Corinne De Keukelaere
NASA Endeavor: STEM Leadership Seminar
Engineering in STEM- WTB 500

Walter T. Bergen Middle School is a public school located in Bloomingdale, NJ with an enrollment of approximately 250 students from 5th to 8th grade. The grade levels are taught in teams with four core class teachers per grade level and one special education teacher per grade level. The students are 1:1 with technology and the classes are one hour long for each core class and special class per day with class sizes ranging from 10- 17 students per class. There is also a half hour Academic Assistance class period where the students have time for state testing preparation, extra help in subjects, gifted and talented, and clubs. There are four teachers that teach art, technology, physical education, and music for the school to equal the thirty teachers in the building. There are also four paraprofessionals in the school.

The participants in the professional development presentation consisted of four teachers (three science teachers (grades 5,6,7), and one technology teacher. The science teachers teach a general science curriculum with some life, earth, and physical sciences incorporated into each grade level. I also did a mini PD with my 2 paraprofessionals so they would have more background knowledge on the Engineering Design Process. Some other teachers (Math, Art, and a Language Arts Teacher) got interested in what we were doing so they also participated in the challenge so I took the opportunity to share my PD with them as well. The teachers were unfamiliar with the engineering design process so it was a good opportunity to share cross curricular ideas especially since the challenge involved art in the theme and design, math to measure and use geometry with the boat design and language arts to explain ideas and plans.

The curriculum topics covered in the professional development were: **Engineering Design, Energy, and Forces & Interactions.** The standards addressed were **Engineering Design**: HS-ETS1-2 & HS-ETS1-3 to design and evaluate a solution to a real life problem. The problem in this case was to create a boat to float and be durable enough to sail through three lakes in the least amount of time possible. The problem was broken down into steps with specific criteria using the NASA Engineering design process to Imagine, Ask, Create, Test, Improve, and Share. The next standard was **Energy**: MS-PS3-1 & MS-PS3-2 to develop and construct a model to show the relationship between potential and

kinetic energy and how the tradeoff would result in varying speeds of the boat. The final standard addressed was **Forces & Interactions:** MS-PS2-2 by examining the interaction between forces and mass on the motion of an object. The challenge required testing to see how mass and force could be altered to create the most direct motion. (see Appendix for full *New Jersey Student Learning Standards)*

The challenge was to create a boat with a theme and four passengers that would move the fastest through three different bodies of water. The goal of the professional development was to present the topic of engineering and design in a fun way to encourage the teachers to incorporate more STEM into their classrooms to supplement their science education. The technology teacher also teaches units on engineering and design so the professional development was a good way of sharing ideas between the classes. The paraprofessionals work with the science teachers in the classes with IEP students so the goal was for them to get a better understanding of STEM and how they can help and encourage the students in this area.

Prior to the training I had the teachers complete the pre- survey. (see Appendix) The pre-survey questions consisted of questions to inquire whether the teachers were familiar and incorporated the steps for the Engineering Design Process. The other questions were to see if the teachers used a design notebook and were familiar with design and engineering resources. Finally the inquiry was to identify the constraints for including STEM into their practices. Then we had a discussion of the NASA Engineering Design Process to see the familiarity of the steps and if the teachers incorporate the steps already without actually knowing the official steps. Before the teachers went through the Engineering Design Process themselves I presented NASA's Best Engineering and Design Model (May, 2017) and showed the "NASA's Best Introduction" (NASAgovVideo, 2014) to introduce and make connections between engineering and the impact NASA has on design and building for the world. At this point I also gave the teachers a preview of the resources I would share with them from NASA for lessons, real time data, and other ideas and materials.

Then I introduced the STEM Challenge by showing my videos of my boat race that gave me the idea for the challenge. I like to create my own challenges incorporating ideas from other resources I find. I created this challenge to replicate a boat race I had recently participated in that required four adult passengers to race through three different lakes and create a theme for the team.

The race required a sturdy, durable boat that was light enough for speed, but distributed the weight properly so it would not sink. Then the participants went through the steps just like students would do in a class highlighting the steps for the NASA Engineering Design Process. The sessions got broken up so we modified the Imagine after a quick discussion of the Ask. The teachers designed their boat and I showed them ideas for a design notebook that students could use throughout the school year for ideas, plans and improvements. Then the participants Created their boats and Tested and had some time to Improve before the Share Boat Race.

The sessions with the teachers evolved into a "Share" session of ideas for STEM challenges. After the PD I got the idea to create more shared resources. I started "shared" documents and folders for the schools from Kindergarten to 8th Grade with the curriculum standards, topics, and STEM ideas. I hope these resources will grow as we all add our ideas and what we do and will help us as we go forth in the writing of new science curriculum with more design and engineering processes woven in. Our planned PD day ended up being very broken so instead of one class I did my PD for the teachers in 3 groups. The PD session also evolved into a way the science and technology teachers could share STEM ideas. The Engineering & Design PD & Challenge involved the students and the teachers since my students were also doing the challenge in class. The teachers raced their improved boats against the students. The competition continued into the next week against the students. The spirit of competition encouraged the improved designs because the students wanted to beat the teachers and the teachers wanted to prevail against the students. The NASA plan for planning- creating- testing- and improving was definitely followed to build the fastest boat and be the champion. The initial disappointment of my PD being broken up turned into a wonderful opportunity to get more teachers involved and create a fun event for the teachers and students!

My plan was to have a lot of fun, use simple materials, and create a challenge that wasn't so complicated to encourage the participants to incorporate STEM into their classes. I then shared with them organized resources associated with STEM challenges and a shared document so as a "Team" we could plan STEM challenges at each grade level throughout the year and even help supplement collaboration with the technology teacher. A post activity I shared with them was to introduce Newton's Laws and have a discussion about which of the three laws was demonstrated the most by the boat race. The three laws of motion are more understandable when it isn't abstract and can be witnessed in real life motion.

STEM challenges that involve motion are good leads to link the science standards to be covered. This final task was "**Create an argument to show which one of Newton's Laws was the most crucial for having the fastest boat in the WTB 500"** . My purpose for this example was to show how STEM activities serve as an entertaining way for the students to collaborate, think, solve problems while at the same time covering content that is required in the standards. STEM activities demonstrate a purpose by requiring more doing instead of telling. Content standards can be woven in to help describe and review the activity. Argument is an excellent way to explain evidence and share ideas.

The participants were asked to complete the post- survey (see Appendix). The post-survey questions consisted of questions to see if the teachers gained more understanding of the steps for the Engineering Design Process and more comfort to incorporate more STEM activities into their classes. The other questions were to see if the PD gave the teachers more ideas for design notebook and engineering resources including ones from NASA. The results of the post survey showed growth for the teachers in their understanding of the steps for the engineering design process going from 29% to 83% very familiar after the PD. The comfort level for incorporating STEM activities with engineering and design rose from 29% to 67%. I believe the comfort level can only increase with actual experience of trying STEM activities on their own. After providing examples of a design notebook and organized resources the post survey showed an improvement from 14% comfort level to 67% comfort level. I hope to continue to increase their comfort level as the resource bank grows along with the continued team sharing of ideas for notebooks and strategies. The objective of the professional development was to help my colleagues with their comfort level with STEM and I aim to continue my support to improve these practices for the whole school. In the future I plan to get the elementary teachers more involved with the "Shared" documents and folders to help them weave more STEM activities into their curriculum and standards they need to cover. The teachers and students had so much fun learning about the engineering design process with the challenge that we hope to have more challenges that involve more grades and teachers. At our next PD day the plan is for the science teachers to use my shared documents to organize their curriculum to align with the standards and to plan for more STEM challenges at each grade level to supplement the standards and incorporate for engineering and design. From my PD a discussion was started to have more school wide challenges. It was decided that the competition will motivate students to design and engineer for a real life purpose. When we meet again we will plan more school wide competitions to integrate STEM, cross curricular activities, and a positive school community.

Our next challenge is before the winter break and will involve creating a gingerbread structure designed to give a nod to a STEM topic or event (Explorelearning Gingerneering Challenge). Each class will have some planning time for the sharing of ideas and then a day to create their structure and then one more day to make improvements. We hope to create some excitement while testing out ideas for a sturdy structure and at the same time thinking about and researching STEM events in history for their structure to demonstrate.

Since my PD evolved in a different way than expected (for the better) I could not predict the results. Of the three science teachers, two are very familiar with the engineering design process as well as the technology teacher. The other science teacher was not familiar with the design process. The other teachers that joined the challenge were not familiar with the design process. The Technology teacher and the one science teacher incorporates STEM challenges as the time into their plans. The two other science teachers do not incorporate STEM as much as they would like to mainly because of "Time" and "Resources". The "Shared" resources that I created was definitely a successful aspect of the PD. When my planned time to share my PD got broken up it gave me the idea to expand my resources into shared folders and documents to organize our curriculum, standards. The resources including ideas I got from the NASA Endeavor classes are a good starting point to find STEM activities to use and adapt. My goal was to increase the comfort level for the teachers to incorporate more engineering and design into their lessons. I know after the challenge the teachers wanted to use more of these practices in their classes because they saw how fun it can be and how they can plan ideas that line up with the standards they have to cover. In order to truly understand something you need to go through the steps yourself. The teachers said by doing the challenge and going through the plan- create- test- improve themselves they really got a good grasp on what it takes to go through the process. Continuing the PD to race the boats against the students created a positive, motivational situation where the teachers really wanted to perfect their designs to beat the students. The PD became an event at my school for both the teachers and the students.

In the article , " 5 ways to be a good teacher leader", (Marshbank 2018) one of the ways to become a good teacher leader was to be an advocate for growth. This project definitely started something for me that I might never have begun. My district has not really had a comprehensive science curriculum since I have been in the district (21 years). I started to organize a plan to write the curriculum

from K-8 with more STEM incorporated. I hope to continue this project to improve the curriculum and help the teachers develop strategies to weave more STEM into their plans. The idea to create more school wide challenges throughout the academic year also serves the purpose to create a more positive school atmosphere with events for the whole building. The students had so much fun competing against each other and the teachers as my PD expanded into improving the designs to involve the students. The sense of community was apparent with the students having fun and being motivated to improve their designs while even giving their teachers ideas to improve their designs as well. The PD also encouraged cross curricular ideas with art and mathematics and even language arts to describe and evaluate their plans and improvements. The more the teachers can collaborate, the more possibility there is to weave the disciplines together to create opportunities for a more comprehensive, purposeful curriculum that will bring more enjoyment for all.

In the article, "Preparing to Lead an Effective Classroom: The Role of Teacher Training and Professional Development Programs", (Berry et al 2010) the authors discussed the teacher's willingness to learn and grow continuously. My project brought me joy. It always feels better to continue to learn and grow and help people. The project gave me the opportunity to get out of my comfort zone a little and work more with teachers. My project ended up combining training teachers as well as students in my challenge. I found out that I really like helping teachers grow and change while forcing myself to do the same. I am excited to continue my ideas to organize and continuously update resources for the teachers to encourage more and more STEM while showing them that these activities do include the science standards that they need to cover. My ambition is to continue to grow and evolve and encourage the other science teachers to do the same. I also would like to inspire the teachers to work more as a team so we can improve our " middle school science story" we would like to tell in a more purposeful, inclusive, enthusiastic way. As we continue to grow and adapt to our ever changing school populations we can improve and meet the needs of our students while making fun a priority and this increased enjoyment can bring about more learning and understanding. More importantly maybe as we improve this can improve the chances for our students to develop a greater love for learning.

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Appendix I:

Pre Survey Questions:

1. Do you know the steps for the Engineering Design Process?

0 Not familiar
1 Somewhat familiar
2 Familiar
3 Very familiar

2. Do you incorporate STEM challenges/ activities in your lessons?

0 Never
1 A few times
2 Sometimes
3 Frequently
NA

3. Do you use a notebook for the students to design solutions to problems?

0 Never
1 A few times
2 Sometimes
3 Frequently
NA

4. Do you have a go to place for resources to incorporate engineering into your lessons?

0 Never
1 A few times
2 Sometimes
3 Frequently
NA

5. What is your biggest constraint for introducing STEM challenges/ activities in your lessons?

Time
Resources
Comfort level
STEM knowledge
Materials

Appendix II:

Post Survey Questions:

1. Do you understand the steps for the Engineering Design Process better after making the boats in the PD?

0 No
1 Gained a little understanding
2 Gained some understanding
3 Gained a lot of understanding

2.Do you think you are more comfortable with the Engineering Design Process to incorporate more STEM challenges/ activities into your lessons after going through the steps yourself?

0 No
1 Gained a little comfort
2 Gained some comfort
3 Gained a lot of comfort
NA

3. After participating in a design challenge did you gain ideas for a Design Notebook by having to draw the model & improvements?

0 No
1 Gained a few ideas
2 Gained some ideas
3 Gained a lot of ideas
NA

4. Were the resources helpful as a go to place to find STEM challenges/ activities?

0 No
1 Somewhat helpful
2 Helpful
3 Very Helpful

5. Are you more comfortable with new ideas to plan STEM challenges/ activities in your class?

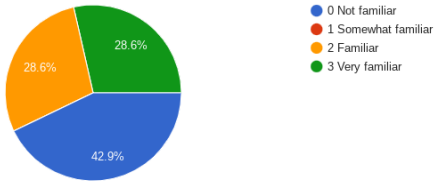
0 No
1 Gained a little comfort to plan STEM Challenges
2 Gained some comfort to plan STEM Challenges
3 Gained a lot of comfort to plan STEM Challenges
NA

Appendix III:

Pre- Survey Results

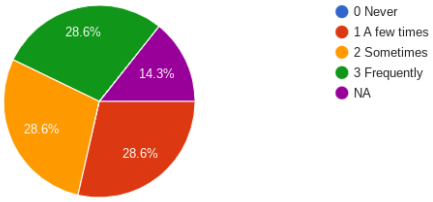
1. Do you know the steps for the Engineering Design Process?

7 responses



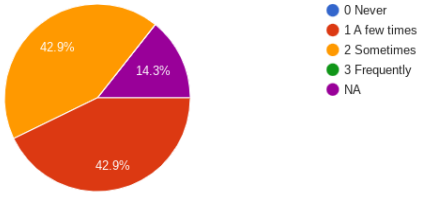
2. Do you incorporate STEM challenges/ activities in your lessons?

7 responses



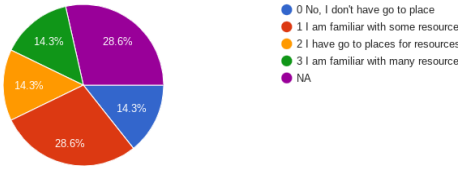
3. Do you use a notebook for the students to design solutions to problems?

7 responses



4. Do you have a go to place for resources to incorporate engineering into your lessons?

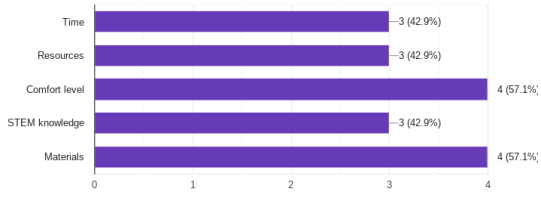
7 responses



5. What is your biggest constraint for introducing STEM challenges/ activities in your lessons? Check all that apply

Copy

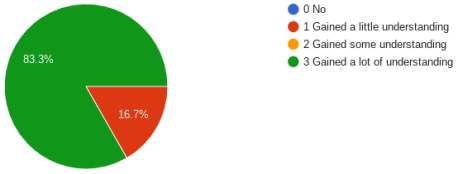
7 responses



Post- Survey Results

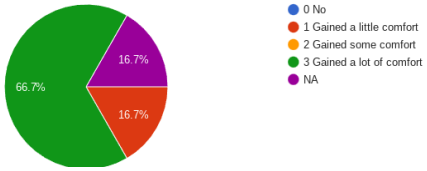
1. Do you understand the steps for the Engineering Design Process better after making the boats?

6 responses



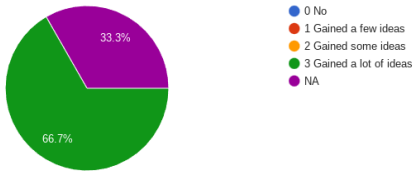
2. Do you think you are more comfortable with the Engineering Design Process to incorporate more STEM challenges/ activities into your lessons after going through the steps yourself?

6 responses



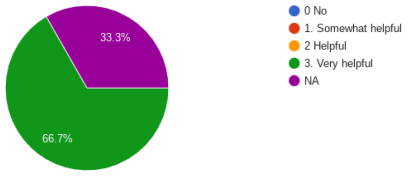
3. After participating in a design challenge did you gain ideas for a Design Notebook by having to draw the model & improvements?

6 responses



4. Were the resources helpful as a go to place to find STEM challenges/ activities?

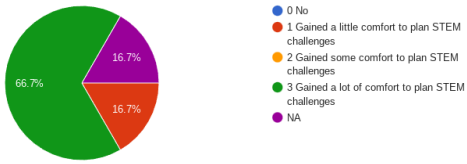
6 responses



5. Are you more comfortable with new ideas to plan STEM challenges/ activities in your class?

C

6 responses



Appendix IV:
New Jersey State Learning Standards:
Engineering Design:
• HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
• HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
Energy:
• MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
• MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
Forces & Interactions:
• MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Appendix V:
STEM Activities and NASA Resources:
1. Engineering Activity: WTB STEM Challenge (CDekeukelaere)
2. WTB 500 STEM Results and Pictures (CDekeukelaere)
3. NASA Engineering Design Process
4. Home Design Insulation Challenge (CDekeukelaere)
5. Engineering Resources from E in STEM
6. NASA STEM Engagement Activity Guides
7. NASA for Kids- Intro to Engineering
8. Dekeukelarere Slides Presentation Boat Building (CDekeukelare)
9. Explore Learning Gingerneering Challenge

Appendix VI:
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