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YOUNG SCIENTISTS: Development of an Interactive STEM Program for Students at Vermillion “Beyond School Adventures

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YOUNG SCIENTISTS:

DEVELOPMENT OF AN INTERACTIVE STEM PROGRAM

FOR STUDENTS AT VERMILLION

"BEYOND SCHOOL ADVENTURES"

by

Ellen Roufs

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ABSTRACT

YOUNG SCIENTISTS: Development of an Interactive STEM Program
for Students at Vermillion "Beyond School Adventures"

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STEM (science, technology, engineering and mathematics) education is of increasing importance in our society. Advancements in technology, a growing need for new ideas in engineering and mathematics, and greater emphasis on science have all contributed to the renewed focus on STEM education. It is crucial that children develop an appreciation and enthusiasm for STEM at a young age. Fostering curiosity in students is a valuable investment in their personal future and the future of our world. The purpose of this thesis project was to design and implement an interactive STEM program for the after-school program, Beyond School Adventures in Vermillion, SD. This program consists of six fun, hands-on, and unique STEM activities for kindergarten and first-grade students; specifically, modules on solar heat, growing a plant, habitats, the science of sounds, engineering a communication device, and exploring plants. Each module involves a short background presentation of the topic being explored, an opportunity for each student to do the activity, and a take-home component for extended learning and sharing of their new understanding. This project involved the development, funding, testing, revision of the modules, and presentation to the students. In future years, this project will be sustained as an outreach program of the USD Biology Club.

KEYWORDS: STEM education, science education, interactive learning, elementary science, after school programs

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I also want to thank Sarah Lane and the members of the USD Biology Club, for their commitment to sustaining this program in future years; Dr. Jeff Wesner, for serving as a member of my thesis committee; and the staff members of Austin Elementary School and Vermillion BSA, for their assistance and cooperation with this project.

CHAPTER ONE

Introduction

Growing Importance

The "STEM" acronym stands for science, technology, engineering, and mathematics. In our rapidly changing world, there is an increased demand for STEM-related careers and technology. As the need for these types of careers is growing, STEM is receiving greater emphasis in schools, universities, and industries. The US Department of Education wrote: "In a world that's becoming increasingly complex, where success is driven not only by what you know, but by what you can do with what you know, it's more important than ever for our youth to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information (US Dept of Ed)." Early exposure to STEM is a key component to the success of these children. Fostering a curiosity in students is a valuable investment in their personal future and the future of our world.

The US Bureau of Labor Statistics released a report in 2017 showing trends in STEM employment over the past decade. Employment in STEM occupations grew by 10.5% between May 2009 and May 2015, compared with 5.2% net growth in non-STEM occupations (Fayer, Lacey & Watson, 2017). The report also included predictions of future job growth rates. From 2014 to 2024, the STEM occupation group projected to have the highest rate of growth is mathematical science, which includes statisticians and mathematicians. It is projected to grow by 28.2%, compared to 6.5% for all other occupations. The number of new jobs in computer occupations is projected to increase by 12.5%. Computer occupations are currently the largest category of STEM occupations, so this growth is estimated to result in nearly half a million new jobs (Fayer, Lacey & Watson, 2017). Another interesting component of this report was educational requirements for entry in these STEM careers. Over 99% of STEM jobs are found in occupations that typically require some type of postsecondary education, compared with 36% of overall employment (Fayer, Lacey & Watson, 2017). It is crucial that our future scientists, engineers, and mathematicians are well-prepared to succeed in their postsecondary education and beyond. This is another reason to increase emphasis on STEM education, especially at a young age.

National Standings in STEM

A topic of much attention in US educational and scientific communities is how the United States ranks alongside other countries in mathematics and science standardized testing. There are two primary international assessments: the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). Both compare student achievement internationally; however, they give different impressions of how the US ranks relative to other countries. The TIMSS focuses on academic content, while the PISA is designed to measure students' ability to apply their knowledge to solving real-world problems. The US generally ranks in a higher relative position in the TIMSS than with the PISA. These tests also differ in student testing age and the number of participating countries, making it difficult to compare them directly. However, they both give a valuable comparison of student performance internationally (Science and Engineering Indicators, 2018).

The TIMSS analyzes many factors and trends in student performance. The two main aspects highlighted here include each country's overall score, which can be compared to all other participant countries, and achievement rates, which compare a country's score to its own scores from previous years. This longitudinal summary provides insight into how STEM education is improving in a given country (Science and Engineering Indicators, 2018).

The most recent administration of the TIMSS was in 2015. The scores for 4th graders in science rank the US 10th internationally with no change in achievement rates since the first time this test was administered in 1995.

The TIMSS also compares student achievement in 8th grade in science, where the US ranks 11th with no change in achievement rates since 2011. In math, US 4th graders ranked 14th internationally with no improvement in achievement since 2011. US 8th grade students in math ranked 11th with slight improvement in achievement since 2011. The top scoring nations include Singapore, Japan, Hong Kong, Korea, Chinese Taipei, and the Russian Federation. These six educational systems consistently rank as the top six countries (in different orders) and have shown increased achievement rates in these areas (TIMSS, 2015). In today's world, there is ever-increasing competition between countries to produce the most advanced science and technology. For the US to compete on a global scale, more attention must be directed to STEM education in classrooms and universities.

Another aspect of the US scores is the low advancement rates for science and math achievement. While the TIMSS scores do place the United States at or above the international average, the change in achievement has not increased significantly. As many other countries--including the top scoring countries--show achievement improvements, US students remain at approximately the same level of science and math literacy. So, although US achievement is not dropping, it is not increasing in pace with other nations (see Appendix A for more data). This is an area of concern for many, especially as the demand for STEM-related careers, services, and technology is increasing at a very fast rate. To meet the demands of an advancing nation and world, STEM education must be granted greater priority in our existing educational system.

The Program for International Student Assessment (PISA) gives a slightly different perspective on student science and math achievement. Instead of testing based on science and math content, it evaluates literacy by testing a student's ability to apply their skills to real-world situations. "The assessment does not just ascertain whether students can reproduce knowledge; it also examines how well students can extrapolate from what they have learned and can apply that knowledge in unfamiliar settings, both in and outside of school" (OCED, 2016). This standardized test is administered every three years to fifteen-year-olds in many countries and cities.

The average US student's 2015 PISA score for math was 270 (on a scale of 0-1000), which is below the international average of 290. The US scored below 36 other countries, including the developing countries of Vietnam, Russia, and Lithuania. The top five average scores were achieved by students in the educational systems of Singapore (564), Hong Kong (548), Macau (544), Taiwan (542), and Japan (532). In science, US students scored an average of 496 (on a scale of 1-1000), which is not significantly different than the test's international average of 493. The US score was lower than those of 18 other countries, and the top scorers were Singapore (556), Japan (538), Estonia (534), Taiwan (532), and Finland (531) (Science and Engineering Indicators, 2018).

Overall, it is safe to conclude that the United States has room for improvement in student science and mathematics achievement. Perhaps even more valuable than content knowledge is the ability to apply that knowledge to real-world situations. In particular, there should be an increased focus on equipping students to use critical thinking skills and collaboration to solve real-world problems in STEM. The US's mediocre performance in this area is another reason to increase the integration of STEM into our education system.

State Standings in STEM

Standardized tests also provide a snapshot of how each state performs in many subject areas, including science and mathematics. The most recent data available are from the 2015 National Assessment of Education Progress (NAEP) and compares academic skills at grades 4, 8, and sometimes 12. Science scores are reported on a 0-300 scale and mathematics scores are reported on a 0-500 scale. State scores are then compared to the NP, or National (public) standard. The NP is the national average percentage of public-school students that are at or above the benchmark standard *proficient.* Scores are reported as the percentage of students above (or below) this NP standard. The average score for South Dakota 4^{th} grade students in science was 4 points higher than the NP. This science score increased to 7 points above NP for South Dakota 8th graders. South Dakota 4th grade average mathematics scores were not significantly different than NP; 8th grade math scores were on average 3 points higher (NAEP, 2015). For more details, see Appendix B.

South Dakota ranks relatively well compared to other states' science and mathematics scores. However, standardized scores only provide a snapshot of student performance. One could argue that it is of even greater importance to foster an authentic enthusiasm for STEM, which ultimately promotes greater STEM literacy.

CHAPTER TWO

Overview and Methods

Proposal and Vision

The purpose of this thesis project was to design and implement an interactive STEM program for the after-school program, Beyond School Adventures (BSA) in Vermillion, SD. This program consists of six fun, hands-on, and unique activities for students. The topics of these modules include a variety of interesting concepts in science, technology, engineering, or math. Each module involves a short background presentation or demonstration of the topic being explored, an opportunity for each student to make or do the activity, and a take-home component for extended learning and sharing of their new understanding. The purpose of each module is to introduce the students to a new concept or aspect of STEM, give them an opportunity for a hands-on exploration of the topic, encourage them to think critically and creatively, foster an enthusiasm for learning and STEM, and provide them with the resources to continue learning with real-life application and sharing of their new understanding with family members at home.

The initial groundwork for establishing this program included designing the materials for each of these modules, budgeting for and collecting all necessary supplies, and visiting BSA every two weeks to share the modules with the students. Each module was designed to take around 20-30 minutes to complete. There are approximately 30 students in grades K-1 enrolled at BSA, so the activities were designed for 12 to 15 students of this age group to complete together.

The modules consist of resources for the leader, handouts for the students, and any materials needed for the activity. These resources are designed to resemble curricula from existing STEM education resources, including objectives, background information, list of materials needed, step-by-step procedures, and pictures. After the first trial of this program in Spring 2018, changes and improvements were made as needed. The revised curriculum was passed along to the University of South Dakota Biology Club and BSA staff for continued use in the future.

Designing the Modules

The first step of designing the modules was to consult the science standards for South Dakota. These science standards are established by the South Dakota Board of Education to guide curriculum and assessments for students K-12. They are available online and are an important resource for teachers (South Dakota Board of Education, 2015). I selected three standards each for Kindergarten and 1st grade, aiming for diversity of topics and disciplines. The selected standards, as given by the South Dakota Board of Education, are:

Kindergarten Standards

- Physical Science concept: Sunlight warms the Earth's surface.
    - K-PS3-1 - Make observations to determine the effect of sunlight on Earth's surface temperature.

- Life Science concept: Plants and animals (including humans) need food and water in order to grow.
    - K-LS1-1 Describe patterns of what plants and animals (including humans) need to survive.
- Earth and Space Science concept: Plants and animals (including humans) need to survive and there is a relationship between their needs and where they live.
    - K-ESS3-1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

First Grade Standards

- Physical Science concept: Sound can make matter vibrate, and vibrating matter can make sound.
    - 1-PS4-1 Plan and carry out an investigation to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.
- Physical Science concept: People use devices to send and receive information.
    - 1-PS4-4 Design and build a device that uses light or sound to solve the problem of communicating over a distance.
- Life Science concept: Plants and animals use their external parts to help them survive, grow, and meet their needs.
    - 1-LS1-2 Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

Once the standards were identified, the next step was to develop activities to meet the conceptual goals. Online education resources, Pinterest, and blogs with kids' science activities were used to find initial ideas. These ideas were modified as needed to 1) align more closely with the SD standard, 2) match the age level of the students, 3) minimize recurring cost, and 4) fit into the time allotted at BSA for these activities. As necessary, a preliminary trial run was conducted to ensure these activities would fit within the framework of the after-school care program.

The next step was to search for a related project or follow-up activity for the students to do at home. It is an important aspect of learning for the students to share their experience with family members and continue their curious exploration of a topic. At the end of each activity, the students should receive a handout that encourages parents to ask about and foster their new learning. The handout will also include an extension activity for them to do on their own (see Appendix E). It is important to ensure that the students' experience of science was not simply limited to their short time at BSA, but that these activities will become a catalyst for continued questioning and problem solving.

In addition to designing a curriculum, it was also critical to develop a manual for the people who will lead these activities. This is intended to serve as a planning resource and guide for the leader of the activities. Each activity has a guide that contains the learning objective, background information about the science topic, overview of the activity, prep and supply checklists, opening questions, guiding tips and details of the activity, possible adaptations (if necessary), concluding ideas, and an explanation of the take-home activity (see Appendix E).

Funding

In order to fund this project, I reached out to several local organizations and asked if they would consider sponsoring this program (see letter in Appendix C). The Vermillion Rotary Club and the Vermillion Area Community Foundation (VACF) replied with interest. After discussing the project proposal with the VACF president, Dr. Kurt Hackemer, I submitted a proposed budget that outlined the estimated cost of supplies for 5 years (see Appendix C). It was important to the funding organizations that the items purchased would be non-consumable, allowing for a one-time investment. This was taken into consideration when designing the activities. However, there are still a few modules that involve a project with consumable supplies. The Vermillion Rotary Club contributed $100 and the VACF contributed the remaining estimated cost of $275. This collaborative arrangement not only supported the project, but also aligned with the mission of the donating organizations. Speaking for the VACF board, Dr. Hackemer wrote: “The board enthusiastically supports your efforts to bring science education into our district’s kindergarten and first grade classes, and we appreciate your efforts on behalf of the kids.”

After the paperwork was completed and funding received, I worked with Laura Dimock, director of the Vermillion BSA, to purchase the supplies. It was agreed to store the supplies in the BSA storage closet at Austin Elementary School for convenience.

Implementation

I visited the Austin BSA program 6 times over the course of the Spring 2018 semester to test and troubleshoot the logistics of each module. It became clear that a smaller group of 5 to 10 students was often more suitable for certain activities. This meant leading the activity two or three times in a row, so all got the chance to participate that day. Additional BSA staff members were asked to help as needed. Changes were made to the activity details as needed. This is discussed in greater depth in Chapter 3.

Project Sustainability

A significant component of this project is its sustainability. One goal is to ensure that this program continues into future years. The initial plan was to pass along the materials for BSA staff to use whenever they wanted to lead a different type of activity with the children. However, it became clear from my visits to BSA that this was not likely to happen. These modules, although designed to be easy to implement, still require some preparation and effort to be successful. Most of the staff members do not feel comfortable to lead these STEM activities or are unaware of the preparation needed.

Consequently, the focus was shifted to finding individuals who would be willing to come and lead these activities as guests. I reached out to several science clubs at the University of South Dakota to ask if this was an outreach program that they would be interested in adopting as a club. The USD Biology Club responded and invited me to pitch my project at a meeting. After I presented an overview and answered their questions, the club agreed to adopt this program as one of their club outreaches. Members of the club will volunteer to lead an activity on a day of their choice, effectively minimizing the commitment for any one person. They also plan to perpetuate this outreach by passing along the materials to future club members.

I met with Sarah Lane, a member of the Biology Club Executive Board, to pass along the binder of materials and explain the logistics of the space at Austin Elementary School. We also coordinated a date when we could both visit BSA to lead a session together. This was a great opportunity for me to explain it to her and for her to get a feel for how the program is implemented.

The collaboration with the Biology Club is an exciting aspect of this project and benefits everyone involved. It is exciting to know that this program will be sustained in future years. The staff at BSA are happy to have guests come in and lead a unique activity for the students. The funding provided by the VACF and Vermillion Rotary Club is now ensured to be put to good use. The Biology Club is enthusiastic about the Young Scientist Program because it aligns with their club goal for community outreach and science education. Vice-president Sarah Lane shared,

"As the activities coordinator for the Biology Club here at USD, it has been a great opportunity to take over Ellen's "Young Scientist" program. Not only does this program allow for Biology Club members to interact with the community, it also provides elementary students with an opportunity to learn basic science in a fun atmosphere. This is also a great program because it provides an outline of activities for the kids to participate in. This is great for the Biology Club because, without the stress of organizing activities and scrambling for supplies, our energy can be focused on the actual program. All in all, I would say that Ellen's thesis project has proved a success and I hope that kids can keep learning from it in the months and years ahead."

CHAPTER THREE

Results: The Modules

The project led to the development of six modules, three each for kindergarteners and first-graders. These modules are described below, with reflections on the implementation of the modules discussed in Chapter Four. More detailed descriptions of the modules are found in Appendix.

Solar Heat: KINDERGARTEN

Solar energy is the radiation of the sun that is capable of producing heat, causing chemical reactions, and generating electricity. The sun is by far the Earth's largest energy source. However, the intensity at the Earth's surface is quite low because most of the energy is dispersed throughout space or absorbed in the atmosphere. Solar energy is a major source of renewable energy and has the potential to provide most of our energy needs in the near future. Humans capture solar energy in two main ways: through thermal energy capture and electricity generation. Thermal energy is collected by large plates that absorb the sun's heat and is used for human applications. On the other hand, solar panels harness the sun's light energy and convert it into electricity (Ashok, 2018).

The learning objective of this module is "Sunlight warms the Earth's surface" as is described in SD Physical Science standard K-PS3-1. The activity is to have the students predict what objects will melt in the sun and to test these predictions by putting the objects in the sun to observe what happens. Some of the suggested objects include crayons, ice cubes, chocolate, coins, butter, soap, and marbles. Students compare the results to their predictions, discuss what surprised them about the experiment, and are given suggestions about how to extend their experiment at home.

Growing a Plant: KINDERGARTEN

All organisms need nutrients to grow, repair, and reproduce. Plants are classified as photoautotrophs, which means they create their own food through the process of photosynthesis. Photosynthesis creates sugar molecules from carbon dioxide, water, and light energy from the sun. They also need to obtain nutrients from their environment for the metabolic processes involved in growth, repair, and reproduction. In order for a plant to thrive, it needs a source of water, nutrients, CO2 (in the air), and sunlight (Yopp & Woodwell, 2018).

The learning objective of this module is "Plants need food, light, air, and water in order to grow" as is described in SD Life Science standard K-LS1-1. The activity is to first use evidence-based learning through photos to determine what plants need to grow; then to plant a bean. Once the concept that plants need a source of food, light, air, and water to grow is introduced, it is connected to students' own lives: they also need food, air, and water to grow. Students are guided through the planting of a bean seed and given instructions on how to transport and care for the seedling at home.

Habitats: KINDERGARTEN

A habitat is a place where an organism or a community of organisms live. Four examples of common habitats include marine, polar, forest, and desert habitats. Marine--or ocean--habitats are the largest habitats on Earth, as ocean waters cover two-thirds of the globe. These ecosystems are dynamic and diverse, characterized by few plants and insects (compared to other common habitats) but many crustaceans, bacteria, and fish. Polar--or arctic--habitats include tundra and polar regions that are covered by ice and snow. These ecosystems are characterized by low annual temperatures and fewer living organisms. Forest habitats are characterized by trees as the dominant life form but are also home to many species of other plants, birds, mammals, and insects. There are many types of forest habitats based on annual temperatures, precipitation, soil type, and biodiversity. Desert areas are extremely dry areas with sparse vegetation and can be hot or cold. The only plants and animals to be found in this type of ecosystem that are those adapted to surviving with very little water (Kingsford, Juday & Smith, 2018).

The learning objective of this module is "Plants and animals can change their local environment. They need to survive and there is a relationship between their needs and where they live" as is described in SD Earth and Space Science standard K-ESS3-1. The activity is to explore different habitats by playing in sensory bins that contain animal figurines, rocks, small trees, sand, water, or snow. The lesson is introduced by showing several images of habitats on the board and talking about the idea that habitats provide everything plants and animals need to survive. Then the students play in the sensory bins, pretending to be each animal. They are encouraged to think about what that animal would need and what would happen if elements of the habitat were changed or taken away.

Science of Sounds: FIRST GRADE

Sound is defined as a mechanical disturbance, a vibration which may or may not be detectable with the human ear. In physics, sound is characterized by the properties of its waves. These waves can have varying frequency (experienced as pitch) and amplitude (experienced as loudness). Vibrating matter causes sound vibrations (think of a guitar string), and sound vibrations can in turn cause matter to vibrate, as sometimes felt when the bass frequencies are turned up (Berg, 2018).

The learning objective of this module is "Sound can make matter vibrate, and vibrating matter can make sound" as is described in SD Physical Science standard 1-PS4-1. The activity is to make a harmonica using rubber bands, straws, and craft sticks to show how vibrations can make sound. After each student has made a working instrument, they are encouraged to discuss how it works.

Engineering a Communication Device: FIRST GRADE

Communication is the exchange of information between individuals. The field of telecommunication more specifically focuses on the transmission of information by electromagnetic means. Before modern electronic communication, people shared information over distance via letters and the telegraph. Soon after came the development of the telephone, radio, fax, and television. Now our main means of communication is through email and the internet (Lehnert & Borth, 2018).

The learning objective of this module is "People use devices to send and receive information" as is described in SD Physical Science standard 1-PS4-4. The activity is to talk about how communication has changed throughout the years and to brainstorm and build a prototype for a new communication device. Images of various means of communication are used to introduce this lesson and students are asked to consider, “If your friend lived on the other side of the world, how would you talk to them or show them something?” Once they have suggested an idea, they are encouraged to draw a plan, then given access to various supplies such as pipe cleaners, buttons, aluminum foil, string, and cardboard to begin building. In conclusion, everyone presents their new inventions to the group.

Exploring Plants: FIRST GRADE

Plants have great diversity of structure and function. Many plants produce seeds as a reproductive structure. Each seed is composed of an embryonic plant, food-storage tissue, and hardened protective covering. Gymnosperms are plants whose seeds are exposed on the surface of cone scales, such as redwoods, firs, and pines. Angiosperms are plants whose seeds are made by a flower and include most fruit and vegetable species. Many plants have unique seed dispersal structures, ranging from burrs to helicopters to fleshy fruit. Roots and stems are found in vascular plants to conduct water from the soil to the leaves, which are the primary site of sugar-producing photosynthesis (Woodwell, 2018).

The learning objective of this module is “plants and animals use many parts to help them survive, grow, and meet their needs” as is described in SD Life Science standard 1-LS1-2. The activity is to explore the diversity of plants by breaking them open and looking at what is inside. After discussing what plants need to survive and grow, students are led outside to explore different plant specimens and search for structures that they can recognize as helping they plant grow and survive. The activity leader then uses a rubber mallet to break open structures and lets students explore the insides. Back into the classroom, each student shares what they found. Students identify the functions of each structure and are allowed to take their item home to share what they have learned with their family members.

CHAPTER FOUR

Discussion and Conclusion

After testing the effectiveness and design each of the activities at BSA, I wrote a reflection and made appropriate changes to the curriculum.

<u>Solar Heat: KINDERGARTEN</u>

I saved this activity for last so that there was a better chance for sun; thank goodness it turned out to be a nice day. I put a tray with all of the 12 items in the sun a few hours before to make sure the effects were obvious. I started by reviewing the habitat activity from the previous time and asking what they remembered. Then we talked about the meaning of the word “solar”, what happens to them when they get hot, and things they know to melt. Then we worked through the chart and they voted on what they thought would melt in the sun. We tested this with a blow-dryer on hot heat; they loved to watch everything melt. The biggest thing I learned was to make the rule that they could not touch anything, otherwise they got chocolate all over their fingers. I then pulled out the tray that had been in the sun for them to compare and contrast with the one we heated ourselves; most observed changes were the same. Some items, such as the plastic beads, rock, candle, crayon, and coin, did not melt at the temperature we were using. However, we did talk about how these things would melt if they got hot enough.

Growing a Plant: KINDERGARTEN

The kindergarteners were really excited about this project. I worked with three groups, 6 to 10 students in each). The simplicity of the experiment made it a great activity for this age level in the time we had. The introduction focused on the things both humans and plants need to grow. Most students had previous knowledge about what a plant needs to grow, some were a little confused that the seed did not need soil yet. I had set out all the supplies on the center of the tables, including plastic baggies that I had punched holes in before the activity. Although the students were enthusiastic about this project when we did it, I was afraid that they might not follow through with the required care at home. I would improve this activity by instructing them to put their seedling in a warm place (and not to put it under their pillow where it will likely be forgotten).

Habitats: KINDERGARTEN

This activity introduced the kindergarteners to the concept of habitats. We opened by reviewing what they learned last time. To my pleasant surprise, most of them had continued to care for the seeds we germinated, and some had transferred to soil. Building off the idea that plants need air, water, sunlight, and food to grow, we transitioned into a discussion about what animals need to survive. I focused on the needs for food, water, and shelter by asking them about their own homes or "habitats". They brainstormed what types of animals they would find in each of the habitats on the board (woods, desert, arctic, and ocean). I encouraged them to think about what it to would be like to be an animal in each of the habitats - where would they find food, water, and shelter? I was unsure how the sensory bins would work with the groups I had because it did not involve a guided activity or task. However, they were a huge success with the kids. They were excited to play and imagine with the figurines in each of the bins and remained engaged the entire time. It was a great opportunity to ask them questions about the animals and their relationships with their habitat. I quickly learned that they should dry their hands after playing with the ocean and arctic bins. This module was a great success. I would improve it by finding a better coloring sheet for them to take home.

Science of Sounds: FIRST GRADE

This was a surprisingly challenging activity for the first graders. As an introduction, we reviewed the last activity we had done together and talked about vibration creating sound. The fine-motor aspects of this activity were challenging for many students, especially twisting the rubber bands on each end to hold the popsicle sticks together. It was a good opportunity to teach this skill and encourage teamwork. We found (after trial and error) that the harmonica only made sounds when the popsicle sticks were held together as tightly as possible. Some students had to squeeze it when blowing. Once everyone was able to produce sound from their instrument, they absolutely loved it. We talked about how the large rubber band is vibrating to make the sound. The only major downfall of this project is that parents will likely find these harmonicas very annoying….

Engineering a Communication Device: FIRST GRADE

This was a fun project for the first graders. I worked with two groups, with seven students in each. This small group size was more conducive to this project. The students had a good understanding of the idea of communication, the real challenge was coming up with a new idea that did not already exist. After the introduction in front of the SmartBoard™, I had the kids share their idea before I approved it and let them begin building it. This helped them focus in on what they were trying to make. Once they got started and heard other students' ideas, their prototypes evolved into a final product. I had most of the supplies in the center of the table, with the exception of the tape (which I handed out as requested). It was fun to see the creativity and imagination that many of the students had. In the original lesson plan, I had wanted them to have a brainstorming session where they drew out a design for their device before building it with the materials. This would be a great addition to the lesson if time allows. Many students were excited about their final product and the idea of making the tin can telephone at home.

Exploring Plants: FIRST GRADE

This activity was better in theory than execution. The goal was to foster a curiosity in the students and to get them thinking about different parts of plants. However, they were much more interested to recklessly smash the fruits, nuts, and vegetables without stopping to think about what they were looking for. I was able to get old fruits and vegetables from the produce section at Walmart. This was great because it helped the budget and wasn't as wasteful as using fresh produce. I also collected several pinecones, walnuts, seed pods, and pieces of bark from the park. We ended up doing this activity on the front sidewalk at Austin Elementary, which was a smart move. In hindsight, I realized that this project should never be done inside because it was very messy. The kids took turns using the rubber mallets to smash open the plants, and most forgot to find a unique seed to show and tell (as was the point). This module needs serious modification before I would recommend doing it again. It might work better if the leader first tells all the students to pick a specimen. Then we could sit in a circle and each student could share what they think that part of the plant is used for (is it a root, fruit, stem, seed, etc.). This would allow the leader to guide their exploration. Then the leader would have the rubber mallet and could smash open any of the fruits while the students watched. Finally, the leader could hold up and pass around the specimens/fruits that none of the students chose. This would ensure that everyone gets a chance to see and learn about all the different plants. I think the kids had fun with this activity, but it could be improved to make it a little less chaotic. Also, peanuts and tree nuts need to be avoided in case of potential allergies.

Conclusion

Recent growth in STEM-related careers and technology has led to an increased focus on STEM education, especially at a young age. It is crucial to inspire a curiosity and help students develop critical thinking skills in elementary school. The purpose of this thesis project was to design and implement an interactive STEM program for the after-school program, Beyond School Adventures in Vermillion, SD. I developed an interactive curriculum called “Young Scientists” for the kindergarten and first grade students in this program. After designing, researching, and obtaining funding for this project, I tested, updated, and passed along the materials to the USD Biology Club for future years. The overall purpose of this project was to introduce the students to a new concept or aspect of STEM, give them an opportunity for a hands-on exploration of the topic, encourage them to think critically and creatively, foster an enthusiasm for learning and STEM, and provide them with the resources to continue learning with real-life application and sharing of their new understanding with family members at home.

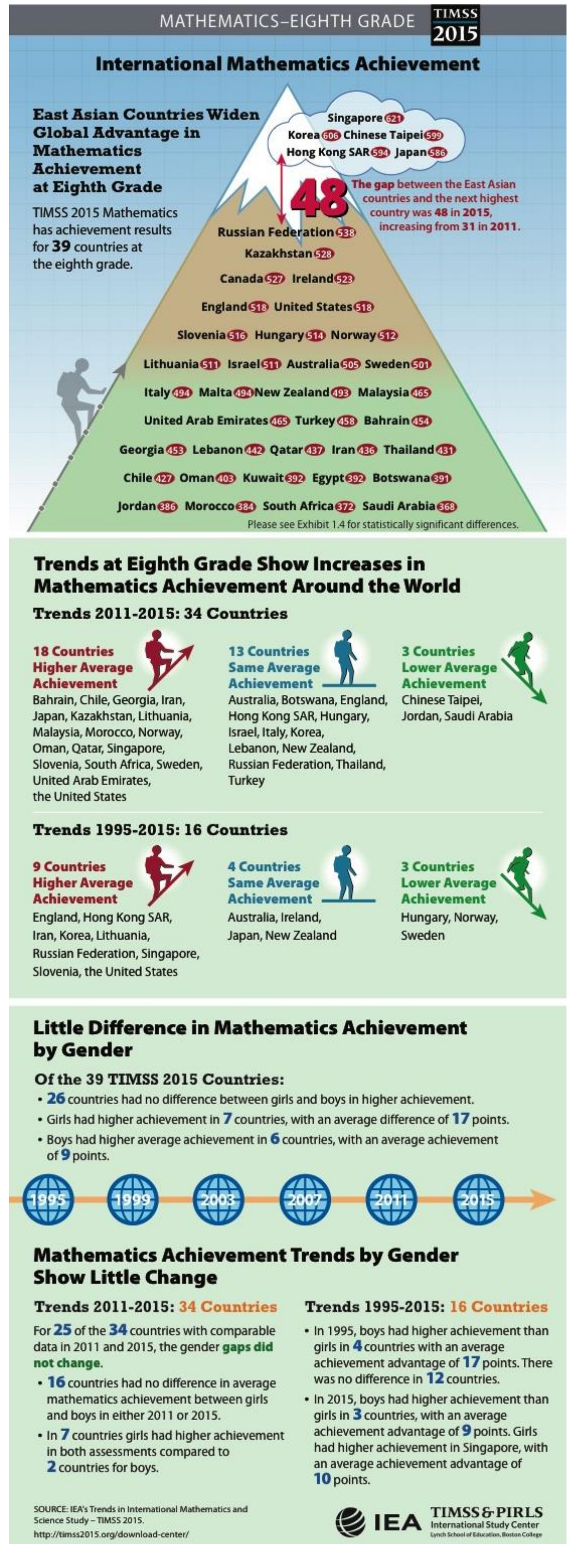
This project also gave birth to collaboration between community organizations, the USD Biology Club, and the BSA after-school program. The students responded well to the activities, and many remembered the key concepts from previous lessons. BSA benefits from the volunteers that come in to work with the students. The funding provided by the VACF and Vermillion Rotary Club is now ensured to be put to good use. The USD Biology Club is excited to adopt this curriculum as a part of their community outreach. As a whole, this project was successful.

APPENDICES

APPENDIX A

Infographics of 2015 TIMSS Test Results

MATHEMATICS–FOURTH GRADE
TIMSS 2015
International Mathematics Achievement
East Asian Countries Top Achievers at Fourth Grade in Mathematics
TIMSS 2015 Mathematics has achievement results for 49 countries at the fourth grade.
Singapore 618 Hong Kong SAR 615
Korea 608
Chinese Taipei 597 Japan 593
23
The gap between the East Asian countries and the next highest country was 23 in 2015, unchanged from 2011.
Northern Ireland 570
Russian Federation 564
Norway 549 Ireland 547 England 546
Belgium-Flemish 546 Kazakhstan 544
Portugal 541 United States 539 Denmark 539
Lithuania 535 Finland 535 Poland 535
Netherlands 530 Hungary 529 Czech Republic 528
Bulgaria 524 Cyprus 523 Germany 522 Slovenia 520
Sweden 519 Serbia 518 Australia 517 Canada 511 Italy 507
Spain 505 Croatia 502 Slovak Republic 498 New Zealand 491
France 488 Turkey 483 Georgia 463 Chile 459 United Arab Emirates 452
Bahrain 451 Qatar 439 Iran 431 Oman 425 Indonesia 397
Jordan 388 Saudi Arabia 383 Morocco 377 South Africa 376 Kuwait 353
Please see Exhibit 1.3 for statistically significant differences.
Trends at Fourth Grade Show Increases in Mathematics Achievement Around the World
Trends 2011-2015: 41 Countries
21 Countries Higher Average Achievement
Bahrain, Chinese Taipei, Croatia, Czech Republic, Georgia, Hong Kong SAR, Hungary, Ireland, Japan, Kazakhstan, Morocco, Oman, Portugal, Qatar, Russian Federation, Singapore, Slovenia, Spain, Sweden, Turkey, United Arab Emirates
15 Countries Same Average Achievement
Australia, Belgium (Flemish), Chile, Denmark, England, Iran, Italy, Korea, Lithuania, New Zealand, Northern Ireland, Norway, Serbia, Slovak Republic, the United States
5 Countries Lower Average Achievement
Finland, Germany, Kuwait, Netherlands, Saudi Arabia
Trends 1995-2015: 17 Countries
14 Countries Higher Average Achievement
Australia, Cyprus, England, Hong Kong SAR, Iran, Ireland, Japan, Korea, New Zealand, Norway, Portugal, Singapore, Slovenia, the United States
1 Country Same Average Achievement
Hungary
2 Countries Lower Average Achievement
Czech Republic, Netherlands
In TIMSS 2015 Boys Had Higher Mathematics Achievement in More Countries Than Girls.
Of the 49 TIMSS 2015 Countries:
• Boys had higher achievement in 18 countries, with an average difference of 9 points.
• Girls had higher achievement in 8 countries, with an average difference of 18 points.
• 23 countries had no difference between boys and girls in average mathematics achievement.
1995 1999 2003 2007 2011 2015
Mathematics Achievement Trends by Gender Show Little Change
Trends 2011-2015: 41 Countries
• In both assessments boys had higher achievement in 11 countries, compared to 2 for girls.
• 16 countries had no difference in average mathematics achievement between boys and girls.
Trends 1995-2015: 17 Countries
• In 1995, boys had higher achievement in 7 countries, with an average achievement advantage of 8 points.
• In 2015, boys had higher achievement in 9 countries, with an average achievement advantage of 8 points.
SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2015.
http://timss2015.org/download-center/
IEA
TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College



MATHEMATICS–EIGHTH GRADE
TIMSS 2015
International Mathematics Achievement
East Asian Countries Widen Global Advantage in Mathematics Achievement at Eighth Grade
TIMSS 2015 Mathematics has achievement results for 39 countries at the eighth grade.
Singapore 621
Korea 606 Chinese Taipei 599
Hong Kong SAR 594 Japan 586
48
The gap between the East Asian countries and the next highest country was 48 in 2015, increasing from 31 in 2011.
Russian Federation 538
Kazakhstan 528
Canada 527 Ireland 523
England 518 United States 518
Slovenia 516 Hungary 514 Norway 512
Lithuania 511 Israel 511 Australia 505 Sweden 501
Italy 494 Malta 494 New Zealand 493 Malaysia 465
United Arab Emirates 465 Turkey 458 Bahrain 454
Georgia 453 Lebanon 442 Qatar 437 Iran 436 Thailand 431
Chile 427 Oman 403 Kuwait 392 Egypt 392 Botswana 391
Jordan 386 Morocco 384 South Africa 372 Saudi Arabia 368
Please see Exhibit 1.4 for statistically significant differences.
Trends at Eighth Grade Show Increases in Mathematics Achievement Around the World
Trends 2011-2015: 34 Countries
18 Countries Higher Average Achievement
Bahrain, Chile, Georgia, Iran, Japan, Kazakhstan, Lithuania, Malaysia, Morocco, Norway, Oman, Qatar, Singapore, Slovenia, South Africa, Sweden, United Arab Emirates, the United States
13 Countries Same Average Achievement
Australia, Botswana, England, Hong Kong SAR, Hungary, Israel, Italy, Korea, Lebanon, New Zealand, Russian Federation, Thailand, Turkey
3 Countries Lower Average Achievement
Chinese Taipei, Jordan, Saudi Arabia
Trends 1995-2015: 16 Countries
9 Countries Higher Average Achievement
England, Hong Kong SAR, Iran, Korea, Lithuania, Russian Federation, Singapore, Slovenia, the United States
4 Countries Same Average Achievement
Australia, Ireland, Japan, New Zealand
3 Countries Lower Average Achievement
Hungary, Norway, Sweden
Little Difference in Mathematics Achievement by Gender
Of the 39 TIMSS 2015 Countries:
• 26 countries had no difference between girls and boys in higher achievement.
• Girls had higher achievement in 7 countries, with an average difference of 17 points.
• Boys had higher average achievement in 6 countries, with an average achievement of 9 points.
1995 1999 2003 2007 2011 2015
Mathematics Achievement Trends by Gender Show Little Change
Trends 2011-2015: 34 Countries
For 25 of the 34 countries with comparable data in 2011 and 2015, the gender gaps did not change.
• 16 countries had no difference in average mathematics achievement between girls and boys in either 2011 or 2015.
• In 7 countries girls had higher achievement in both assessments compared to 2 countries for boys.
Trends 1995-2015: 16 Countries
• In 1995, boys had higher achievement than girls in 4 countries with an average achievement advantage of 17 points. There was no difference in 12 countries.
• In 2015, boys had higher achievement than girls in 3 countries, with an average achievement advantage of 9 points. Girls had higher achievement in Singapore, with an average achievement advantage of 10 points.
SOURCE: IEA's Trends in International Mathematics and Science Study – TIMSS 2015.
http://timss2015.org/download-center/
IEA
TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

APPENDIX B

South Dakota National NAEP Reports

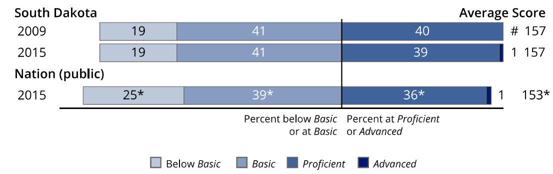
The Nation's Report Card

2015 Science State Snapshot Report
South Dakota ▪ Grade 4 ▪ Public Schools

Overall Results

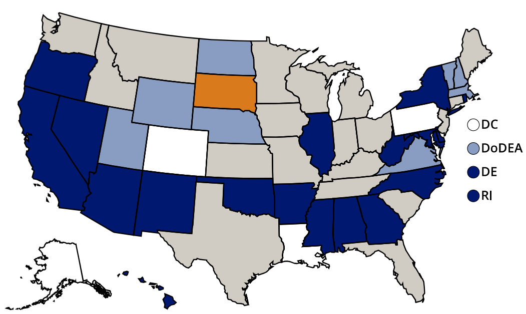
- In 2015, the average score of fourth-grade students in South Dakota was 157. This was higher than the average score of 153 for public school students in the nation.
- The average score for students in South Dakota in 2015 (157) was not significantly different from their average score in 2009 (157).
- The percentage of students in South Dakota who performed at or above the NAEP *Proficient* level was 40 percent in 2015. This percentage was not significantly different from that in 2009 (40 percent).
- The percentage of students in South Dakota who performed at or above the NAEP *Basic* level was 81 percent in 2015. This percentage was not significantly different from that in 2009 (81 percent).

Achievement-Level Percentages and Average Score Results



Rounds to zero.
* Significantly different ($p < .05$) from state's results in 2015. Significance tests were performed using unrounded numbers.
NOTE: Detail may not sum to totals because of rounding.

Compare the Average Score in 2015 to Other States/Jurisdictions

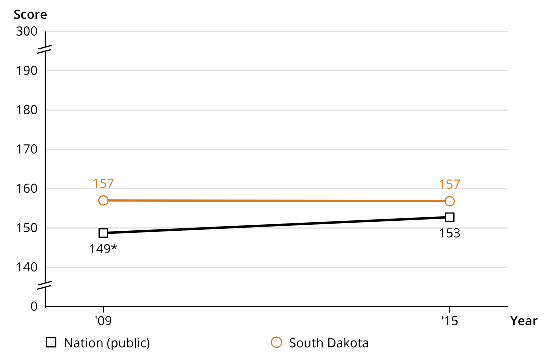


In 2015, the average score in South Dakota (157) was
- lower than those in 9 states/jurisdictions
- higher than those in 18 states/jurisdictions
- not significantly different from those in 19 states/jurisdictions

- 5 states/jurisdictions did not participate in 2015

DoDEA = Department of Defense Education Activity (overseas and domestic schools)

Average Scores for State/Jurisdiction and Nation (public)



* Significantly different ($p < .05$) from 2015. Significance tests were performed using unrounded numbers.

Results for Student Groups in 2015

Reporting Groups	Percentage of students	Avg. score	Percentage at or above *Basic*	Percentage at or above *Proficient*	Percentage at *Advanced*
Race/Ethnicity					
White	75	163	88	46	1
Black	3	142	65	21	#
Hispanic	5	146	71	24	#
Asian	1	‡	‡	‡	‡
American Indian/Alaska Native	13	131	52	13	#
Native Hawaiian/Pacific Islander	#	‡	‡	‡	‡
Two or more races	3	155	82	35	1
Gender					
Male	51	157	81	40	1
Female	49	157	81	39	1
National School Lunch Program					
Eligible	42	145	70	25	#
Not eligible	57	166	90	50	1

Rounds to zero.
‡ Reporting standards not met.
NOTE: Detail may not sum to totals because of rounding, and because the "Information not available" category for the National School Lunch Program, which provides free/reduced-price lunches, is not displayed. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin.

Score Gaps for Student Groups

- In 2015, Black students had an average score that was 21 points lower than that for White students. Data are not reported for Black students in 2009, because reporting standards were not met.
- In 2015, Hispanic students had an average score that was 17 points lower than that for White students. This performance gap was not significantly different from that in 2009 (17 points).
- In 2015, male students in South Dakota had an average score that was not significantly different from that for female students.
- In 2015, students who were eligible for free/reduced-price school lunch, an indicator of low family income, had an average score that was 21 points lower than that for students who were not eligible. This performance gap was not significantly different from that in 2009 (22 points).

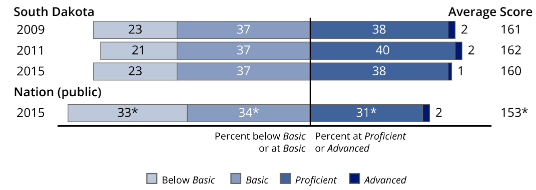
ies NATIONAL CENTER FOR EDUCATION STATISTICS
Institute of Education Sciences

NOTE: The NAEP science scale ranges from 0 to 300. Statistical comparisons are calculated on the basis of unrounded scale scores or percentages.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 and 2015 Science Assessments.

Overall Results

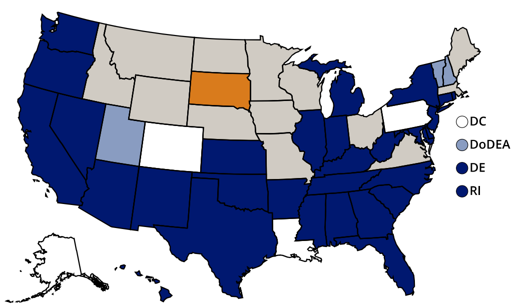
- In 2015, the average score of eighth-grade students in South Dakota was 160. This was higher than the average score of 153 for public school students in the nation.
- The average score for students in South Dakota in 2015 (160) was not significantly different from their average score in 2011 (162) and in 2009 (161).
- The percentage of students in South Dakota who performed at or above the NAEP *Proficient* level was 40 percent in 2015. This percentage was not significantly different from that in 2011 (42 percent) and in 2009 (40 percent).
- The percentage of students in South Dakota who performed at or above the NAEP *Basic* level was 77 percent in 2015. This percentage was not significantly different from that in 2011 (79 percent) and in 2009 (77 percent).

Achievement-Level Percentages and Average Score Results



* Significantly different ($p < .05$) from state's results in 2015. Significance tests were performed using unrounded numbers.
NOTE: Detail may not sum to totals because of rounding.

Compare the Average Score in 2015 to Other States/Jurisdictions

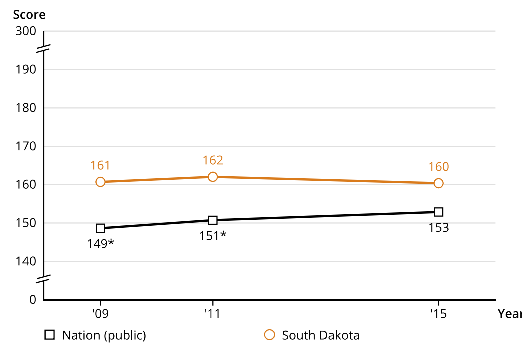


In 2015, the average score in South Dakota (160) was
- lower than those in 4 states/jurisdictions
- higher than those in 29 states/jurisdictions
- not significantly different from those in 13 states/jurisdictions

- 5 states/jurisdictions did not participate in 2015

DoDEA = Department of Defense Education Activity (overseas and domestic schools)

Average Scores for State/Jurisdiction and Nation (public)



* Significantly different ($p < .05$) from 2015. Significance tests were performed using unrounded numbers.

Results for Student Groups in 2015

Reporting Groups	Percentage of students	Avg. score	Percentage at or above *Basic*	Percentage at or above *Proficient*	Percentage at *Advanced*
Race/Ethnicity					
White	78	166	84	46	2
Black	2	‡	‡	‡	‡
Hispanic	4	142	56	18	1
Asian	2	‡	‡	‡	‡
American Indian/Alaska Native	12	138	48	11	#
Native Hawaiian/Pacific Islander	#	‡	‡	‡	‡
Two or more races	2	‡	‡	‡	‡
Gender					
Male	51	163	79	44	2
Female	49	158	75	36	1
National School Lunch Program					
Eligible	37	149	63	25	#
Not eligible	62	168	85	49	2

Rounds to zero.
‡ Reporting standards not met.
NOTE: Detail may not sum to totals because of rounding, and because the "Information not available" category for the National School Lunch Program, which provides free/reduced-price lunches, is not displayed. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin.

Score Gaps for Student Groups

- Data are not reported for Black students in 2015, because reporting standards were not met.
- In 2015, Hispanic students had an average score that was 23 points lower than that for White students. This performance gap was not significantly different from that in 2009 (31 points).
- In 2015, male students in South Dakota had an average score that was higher than that for female students by 5 points.
- In 2015, students who were eligible for free/reduced-price school lunch, an indicator of low family income, had an average score that was 19 points lower than that for students who were not eligible. This performance gap was not significantly different from that in 2009 (19 points).

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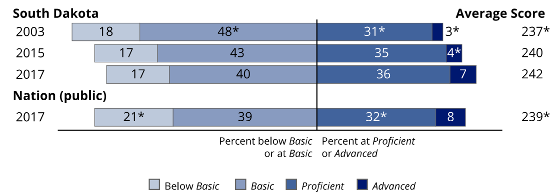
NOTE: The NAEP science scale ranges from 0 to 300. Statistical comparisons are calculated on the basis of unrounded scale scores or percentages.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 2009-2015 Science Assessments.

Overall Results

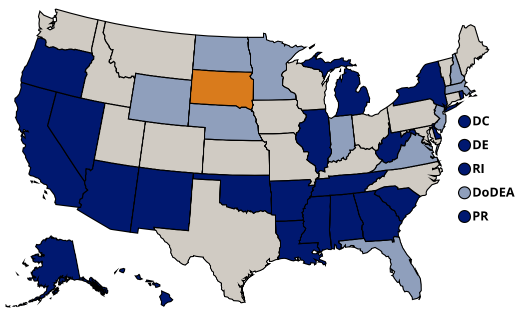
- In 2017, the average score of fourth-grade students in South Dakota was 242. This was higher than the average score of 239 for public school students in the nation.
- The average score for students in South Dakota in 2017 (242) was not significantly different from their average score in 2015 (240) and was higher than their average score in 2003 (237).
- The percentage of students in South Dakota who performed at or above the NAEP *Proficient* level was 43 percent in 2017. This percentage was not significantly different from that in 2015 (40 percent) and was greater than that in 2003 (34 percent).
- The percentage of students in South Dakota who performed at or above the NAEP *Basic* level was 83 percent in 2017. This percentage was not significantly different from that in 2015 (83 percent) and in 2003 (82 percent).

Achievement-Level Percentages and Average Score Results



* Significantly different ($p < .05$) from state's results in 2017. Significance tests were performed using unrounded numbers.
NOTE: Detail may not sum to totals because of rounding.

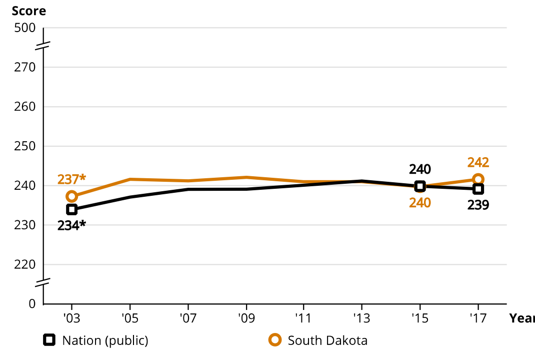
Compare the Average Score in 2017 to Other States/Jurisdictions



In 2017, the average score in South Dakota (242) was
- lower than those in 11 states/jurisdictions
- higher than those in 23 states/jurisdictions
- not significantly different from those in 18 states/jurisdictions

DoDEA = Department of Defense Education Activity (overseas and domestic schools)

Average Scores for State/Jurisdiction and Nation (public)



* Significantly different ($p < .05$) from 2017. Significance tests were performed using unrounded numbers.

Results for Student Groups in 2017

Reporting Groups	Percentage of students	Avg. score	Percentage at or above *Basic*	Percentage at or above *Proficient*	Percentage at *Advanced*
Race/Ethnicity					
White	73	247	90	50	9
Black	2	219	60	14	#
Hispanic	5	229	69	28	2
Asian	1	‡	‡	‡	‡
American Indian/Alaska Native	14	220	59	17	1
Native Hawaiian/Pacific Islander	#	‡	‡	‡	‡
Two or more races	4	240	81	39	7
Gender					
Male	50	244	84	46	9
Female	50	239	82	39	4
National School Lunch Program					
Eligible	41	230	72	27	2
Not eligible	58	250	91	54	10

\# Rounds to zero.
‡ Reporting standards not met.
NOTE: Detail may not sum to totals because of rounding, and because the "Information not available" category for the National School Lunch Program, which provides free/reduced-price lunches, is not displayed. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin.

Score Gaps for Student Groups

- In 2017, Black students had an average score that was 28 points lower than that for White students. Data are not reported for Black students in 2003, because reporting standards were not met.
- In 2017, Hispanic students had an average score that was 18 points lower than that for White students. This performance gap was not significantly different from that in 2003 (18 points).
- In 2017, male students in South Dakota had an average score that was higher than that for female students by 4 points.
- In 2017, students who were eligible for free/reduced-price school lunch, an indicator of low family income, had an average score that was 21 points lower than that for students who were not eligible. This performance gap was wider than that in 2003 (16 points).

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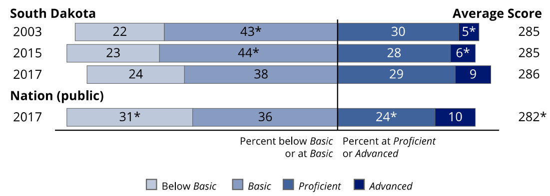
NOTE: The NAEP mathematics scale ranges from 0 to 500. Statistical comparisons are calculated on the basis of unrounded scale scores or percentages. Read more about how to interpret NAEP results from the mathematics assessment at https://nces.ed.gov/nationsreportcard/mathematics/interpret_results.aspx.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 2003-2017 Mathematics Assessments.

Overall Results

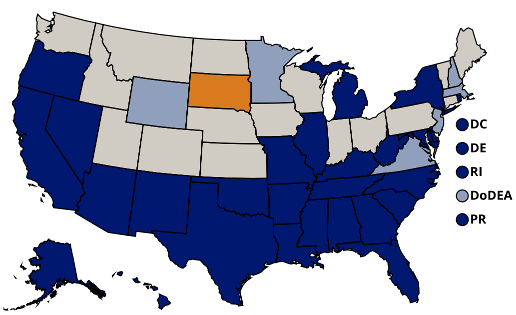
- In 2017, the average score of eighth-grade students in South Dakota was 286. This was higher than the average score of 282 for public school students in the nation.
- The average score for students in South Dakota in 2017 (286) was not significantly different from their average score in 2015 (285) and in 2003 (285).
- The percentage of students in South Dakota who performed at or above the NAEP *Proficient* level was 38 percent in 2017. This percentage was greater than that in 2015 (34 percent) and in 2003 (35 percent).
- The percentage of students in South Dakota who performed at or above the NAEP *Basic* level was 76 percent in 2017. This percentage was not significantly different from that in 2015 (77 percent) and in 2003 (78 percent).

Achievement-Level Percentages and Average Score Results



* Significantly different ($p < .05$) from state's results in 2017. Significance tests were performed using unrounded numbers.
NOTE: Detail may not sum to totals because of rounding.

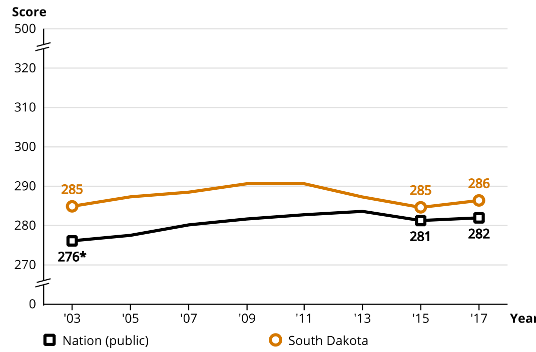
Compare the Average Score in 2017 to Other States/Jurisdictions



In 2017, the average score in South Dakota (286) was
- lower than those in 7 states/jurisdictions
- higher than those in 29 states/jurisdictions
- not significantly different from those in 16 states/jurisdictions

DoDEA = Department of Defense Education Activity (overseas and domestic schools)

Average Scores for State/Jurisdiction and Nation (public)



* Significantly different ($p < .05$) from 2017. Significance tests were performed using unrounded numbers.

Results for Student Groups in 2017

Reporting Groups	Percentage of students	Avg. score	Percentage at or above *Basic*	Percentage at or above *Proficient*	Percentage at *Advanced*
Race/Ethnicity					
White	77	293	83	45	11
Black	3	258	47	11	#
Hispanic	5	269	60	20	2
Asian	2	‡	‡	‡	‡
American Indian/Alaska Native	11	254	40	10	1
Native Hawaiian/Pacific Islander	#	‡	‡	‡	‡
Two or more races	2	282	75	29	7
Gender					
Male	51	286	75	39	9
Female	49	287	77	38	9
National School Lunch Program					
Eligible	35	269	59	21	3
Not eligible	63	296	86	48	12

\# Rounds to zero.
‡ Reporting standards not met.
NOTE: Detail may not sum to totals because of rounding, and because the "Information not available" category for the National School Lunch Program, which provides free/reduced-price lunches, is not displayed. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin.

Score Gaps for Student Groups

- In 2017, Black students had an average score that was 36 points lower than that for White students. Data are not reported for Black students in 2003, because reporting standards were not met.
- In 2017, Hispanic students had an average score that was 25 points lower than that for White students. Data are not reported for Hispanic students in 2003, because reporting standards were not met.
- In 2017, male students in South Dakota had an average score that was not significantly different from that for female students.
- In 2017, students who were eligible for free/reduced-price school lunch, an indicator of low family income, had an average score that was 27 points lower than that for students who were not eligible. This performance gap was wider than that in 2003 (19 points).

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NOTE: The NAEP mathematics scale ranges from 0 to 500. Statistical comparisons are calculated on the basis of unrounded scale scores or percentages. Read more about how to interpret NAEP results from the mathematics assessment at https://nces.ed.gov/nationsreportcard/mathematics/interpret_results.aspx.
SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 2003-2017 Mathematics Assessments.

APPENDIX C

November 24, 2017

To whom it may concern:

My name is Ellen Roufs and I am an Honors Student at the University of South Dakota. I am currently studying Biology and hope to continue to earn my master's degree in Secondary Education so that I can teach high school science! As a part of the Honors program, I am working on a thesis project which aims to expose young children in the Vermillion area to the exciting world of (Science, Technology, Engineering and Mathematics (STEM), and I am asking for your support!

STEM education is of increasing importance for children in our society. Advancements in technology, a growing need for new ideas in engineering and mathematics, and greater emphasis on science have all contributed to the renewed focus on STEM education. It is crucial that children develop an appreciation and enthusiasm for STEM at a young age. Fostering a curiosity in students is a valuable investment in their personal future and the future of our world!

Currently, Kindergarteners and First Graders at Austin Elementary school in Vermillion do not receive any science education as a part of their school day. The goal of this project is to provide an opportunity for some of these students to encounter science during their time at the after-school care program, Beyond School Adventures. The six fun, hands-on, and unique activities for students will include a variety of interesting concepts in STEM. Each module will involve a short background presentation/demonstration of the topic being explored, an opportunity for each student to make/do the activity, and a take-home component for extended learning and sharing of their new understanding. I also hope to leave the resources with the Beyond School Adventures (BSA) program for use in future years!

Here is where I need your help. Because I am an undergraduate student, I am unable to fund this program personally. I am reaching out to you because I believe that you understand the importance of investing in these children! The main financial need is for basic supplies for the activities. I would estimate the cost to be approximately $100 for this year. A larger donation could fund the program for additional years to come!

I hope to bring these activities to BSA beginning in January 2018. I would appreciate if you could get back to me as soon as it is possible. Please feel free to contact me if you would like more details!

Thank you,

Ellen Roufs

APPENDIX D

Proposed Budget for "Young Scientists" Program at Vermillion BSA			
50 students K-1			
Many supplies are 1-time investment, others are consumable (for projects). This budget includes enough consumable supplies for 5 years			
	Quantity	**Price each**	**Total price**
KINDERGARTEN			
Growing a Plant: $15			
bag of beans			$2.00
paper towels			$2.00
plastic baggies	150		$6.00
plant posters			$5.00
Habitat Exploration Bins: $94			
Plastic storage tubs	4	$2.00	$8.00
Animal figurines (4 tubes with 10 figurines each)	4	$14.00	$56.00
Habitat building elements			$30.00
Solar Heat: $22			
Ice cube trays	2	$3.00	$6.00
Magnifying glasses	12	$0.50	$6.00
Miscellaneous items to test			$10.00
FIRST GRADE			
Exploring Plants: $89			
produce (buy each year)	5	$10.00	$50.00
rubber mallets	2	$6.00	$12.00
safety glasses	20	$1.35	$27.00

Engineering a Communication Device: $30			
paper and drawing materials			$10.00
misc. supplies for building prototypes (rubber bands, wire, tape, pipe cleaners, popsicle sticks, cardboard, etc.)			$40.00
Science of Sounds: $33			
straws	150		$3.00
rubber bands	100		$10.00
large popsicle sticks	600		$20.00
OTHER			
Binders/printing for instruction manual			$5.00
Plastic storage tubs	8	$2.00	$16.00
Misc./unforeseen expenses			$50.00
GRAND TOTAL (consumable supplies for 5 years)			**$374.00**
Cost for Each Additional Year: $50			
bag of beans			$1.00
paper towels			$1.00
plastic baggies			$2.00
Miscellaneous items to test			$3.00
produce (buy each year)			$10.00
paper and drawing materials			$4.00
misc. supplies for building prototypes (rubber bands, wire, tape, pipe cleaners, popsicle sticks, cardboard, etc.)			$10.00
straws			$1.00
rubber bands			$3.00
large popsicle sticks			$5.00
Misc./unforeseen expenses			$10.00

TOTAL			**$50.00**

APPENDIX E

The following pages contain the handouts for the students to take home with them after the activity.

These documents are also available at https://tinyurl.com/youngscientistsbsa.

General Instructions

K: Solar Heat

K: Growing a Plant

K: Habitats

1: Science of Sound

1: Engineering a Communication Device

1: Exploring Plants

YOUNG SCIENTISTS

Beyond School Adventures

General Instructions

Contact: Laura Dimock, BSA Coordinator

- laura.dimock@k12.sd.us
- 1 (605) 677-8398
- ***Call or text Laura the day before you are coming so she can inform BSA staff that you will be there!***

Location: Austin Elementary School (17 Prospect Street, Vermillion, SD)

- You can park across the street or on the next block
- Enter the front doors and check in with the office secretary

Prep:

- **Arrive around 3:00** or 3:15pm
- Students will have play and snack time until about 4:00pm (this gives you time to set up)
- (Most) supplies are in tubs under the bench in the BSA storage area/nurse office
    - ***Some activities require you to collect or prep stuff ahead of time!***
    - If you need to purchase anything, like fruit for "Exploring Plants", contact Laura
    - Some supplies (like scissors, etc) are in the metal cabinets in this area (you can always ask BSA of Austin staff)
- Do the activities in the **STEAM lab** (unless it specifies to do it outside, ie: "Exploring Plants")
- Copy take-home handouts (can use copier in office, ask secretary, use code for **BSA: 8398**)
- Pull up introduction slides on SmartBoard
    - Computer username/password in STEAM lab: **BSA/bsa**
    - Link to Google Slides: **https://tinyurl.com/youngscientistsbsa**
- Clean up and leave space as you found it!

Other important tips:

- Have the students sit on the floor by the SmartBoard for the introduction before starting the activity
- Inform BSA staff what grade/how many students you want to take at a time (this usually depends on how many are there that day)
- BSA staff will typically come to the STEAM lab to help you with supervision
- Have fun! Taylor the activities to match your personality and skills!

YOUNG SCIENTISTS

Beyond School Adventures

K **Solar Heat**

Learning Objective: ***Sunlight*** *warms the Earth's surface.*

Ask me what I learned today!

An important part of learning is being able to *share* and *apply* that knowledge and skill. Ask your child what they learned today, what they created, how and why it works, and encourage them to continue learning by finding ways to extend this experience!

Solar Energy Balloon Blow-up Experiment

Need:

- 2 empty pop bottles
- 2 balloons
- White and black paint

1. Paint both bottles, one white and one black.
2. Attach a balloon tightly to the mouth of each bottle.
3. Place both bottles in the sun and watch what happens. It won't take very long for the balloon on the black bottle to start to expand. The balloon on the white bottle will hardly change.

Why did this happen? - Here are some questions that could be answered:

- Did one bottle get warmer inside? Why?
- What did the air inside the black bottle do?
- Why does the balloon on the black bottle get bigger?
- Could you use this method to heat your house? How?

Adapted from geocities.com/thesceincefiles

YOUNG SCIENTISTS

Beyond School Adventures

K

Growing a Plant

Learning Objective: *Plants and animals need food and water in order to grow.*

Ask me what I learned today!

An important part of learning is being able to *share* and *apply* that knowledge and skill. Ask your child what they learned today, what they created, how and why it works, and encourage them to continue learning by finding ways to extend this experience!

PLANT CARE INSTRUCTIONS

- Wear the bag around your neck, under your shirt to keep it warm.
- Put the bag in a warm place. The seeds should start to sprout little roots and leaves (germinate) in a few days.
- After 7-10 days, you can transfer the germinated seeds into a pot or cup of soil.

Here are some more fun projects for you to try at home!

- Take a nature walk. Where do you find plants and seeds? Where do you not find them?
- What plants and seeds do you eat? Have a scavenger hunt around your kitchen!
- Sprout a cob of corn!
    1. Put a corn cob in a shallow tub of water, put in a warm and sunny spot.
    2. After a few days, you should notice an exciting change!
    3. Does it look the same as the other seeds you grew?

YOUNG SCIENTISTS

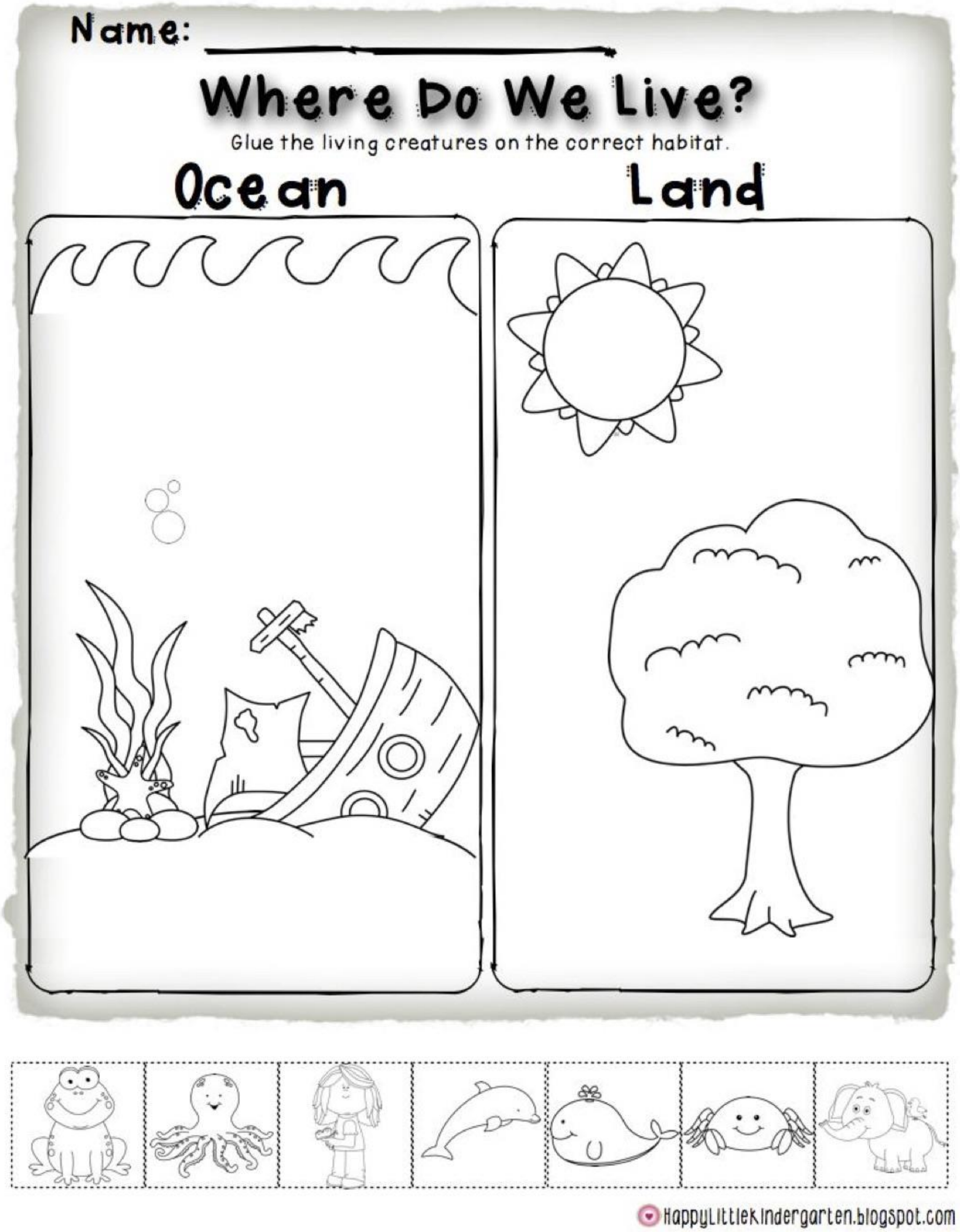
Beyond School Adventures

K Habitats

Learning Objective: *Plants and animals can change their local environment. They need to survive and there is a relationship between their needs and where they live.*

Ask me what I learned today!

An important part of learning is being able to *share* and *apply* that knowledge and skill. Ask your child what they learned today, what they created, how and why it works, and encourage them to continue learning by finding ways to extend this experience!


Name:
Where Do We Live?
Glue the living creatures on the correct habitat.
Ocean
Land
HappyLittleKindergarten.blogspot.com

YOUNG SCIENTISTS
Beyond School Adventures

1 Science of Sounds

Learning Objective: ***Sound*** *can make matter vibrate, and vibrating matter can make sound.*

Ask me what I learned today!

An important part of learning is being able to *share* and *apply* that knowledge and skill. Ask your child what they learned today, what they created, how and why it works, and encourage them to continue learning by finding ways to extend this experience!

Here is another fun project for you to try at home!

What you need:

- Unpainted metal clothes hanger
- String
- Scissors

What you do:

1. Cut two lengths of string, each about two feet long.
2. Tie one end of each string to a different side of the metal hanger.
3. Wind the free end of one string around your pointer finger a few times. Wind the other string around the pointer finger on your other hand.
4. Allow your assembly to swing freely from your two fingers.
5. Place your index fingers (with hanger assembly attached) gently on the small flap of skin just in front of your ears, closing off the ear canal without putting your fingers into your ears.
6. Swing the hanger so that it bangs lightly against something hard, like the edge of a desk or a door frame, and then let the hanger hang free. As the hanger vibrates, you should hear the resulting sound ring through the strings like chimes.

What's happening?

It's all about vibrations! When you hit the coat hanger against another object, it starts vibrating. The vibrations in the metal travel through the string and into your fingers. The vibration is transferred to your head! Try it without holding the strings to your head, the sound will be much duller because it is traveling through air.

Adapted from www.exploratorium.edu

YOUNG SCIENTISTS

Beyond School Adventures

1 Engineering a Communication Device

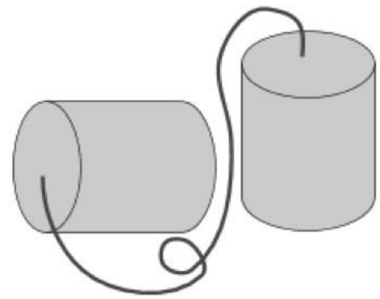
Learning Objective: *People use **devices** to send and receive information.*

Ask me what I learned today!

An important part of learning is being able to *share* and *apply* that knowledge and skill. Ask your child what they learned today, what they created, how and why it works, and encourage them to continue learning by finding ways to extend this experience!

Here is another fun project for you to try at home!

Tin-Can Telephone



- Two tin cans, tops removed
- Duct tape
- A nail
- A hammer
- String
- Markers, paint, glitter, felt, or other decorations

1. If the can opener left rough edges when you removed the tops, tape over them so you won't scratch a finger. Use the decorations to make the telephone look cool!
2. Turn both cans upside down and hammer a nail through the bottom of each can to make a hole in the center. Remove nail and set aside.
3. Cut a long length of string – up to 10 feet.
4. Poke one end through the bottom of one can, knotting on the inside. Repeat with the other end of string in the other can.
5. Instruct two kids to each take a can and move apart until the string is taut.
6. One child should put a can to his ear while the other talks directly into the other can. The sound will travel over the "wire."

What happened?

When you speak, your voice makes vibrations. Once the string is stretched tight enough, these vibrations travel down the string and vibrate the bottom of the can on the other end which, in turn, vibrates the air and those vibrations travel through the air to the other person's ear.

Adapted from education.com

YOUNG SCIENTISTS

Beyond School Adventures

1 Exploring Plants

Learning Objective: *Plants and animals use many parts to help them survive, grow, and meet their needs.*

Ask me what I learned today!

An important part of learning is being able to *share* and *apply* that knowledge and skill. Ask your child what they learned today, what they created, how and why it works, and encourage them to continue learning by finding ways to extend this experience!

Here is another fun project for you to try at home!

How Plants Breathe Experiment

1. Fill large clear bowl with lukewarm water.
2. Pick a leaf from a tree or plant (must be active, so make sure you pick one from the plant) and submerge in water. Put a small stone on top so it remains underwater.
3. Set the bowl in the sun for a few hours. After this time has passed, look closely at the leaf. You can use a magnifying glass if you have one. You should see little bubbles coming out of the leaf!

Why did this happen?

The leaf is using the sunlight as part of the photosynthesis process (where leaves convert sunlight to chemical energy). As the leaf releases oxygen during this process, it can be seen as bubbles in the water! Think about when you are underwater at the pool, you also make bubbles when you breathe out. It is almost the same, but you use your mouth/lungs and plants use their leaves!

Adapted from kcedventures.com

APPENDIX F

The following pages contain the leader manuals to guide the activities. These documents are also available at https://tinyurl.com/youngscientistsbsa.

K: Solar Heat

K: Growing a Plant

K: Habitats

1: Science of Sound

1: Engineering a Communication Device

1: Exploring Plants

YOUNG SCIENTISTS

Beyond School Adventures

Solar Heat

Learning Objective: ***Sunlight*** *warms the Earth's surface.*

Background:

Solar energy is the radiation of the sun that is capable of producing heat, causing chemical reactions, and generating electricity. The sun is by far the largest energy source on the Earth. However, the intensity at the Earth's surface is quite low because most of the energy is dispersed throughout space or absorbed in the atmosphere. Solar energy is a major source of renewable energy and has the potential to provide most of our energy needs in the near future. Solar energy is captured in two main ways: through thermal energy capture and electricity generation. Thermal energy is collected by large plates that absorb the sun's heat and used for human applications. On the other hand, solar panels harness the sun's light energy and convert it into electricity (Ashok, 2018).

Activity:

- Predict what will melt in the sun
- Test by putting objects in sun and observing what melted!

Prep:

- Need: Paper and coloring supplies
- Find objects that may/may not melt
    - Crayons
    - Ice cube
    - Chocolate
    - Coins
    - Lego
    - Butter
    - Marble
    - Cheese
    - Marshmallow
    - Soap
    - Etc.
- If possible, put a muffin tin with each of these objects in the sun several hours before the experiment for more dramatic results (if this is not possible, can adapt by using blow dryer)
- Adaptation: need blow dryer
- Project PowerPoint on SmartBoard (chart with image of each item, how many people think it will/will not melt)
- Print take-home handouts

Opening:

- What happens when you get hot?
- What happens when an ice cube gets hot?
- Why do you get hot on a sunny day?
- Why do you think the earth gets hot?

The sun is hot and makes the earth warm. Today we are going to see what the sun will melt!

Predict and test

- Fill out chart: raise your hand if you think this *will* melt in the sun/raise your hand if you think it *will not*
- Put different objects in muffin tins and put in sun
- While waiting: What else happens when it is sunny and hot? Draw the sun and show what happens on a hot day (ice cream melt, car hot, sidewalk hot, sweaty, dog pants, etc.)
- After ~20 min, check your objects and see what changed
- Compare with tin that was in the sun for several hours beforehand

Adaptation (if sun not out/hot enough)

- Fill out chart: raise your hand if you think this *will* melt in the sun/raise your hand if you think it *will not*
- Put different objects in muffin tins
- Use hair dryer to heat each object for approximately 20 seconds

Conclusion

What in the “melt” tray did/did not melt? What about the “not melt” tray? Was anything a surprise?

Take-home:

- Show your family the picture you drew and tell they about what you learned today!
- You can do this experiment again at home, try objects around your house!
- What happens if you use a magnifying glass? Do things melt faster? Try to build something to increase the sun’s energy
- Use your imagination and build something to *block* the sun’s energy

YOUNG SCIENTISTS

Beyond School Adventures

K Growing a Plant

Learning Objective: *Plants and animals need food, light, air, and water in order to grow.*

Background:
All organisms need nutrients to grow, repair, and reproduce. Plants are classified as photoautotrophs, which means they create their own food through the process of photosynthesis. Photosynthesis creates sugar molecules from carbon dioxide, water, and light energy from the sun. They also need to obtain nutrients from their environment for the metabolic processes involved in growth, repair, and reproduction. In order for a plant to thrive, it needs a source of water, nutrients, CO_2 (in the air), and sunlight (Yopp and Woodwell, 2018).

Activity:

- Talk about what plants need to grow: evidence-based learning through photos
- Have supplies available to plant a bean

Prep:

- Project powerpoint on SmartBoard (images of what plants look like without sun/water/soil vs a healthy plant)
- Collect supplies for them to plant a bean
  - Paper towels
  - Plastic baggies
  - Dried beans
  - Water (in plastic cup/container)
  - Yarn
  - Hole punch
- Print take-home handouts

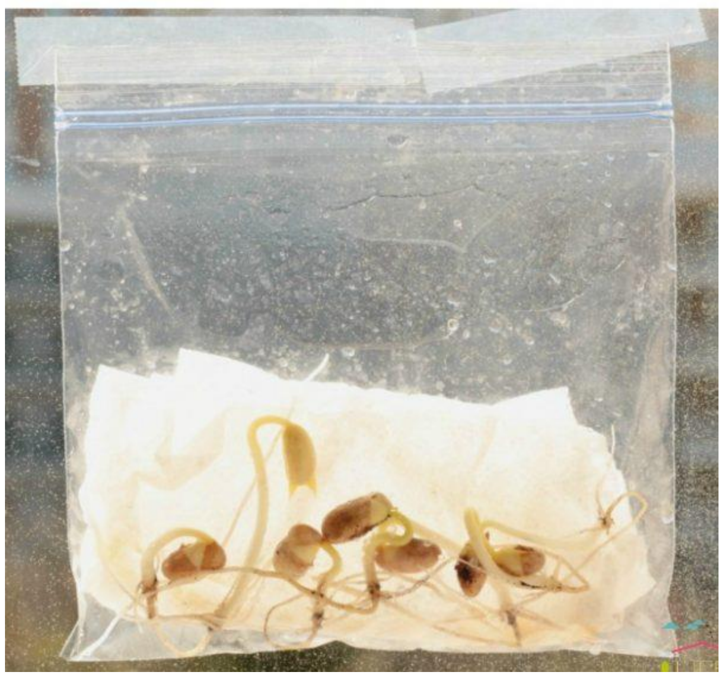
Opening:

- How many of you are growing?
- What do you need to grow?
- Why do you think you need these things to grow?
- What do you think plants need to grow?

Plants need soil, air, water, and sunlight to grow. Today we are going to plant a seed and hope it grows!

Plant the seeds:

- Put a few seeds in ziplock baggie with a wet paper towel, seal (it will have water and air in the bag).
- Punch holes in top strip of the baggie (so you do not break the seal) and string yarn through it.
- Wear the bag around your neck, under your shirt to keep it warm.
- Put the seedlings in a warm place. The seeds should start to sprout little roots and leaves (germinate) in a few days.
- After 7-10 days, you can transfer the germinated seeds into a pot or cup of soil.



Adapted from lifeovercs.com

Take-home:
Teach your family what you learned about what a plant needs to grow! Here are a few more ideas of how you can see how plants grow!

YOUNG SCIENTISTS
Beyond School Adventures

K Habitats

Learning Objective: *Plants and animals can change their local environment. They need to survive and there is a relationship between their needs and where they live.*

Background:

A habitat is a place where an organism or a community of organism lives. Four examples of common habitats include marine, polar, forest, and desert habitats. Marine--or ocean--habitats are the largest habitats on Earth as ocean waters cover two-thirds of the globe. These ecosystems are dynamic and diverse, characterized by few plants and insects (compared to other common habitats) but many crustaceans, bacteria, and fish. Polar--or arctic--habitats include tundra and polar regions that are covered by ice and snow. These ecosystems are characterized by low annual temperatures and very few living organisms. Forest habitats are characterized by trees and the dominant life form, but are also home to many species of plants, birds, mammals, and insects. There are many types of forest habitats based on annual temperatures, precipitation, soil type, and biodiversity. Desert areas are extremely dry areas with sparse vegetation and can be hot or cold. The only plants and animals to be found in this type of ecosystem that are those adapted to surviving with very little water (Kingsford, Juday, and Smith, 2018).

Activity: Explore different habitats by playing in sensory bins.

Prep:

- Prep sensory bins
  - Fill polar bin with snow/ice
  - Fill marine bin with water
- Optional: playdough to create shelter for animals (if larger groups)

Opening:

- Where do you live? What do you need in your house to survive and be happy? (food, water, bed, toys, etc.)
- What do you think animals and plants need to survive?

Today we are going to pretend to be animals living in a habitat! What do I need to do? Where do I get food/water/shelter?

Explore: Have animal figurines and a variety of materials to make a habitat in a bin

Conclusion: What habitats do you see around the school? In the country? In your backyard? What do you think happens to the animals if I change or take away parts of their habitat?

Take-home:
Tell your family what you learned about today! See if you can find habitats in your backyard!

YOUNG SCIENTISTS
Beyond School Adventures

1 Science of Sounds

Learning Objective: ***Sound*** *can make matter vibrate, and vibrating matter can make sound.*

Background:

Sound is defined as a mechanical disturbance, a vibration which may or may not be detectable with the human ear. In physics, sound is characterized by the properties of its waves. These waves can have varying frequency (experienced as pitch) and amplitude (experienced as loudness). Vibrating matter causes sound vibrations (think of a guitar string), and sound vibrations can in turn cause matter to vibrate (think of loud bass music in your car) (Berg, 2018).

Activity: Make a harmonica instrument that uses vibrations to make sound.

Prep:

- Collect supplies
    - Large craft sticks (2 each)
    - Large rubber bands (1 each)
    - Small rubber bands (2 each)
    - Plastic straws
    - Scissors

Opening:

- How do you hear? What do you hear?
- Can you see what you hear? Why not? What is sound?
- What is vibration?

Today we are going to make an instrument that makes sound with vibrations!

Create:

1. Cut two pieces of straw that are 1 – 1 .5 inches long.
2. Stretch the thick rubber band around one of the craft sticks. Place one of the straws under the rubber band.
3. Put the other craft stick on top and attach them with one of the small rubber band on the same end as the straw.
4. Stick the other piece of straw at the other end of the harmonica, but this time place it on top of the wide rubber band. Secure the end with the second small rubber band.
5. Blow across to make sound!

Conclusion: What happens if you move the straws? Why do you think this makes sound?

Take-home:
Show your family what you made and teach them how it works! Here are the instructions for another fun project that you can make at home.

Adapted from frugalfun4boys.com

YOUNG SCIENTISTS
Beyond School Adventures

1 Engineering a Communication Device

Learning Objective: *People use **devices** to send and receive information.*

Background:

Communication is the exchange of information between individuals. The field of telecommunication more specifically focuses on the transmission of information by electromagnetic means. Before modern electronic communication, people shared information over distance via letters and the telegraph. Soon after came the development of the telephone, radio, fax, and television. Now our main means of communication is through email and the internet (Lehnert and Borth, 2018).

Activity:

- Talk about ways that people communicated in the past and how they communicate now - pictures on SmartBoard
- Brainstorm and draw out a new device for communication
- Have supplies available to make prototypes

Prep:

- Collect supplies for them to make prototypes of their new device
    - Paper and drawing supplies
    - Pipe cleaners
    - Cardboard
    - Wire
    - Cardboard rolls
    - Glue
    - Buttons
    - Aluminum foil
    - Tape
    - Markers
    - String
    - Popsicle sticks
    - Scissors
    - Anything you can find!
- Pull up introduction slides
- Print take-home handouts

Opening:

- If your friend lived on the other side of the world, how would you talk to them or show them something?

- What are some things that you have used to talk to someone far away?

- What do these things all have in common? (be able to see or hear information) Think about how you could change these things to make them better!

Today we are going to design a new device that can help us talk to someone who is far away.

Design and build:

- Everybody gets a piece of paper and supplies to draw their idea for a new communication device - use your imagination!

- Have supplies laid out for them to make a prototype of their new device

Conclusion:
Show and Tell - everyone gets a chance to show what they made and explain how it would work!

Take-home:
Show your family what you made! Here are the instructions for another fun project that you can make at home.

YOUNG SCIENTISTS
Beyond School Adventures

1 Exploring Plants

Learning Objective: *Plants and animals use many parts to help them survive, grow, and meet their needs.*

Background:

Plants have great diversity of structure and function. Many plants produce seeds as a reproductive structure. Each seed is composed of an embryonic plant, food-storage tissue, and hardened protective covering. Gymnosperms are plants whose seeds are exposed on the surface of cone scales, such as redwoods, firs, and pines. Angiosperms are plants whose seeds are contained in a flower, such as most fruit and vegetable species. Many plants have unique seed dispersal structures, ranging from burrs to helicopters to fruit. Roots and stems are found in vascular plants to conduct water from the soil to the leaves, which are the primary site of sugar-producing photosynthesis (Woodwell, 2018).

Activity:

- Explore plant parts by smashing them open and looking what is inside
- Plant Part Scavenger Hunt to identify functions of structures

Prep:

- Purchase fresh fruits and vegetables for them to smash open and explore
  - Apple
  - Corn on the cob
  - Banana
  - Cantaloupe
  - Tomato
  - Whole carrot
  - Beans
  - NO PEANUTS OR TREE NUTS (allergies)
  - Anything you think would be fun to smash open!
- Collect leaves, seeds, and nuts from nature (*be confident that you are collecting plants that you are familiar with and that are not poisonous!)
  - Helicopters
  - Dandelions
  - Cattails
  - Flat leaves
  - Evergreen needles
  - Waxy leaves
  - Flowers
  - Bark
  - Roots
  - Anything you can find!
- Collect other supplies: safety glasses, rubber mallets, scissors
- Prepare space OUTSIDE
- Print take-home handouts

Opening:

- What do you need to SURVIVE?
- What do you need to GROW?
- What do you think other living things need to survive and grow?
- How are people and plants the same and different?

Today we are going to explore what special things plants use to survive and grow.

Explore:

- Safety first: need to wear safety glasses when using mallet
- Cut open fruit, nuts, etc. to collect seeds
- Look at different types of leaves and other plant structures

Conclusion:

Scavenger Hunt Chart (can be on SmartBoard): *Who found this?*

- Something for getting water
- Something for getting light
- Something for spreading seeds
- Something for protecting
- What part makes food for the plant?
- What part attracts butterflies and bees?
- What part does the plant use to breathe?

Take-home:
Everyone can pick something they want to bring home and show their family. Tell them what the plant uses it for!

APPENDIX G

The following pages contain images of the slides available to introduce the activities.

These slides are available at https://tinyurl.com/youngscientistsbsa.

K: Solar Heat

K: Growing a Plant

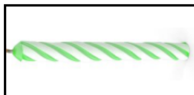
K: Habitats

1: Science of Sound

1: Engineering a Communication Device

1: Exploring Plants

What will melt?

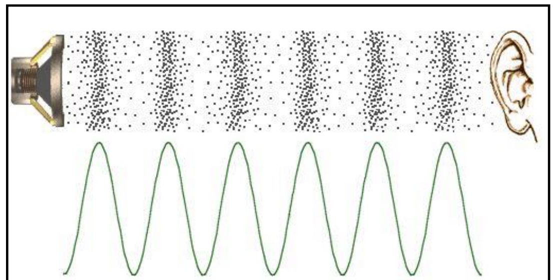
					
					
					
					
					
					

Plants

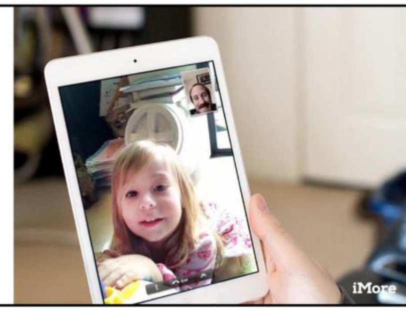
Let’s plant a bean!

Habitats

Sound



Communication



Your turn!

Plant Part Scavenger Hunt

Who found this?

A seed

A leaf

A stem

A root

A flower

Something for getting water	Something for spreading seeds
Something for protecting	What part makes food for the plant
What part attracts butterflies and bees	What part the plant uses to breathe

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