to give students the same experience without the help of a trained STEM teacher. District administration suggested that parent volunteers could provide an equivalent experience. My principal and I both thought our staff could use some achievable ideas to teach engineering at the elementary level.

Our activity was to review the engineering design process and look at ways to add more engineering challenges into each classroom. The resources I used to design this lesson were mostly from the NASA website. I began with a story about a field trip I took to Intuitive Surgical in Sunnyvale, California to meet with the engineering design team of the Da Vinci surgical robot. Participants shared their own stories about engineering “Aha!” moments. We then did a quick Kahoot! game to review the steps of the engineering design process. Another resource that I love to use is Storytime from Space. We watched NASA Astronaut, Kate Rubins reading Rosie Revere, Engineer from the International Space Station. It was also a good connection to Women’s History month for March. We didn’t watch the whole story due to time constraints but teachers were able to see how engaging the resource can be. Watching the astronauts float in the shuttle as they read the story is mesmerizing. Since much of the research I have read on effective professional development includes a hands-on component, I decided to try to find a low-prep, quick activity that teachers could experience as a learner. “Make a Paper Mars Helicopter” from the Jet Propulsion Laboratory education website was the perfect fit. It can easily be adapted for transitional kindergarten students through 6th graders. I created a recording sheet to guide teachers through the steps of the engineering design process and printed out a template for each

teacher. Fortunately, my colleagues jumped right in and eagerly created their own design. We were in our STEM lab so they were able to add feathers, different types of paper, or other items to improve their helicopter. I even had a ladder available for them to safely drop their spinning creation from a higher point. We got back together for a discussion on the engineering projects we each do in our own classrooms. Teachers added post-its to charts throughout the room that listed the projects they already do and the resources they need to do more in the classroom. Of course time was the most needed resource but we also discovered some needs that we can help support. For our wrap up, we did a quick gallery walk and then I shared resources from NASA, JPL, and Storytime in Space. Teachers were eager to spend time exploring the links on their own.

Brief Outline of the Resources

Kahoot!- Kahoot is an online game based learning platform. It allows teachers, and others to set up fun quizzes to engage students in the content. Teachers can create their own quizzes or use ones that other teachers have posted. We used Kahoot! to review the Engineering Design Process.

Storytime from Space - Storytime from Space is a free collection of videos of astronauts reading children’s stories from the International Space Station. It is a nonprofit organization that relies on donations and grants. In addition to stories, the website also contains Science Time videos of astronauts demonstrating experiments on the International Space Station to answer questions about scientific phenomena.

NASA - The NASA STEM Engagement webpage has a plethora of free resources for K-12 educators. Teachers can search by topic and grade level to find the perfect lesson to investigate Next Generation Science Standards in their classroom. Many activities have tutorials for students to view anywhere online.

Jet Propulsion Laboratory - The education website for JPL has activities that can be searched by subjects, grades, and topics. Teachers can find engaging lesson plans to meet grade level standards. The hands-on activity, “Make a Paper Mars Helicopter”, was found on this website. It was tagged as an engineering activity for 2nd-8th grade. In addition to engineering standards for K-5th grade, it also supports mathematics standards in 2nd, 3rd, and 5th grade.

Follow up activities and Post-Survey Questions

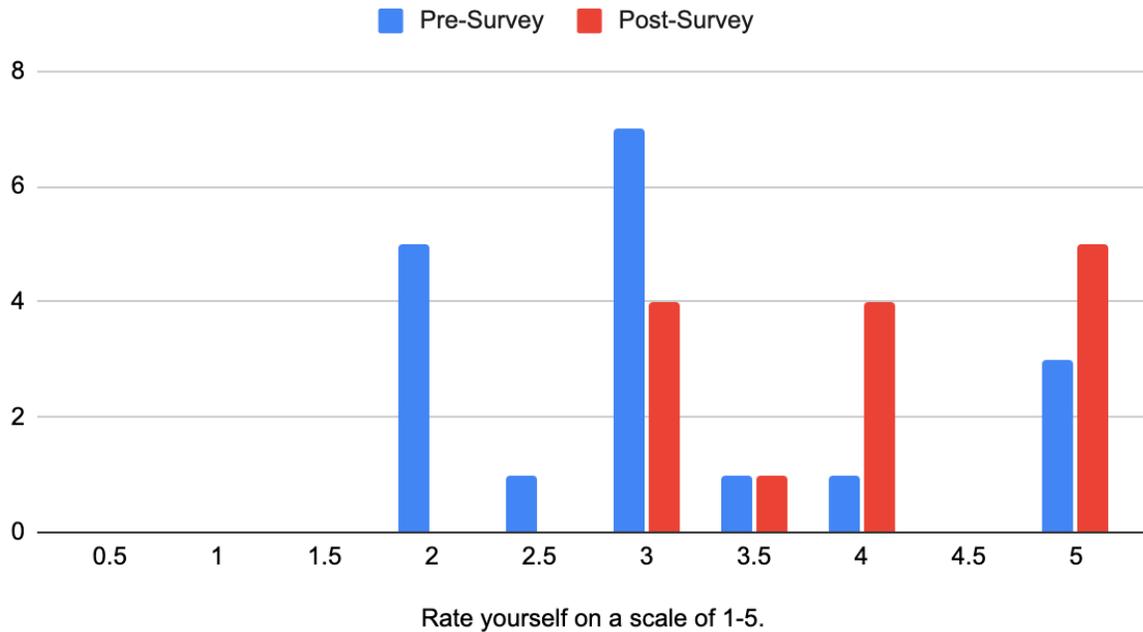
My final request was to fill out the post survey which included these questions and a summary of the responses.

Survey Questions	Summary of Responses (16 total)
Can you name the steps to the engineering design process?	100% correct! Some even wrote it as a cycle this time.

<p>On a scale of 1-5, do you feel ready to teach engineering to your students?</p>	<p>Four answered 3 One answered 3.5 Four answered 4 Seven answered 5 This is definite improvement from the pre-survey but it might be the way I worded the question.</p> <p>See Graph 1 to compare pre and post survey data side by side.</p>
<p>Would you be willing to answer some interview questions one on one? ○ If yes, please put your name.</p>	<p>Eight busy teachers were willing to answer follow up questions!</p>
<p>What suggestions do you have to improve this PD?</p>	<p>Many positive comments like “Great job!” The constructive comments included requests for specific grade level resources, more time to go through the entire engineering cycle, more time to build, test, and play with STEM supplies, more time to look through the NASA resources, guidance to connect explicit lessons to grade level content. Time seemed to be a recurring theme. Most teachers understood that we only had an hour to review the material.</p>

Graph 1

Are you ready to teach engineering to your students?



I used this information for my reflection. Most of my major takeaways from the surveys and teacher comments were positive. Even though teachers were tired after a long day of school, they were engaged, enthusiastic, and wanted to keep going. The hands-on component reminded teachers that engineering is fun and worth the effort plus it doesn't have to be difficult to prep. Active learning as a vital part of effective professional development. Giving the teachers the opportunity to get up and learn as opposed to passively sitting and listening to lectures sets a positive example for lessons in the elementary classroom (Darling-Hammond, Hyler, & Gardner, 2017). The participants had a blast creating their own helicopter and worked together to make each design a little bit better. A spark was lit to reignite our STEM program for next year. I will be working with my principal to try to increase teacher confidence in engineering to benefit all students.

The presentation also had room for improvement. I should have given my pre-survey at least a week ahead of time in order to guide my instruction. My questions for both surveys need some tweaking. I had trouble utilizing the data to see if I had met my objective. I also needed to give participants more time to explore resources and more guidance on grade level specific resources. According to DeSimone, "professional development activities should be spread over a semester and should include 20 hours or more of contact time" (DeSimone, 2011, p. 69). Trying to make a significant impact in just one hour is nearly impossible. Overall, most responses were

positive but having a mandatory training is never going to be a positive experience for everyone. In order to make a difference in our school culture, I am going to need to continue to offer support and encouragement throughout the following school year.

In the one on one interviews after the professional development, I gained some valuable insight. Teachers admitted that they often used any STEM project to assess their students for the engineering standard on our report card. A quick tweak for a project might make a follow the recipe experiment a good engineering challenge. Teachers also shared how much their confidence has grown each time they experienced an engineering project with their students. A recent hire to our district glowed when she told about how last year she would have rated herself a zero in engineering confidence but after this year, she feels like a five. The post interviews also provided me with ideas for next steps.

All in all, I would consider my professional development session a success. There are definite areas for improvement but the teachers had a good time. I have had several hallway conversations about engineering ideas my colleagues want to try and the increase in confidence gained with each attempt in the classroom. The first grade team even took the extra copies of our sample to lesson to use in their classrooms the following week. My principal was so pleased with the quality of my engineering lesson that she asked Human Resources to keep me at her school for one more year so we could continue to work together to help facilitate teacher growth. As heart-breaking as it has been to watch our STEM program deteriorate, it was encouraging to see a few embers spark back up and I look forward to seeing what our school can accomplish as a team.

Appendix

Next Generation Engineering Standards

Students who demonstrate understanding can:

- K-2-ETS1 -1.** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- K-2-ETS1 -2.** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- K-2-ETS1 -3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Students who demonstrate understanding can:

- 3-5-ETS1 -1.** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1 -2.** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1 -3.** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Students who demonstrate understanding can:

- MS-ETS1 -1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1 -2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1 -3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1 -4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

References

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