Title: STEM Robotics and the Coding Connection
Presenter Lisa Holt-Taylor

STEM Robotics and the Coding Connection was presented on February 15, 2019, at a teacher in-service day at Boyd E Smith Elementary. Boyd E Smith is one of six K-6 grade buildings within the Milford Exempted School district in a suburb of Milford, Ohio. Boyd has about 560 students and 32 teachers. The professional development (PD) was completed on one of three teacher in-service days scheduled throughout the 2018-19 school year. This PD was advertised through a principal created document outlining the planned teacher in-service day events. One other PD was offered at the same time as the STEM Robotics and Coding Connection PD. Also, the STEM and Robotics PD was announced in a short staff meeting two weeks before the in-service day as well.

On Feb. 15, 2019 from 10:15-11:45 a.m., six educators attended this 90-minute session. The educators in attendance were as follows; self-contained teachers include two- first grade and two-second grade teachers, and one- third grade LA teacher and one- third-grade math teacher. Although, the session was open to 32 teachers during a time when only one other session was supposed to be available, on the day of the PD, the principal opened more last minute unplanned collaborative meetings and this resulted a decrease in my PD session attendance. (I was extremely disappointed.)

The topic was selected for the following reasons;

1. Although STEM has been around for a few years, there is a lack of PD within our building concerning its meaning.
2. There seems to be some confusion between what is meant by inquiry, engineering, versus tinkering.
3. Some new initiatives are being rolled out including robotics, coding and Maker Spaces (basically incorporates building models and straightforward coding).

On January 29, I rolled out our first robotics afterschool Lego WeDo2 Club. Part of my intention is to share some background knowledge, and some depth of the activities offered in the Lego program.

The professional development topics to be covered include:

- Define what is meant by STEM
- State the difference between science inquiry, engineering, and tinkering

- Look at WeDo2 connections with science inquiry and engineering while incorporating building and coding.
- Complete the activity LEGO Speed
- Discuss the district initiatives into maker spaces
- Give some additional resource ideas to investigate for maker spaces.
- A Google Slide presentation was created and used for this professional development https://docs.google.com/presentation/d/1P9H68HO5_9Wge9KMq582cEUWlKrK-UG5mnyQ1Bo5g2E/edit?usp=sharing

Professional Development at a Glance: Framework for Implementation
Participants will

1. Take a Pre Survey (http://holttaylorengineering.weebly.com/)
2. Get a brief overview of STEM, Science Inquiry, Engineering and Tinkering
3. Participate in an inquiry activity with Lego called "Speed". Here teachers create a car and test the wheel size and pulley systems seeing how it impacts speed.
4. Examine and discuss how do our maker space program fits in?
5. Introduce some further resources to consideration for engineering and maker spaces. http://holttaylorengineering.weebly.com/
6. Complete the post survey http://holttaylorengineering.weebly.com/

NASA Connection

- This professional development incorporates course work from each of the NASA courses that I have taken up to this point: Methods in STEM, The E in STEM, and the Robotics and Coding courses.

- I will include some resources via a webpage from the NASA site giving hands-on activities to reinforce and extend content for K-6 teachers as well as add some Maker Space links. This website is not a finished but is a site that will continue to grow as more resources are added.

Pre-questions/Post Survey Questions

The following questions were ranked on a Likert scale ranging from strongly agrees to strongly disagree. Pre and post surveys were given. An additional question asking for any additional feedback was given in the post survey only.

1. I would like to teach more STEM.
2. I can teach someone the difference between inquiry and engineering.
3. I can teach engineering to my students.

4. I can teach someone the difference between tinkering and engineering.
5. I think engineering would take away time from important academic content.
6. I am familiar with engineering curricula resources appropriate for my students' grade level.
7. I do not think STEM fits in with teaching standards.
8. I would like additional professional development in STEM and engineering.
9. My administration and district puts emphasis on STEM.
10. I am familiar with Lego's WEDO 2 educational program.
11. Do you teach science or are you self contained?
Any other feedback you would like to give?

Findings from the pre and post survey

An item analysis was performed looking at the pre and post attitudinal surveys collected via a Google form survey.

Statement	**Pre Survey**	**Post Survey**
I would like to teach more STEM. (Q 1)	50% Strongly Agree 50% Agree	100% Strongly Agree
I can teach someone the difference between inquiry and engineering. (Q 2)	16.7% Agree 50% Neutral 33.3% Disagree	33.3% Strongly Agree 66.7% Agree
I can teach engineering to my students. (Q 3)	50% Disagree 50% Strongly Disagree	16.7% Strongly Agree 66.7% Agree 16.7% Neutral
I can teach someone the difference between tinkering and engineering. (Q 4)	16.7% Agree 33.3% Neutral 33.3% Disagree 16.7% Strongly Disagree	66.7% Strongly Agree 33.3% Agree
I think engineering would take away time from important academic content. (Q 5)	83.3% Strongly Disagree 16.7% Neutral	83.3% Strongly Disagree 16.7% Neutral
I am familiar with engineering curricula	50% Strongly Disagree 33.3% Disagree	16.7% Strongly Agree 50% Agree

resources appropriate for my students' grade level. (Q 6)	16.7% Neutral	33.3% Disagree
I do not think STEM fits in with teaching standards. (Q 7)	83.3% Strongly Disagree 16.7% Disagree	100% Strongly Disagree
I would like additional professional development in STEM and engineering. (Q 8)	50% Strongly Agree 33.3% Agree 16.7% Neutral	100% Strongly Agree
My administration and district puts emphasis on STEM. (Q 9)	33.3% Strongly Agree 33.3% Agree 33.3% Disagree	33.3% Strongly Agree 33.3% Agree 16.7% Neutral 16.7% Disagree
I am familiar with Lego's WEDO 2 educational program. (Q 10)	16.7% Strongly Agree 33.3% Disagree 50% Strongly Disagree	16.7% Strongly Agree 83.3% Agree
Do you teach science or are you self-contained? (Q 11)	66.7% Yes 33.3% No	66.7% Yes 33.3% No

Findings:

One of the objectives of the PD was to inform participants of the difference between inquiry, engineering, and tinkering. The pre and post survey indicate that participants are more confident in knowing the differences.

A second objective was to look at our new LEGO Club WeDo2 afterschool program and what it has to offer our students with the intention to promote the program by having teachers have firsthand experience. The teacher experiences its connection with scientific inquiry and engineering while incorporating building and coding while completing a LEGO Speed. When answering the question “I am familiar with Lego's WEDO 2 educational program.” Results on the pre-survey responded Strongly Agree 16.7%, Strongly Disagree 33.3%, and Strongly Disagree 50% compared to the post-survey Strongly Agree 16.7% and Agree 83.3%.

A third objective was to look at some additional resources that teachers could use at their grade level. Several of the participants are in self-contained classrooms and have limited time (2 times per week for 30 min) for teaching science and social studies. Providing them with engineering

resources that would tie into their specific content area offers opportunities for incorporating STEM within the classroom. Perhaps trying an engineering project into their Ready Gen nonfiction literacy and grade level science curriculum would be beneficial and fun. Having these projects readily available for the self-contained teacher might include the likeliness that teachers would use the plans.

Also, a couple of the teachers present at the PD are on the technology committee and are partially responsible for determining maker space activities. Currently, we have a new Maker Space initiative within the district to get students to build and code. There are 6-7 activities used by all students in grades K-6. Many of these activities lack depth, and so a webpage was developed (and continues to evolve) to present more ideas for our technology committee to investigate and maybe, incorporate into our Maker Space for next year. The webpage (holttaylorengineering.weebly.com) is not a final product but one that is evolving as we find more resources for the committee. Several of these resources are from my experiences in the NASA program. Rather than have a pickup program that teachers may throw off to the side, I find that an ever-evolving webpage would allow them to tap in as needed. It is an easy avenue to send interested teachers projects via an email containing a webpage link. Also, the website gives our technology committee resources for Maker Space ideas in future planning.

How Does the Project Relate to the Reading?

Examining Lustick's research, DeSimone suggests a framework for evaluating professional development. DeSimone outlines the standard features of an effective PD including

1. Content focus is incorporating subject matter as well as how students learn content.
2. Active learning of the student!
3. Coherence where everyone is on the same page
4. Duration and spread over the semester which includes 20 hours or more of contact hours
5. Collective participation where the participant interacts within a learning community.

Looking at the structure and evaluating them through the use of a rubric or a survey would add value when setting up professional development in the future. Reflecting on the 90-minute professional development, I can see that it does not accomplish the suggested framework components, but it does provide the beginning foundational base.

The professional development “STEM Robotics and the Coding Connection” is a good starting point for building a foundational understanding and the groundwork for knowing the difference between inquiries, engineering, and tinkering. Delivering this PD was a great start, but more is needed. Teachers indicated in the post-survey that more grade specific curriculum activities are required. The next step is to continue to introduce projects to teachers that are very doable and rich in content connections within their grade level over a greater length of time (DeSimone, 2011).

Examining three reflective questions posed by DeSimone (1. Does the teacher learn? 2. Does the teacher change their practice? 3. Does student achievement increase?) for measuring success, I can honestly say that probably only the first question was accomplished and so it brings up the question on how to further develop the experience to increase student achievement. Beginning a professional learning community will be ideal timing if the interest is there. Igniting the STEM fire would only require a few people to start. In the article, “Science Teacher Leadership: Learning from a Three-year Leadership Program” Luft stresses how vital it is to have teachers collaborate within professional leadership communities. Having a professional leadership opportunity gives teachers the time to discuss challenges and ideas during the implementations process which directly influence the student experience and learning (Luft et al., 2016). To begin with, a couple of easy, short engineering projects that students would love might get others on board and open to the opportunities and excitement engineering projects could bring to the classroom. These projects would be concrete and tied to grade level content.

References

DeSimone, L. (2011, March). A Primer on effective Professional development. *Kappan Magazine*, *92*(6), 68-71.

Luft, J.A. DuBois S.L. & Plank L. (2016) Science teacher leadership: learning from a three-year leadership program. *Science Educator*, 25 (1), 1-9.

Lustick, D. S. (2011). Experienced secondary science teachers' perceptions of effective professional development while pursuing National Board certification. *Teacher Development*, *15*(2), 219-239. doi:10.1080/13664530.2011.571511

I. Names and contact information of four educators who attended the PD.

Jennifer Weiler Weiler_j@milfordschools.org
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Standards Addressed

The professional development delivered, laid the groundwork for Ohio's guiding principles found in the beginning of 2018 revised Ohio Science Standards. In the guiding principles the following areas are defined 1. Definition of Science 2. Science Inquiry 3. 21st Century Skills 3. Technological Design 4. Technology and Engineering. One purpose of the PD was to lay the ground work for these guiding principles making a clear distinction between science inquiry, technology, engineering, and tinkering.

The LEGO activity is an inquiry looking at wheel size and pull different types of pulleys. It addresses the following standards;

Ohio Model Curriculum Revision includes the following:

- TECHNOLOGICAL AND ENGINEERING DESIGN

  - Identify problems and potential technological/engineering solutions
  - Understand the design process, role of troubleshooting
  - Understand goals of physical, informational and bio-related technologies
  - Recognize role of design and testing in the design process
  - Understand how physical technologies impact humans
  - Apply research, innovation and invention to problem solving

5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted. Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t).

NGSS Standards

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. The performance expectations above were developed using

3-PS2-2. Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.

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.