

Endeavor STEM Leadership Seminar Project: Using NASA Data and Lessons in the NGSS Middle School Classroom

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CURRICULUM TOPIC

The curriculum topic is “Using NASA Data and Lessons in the NGSS Middle School Classroom.” This topic addresses many goals in the 21st century STEM classroom, such as using real time data from leading institutions for scientific research and innovation, offering opportunities for students to practice critical science and engineering skills, and to adhere to national standards for science education. In this project, the focus will be to utilize data from the National Aeronautics and Space Administration to address student content learning on the topic of climate change.

Educators will first experience the function of the data during a professional development workshop where they will design methods of implementation to bring this experience to their students. As the result of the professional development, the educators will engage with the professional development facilitator to prepare for implementation or to develop alternative measures, use of other data, and form a professional relationship to further seek solutions to enhance the potential role of NASA data and lessons in the science or STEM classroom. To clarify, the NASA resources are meant for both science and STEM middle school learning experiences.

SCHOOL & DEMOGRAPHICS

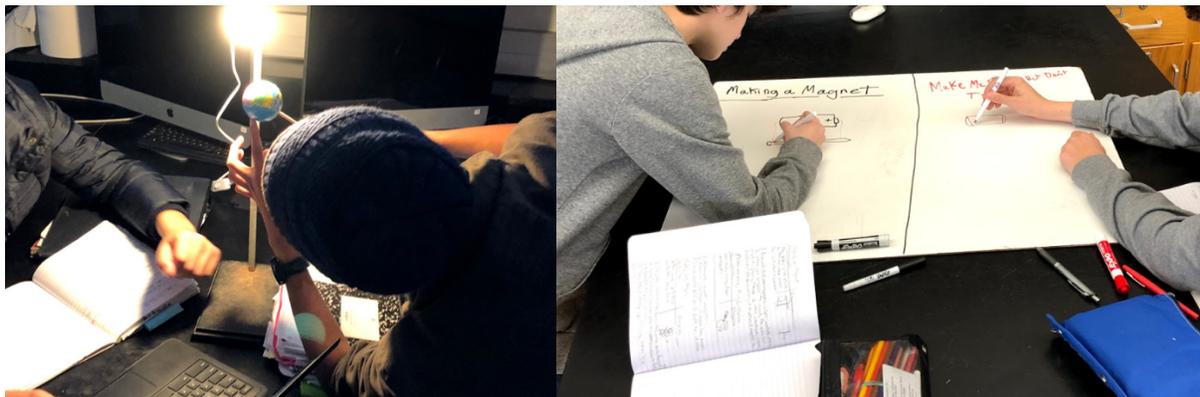
The primary schools of focus for the professional development are Huntington and Hull middle schools, in addition to possible external school networks and online communities, if necessary for the project. On the established dates, guest educators from the district or other were welcome to participate. Currently the facilitator is teaching at Huntington Middle School, located in San Marino, California. It is a part of the San Marino Unified School District which consists of a total of two elementary, two middle, and one high school. In 2017, it was noted as California's top district through the evaluation of the school site's test scores and growth in various student focus categories. Currently the professional development facilitator is working directly with eighth grade students as a middle school science teacher.

Huntington Middle School is a public school and has an estimated enrollment of 780 students for the 2018-2019 academic year. It serves the grade levels between six to eight and has a current 9/10 rating through GreatSchools and is a California Distinguished School. The ethnic and race composition of the school is 56% Asian, 40% White, 3% Hispanic, and 1% Black. Only 5% are from low-income households; 24% of the students have designated disabilities; has a faculty size of 35 educators; and 90% of the faculty has three or more years of teaching experience. Based on the school's 2018 test results, Huntington Middle School achieved 82% proficiency in math and 83% proficiency in English. In terms of STEM courses, Huntington Middle School is within its second year of implementing the NGSS integrated model.

Curriculum shifts have been made in the areas of reducing textbook use to minimal or none for the seventh and eighth grades. In these grades, students are maintaining science notebooks and assignment goals are highly focused on developing disciplinary core ideas as outlined by the performance expectations and skills as outlined by the science and engineering

practices. For the grades seven and eight it is clear through department level collaboration and communication that the NGSS performance standards, student-centered focuses, and inquiry drives the curriculum. It is unclear how the sixth grade plans their curriculum, but the NGSS is a part of the goals and students do experience hands-on and virtual simulation of labs and demonstrations. Work is primarily through a science workbook. In terms of using NASA data, the eighth-grade curriculum has used the resource up to two times per unit topic. And there is overall potential for all grades to be utilizing NASA resources. Elements that influence the curriculum is Teachers' Curriculum Institute (TCI) which has influence lessons where the NASA lesson resources were not available to support. All other aspects of the curriculum, since a textbook is not being used for seventh and eighth grades are pulled from various organizations or created originally by the department staff.

Figure 1. Below are “safe” photos of students engaging in exploring earth process (i.e. planet rotation) and collaborating to explain phenomena (electricity) in a Hunting Middle School classroom.



Additionally, the school brings STEM opportunities to the students by having STEM professionals present during career day, organizing a Science Olympiad team, a robotics team, and support students in attending a regional science and engineering fair. Among other

programs, the San Marino Unified School Districts utilizes the “4As: Academics, Arts, Athletics, & Activities” to build strong scholars and future community leaders. The middle school student expectations are summarized by the “7Cs: Caring, Character, Citizenship, Critical Thinking, Collaboration, Communication, and Creativity.”

Hull Middle School is a Title I public school located in Torrance, California, and is a part of the Torrance Unified School District. It was another focus site for professional development and outreach to meet the criteria for the STEM Leadership Seminar Project. The enrollment estimate for the 2018-2019 academic year is 712 students and serves grades sixth to eighth. Its GreatSchools ranking is 6/10 where reported test scores indicate student overall math proficiency to be 41% and English is 50%. The school site is comprised of student body that is Hispanic, 19% White, 16% Asian, 7% that is two or more races, and 5% Black. Approximately 53% students are designated low-income, with 20% English language learners, and 10% with disabilities.

The professional development facilitator spent six years teaching middle school science at the school site, has experienced the district roll-out action from subject-specific to integrated NGSS curriculum, and has developed various STEM programs for students which made it a primary focus for professional development (in addition to accessibility and having a relationship with the school). The school site began the shift to align with the NGSS in 2014 beginning with select demonstration leaders before district provided professional developments for all science teachers at the middle school levels. Beginning with the sixth grade, the NGSS performance expectations were rolled out, followed by the seventh grade, and ending with eight grades. As of the 2017-2018 academic year, at last one grade level science teacher would have implemented the entire integrated model for each grade level. The curriculum utilizes a mixture of textbook

resources, with hands-on opportunities, virtual simulations, writing up personal lessons, and more in the learning environment. Currently, grade level peers are variable in their curriculum implementation and what they provide as a learning experience to their students. And they are in practice in aligning fully to the NGSS while seeking personal opportunities for professional development rather than district required workshops.

THE EDUCATORS

Below is a listing of each of the educators, identified by their first names, their subject, grade level, experience, types of professional development they participate in, use of NASA specific resources, and curriculum goals. This information was gathered from their survey or interview responses. Both of these methods were used in case a participant did not complete a survey or if they were available for interview. Most of the participants are from the San Marino or Torrance Unified School District. However, the professional development was offered to educators from the area not in the district. Further, one-on-one professional development meetings were set up with select participants that could not attend the professional development but were willing to meet and learn more about the NASA curriculum and how it can be incorporated into their curriculum.

Table 1. Summary of participants in the professional development highlighting their subject taught, grade, experience in years, usual form of professional development, how frequently they use NASA specific resources, and overall curriculum goals.

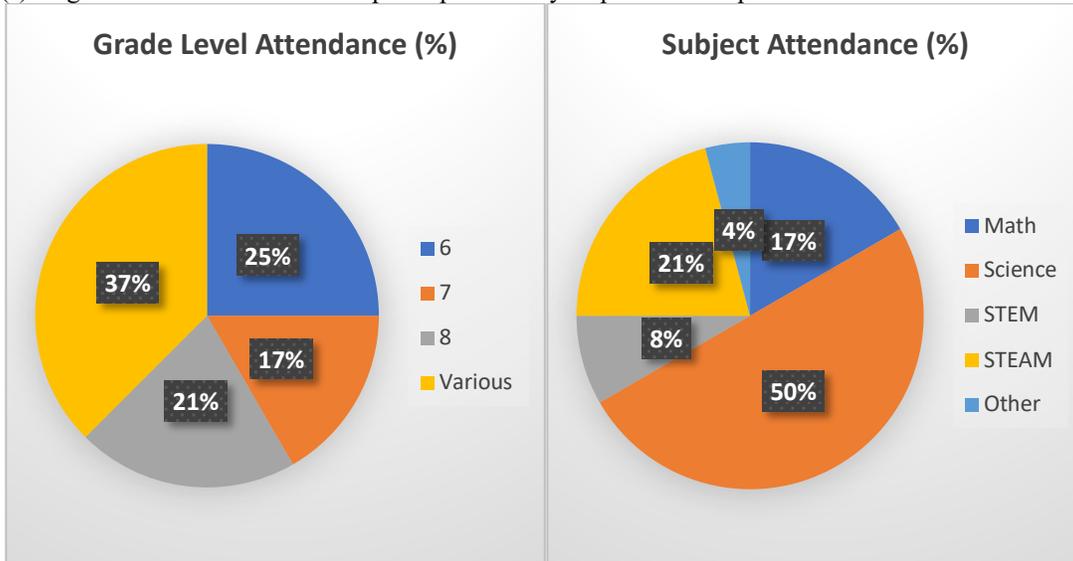
Name, Subject, & Grade	Experience (Years)	Professional Development	NASA Specific Resources- Use
Song Science 6	10+	Conferences, PLC	None
Crystal Science 6	10+	Conferences, PLC	None
John Science 6	10+	Conferences, PLC	None

Dave Science 6	10+	Conferences, PLC	None
Hannah Math 6	8	Conferences, Master's Program, PLC, Other	None
Simone Science 6	4	Conferences, Master's Program, PLC, Other	None
Jana Science 7	10+	Conferences, Master's Program, PLC, Other	Sometimes
Cynthia Science 7	8	Conferences, PLC	Rare
Kimberly Math 7	10+	Conferences, Master's Program, PLC, Other	None
Jessie Math 7	5	Conferences, PLC, Other	None
Kathleen STEAM 7-8	10+	PLC, Other	None
Suzanne Science 8	10+	Conferences, Master's Program, PLC, Other	Sometimes
Aimee Science 8	8	Conferences, Master's Program, PLC, Other	Sometimes
Vernice Science 8	8	Conferences, Master's Program, PLC, Other	None
Megan Math 8	10+	Conferences, Master's Program, PLC, Other	None
Jan Math & Science 8	2	Conferences, PLC, Other	Rare
Ron STEM 6-8	10+	Conferences, Other	None
Tabi STEAM K-8	1-2	Conferences, Other	Sometimes
Christine STEAM K-8	10+	Conferences, Master's Program, PLC, Other	Some
Katie STEAM K-12	1-2	Conferences, Other	Sometimes
Candice STEAM 6-12	1-2	Conferences, Other	Sometimes
Crystal Science 8-12	10+	Conferences, Master's Program, PLC, Other	None
Gustavo STEAM K-12, Public Outreach	10+	Other	None
Anne Academic Tutor K-12	7	Other	None

All of the educators work with public school students between the grades of K-12, but the majority are middle school (grade 6-8) educators. The participants grade levels in which they taught were 37% grade various grade levels; 25% grade 6; 21% grade 8; and, 17% grade 7. The

percent of subjects represented are 50% science; 21% STEAM; 17% math; 8% STEM; and, 4% other.

Figure 2. Percent summary of participants in the professional development highlighting their grade level and subject(s) taught. Information is based on participant survey responses or in-person interview.



NEXT GENERATION SCIENCE STANDARDS

When developing curriculum, one method for beginning the lesson planning is pin-pointing the standard, and in this case the Next Generation Science Standards (NGSS). At the time of the proposal drafting, the identified NASA resource suggested Grade 5 and high school performance expectations. With more research, more appropriate for the middle school professional development audience suggests that the NASA data and lesson would align well with the middle school NGSS performance expectation for Earth and Space Sciences. The performance expectation is MS-ESS3-5 which involves asking questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century (NGSS, 2013).

Suggested examples, such as using factors of human activities and natural processes, that may be used to guide student learning to complete the performance task. Students are able to cite evidence from tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and rates of human activities. Performance expectations MS-ESS3-5 has a large emphasis on human activities and their role in global temperatures.

Figure 3. Next Generation Science standard performance expectation MS-ESS3-5 Earth and Human Activity is the middle school standard to be selected to align with the NASA Graphing Sea Level lesson activity. Although other grade 5 and high school performance expectations were selected on the resource page this performance expectation could be used to guide learners to meeting these skills and content. (NGSS, 2015)

MS-ESS3-5 Earth and Human Activity		
<p>Students who demonstrate understanding can:</p> <p>MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]</p>		
<p>The performance expectation above was developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i>:</p>		
<p>Science and Engineering Practices</p> <p>Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.</p> <ul style="list-style-type: none"> Ask questions to identify and clarify evidence of an argument. 	<p>Disciplinary Core Ideas</p> <p>ESS3.D: Global Climate Change</p> <ul style="list-style-type: none"> Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth’s mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. 	<p>Crosscutting Concepts</p> <p>Stability and Change</p> <ul style="list-style-type: none"> Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

The NASA JPL activity, “Graphing Sea-Level Trends,” addresses STEM learning by integrating skills, subject content, and interpreting patterns. To further address integration of the other subject areas such as technology and engineering, additional activities will be developed to optimize STEM learning. The lesson primary topic is Earth and Space Science; additionally, topics include data collection, analysis and probability, earth processes, measurement, science

and society, and the scientific process. The NGSS suggested by the NASA JPL education resource page is develop a model to describe ways the geosphere, hydrosphere, biosphere and atmosphere interact (5-ESS2-1); analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems (HS-ESS2-2); and, analyze geoscience data and results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems (HS-ESS3-5). Various math standards are also associated with the lesson. Math, science, and engineering skills, content, and cross-cutting concepts will be highlighted as a focus of the lesson activity. The lesson overall relies on graphing, interpreting data, and forming claims with evidence to support ideas in climate change and geoscience processes having to do with sea-level changes.

Using the middle school performance expectation, the “Graphing Sea-Level Trends” will be appropriate because it aligns with the suggested science and engineering practices, disciplinary core ideas, and crosscutting concepts. These are the NGSS dimensions which ensure students are engaging in an actual practice of learning to understanding a core idea in science by utilizing concepts in phenomena. In the selected lesson, students will be able to address the ideal dimensions through the practice of asking questions and defining problems; analyzing and interpreting data; and constructing explanations. This will be the guide towards examining global temperatures, where there is also a NASA activity to address the performance directly. The disciplinary core idea relates to human impacts on earth systems and how humans have a significantly altered the biosphere; in addition to how human activities release greenhouse gases from burning fossil fuels are a major factor in the current rise in Earth's mean surface temperature. Lastly, in the lesson students will focus on developing their skills and content

understanding by utilizing patterns from graphs, cause and effect relationships, and stability and change as the result of sudden events or gradual changes over time.

SUMMARY OF PROJECT

The professional development will be delivered in-person at two primary locations. As planned within the original proposal the professional development took place in February and March 2019. The sessions were approximately thirty to an hour in length depending on the location and audience. Multiple sessions were planned to obtain the required number of equators for the project and was based on availability. Ideally, if there were more educators to be engaged in the professional development individual sessions were would be offered where possible. Educators were encouraged to bring personal laptops to take surveys, access professional learning community Google Drive, access lesson activities, and receive materials.

Email and personal invitations are sent out to STEM subject educators at the school site for the date, location, and purpose of the professional development. The dates were selected because they were the usual department meetings times, not to take away too much time from the educators. Upon arrive, educators were greeted and asked to complete the pre-survey.

Follow-ups were conducted with post-surveys and individual appointments where needed. Overall, working with a new district and having a remaining relationship with past educational institutions helped with gathering a appropriate audience for the professional development. The variety of interests and skills of the participants, in addition to content learning were most valuable to begin a discussion with. I learned much about the needs of educators, as much as the needs of middle school students. As a result, the designed next steps will be

beneficial to improving future professional development plans I have for myself as a participant and facilitator.

Figure 3. Original schedule of professional development.

February 4 or 12, 2019	March 18 or 19	Other Dates
Huntington Middle School Science Department & Open to Others Interested 10-15 Participants	Hull Middle School STEM Subject Areas & Open to Others Interested 10-15 Participants	April 26: Conference Webinar Individual Appointments

PRE-QUESTION SURVEY LIST

The pre-survey and post-survey questions were formatted for the best use onto Google Forms. Some questions were removed from the initial proposed questions to reduce the time spent answering questions that could be addressed in the post-survey.

Pre-Survey Questions

<p>Name, Title, Grade Level, School</p> <ul style="list-style-type: none"> ▪ What is your first and last name? ▪ What is your occupation title? ▪ What grade levels do you teach? ▪ What subjects do you teach? ▪ What is your school or district name?
<p>Email</p> <ul style="list-style-type: none"> ▪ What is your email address? ▪ Do you wish to have your information shared? ▪ Do you want more information on the NASA Endeavor program?
<p>Familiarity with NASA data for lessons</p> <ul style="list-style-type: none"> ▪ Have you used NASA data in lessons before? ▪ Professional or personal history of implementing NASA data into lessons?
<p>Goal from the workshop</p> <ul style="list-style-type: none"> ▪ What are your immediate goals and/or expectations from the workshop?

Table 2. A list of the Pre-Survey Questions distributed in Google forms electronically to participants prior to the professional development.

The survey was created on digital forms with opportunity to select responses or to respond in free text by the attendance member. The preferred outcome would be 80-100% audience participation and implementation of the select lesson activity, or interest with support to implement one of another topic. However, I believe realistically I would fully engage at least 30% of the audience and will be able to work one-on-one with the educator at the school site or during free hours of the day depending on their location or interest in another data topic. Further, the timeframe between the professional development and when the educator will implement the activity will be considered. If audience members do not implement the activity I would look forward to them at least sharing the NASA data resource with a educator and to encourage others to access the data if possible. The surveys, audience quotes, and student evidence from participating educators will be used to analyze the success of the professional development and will be used to form next steps. And create necessary alternatives to adjusting methods to achieve goals in the leadership proposal to reach more audience members if needed.

THE PROFESSIONAL DEVELOPMENT TRAINING

The participants introduced themselves and what they were currently working on in the classroom. Following, the educators began interpreting gallery images of photos related to climate change where they selected a photo to discuss what they saw and if they had any questions. Each photo is related to the biosphere and hydrosphere. Then the educators are asked to determine what the common theme was supposed to be.

The NGSS performance expectation is revealed to the educators and the session provided time for the educators to read, interpret, ask questions, and familiarize themselves with “MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global

temperatures over the past century” (NGSS, 2013). It was explained that the educators can manually or digitally graph the data from the NASA activity as suggested by the lesson. When beginning the lesson, educators were directed to access the NASA Jet Propulsion Laboratory-California Institute of Technology Education website. This way the audience can note there is not just one lesson but that there are many resources organized by subject and grade level to meet their needs.

“Graphing Sea-Level Trends” is a classroom activity that has been designated by NASA as aligning to the subjects of science and mathematics, focusing on the use of models to teach climate change and graphing. In the activity, the goal is to engage students in the use of sea-level rise data to create models and compare short-term trends to long-term trends. This aligns with the variable of climate change occurring over time, let alone decades. The indicated grade levels for the activity are grades “5-12” and matches the NGSS performance expectations for earth and space science. However, for the professional development the grade level focus is simply middle school, grades 6-8, and suggests one to two hours. But it will have to be condensed to a shorter time frame for the intended sessions. Ultimately, the audience will brainstorm and understand how NASA data has an importance in the NGSS classroom, if not other subject areas of STEM. Educators will then implement the lesson activity best suited for their classroom and engage students in determining whether sea-level rise is occurring using the data and focusing on observations and evidence.

The participants are able to use printed copies of the provided student record sheet. However, they will be encouraged to modify and create their own template for the activity to consider their students’ needs, such as learning levels, differentiation, and critical thinking. The questions focus on identify the time frame of the data through the questions “What year and

month does your data set begin?” and “What year and month does your data set end?” The participants would have to identify the “global mean sea level (GMSL)” using the data at the beginning, end, and determine the difference through the time of the data. The audience would also practice determining the trendline for the data and whether there is a significance of it compared to a visual assessment of the data. The audience would have the option of using multiple sets of the data during the professional development based on their preference, a 30, 100, and a 130-year set depending on their comfortability and to think about how they would want to implement the size of the data set into the classroom for their students. (NASA JPL, 2018)

In conclusion, once the participants have had enough time to complete the activity they viewed NASA’s Oceans of Climate Change Video (Link: climate.nasa.gov/climate_resources/40/video-oceans-of-climate-change/) to form connections between the lesson activity. The remainder of the time was made available for individual or collaborative planning, to ask further questions, or to explore more NASA resources relevant to the participant’s curriculum need. Lastly, they were asked to complete a post-survey at the conclusion or within three days of the professional development.

OUTLINE OF ACTIVITIES IN THE UNIT

The organizer below is a brief summary of the activities within the unit for Climate Change and Human Impact, a topic aligned to the NGSS middle school grades. Using the 5E Learning Cycle the participants in the professional development will practice with the NASA lesson in a mock 5E lesson to provide an opportunity to utilize inquiry, student-centered approaches, and to increase student understanding.

Sea Levels with NASA Data

Topic: Climate Change & Human Impact

Time: 1-2 days (55 Minute Periods)

NGSS: MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Engage: H2O Gallery Walk Professional Development Time: 5 minutes	Participants work with a partner or in small groups of three to observe and record interpretations of four images. The themes for the images are the interactions between the biosphere, hydrosphere, atmosphere and cryosphere (i.e. oil spill and marine birds, polar bear on iceberg, drought, and humans collecting fish). Themes and questions derived from the images are shared with the whole group.
Explore: Graphing Sea Levels Professional Development Time: 10-15 minutes	Participants form a prediction, or hypothesis, to the question “What are characterizes of sea-levels throughout periods of time?” The activity files are used with a spreadsheet program to graph the sea level rise. Partners compare their graphs to determine noticeable trends. Tutorials and modeling for manual graphing, Microsoft Xcel, and Google Spreadsheets should be presented here.
Explain: NASA Data Professional Development Time: 5 minutes	Working with a partner, participants interpret the trends onto their graphs, identify variables, and answer the exploration question and forms questions using the graph. Participants share questions to the whole group along with their interpretations. Question progression should increase the depth of knowledge and critical thinking of the learner.
Elaborate: Satellite Data Professional Development Time: 5 minutes	Participants interpret the satellite sea level trends graph to help answer questions that were further developed during the explanation. Reading a short segment for the graph will help elaborate on the connections between the spheres on Earth to sea level data, and human activities. Learners are asked to develop larger questions that tie the sea-level phenomena to other earth processes.
Evaluate: Claim-Evidence-Reasoning Professional Development Time: 5 minutes	Participants select a related question they believe is the best-fit for the NASA data on sea-level trends. A claim, two to three points of evidence, and a reasoning will be formed to show the learner has predictions to what may cause a rise in global temperatures over the past century. Learners are asked to develop a next step to devise a solution or to learn more about planet processes and the role of human and their activities.

NASA DATA

Some background on the NASA “Graphing Sea-Level Trends” lesson activity focuses on the variety of methods that scientists have used to understand the significance of the global sea level, which is the average height of the sea surface across the planet. By interpreting the data the scientists are able to better understand the varied trends of sea level throughout the decades during times of ice ages and more. The importance of the NASA data is to tell a story about how in recent history, sea levels became steady and has been rising over the last century- specifically 3.4 millimeters per year over the past century.

The real-time collection of ocean data from 120 sea-level monitoring stations in the US, and 240 additional stations worldwide, give scientists useful information about local conditions which can be used to calculate the global average sea level and study it over time to support a planet-wide scale of sea level change. Many technological tools monitor the sea from the water, such as shoreline research stations or research buoys, and from the air, such as satellites. Using the NASA data, educators and students will be able to understand and support with evidence how they know the sea level is rising.

Looking into the provided CSV and data files for the activity, there are 20 sets available to use. Each set contains data for the variables of time and GMSL (mm) which can be graphed using a program, such as Microsoft Excel. If students do not have the skills to use a spreadsheet program for graphing then select intervals from the CSV files can be used for manual graphing.

Found on the same lesson activity website is the NASA satellite sea level observations is available as a graph comparing time with change in Earth’s global sea level since 1993 to the present year. The interactive graph allows the audience to scroll over the data line to explore the data and sea level rise for that day. By analyzing this specific graph and asking questions the

audience can understand that the total amount of water on Earth is not increasing. Rather the volume of liquid that fills the ocean basin is growing and raising the elevation of the sea's surface and spilling ocean water onto low-lying land.

The data can encourage asking questions that lead to understanding that the volume of water entering the seas and increasing the level are from two major sources. First melting ice sheets and glaciers on land add water to the sea and, second, there is thermal expansion where water expands as it warms so the more heat energy the ocean absorbs the more space its water requires. Overall, the ocean can absorb a lot of heat, so as the atmospheric temperatures rises, so does the ocean temperature. This leads into possible concepts behind the processes of greenhouse gases, human activity, and effects of global warming as focused on by the selected performance expectation.

FOLLOW-UP ACTIVITIES & POST-QUESTIONS SURVEY LIST

Post-Survey Questions

Email

- What is your email address?

Quality of the professional development

- Were you satisfied with the professional development?
- Did it address your subject, grade-level, and implementation concerns?

Feedback

- Are you likely to implement the activity into the classroom?
- What are concerns about the lesson before you implement into the classroom?
- Are you interested in additional support to implement NASA data into the classroom?
- Are you interested in other NASA data-based activities to implement?
- How can the professional development be further improved?

Table 3. A list of the Post-Survey Questions distributed in Google forms electronically to participants prior to the professional development. Participants were encouraged to complete the survey after the professional development or no more than three days following.

OUTCOMES

As of April 24, 2019 and the reporting of this Endeavor STEM Leadership Seminar Project, twenty-four educators participated in the Graphing Sea-Levels professional development. The professional development served a total of 24 educators from different districts. Participants grade levels in which they taught were 37% grade various grade levels; 25% grade 6; 21% grade 8; and, 17% grade 7. The percent of subjects represented are 50% science; 21% STEAM; 17% math; 8% STEM; and, 4% other.

The goal was to interact with thirty educators, so the project did not reach 100% of the anticipated participation. Success of the project was also dependent on other variables such as delivering the activity in a timely fashion, collecting surveys from participants, and following-up with participant needs, questions, and implementation. Communication was primarily from email, in-person conversations, and social media messaging as a form of sharing information about the professional development and inviting educators. It was particularly difficult to obtain early responses to attend.

In terms of content, most of the participant agreed that human impact, an NGSS topic category was related to their content if they were a science teacher. For math, STEM, and STEAM educators the engagement had to be at the perspective of graphing, hands-on opportunities to engineer, and utilizing creativity and art. Further, the 5E Learning Cycle was the primary delivery template for delivering the professional development as it would be important to model a clear sequence of events and to practice ideal pedagogy. Ideally, the activities were centered towards the participants observing, discussing, explaining, asking questions, graphing, and more.

The initial February 4, 2019 professional development only included two middle school science teachers. It was not until February 12, 2019 was there more participants during a staff meeting. In attendance was 8 educators which was lower than the goal of 15 participants. Within the group, the activity went smoothly as the participants believed technology had a large role in curriculum. The largest growth was in the area of transferring Microsoft Xcel skills into Google spreadsheets, as the primary method of data organization. This group consisted of only middle school educators for grades 6-8 and were all science educators. Potential to schedule another professional development was challenging as department meetings were not frequent and the culture of the department was restricting to grade level collaboration. Follow-ups with the participants were specific to in-person conversations and by request. Majority of the educators were veteran educators of ten or more years, taught mostly full-time, one part-time, and did not actively engage in grade level or subject collaboration formally – for personal reasons.

On March 18 and 19, 2019, there was an opportunity to engage with nine additional educators while also facilitating a STEAM Fair. The educators consisted of math, science, STEM, and STEAM educators in the middle grades, as well as those who work with K-12 grade levels. A challenge in this group was technology proficiency in using data, so a lot of time was spent practicing how to use Xcel and spreadsheet applications. It was realized that data and technology may not be so appealing to some of the participants as some of the discussions defaulted to interpreting the completed graphs on the NASA resource page after some time working on the spreadsheet and graphing. In this group about half of the participants wanted to manually graph but watched a brief walk through of using Excel. This highlighted the importance of differentiating for the learners in the audience.

The greatest results in terms of conversation and growth came from working with individual educators who could not attend the professional development due to distance or time availability. This opened up an understanding that proximity and need for curriculum ideas are critical to obtaining an audience. Educator colleagues from neighboring districts were willing to participate in 45 minutes or 60 minutes professional developments in-person or online to assist with the leadership project. As a result, all the educators completed the Graphing Sea Level activity, felt confident navigating the webpage and was able to clarify how they could use this activity in their own classroom. Of course, one-on-one online sessions and in-person meetings were effective but not efficient. But the seven educators were highly engaged and felt the lesson could be adapted to their math, science, STEM, and STEAM curriculum.

There was a comment from a math teacher, stating they were surprised they were at a professional development with science and STEM teachers because “they usually have all the fun.” I took this as an opportunity to communicate how STEM can be a area of convergence, and integration, for professional learning communities. Such as, the sole STEM teacher at their school site does not meet with any department. In a study by the National Science Foundation, it was found, and highly recommended, that STEM educators participate in professional learning communities and support the bridging of practices and content between academic subject areas. This proposes that STEM educators have absolute flexibility in their professional learning communities (Fulton and Britton, 2011).

Overall, I was able to implement the lesson activity in an eight-grade classroom personally so that I could troubleshoot participant inquiries and procedures. Through follow-up, three participants implemented the lesson and an additional global temperatures lesson with their students at the middle school level for climate change. Four participants left off indicating they

will be likely to implement the lesson by the end of the 2018-2019 academic year. All participants agreed the skills required for the lesson was a middle school necessity for literacy in the STEM areas, but the remainder of the professional development audience would consider using the lesson or they were not sure if they would. However, they believed the elements of graphing, interpreting trends, integrating real-world connections, and exploring other NASA JPL education activity ideas were important.

Teacher leadership takes time and practice, and at any time point teacher leadership may be successful or not successful. However, it needs to be reflective and thoughtful based on the ideas from a three-year leadership program for science teacher leadership. I do not believe I was 100% successful based on the number of participants that I began to work with and how I was able to influence and follow-up with their implementation. There are specific features in leadership, such as demonstration lessons, observation and debrief cycles, building a relationship and more that I may not have had with some of the educators that could have increased chances of a successful project. However, there are levels of the teacher leader for how they can communicate their knowledge and skills to effectively impact their professional community. Factors I may consider for the future are to learn how to be a change agent, learn more about professional learning, and personal learning (Luft, Dubois, Kaufmann, and Plank, 2016).

Next steps after the conclusion of the activity will be to continue to implement NASA lessons and data into my personal curriculum and to build a culture of sharing and lesson demonstrations at the school site. I believe modeling is vital to encouraging implementation of new lessons in the classroom and to continue to attend more professional development to learn how to effectively run a higher-attended professional development. Further, I was hoping to present at a local conference for gifted and talented students using the NASA lesson on April 27,

2019. But the date conflicted with other arrangements. Ideally, this was meant to obtain another pool of educators that could have participated in the professional development. I have a greater understanding in the amount of research and leadership it takes to facilitate both youth and adult learners.

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