

Professional Development Implementation

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Endeavour STEM Leadership Seminar

STEM Education in the Classroom

The professional development was conducted at a small populated school called Enemy Swim Day School on the reservation in South Dakota. It is a Kindergarten through eighth grade school in the Waubay area. Seven educators did attend the training. Those who attended were two fifth-grade, one seventh, one eighth, one fourth, one instructional assistant, and one administrative teacher. Those who attended had the pleasure of learning what STEM means and the benefits along with the 5E Instructional Model that is implemented into the lesson that each were able to experience during the training. The lesson that they participated in was a physical science and engineering that included energy, design process, motion, and problem solving.

Standards

In the state of South Dakota, they have adopted the Next Generation Science Standards (NGSS) for the curriculum. The standards included in the lesson activity are:

Performance Expectations

- 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.
- 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.

(Note: During the professional development, I did mention that these performance expectations were used when taught the same lesson to my students.)

Disciplinary Core Ideas

- PS2.A Forces and Motion: The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
- PS3.A Definitions of Energy: Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.
- PS3.A Definitions of Energy: A system of objects may also contain stored (potential) energy, depending on their relative positions.
- PS3.C Relationship Between Energy and Forces: When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Crosscutting Concepts

- Systems and System Models: Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

Science and Engineering Practices

- Planning and Carrying Out Investigations: Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Analyzing and Interpreting Data: Construct and interpret graphical displays of data to identify linear and nonlinear relationships.
- Scientific Knowledge is Based on Empirical Evidence: Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Project

Every year, grades K-8 participate in a science fair in the month of February. It was my goal to familiarize the staff of what STEM is along with the 5E instructional model. I originally wanted it to be a STEM Fair so that the students were incorporating not just the science piece, but the technology, engineering, and mathematics piece. Unfortunately, the superintendent would not allow me to change it. She stated that they were a “science school”. I changed my title and anticipate that what the teachers learned will carry over into their classrooms. Hopefully, they will encourage their students to incorporate STEM for the science fair. Lastly, the teachers will incorporate the 5E instructional model as well.

Pre-questions Survey

To gain some background knowledge about the teachers and their experiences with STEM and the 5E Instructional Model, I had the teachers take part in a pre-question survey. Each teacher was asked the following:

- How many years have you been teaching?
- What grade do you teach?
- What subject/s are you most comfortable teaching?
- On a scale 1-5, how familiar are you about STEM?
- On a scale 1-5, how familiar are you about the 5E Instructional Model?
- Rate the following 1-5, 1 as being boring and 5 as interesting: Science, Technology, Engineering, Mathematics

PD Description

The implementation of the professional development training went well. The time allotted was an hour. For pacing and better organization of the information, I created a Google Slide presentation and each person who attended received a copy of them. The slides were set up with the objectives posted and a silly cartoon to grab their attention. We discussed what the acronym STEM meant and why we want to incorporate it in the classroom. We also discussed the 5E instructional model. For the teachers to gain the hands-on approach, I followed up with a lesson that included STEM and the 5E instructional model. Once we completed the activity, I had asked the teachers to point out the STEM and the 5Es used in the lesson. I did follow-up with other questions wanting to know, “How they could use this same lesson in their class?” “Could you use other forms of technology?” and “How would they use STEM and the 5E model in their lesson? Lastly, the teachers participated in a second survey as an exit ticket out the door.

Activities

The activity that the teachers participated in was called, “Soda Straw Rocket”. This lesson implements the 5E instructional model such as engage, explore, explain, elaborate, and evaluate. The lesson also includes the components of science, technology, engineering, and mathematics. The synopsis of the lesson lets the students test a model rocket and predict the motion. The lesson digs into exploration beyond our planet and do this, engineers use their problem-solving skills to design and create something to do this. With the engineering design process helps us reach our goals. The inquiry process is being modeled throughout the lesson. Forces and net forces are explained pertaining to gravity in the explore step, build rockets, and test them with the moon being the target. The teachers who participated were able to draw conclusions from the data and evidence from the soda straw rockets (referring to forces and net forces explained on the additional worksheet in lesson packet). With this, other possible variables are discussed such as what could affect the flight pattern of the rocket. The lesson does end with an evaluation piece to check for understanding (see Appendix VII).

NASA Data

The lesson comes from NASA posted on an Arizona State University education site. Mention of the NASA JPL site was included with the additional resources given to the teachers. As an engaging piece, a video on the NASA LSP was shown as well as the archives with different images of different rockets. With these resources, the participants are asked what they may notice about the rockets and launches. What do they have in common? They explain how gravity affects the motion or path of a model rocket?

For the 5E Instructional Model, NASA has a website called NASA eClips that explains in-depth of the each of the components that make up the model. Teachers were given a copy of this link with a regular printout from NSTA's model example from the book (see Appendix VIII).

Follow-up Activities/Post-questions Survey

The post-question survey was sent out at the end of the professional development. Some of the same questions were the same and additional questions about the training were added. I posed the following questions before they left as an exit ticket (ticket out the door):

- How many years have you been teaching?
- What grade do you teach?
- After the STEM PD, how comfortable would you be creating a lesson implementing the 5Es and the components in STEM?
- After today's PD, what do you hope to try with your students?
- What might a successful STEM program look like?
- What are or would be your top three challenges when it comes to teaching STEM?
- Please list anything else that you may want more information on or questions that you may still have.

Once the responses were collected, they were sorted and categorized by average ratings and individual responses based on essay portions. The survey result summary does have graphs showing results of those questions part of the scoring part of the survey. The survey used in the professional development was Survey Planet (see Appendix IX).

Outcome/Final Analysis

The results and comments made on the survey were not disappointing at all. Before the training, majority of the teachers had little to no knowledge of what STEM and the 5E Instructional Model were. They may have known what the acronym meant, but the purpose was still questionable to some of the teachers in the training. The average for knowledge of STEM was a 2.43 and the instructional model was 1.86 (see Appendix X). The end results were satisfying in the fact that they learned something new and would be willing to implement STEM or the 5E Instructional Model somehow into their lesson. The question posed on the survey asks, "After the STEM PD, how comfortable would you be creating a lesson implementing the 5Es and the components in STEM?" The average result was 3.45 out of 5. If there were more trainings, I believe the score could be much higher because they would become more familiar with the criteria.

The academic administrator is willing to help me find additional resources for future trainings.

Overall, the training went very well. However, I only had seven educators attend. I would have loved to have more to gain more feedback and the average could have been higher with the end result. Although the lesson went smoothly, I did feel that it was rushed in the one hour that was given for the professional development. The lesson did ask for 90 minutes to

complete. I chose this activity for the teachers, because I assumed, they would run through faster than if it were the students. Again, I should have found a lesson using less time so did not feel rushed. I was still asking them some in-depth questions for inquiry throughout the lesson. It is important to me that the teachers get the information and use it to their advantage.

It was nice to see the teachers participate in the activity like students again. They were working in partners or one group of three to answer the questions and construct their individual rockets. I did not assign them jobs like I would with my students, but I did bring it up during the activity as something that is done with them. It keeps the student on track and organized. Although, on the survey I did not ask if they would come to this type of professional development again, observing them during the activity and remarks of them having fun with the lesson was a great indicator.

Making a connection with the readings from class, I would have to resonate with the article by Laura Desimone. She talks about the core features of an effective professional development such as content focus, active learning, coherence, duration, and collective participation. While planning my training, I wanted to make sure that I tried to incorporate those tools. I was happy to hear that the administrator who attended would like to continue this type of training for all teachers if possible. She is willing to work with me in this area to educate the other teachers who are not familiar with STEM and the 5E Instructional Model. Since Enemy Swim participates in a school-wide science fair, she thought it would fit perfectly in this area. Therefore, this will help in the duration piece of professional development.

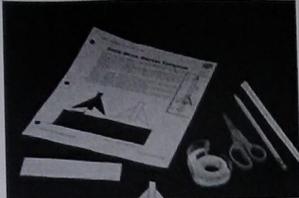
In conclusion, it was a memorable experience being able to present a professional development training at my school. I liked that it was a smaller setting to gain some experience until I am confident enough to present at a much larger school next time. Was I nervous? Absolutely! In the end, I knew that educating my fellow peers at work was helping them understand the concept of STEM and the 5Es in a classroom setting. With this experience it was surprising that not too many teachers at my small school knew what my topic was about. It was fulfilling, and I am proud of myself for educating them.

Appendix VII

National Aeronautics and Space Administration 

Lesson: Soda Straw Rockets

Grades: 3rd – 5th Grade Prep Time: ~15 Minutes Lesson Time: ~90 Minutes





WHAT STUDENTS DO: Test a rocket model and predict its motion.

Curiosity about what lies beyond our home planet led to the first rocket launches from Earth and to many exploration missions since. Using simple materials (soda straws and paper), students will experience the processes involved in engineering a rocket. Conducting engineering tests, students will have the opportunity to answer a research question by collecting and analyzing data related to finding out the best nose cone length and predicting the motion of their model rockets. In this collection, this lesson builds on the concept of using models encountered in Lessons 1-3, and introduces the concepts of prediction and hypothesis.

NRC FRAMEWORK / NGSS CORE & COMPONENT QUESTIONS	INSTRUCTIONAL OBJECTIVES (IO)
<p>HOW CAN ONE EXPLAIN AND PREDICT INTERACTIONS BETWEEN OBJECTS AND WITHIN SYSTEMS OF OBJECTS? <small>NRC Core Question: PS2: Motion and Stability: Forces and Interactions</small></p> <p>How can one predict an object's continued motion, changes in motion, or stability? <small>NRC PS2.A: Forces and Motions</small></p> <p>What underlying forces explain the variety of interactions observed? <small>NRC PS2.B: Types of Interactions</small></p> <p>HOW DO ENGINEERS SOLVE PROBLEMS? <small>NRC Core Question: ETS1: Engineering Design</small></p> <p>What is energy? <small>NRC PS3.A: Definitions of Energy</small></p> <p>What is a design for? What are the criteria and constraints of a successful solution? <small>NRC ETS1.A: Defining and Delimiting an Engineering Problem</small></p>	<p style="text-align: center;"><i>Students will be able to</i></p> <p>IO1: Plan and conduct an investigation into the effects of forces on the distance and path traveled of a soda straw rocket using empirical evidence to explain the impact of a net force on an object.</p>

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The 5E Instructional Model

What is the 5E?

The 5E represent five stages of a sequence for teaching and learning: **Engage, Explore, Explain, Extend** (or **Elaborate**), and **Evaluate**.

ENGAGE: The purpose for the **ENGAGE** stage is to **prime student interest and get them personally involved in the lesson, while pre-assessing prior understanding**. During this experience, students first encounter and identify the instructional task. During the **ENGAGE** stage, students make connections between prior and present learning experiences, setting the instructional ground work for upcoming activities. NASA eClips™ are designed to **ENGAGE** students. Through discussions, the videos may be used to uncover students' prior understanding. The video format arouses students' curiosity and encourages them to ask their own questions.

EXPLORE: The purpose for the **EXPLORE** stage is to **get students involved in the topic, providing them with a chance to build their own understanding**. In the **EXPLORE** stage the students have the opportunity to get directly involved with phenomena and models, as they work together in teams, students build a set of common experiences which promote sharing and communicating. The teacher acts as a facilitator, providing materials and guiding the students' focus. The students' inquiry process drives the instruction during an exploration. Students are actively learning through inquiry based science instruction and engineering challenges. Emphasis is placed on: Questioning, Data Analysis and Critical Thinking. NASA eClips™ help students **EXPLORE** new topics on their own. Through self-discovery or guided exploration students make hypotheses, test their own predictions, and draw their own conclusions.

EXPLAIN: The purpose for the **EXPLAIN** stage is to **provide students with an opportunity to communicate what they have learned so far and figure out what it means**. **EXPLAIN** is the stage at which learners begin to communicate what they have learned. Learning activities involve the sequencing events into a logical format. Communication occurs between peers, with the facilitator, and through the reflective process. One student builds their own understanding, they may use NASA eClips™ to help summarize or **EXPLAIN** their own ideas. These segments introduce vocabulary, processes and correct or reinforced misconceptions.

EXTEND: The purpose for the **EXTEND** stage is to **allow students to use their new knowledge and continue to explore its implications**. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understanding to the world around them in new ways. NASA eClips™ segments help students **EXTEND** and apply what they learned to new and unfamiliar situations.

EVALUATE: The purpose for the **EVALUATE** stage is for **both students and teachers to determine how much learning and understanding has taken place**. **EVALUATE**, the final "E", is an on-going diagnostic process that allows the teacher to determine if the learner has attained understanding of concepts and knowledge. Evaluation and assessment can occur at all points along the continuum of the instructional process. Some of the tools that assist in this diagnostic process are: rubrics, teacher observations, student interviews, portfolios, project and problem-based learning products. Video segments can be used to determine students' depth of understanding. Students will be asked to demonstrate their understanding through journals, drawings, models and performance tasks.

Who developed the 5E model?

The National Science Curriculum Study (NSCS), a team led by Principal Investigator Roger Biben, developed the instructional model for construction, called the "Five E's". Other models have been adapted from the model including the 6E and 7E models.

What is constructivism?

Constructivism is a philosophy about learning that proposes learners need to build their own understanding of new ideas. Two of the most prominent constructivist researchers are: **Jean Piaget** (stages of cognitive development) and **Howard Gardner** (multiple intelligences).

Sample 5E Model: Star Power

Star Power

Engage—Sunny Ideas

KEY IDEA: The amount of radiation that reaches Earth is not always the same.

Linking Question:
How can you use models to explore factors that affect the amount of sunlight reaching Earth?

MAJOR CONCEPTS

- Several factors affect the solar radiation that reaches Earth's surface.
- Stars emit different kinds of energy.
- The tilt of Earth's axis of rotation causes seasons by affecting the amount of radiation reaching Earth.
- Models can show the radiation that planetary objects get from stars like the Sun.
- Technology helps us answer scientific questions.

Evaluate—Stellar Energy

KEY IDEA: You can compare the energy emitted by stars and the amount of energy that reaches objects orbiting them. This relates to the seasons that you notice on Earth.

Linking Question:
Are there different ways to calculate the energy Earth receives from the Sun?

Explore—Energy Variation

KEY IDEA: Several factors affect how much energy reaches the surface of an object, such as Earth, from a source of energy, such as the Sun.

Linking Question:
What factors affect the amount of solar energy reaching Earth's surface?

Explain—Sunshine to Earth

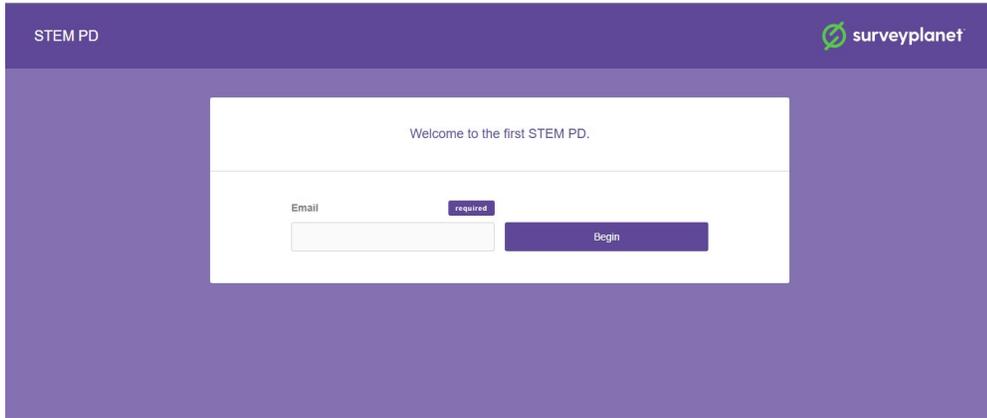
KEY IDEA: Four factors affect the solar radiation reaching a point on Earth. Stars like the Sun emit ultraviolet, visible, and infrared energy.

Elaborate—Reason for Seasons

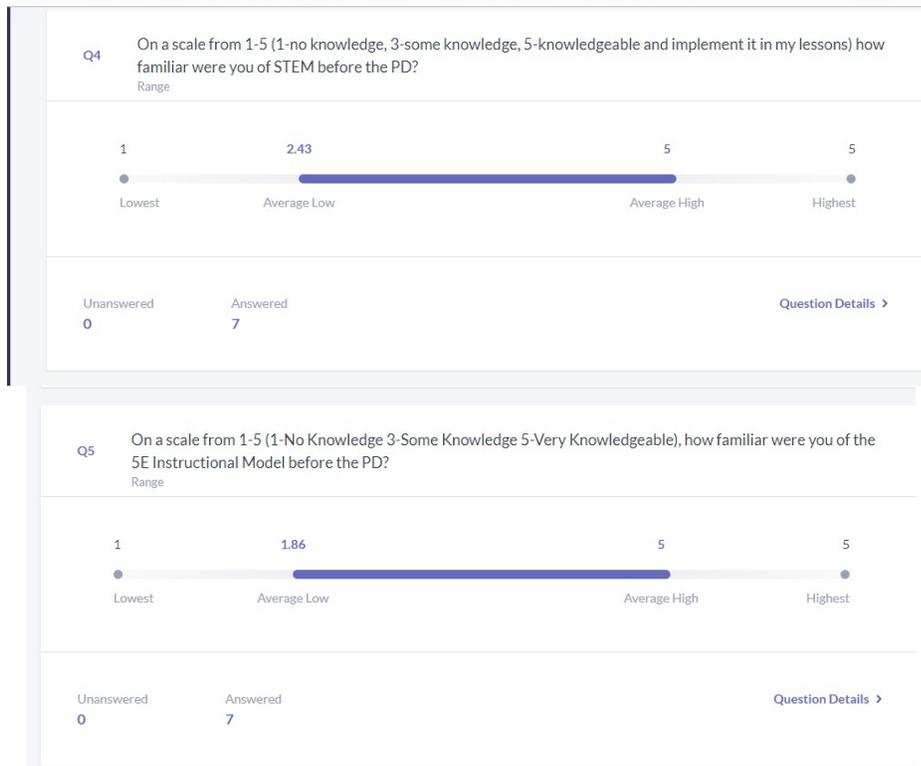
KEY IDEA: The tilt of Earth affects the amount of solar radiation on different parts of the planet, which leads to seasons.

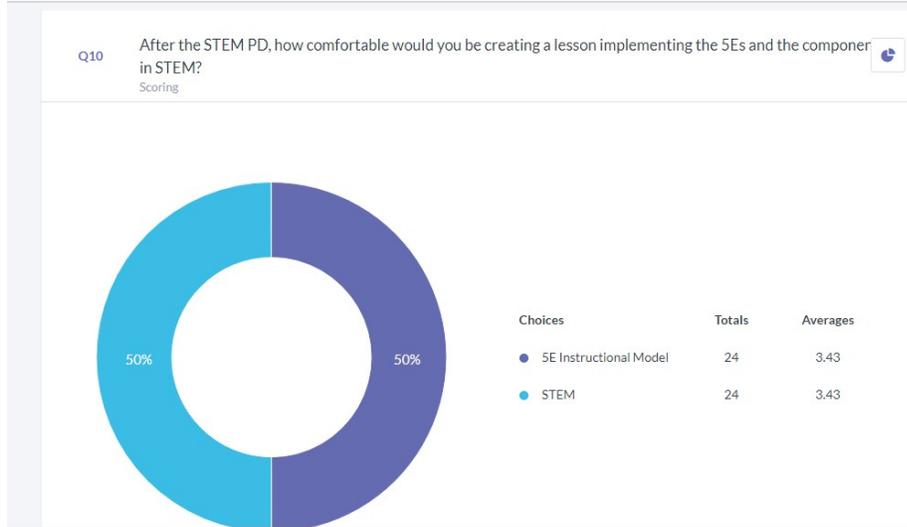
Linking Question:
What changes in solar energy cause seasons on planets like Earth?

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Appendix X





Q11 After today's PD, what do you hope to try with your students?
Essay

Latest Responses

Assisting with planning of STEM activities.

Both STEM lessons while incorporating the 5E Instructional Model.

I would like to plan my lessons using the instructional model and when we are learning math or science, try to integrate the other components.

As a math teacher try to implement STEM so that students can apply it to the real world experiences they encounter.

Integrating the 5E model into instruction.