

The Journal of the Illinois Science Teachers Association

SPECTRUM

Fall 2017, Volume 41, Number 1



In this Issue

Exploring the Atmosphere
with a Weather Balloon

The Soil Moisture Project

Plan Ahead:

Science in the South, January 19, SIU-Carbondale

NSTA National Conference on Science Education, March 15-18, Atlanta

STEM Forum and Expo, July 11-13, Philadelphia





Spectrum

The Journal of the Illinois Science Teachers Association

Fall 2017, Volume 41, Number 1

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Spectrum is published two times per year, in spring and fall by the Illinois Science Teachers Association

Submissions and inquiries should be directed to the Executive Director at istaspectrum@gmail.com. Refer to the next page for information about writing for the Spectrum.

The Illinois Science Teachers Association recognizes and strongly promotes the importance of safety in the classroom. However, the ultimate responsibility to follow established safety practices and guidelines rests with the individual teacher. The views expressed by authors are not necessarily those of ISTA, the ISTA Board, or the Spectrum.

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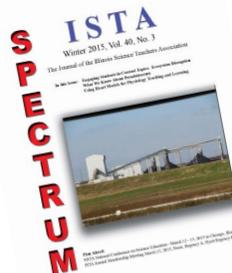
Write for the ISTA Spectrum!



What is the ISTA Spectrum and Why Should I Consider Writing for the Spectrum?

The Spectrum is a digital, peer-reviewed journal published by the Illinois Science Teachers Association. Tremendous value comes from the professional writing process when shared with your peers.

- You have direct involvement with the professional development and growth of your peers and colleagues.
- You gain greater perspective and insight about your own work.
- Sharing with peers causes one to be more reflective.
- Writing for a broader audience expands one's views.
- Publications enhance one's vitae.
- Peers provide invaluable feedback.
- You establish new professional contacts and networks throughout the state.



What kinds of work will be considered? Here are just a few ideas.

- A new slant on a recurring theme
- Book reviews of relevant pieces
- Content and curriculum ideas
- Classroom strategies, pedagogy, labs and demonstrations
- Hot topics
- Action research
- Dynamic resources and how you used them
- Innovations
- Interesting and unique

What else do I need to know about writing for the Spectrum?

- Submitted works must be original and not have been published elsewhere.
- The author must submit the work as a Word document, preferably of 3000 words or less.
- All authors' names, affiliations, email addresses, and brief biographies of three or four sentences must be included.
- Consider including illustrations, photographs, and other graphics as appropriate.
- Include references and in-text citations in APA style.
- Illustrations, photographs or graphics that are the work of those other than the authors must be accompanied by permission from the creator and credited appropriately.
- Email completed manuscripts that meet the above criteria to istaspectrum@gmail.com.
- Manuscripts will be accepted year round. The editorial staff will make selections for each edition based on relevance and timeliness of topics.

What happens after I email the manuscript?

Upon receipt of the manuscript authors will be notified. The editorial staff may request revision. Once a determination has been made to include the submitted work in a future edition of the Spectrum, the author(s) will be notified.

Questions?

Email your questions to Mary Biniewicz, ISTA Executive Director, istaspectrum@gmail.com.

Editor's Page

Dr. Christopher P. Cunnings
Assistant Professor of Education, Millikin University

Remarks

First and foremost, I am proud to serve as the editor that has resurrected the Spectrum journal after a brief hiatus. As a former high school science and mathematics teacher, and current professor of science education, I have made it my life's work and undying passion to advance students' interest, knowledge, and appreciation of STEM through a variety of student-centered, inquiry-driven approaches to science instruction and curriculum development. If you are reading this, there is a very strong chance that your life's work aligns strongly with what I've described, and my guess is that all of our readers and members are united in this objective. It is my hope that by regularly publishing new editions of Spectrum, we can provide a wide-reaching platform for helping all teachers in our state discover exciting and meaningful paths making science the favorite subject of an increasingly larger percentage of Illinois students.

This edition of Spectrum includes newly-submitted content from current or retired Illinois educators and college professors, but it also includes a nostalgic piece from one of our past Spectrum editions. Our hope is to not only publish high-quality original submissions, but to occasionally feature articles that still resonate with contemporary science educators after withstanding the test of time. I urge all of our readers to consider organizing and writing a manuscript for publication because, frankly, most of us are doing creative and exciting things in our science classrooms that are worth sharing! Below, I've provided some information for anyone interested in being published in our journal. Although we haven't concretely decided how many editions we'd like to put out annually, the hope is to be able to put out editions as regularly as we're receiving and processing high-quality, original, STEM-focused content.

My challenge to all of our readers is simple: Force us to put out at least 3-4 journal editions per year in the future by spending some time over winter, spring, or summer break writing a manuscript. The more high-quality submissions that we receive, the more editions we will publish! If you prefer, ask a colleague to co-write the article with you. Showcase some of the unique science lessons, activities and projects that you are using not just to your students and principal, but to science educators all across the state of Illinois. Frankly, if you have something worth sharing that could benefit the greater science education community, it is my hope (and the hope of ALL of us at ISTA) that you choose our journal as a means of disseminating your work.

Please see the information below if you are interested in submitting a manuscript to Spectrum, and do not hesitate to contact me if you have any questions regarding the submission process, peer review process, or anything in general.

Information for Spectrum Contributors

Spectrum is the official journal of the Illinois Science Teachers Association (ISTA). We seek to publish original, high-quality articles related to all aspects of STEM education in an effort to support and enhance the educational opportunities provided to Illinois K-12 science students. We welcome manuscripts submitted by Illinois K-12 teachers, college professors, retired educators, scientists, and science enthusiasts. If you are doing something interesting in your science classroom, or if you've completed an educational research project related to STEM education, we urge you to consider sharing your experience, insights, and/or research with our readers. Having your manuscript published is an outstanding resume inclusion and Danielson Evaluation Domain 4 artifact, but it is also integral to helping other Illinois science teachers optimize their curriculum and instruction by learning from your experiences, perspectives, and ideas. Submissions may pertain to innovative STEM projects, student-centered teaching approaches for science educators, contemporary issues in science education, NGSS curriculum development and alignment, book critiques/reviews, or any other science-relevant topics that enhance the educational opportunities provided to K-12 Illinois students.

Submission Formatting Requirements

Please submit all articles to istaspectrum@gmail.com. Articles should have been proofread in advance of submission and formatted similarly to the inclusions in this Spectrum edition. Please use Times New Roman 12-point font throughout, and provide your submission as a Microsoft Word file that is named with the title of your article and your last name (e.g., Cunnings F-IO Physics Project Manuscript). Make sure that you include your current title and workplace (e.g., Biology and Chemistry Teacher, _____ High School) and, if you'd like, a short "About the Author" biographical piece. If you have references to cite, please follow APA guidelines when writing and formatting your manuscript. Additionally, you are strongly encouraged to include pictures, tables, graphs, and/or diagrams whenever appropriate, and if you choose to include any of the aforementioned pieces, please reference them as either "Table _" or "Figure _" throughout your article. If you have any questions about formatting and proofing, please feel free to contact the Spectrum editor at istaspectrum@gmail.com.



President's Corner

Jason Crean



Welcome back!

With this being our 50th anniversary, I am so proud to lead such a vibrant organization that focuses on bringing the very best to students throughout Illinois. ISTA has continued to work with a phenomenal Board of Directors and support team to create some exciting things for you!

Our annual conference has always been a place to revitalize and refresh. And with so many choices, you will undoubtedly find numerous ideas and strategies that you can take back to your classroom. This year's conference marks the celebration of 50 years of dedication to high quality and ever-improving science education. In that time, so many changes have been sent our way as educators that it can be difficult to keep up and maintain focus. The introduction of the Next Generation Science Standards is no exception. That is where ISTA comes in!

Currently, we are launching several new programs to reach as many science teachers as possible. The ISTA Professional Learning Team has been producing webinars and workshops that aim to provide sustained professional development over time. Our Director of Professional Learning is also hard at work increasing the outreach that ISTA does with ROE's and other entities. The ISTA Director of Assessment has also been working on the "ISTA Real Talk" video podcasts that tackle issues science teachers face every day. We continue to strengthen and expand current programs that have proven successful in supporting teachers. Our NGSS Biology Storylining Working Group has worked for the 18 months on writing engaging, phenomenon-driven storyline units and we are in the planning stages to do the same for the physical sciences. Building partnerships with other science education based entities is another area of focus, which will fortify ISTA in its work to meet the needs of teachers and to do so in innovative and exhilarating ways.

ISTA continues to improve its digital presence and communication. Some of you may have already noticed recent changes in the website (www.ilsceience.org) and the increased frequency of ISTA emails and news. Our fantastic volunteers have worked diligently to expand the ways in which we can reach educators and have you reach out to our organization.

Have an idea? Need support? Please contact us at ISTA so we can help! We are here to serve and bring you the most current information science education has to offer.

Thanks for your continued support!

Jason Crean, MS, EdD

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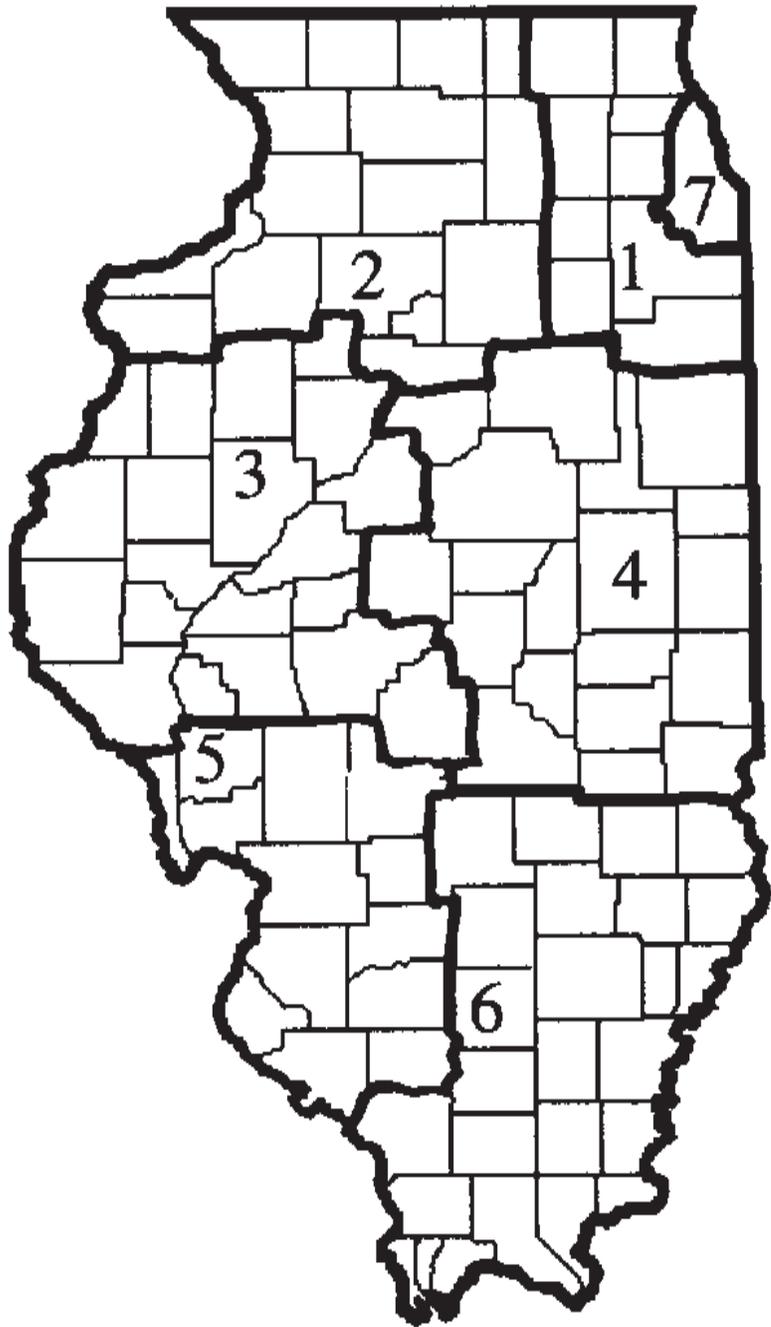
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*Photograph of
Elizabeth M. Rueck, 1966*

In the Spring of 1966, Elizabeth M. Rueck, chairperson of the Barrington Consolidated High School (BCHS) science department; Katherine Taft, BCHS chemistry and Earth science teacher; together with Ms. Nadine Dungan, a State of Illinois science supervisor; Sister Mary Alvernia, OFSC, of Madonna High School; and Sister Mary Wilma, SJ, of Nazareth Academy were invited to a meeting in St. Louis by Hank Blindel, NSTA's liaison for state and chapter groups.

Following this dialogue and with financial support from Barrington Consolidated High School and the Illinois Office of Education, plus the enthusiastic support from the science staff at BCHS and other volunteers, the process of establishing a state affiliate of NSTA was begun.



Barrington Consolidated High School provided the initial facilities, funding, staff, and motivation for the founding of a statewide organization. With the support of the Illinois Office of Education and the help of many volunteers, letters were sent to elementary, middle, and high school teachers of science inviting them to the October, 1966 NSTA regional convention in Chicago and to an organizational meeting of the Illinois Science Teachers. At this meeting of science teachers, Rueck was selected as the chairperson of this new science teachers group. Her selection was based on two considerations. First, Barrington was far enough from Chicago that it would not be viewed as a Chicago organization, but rather a statewide effort; and second, Rueck was well known for getting things done. The following statement by BCHS superintendent Robert Finley regarding her ability best exemplified her reputation, "Give her the job and get the hell out of her way!" In March, 1967 Rueck was officially elected the first president of the Illinois Science Teachers Association.

Planning for the first ISTA conference, to be held in the fall at LaSalle-Peru Community College and High School, began immediately with Mary Keegan serving as the first ISTA conference chair. There was consensus from the very beginning that the conference program collectively would encompass grade levels kindergarten through university science education and all science disciplines. The first program reflected this balance with a kindergarten teacher presenting a session on Sensory Observations; high school teachers presenting sessions titled Physics in Illinois and Model Making in Chemistry; and junior high teachers presenting IPS: Introductory Physical Science. Program sessions also included Evaluating Science Instruction and Engineering Concepts. This balanced program strategy was a success with 650 attendees and fifty-four exhibitors participating in the conference. The first conference drew science educators from as far away as Marion, even though it meant leaving home at 3AM!

The 1968 NSTA regional conference in Chicago served as the state conference the next year. The second annual ISTA conference was held in Rock Island in September 1969 and included a Friday afternoon and evening session. Lois Case served as the program chairperson for this conference and Maurice Kellogg chaired the Friday evening program.

ISTA continues to sponsor an annual conference at sites such as Edwardsville, Chicago, Bloomington, Springfield, Rock Island, and Peoria, ensuring access to teachers throughout the state of Illinois. Membership continues to flourish under the aegis of ISTA leaders and members.

*It is with great pride that the Illinois Science Teachers Association celebrates its 50th anniversary. ISTA continues to serve with endless dedication and commitment all science teachers in Illinois, with a firm resolve to continue the ISTA legacy of –
Breaking Barriers.*





Presidential Awards for Excellence in Mathematics and Science Teaching

Rewarding & Inspiring Great Teaching Since 1983



Call for Nominations

The Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) are the highest honors bestowed by the United States Government specifically for K-12 mathematics and science teaching. Awardees serve as models for their colleagues, inspiration to their communities, and leaders in the improvement of mathematics and science education. Since 1983, more than 4,700 teachers have been recognized for their contributions to mathematics and science education. Up to 108 teachers are recognized each year.

Presidential Awardees receive:

- A citation signed by the President of the United States
- A trip for two to Washington, D.C. to attend a series of recognition events and professional development opportunities
- A \$10,000 award from the National Science Foundation

Who Can Nominate?

Anyone—principals, teachers, parents, students, or members of the general public—may nominate exceptional mathematics and science (including computer science) teachers.

NOMINATION DEADLINE: April 1, 2018

Who Can Apply?

Elementary school mathematics and science teachers (K–6) can apply this year. Secondary school teachers (7–12) will be eligible to apply during a future cycle.

APPLICATION DEADLINE: May 1, 2018

To nominate or apply, visit: www.paemst.org

The National Science Foundation administers PAEMST on behalf of
The White House Office of Science and Technology Policy.

Exploring the Atmosphere with a Weather Balloon

Brianna Marszalek¹, Bernhard Beck-Winchatz², and Emily Matthews³

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Introduction

It was mid-February when I first told my 3rd graders at Gower West Elementary School I would be participating in a high-altitude balloon launch. “I will be going with some very special people”, I said. After guesses such as President Obama and Taylor Swift, one student arrived at the answer: our class! After the initial cheers and excitement, reality set in and I sat down with my two collaborators from DePaul University to plan the steps leading to my first launch with my students.

3rd Grade Atmospheric Explorers In Training

The first task was to teach the students about the atmosphere that they would soon be exploring. We began with a KWL as a means of informal assessment. Figure 1, shown below, provides an example of how KWL was used for this project.

K	W	L
<ul style="list-style-type: none">• In the sky• before space• air planes fly there• Ozone layer• it's blue	<ul style="list-style-type: none">• Where does space start?• How many layers are there?• How high is it?• Why is it blue during the day and black at night?	<ul style="list-style-type: none">• It gets alot colder in the upper atmosphere.• Water bubbles• Air pressure is really low.• Air molecules are more spread out• Hard to breathe

Figure 1: KWL Table for the Weather Balloon Project

This led into a lesson in which the students learned about the layers of the atmosphere through making a foldable which was easily referenced throughout the unit (See Resources). This new knowledge helped students

design and build experiments for the launch and make connections when analyzing the data they retrieved. Since the students would be responsible for making flight predictions on a map and navigating the bus through small towns and country roads, their next task was to learn about navigating with maps. We started by identifying well known landmarks on a map of our town. The students then sat back-to-back and practiced giving their partner directions from one landmark to the next. The students loved this activity and they learned common terminology to use when giving directions.

Now, the students were ready to sign up for one of the five teams that would work together to launch the balloon: payload team, launch team, tracking team, retrieval team, and photo crew. On our first training day, students practiced using the technology and software they would need to collect data and track their balloon. The payload team learned how to collect data with a Vernier LabQuest 2 interface and then lead groups of students around the school building to measure temperature, air pressure, and wind speed. When the groups returned to the classroom each team reported the results and findings. They could easily identify locations around the school where temperature and wind speed were higher or lower than in other places, but air pressure did not seem to change at all! This finding led to a discussion about what air pressure really is, and how they could feel it change in their ears when riding elevators, driving up a mountain, swimming underwater and flying in an airplane. It seemed clear that air pressure changes when you go up or down, but what exactly would happen when they launch a balloon way up into the atmosphere?

The second training day focused on understanding air pressure, and how pressure changes affect different types of objects. Students reminded each other what they had discovered about pressure from their measurements around the school. Next, they placed a LabQuest 2 with a pressure probe into a bell jar and observed how the air pressure readings decreased rapidly when the air was removed from the jar with a vacuum pump. We then asked them to think about how pressure might affect different objects, such as a partially inflated party balloon, a chip bag, a crushed plastic water bottle and a cup of water, and to write their predictions into their science notebooks. They were amazed to see the balloon, chip bag and water bottle expand when the pressure was decreased and contract back to their original size when the air was let back into the bell jar. At first they hypothesized that the decrease in pressure was heating up the water. But amazingly, after placing a temperature sensor into the water they discovered that the temperature did not change at all. How was it possible that low pressure could make cool water boil? After completing their pressure experiments and using academically productive talk to discuss the results with each other, they wrote about their findings in their science notebooks. These writings served as formative assessments to determine if students were making connections about the ideas of pressure changes.

The bell jar experiments enabled the 3rd graders to form evidence based hypotheses about how these objects would change during the flight. They realized that because they were not sure whether pressure would increase or decrease during the ascent and descent they needed to include objects that would change either way. As a group, they chose the following objects: A crushed water bottle, a partially inflated party balloon, a partially inflated latex glove, and a packaging air pillow. All four of these objects could either expand if the pressure were to decrease during the ascent, or shrink if it were to increase. They also decided to add piece of chalk and a glue stick to the payload to see whether the tiny air bubbles inside of them would cause any changes. Finally, they also included a flower to test their hypothesis that a lack of air in the upper atmosphere would cause the flower to wilt more quickly.

Final preparations before the launch focused on finalizing experimental designs and assembling three payload boxes. Figure 2 depicts the final assembling process taking place for one of the three payload boxes.



Figure 2: Assembling the Payload Box

The first box contained the objects students had chosen for their experiments. The second box held three GoPro video cameras to record the flight. The students also decided to place the LabQuest and sensors they had used to measure temperature, pressure, and wind speed during the flight. After carefully arranging the objects to make sure that they were all visible to the GoPro camera recording them from above, the students secured them with cable ties. They also constructed a scale with 1-inch tick marks so they could measure changes in the diameter of the balloon during the flight.

Launch Day!

We loaded the school bus at 8:30 AM. We were ready to take the 90 minute trip to our launch site at Pontiac High School, far enough from Chicago to ensure a safe flight and avoid landing in a densely populated area or Lake Michigan. After arriving at the launch site the students got right to work with final preparations. The payload team connected the three boxes containing their experiments to the balloon neck with mason line. They also attached two GPS trackers that would transmit the location of the balloon during the flight and after landing. Meanwhile, adults mounted the antenna on the roof of the school bus and set up the tracking laptop.

Then it was time to fill the weather balloon! The launch team put on goggles and latex gloves to protect their eyes and balloon skin. (NSTA, 2013). One student inserted the helium tank hose into the balloon while holding onto the balloon neck. Another student opened the valve of the helium tank. The remaining launch team positioned themselves around the balloon to keep it from being blown around by the wind. The excitement of the students was palpable as they watched the balloon inflating (see Figure 3 below). After 15 minutes it towered eight feet above the students! The balloon was ready for lift off!



Figure 3: Preparing for Liftoff!

Slowly, the students let the balloon rise, releasing one payload box at a time. With only one final box to release, we counted 10-9-8- ... 3-2-1-LIFTOFF! We watched in awe as the balloon ascended into the sky.

We hopped back on the bus to follow the balloon. The tracking team carefully monitored the location and altitude of the balloon on the computer screen. Like tornado chasers, the tracking team directed the bus driver through country roads of Pontiac in pursuit of the balloon. 40 minutes after launch, when the balloon had reached an altitude of over 14,000 meters, the tracking team noticed that the altitude had started rapidly decreasing. The balloon had popped and the payload was descending. Now the tracking team's job was to get us close to where the payload would land. After 20 minutes, the tracking team announced that the payload had stopped moving. It had landed less than two miles from where we were! A few minutes later we saw our payload boxes resting safely in a field not far from the side of the road. Figure 4 was taken after the tracking team had located the payload.



Figure 4: Retrieving the Payload

A cheer echoed through the bus congratulating our tracking team. After retrieval, the students carefully examined the payload containers. Other than the flower having curled up a bit, everything seemed to look the same as before launch. The students also noticed that all three GoPro cameras were still recording, and were anxious to watch the videos recorded during flight.

Making Sense of our Data

The following day, the students examined all three videos to see what happened during the flight. The upward facing camera showed the weather balloon expanded during the ascent to more than twice its original size before bursting. The downward-facing camera showed the party balloon, latex glove, water bottle, and air cushion also expanded during the ascent and then shrank back to their original size during the descent. However, the hypothesis that the tiny air bubbles in the glue and chalk would expand or shrink and cause the glue to ooze out and the chalk to break could not be confirmed. This led to a discussion about the properties of liquids, solids, and gases that caused them to react differently to pressure changes.

We provided students with a table listing altitude and pressure at ten different times between launch to burst. After reviewing this table, they concluded that the balloon had reached an altitude of 14,379 meters before popping and that the air pressure decreased from nearly 99 kPa on the ground to only 13 kPa at the highest altitude. We agreed that this large decrease was an important scientific discovery, especially because a few weeks earlier they had found that air pressure hardly changed when they measured it inside and outside the school. The students decided that upper atmosphere is definitely a very different place!

The continuous pressure decrease with altitude recorded by the LabQuest during the flight helped the students make sense of the video recording of the party balloon. Using the scale they drew on the payload box, different students came to the front of the classroom to measure the diameter of the balloon on the projection screen. The class quickly noticed that as the altitude increased and the pressure decreased, the diameter of the balloon

grew larger and larger. This made sense! The same thing happened when the air was removed from the bell jar. After three or four measurements the students were able to accurately predict the diameter, even before they measured it.

Applying our Learning

After the many experiments performed in the bell jar and during the launch, the students were aware that conditions varied in the upper atmosphere. They knew about pressure and its effects on gases. This would lead to a group activity in which the students used evidence from their experiments to predict what life would be like on Earth's surface if the pressure was 13kPa, as it was when the balloon popped. Students could also utilize the temperature data from the launch to make predictions. The students can brainstorm how the much lower temperature and pressure would impact life on Earth's surface. For example, students may suggest that farms wouldn't be able to yield crops with lower temperatures and pressures. Other ideas that come up are that ecosystems would be different. Rainforests would no longer be warm. Engaging in sports activities outside would be difficult to run and breathe with the different pressures and temperatures. Would water always be boiling? How would we cook if the water wasn't hot? This authentic application of pressure and temperature to student's lives brings the conditions we discovered in the upper atmosphere back down to Earth's surface. This activity can be done individually or in groups and is an opportunity to formally assess of student understandings of the conditions in the upper atmosphere.

Learning Outside the Box

The weather balloon mission was not just an exciting opportunity for our students to complete an authentic science investigation outdoors. Student assessments and classroom discussions showed that it also supported learning about our atmosphere and about how scientists make sense of our natural world. As educators, this project taught us that we should always look for new engaging ways to challenge our students beyond what we think their limitations may be. We are likely to find they can accomplish much more than we imagined! The success of this launch was largely due to collaboration with a university partner. (For alternatives see resources)

References:

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NGSS Project Alignment:

3-ESS2 Earth's Systems

3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

ESS2.D: Weather and climate

Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.

Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.

The materials/lessons/activities outlined in this article are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

Performance Expectation	Connections to Classroom Activity <i>Students:</i>
3-ESS2-1: Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.	Collect temperature Display data in tables and graphs
Science and Engineering Practices	
Planning and Carrying Out Investigations Analyzing and Interpreting Data Engaging in argument from evidence	Designed experiments to send into the upper atmosphere Analyzed temperature, wind, and pressure data collected at school and in the upper atmosphere Constructed an evidence based argument
Disciplinary Core Idea	
ESS2.D: Weather and Climate Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	Collect temperature, wind, and pressure data at school and at various altitudes
Crosscutting Concepts	
Patterns Cause and effect	Analyze the data table to predict the diameter of the balloon as it ascends Analyze the data table to conclude that as altitude increases, pressure decreases

Connections to the Common Core State Standards:

Literacy

CCSS.ELA-LITERACY.L.3.6

Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships (e.g., *After dinner that night we went looking for them*).

CCSS.ELA-LITERACY.W.3.1.A

Introduce the topic or text they are writing about, state an opinion, and create an organizational structure that lists reasons.

CCSS.ELA-LITERACY.W.3.1.B

Provide reasons that support the opinion.

CCSS.ELA-LITERACY.W.3.8

Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Math

CCSS.MATH.CONTENT.3.MD.A.2

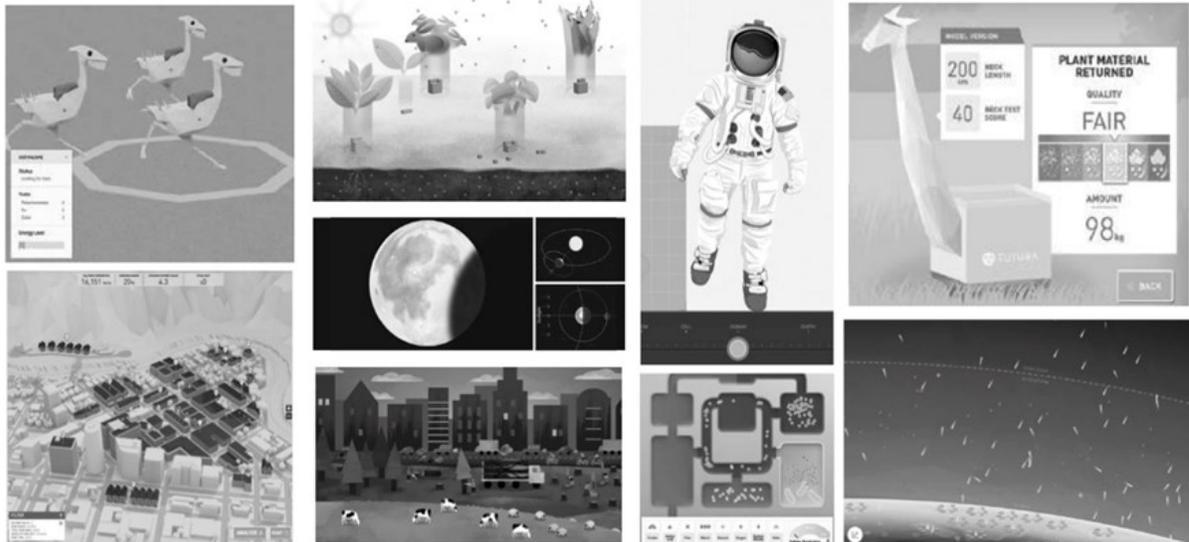
Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).

About the Authors:

Brianna Marszalek is a third grade teacher at Gower West Elementary School in Willowbrook, IL. She received her masters degree in STEM Education from DePaul University. Brianna is currently working on writing and implementing new units aligned with NGSS for her school district.

Bernhard Beck-Winchatz is a college teacher in the Physics and STEM Studies Departments at DePaul University. He teaches STEM courses for teachers and physics courses at the undergraduate and graduate level. He launched DePaul's ballooning program in 2009 and has completed nearly 100 launches with his students since then. The 3rd graders in Ms Marszalek's class are the youngest students he has ever worked with.

Emily Mathews believes that all students deserve a sustained, high-quality science education. She is a former Chicago Public Schools science teacher and, more recently, a science instructional coach and professional development leader for the STEM Center at DePaul University. Emily currently works at Science in Society, a research center at Northwestern University, as a senior program coordinator where she guides their flagship program, Science Club, and Science Club Summer Camp, a practicum-based professional development program for third-grade CPS teachers.



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- **Actionable data and robust embedded support** for teachers to support the transition to three-dimensional teaching and learning

**An Inquiry-based STEM Activity Using the Internet of Things (IoT) Data:
The Soil Moisture Project**

Do-Yong Park

Associate Professor in the School of Teaching and Learning, Illinois State University

Introduction:

At various professional development programs on science education, the author more than often met a number of inservice science teachers who had difficulty coming up with an idea of how to integrate inquiry-based instruction with STEM using cutting edge technology in classrooms. This is not surprising considering that the author also faced the same issue, especially when the current classrooms were inundated with a variety of new initiatives, i.e., STEM, NGSS, CCSS, and IoT. How do they integrate all the technology in a reasonable way? The school districts asked science teachers to update and align information from various new initiatives in their lessons, providing a professional development opportunity. The activity “The Soil Moisture (SM) Project” described below was designed to help science teachers who have difficulty with integration by integrating inquiry-based instruction with STEM, NGSS, and CCSS using state-of-the-art technology.

Soil moisture of a potted plant primarily changes in response to humidity and temperature in a room. Many may wonder when it is a good time to water a potted plant due to a lack of knowledge about the plant or difficulty remembering to water. If a sound alert could remind people when to water, that would be great! The Soil Moisture (SM) project makes it possible to meet this need with a device called Internet of Things (IoT) that uses Arduino to measure soil moisture of a potted plant along with temperature and humidity every day for 365 days. The collected data would be sent to an internet-based data bank and presented as a graph and table automatically. When the soil moisture falls under 20% (changeable depending on the need), it gives a sound alert. Using the data from The SM project, teachers can offer students a personal and meaningful experience with soil moisture by integrating STEM, NGSS, CCSS and Internet of Things (IoT) through Inquiry-based Instruction.

Science, Technology, Engineering, and Mathematics (STEM) is an integrated subject that teaches technology and engineering based on science and mathematics (Bybee, 2010). Thus, in STEM education, you teach more than two fields of STEM in an integrated way. Although teaching STEM may not be as active as expected in actual science classrooms across grade levels, the major science education reform documents strongly recommend that it should be taught at K-12 levels. Teaching students in STEM contexts is newly initiated in nationwide reform efforts, i.e., Next Generation Science Standards (NGSS) (Achieve, 2013). In particular, the NGSS emphasize the importance of technology and engineering education alongside K-12 science curricula by including ‘Engineering Practices’ and ‘Crosscutting Concepts’ for the first time since the sputnik-triggered curriculum revolution in 1950s. Measuring soil moisture in a potted plant is the key idea of this Soil Moisture project, and building a system that enables students to gauge the amount of moisture in the soil of a potted plant incorporates technology and engineering (see Figure 1).



Figure 1: The System of the Soil Moisture Project Using Arduino

In addition, concepts of humidity and temperature, condensation and evaporation along with precipitation are the areas of science to be taught. The weather data, including soil moisture, has been archived since November 2015 up to date (visit <http://ha.everykit.io/officeView3.php>). The data including the soil moisture of a potted plant, temperature, and humidity (S) of inside and outside of the building have been recorded 24 hours and 7 days a week at every minute all year around. Digging through the data, students can find a pattern of fluctuation for the three parameters.

In the same vein, in 2009, the Common Core State Standards (CCSS) were initiated to make sure that all students achieve College and Career Readiness by the time they graduate from high school. They promote equity by ensuring that all students are better equipped for the competitive world beyond school. Therefore, the CCSS recommend that all K-12 curricular be “aligned to the expectations of colleges, workforce training programs, and employers” (see CCSS’s homepage). This readiness is the backbone of the Common Core and it translates into specific standards in mathematics and English language, and arts in each grade level. Thus, the Common Core implies that STEM fits the basics of CCSS. STEM learning may occur not only by reading soil moisture, evaporation, condensation, and precipitation, but also by building a system that measures the soil moisture of a plant corresponding to the weather and helps to sustain the growth of a potted plant. Through this learning experience, students come to a more complete understanding about the intricacy of condensation, precipitation, and evaporation as well as soil moisture. At the same time, students are equipped with knowledge and skills for their potential careers in STEM fields. As such, STEM is a good subject to implement both NGSS and CCSS.

The Internet of Things (IoT), as one STEM field, is one of the fastest growing industries. IoT is the network that connects products, machines, buildings, and humans in order to produce and ship the ordered goods in a faster time frame. The Internet connects computing into the real world embracing everyday objects. Physical items in everyday life are “no longer disconnected from the virtual world, but can be controlled remotely and can act as physical access points to Internet services. An Internet of Things makes computing truly ubiquitous. This development is opening up huge opportunities for both the economy and individuals” (Mettern & Fe-loerkemeier, 2010, p.1). Almost every physical object can be developed in the Internet of Things (IoT). This learning environment not only provides students with endless opportunities to create and develop everyday objects but also increases their interest toward STEM fields. One of the popular IoTs is *Arduino*. Arduino is an open-source, microcontroller-based prototyping platform. The Arduino boards can connect to sensors, such as sound sensors, light sensors, pressure sensors, or even humidity or temperature sensors. These inputs are

fed into a program written to process the input and make decisions. The results of those decisions can drive some output in the physical world, such as relay or a switch. As such, Arduino of the Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructures (Bartolomeo, 2014), creating opportunities for more direct integration between the physical world and computer-based systems and resulting in improved efficiency, accuracy and economic benefits (Lopez, 2013; Lindner., 2015; Mattern et al., 2010). It is estimated that the IoT will consist of almost 50 billion objects by 2020 (Evans, 2011). The future market value for this industry is expected to be 19 trillion \$USD (Kharif, 2014).

There are other makers of IoT in the market, including *Intel Galileo*, *Raspberry Pi*, *LittleBits*, *Lego Mindstorms*, *Kudoino*, and so on. However, Arduino remains popular for it is fairly simple to program and are low-cost as well.

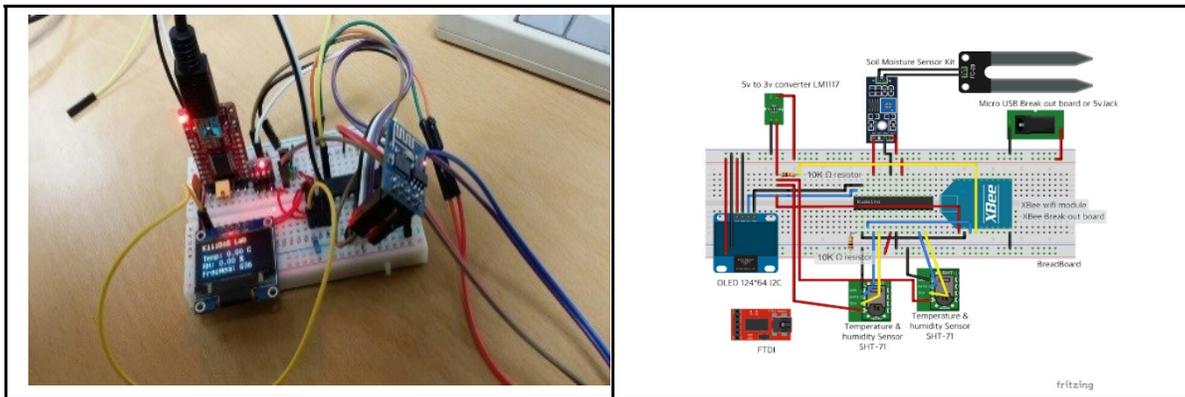


Figure 2: *The Internet of Things Connecting Arduino to a Sensor on the Breadboard*

Using Arduino, this STEM activity emphasizes student learning that creates an environment for students to investigate phenomena of the real world using computer-based systems in multiple and creative ways. This experience is critical as it offers opportunities not only to have fun, but also to learn about problem solving. For example, this particular Soil Moisture (SM) project shows how Arduino with sensors acquires soil moisture data from a potted plant in real-time (Figure 2). Along with temperature and humidity data from both inside and outside of an office, soil moisture data are augmented and stored into a web-based data bank. A moisture sensor's value could be coded into a program that buzzes if the soil moisture is too low. In other words, the device acts as a simple security alarm. At the same time, Arduino with sensors translate the data into a graph with real-time pictures of the plant on the website (Figure 3).

The entire process of data collection, augmentation, and presentation is automatic. Such IoT devices enable students to investigate how soil moisture responds to temperature and humidity of the air in real-time and make it possible for them to focus on core ideas, find a pattern, and establish a theory on how soil moisture, humidity, and temperature respond to each other.

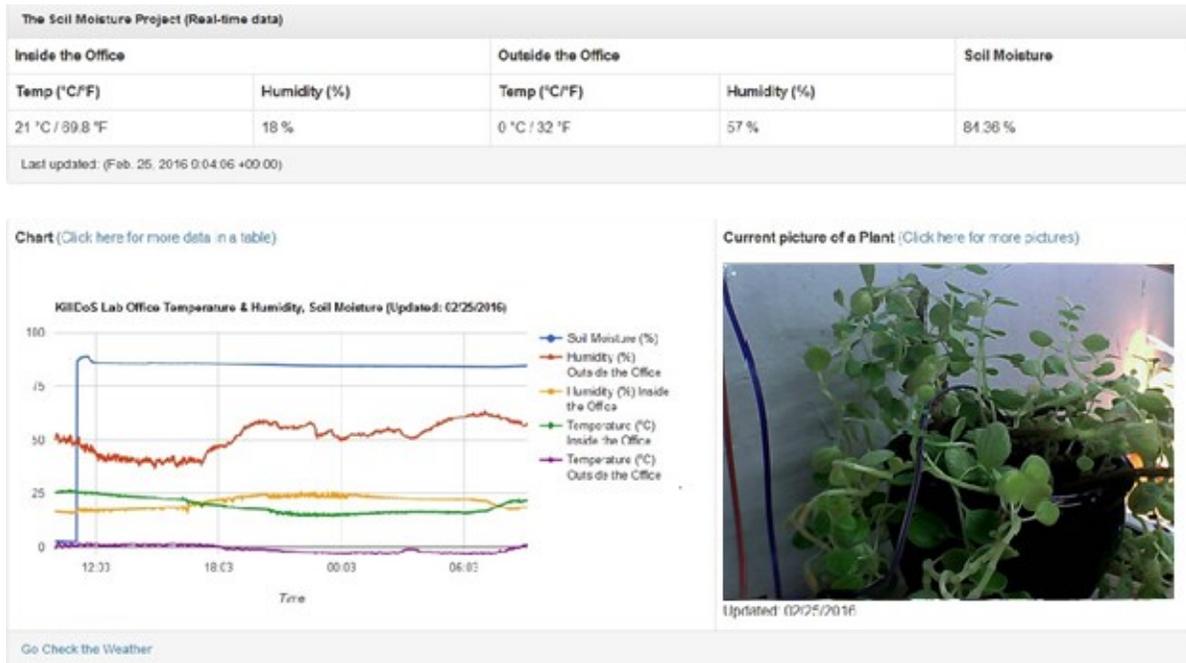


Figure 3: A Sample Page of the Soil Moisture Project Website

(Note: The top line indicates soil moisture, the second line from the top is humidity outside the office, the third line is humidity inside the office, the fourth one is temperature inside the office, and the very bottom line is temperature outside the office)

An Inquiry-based Instruction has been a major framework of science teaching. Learning Cycle or 5E Instructional Model of teaching science was adopted as an inquiry-based instruction. Why inquiry-based instruction? Because it helps students (a) to better master scientific content, (b) to understand how to carry out scientific investigation, and (c) to understand the nature of science (NOS). Investigating how soil moisture responds to the change of humidity and temperature in a confined room is a good topic for scientific inquiry. The instruction flows in a learning cycle, which includes Engage, Explore, Explain, Elaborate, and Evaluate (Bybee et al., 2006). However, the SM project used the 5E+R model in which Reflect is added to 5E. While evaluating each E's activity, the teacher reflects on the instruction in terms of what worked well and what did not work to increase the students' understanding of the target concept. At the same time, the teacher reflects on each activity of 5E and examines how students carry out the investigation (see Figure 4). Reflect is a process of explicitly examining instructional practice, making teachers more aware of students' understanding. Such reflection encourages practice that is more responsive to students' needs, thus stimulating deeper learning. The following is the 5E's inquiry lesson plan used in science classroom.

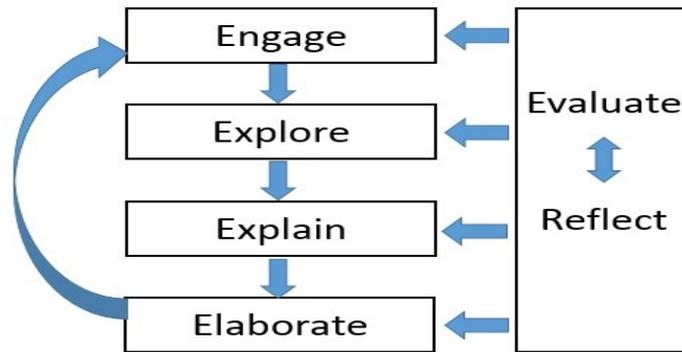


Figure 4: The 5E+R Instructional Model for Science Instruction

Engage-Ask a question to initiate inquiry about objects and events in the natural world.

Explore-Plan and conduct investigations to collect relevant data.

Explain-Use data to construct knowledge, generate interpretations, and propose explanations that make sense of the world and answer questions.

Elaborate-Further investigate and apply concepts and theories to new contexts and problems.

Evaluate-Demonstrate knowledge, understanding, and ability to use inquiry strategies through formal and informal assessments.

Reflect-Reflect on what worked well and what worked less and figure out how to increase students' understanding of the target concept.

Objectives

This activity will enable students to

- (a) figure out the right time to water a potted plant in a room.
- (b) find a pattern of change for weather parameters including air temperature, humidity, and soil moisture.
- (c) understand the benefits of Arduino for solving problems in daily life.

Next Generation Science Standards

3-ESS2-1: Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

Science and Engineering Practices: 3-ESS2-1: Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.

Disciplinary Core Ideas: 3-ESS2-1: Scientists record weather patterns at various times and across different areas to make predictions about what kind of weather might happen next.

Crosscutting Concepts: 3-ESS2-2: Patterns of change can be used to make predictions.

Common Core State Standards Connections:

RI.3.1: Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-ESS2-2)

RI.3.9: Compare and contrast the most important points and key details presented in two texts on the same topic. (3-ESS2-2)

W.3.8: Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-ESS2-2)

MP.2: Reason abstractly and quantitatively. (3-ESS2-2)

MP.4: Model with mathematics. (3-ESS2-2)

Information Resources (per group)

- Access to the SM project homepage at <http://ha.everykit.io/officeView3.php> provides a graph and pictures of a potted plant in real time.
- Retrieval of archived data of one or two months from the SM project’s web-based data bank. Each group chooses a certain month or two from winter or spring.
- Computer with Excel

1. Engagement: Thinking about it

Have students think about how to figure out the right time to water a pot plant growing inside a room. Ask them to turn to their peer and discuss the potential solution. As one solution, suggest using Arduino to answer the question by measuring soil moisture automatically. To help get students motivated and engaged in this topic, show a short video clip (less than 5 min; only show an essential part if it is long) explaining how it can be done. The following is a good example - Soil Moisture Sensor with Arduino- Interface and Coding (4:48) at <https://www.youtube.com/watch?v=Pm83L104naY>. Since inquiry-based lessons begin with a question, propose an inquiry question as follows.

“In what way can one best figure out the right time to water a potted plant in the classroom?”

2. Explore: Investigating

- Have groups of four visit the data-archived website of the Soil Moisture (SM) project at <http://ha.everykit.io/officeView3.php>. The moisture level is set 75% on this IoT system so anytime the level of soil moisture goes under 75%, it gives a buzz automatically.
- Retrieve one month of data from the archive of the SM project. Each group has the liberty to choose which month. Students can retrieve the data by clicking the link “Click here for more data in a table” located right next to the Chart. Once they obtained it, they can manipulate the data in their own way.
- Find a pattern of relationships among the three weather parameters – soil moisture, temperature, and humidity inside and outside the building.
- Draw a graph based on the data.
- Have each group present their results to the class.
- Based on the pattern discovered by each group, discuss the change of soil moisture, temperature, and humidity each day.
- Have a recorder in each group fill in the table below as other members work on tasks.

Group Name: _____	Result
Explain a pattern of temperature changes	
Explain a pattern of humidity changes	
Dates of soil moisture under 20%	
Explain a pattern of soil moisture changes	
Describe any outliers in soil moisture changes	
Conclusion: How can one figure out the right time to water a plant?	

- For example, if a group chose a date between January 8 and March 4, 2016, the SM project helps students investigate as follows.
- Students found a typical change of temperature, humidity, and soil moisture shown in Figure 5. In general, the air temperature typically reaches a high around mid-day both inside and outside the building, whereas humidity hits a low at around mid-day (see Figure 5; the first line is soil moisture).

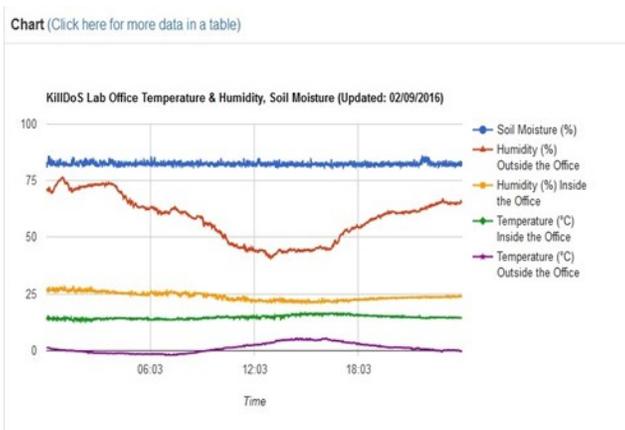


Figure 5: Typical Changes of Temperature, Humidity, and Soil Moisture in One Day

The soil moisture does not show much fluctuation in one day as it is reserved in the soil of a potted plant. However, the soil moisture gradually goes down with time. In preview session, the students found the fact that somehow soil moisture *drops dramatically near a zero amount of moisture* a couple of days later when the plant begins to dry up, using the data from Jan. 16 – Jan. 18, and from Feb. 22 – Feb 24, 2016 (see Figure 6; soil moisture line has a dark round dot).

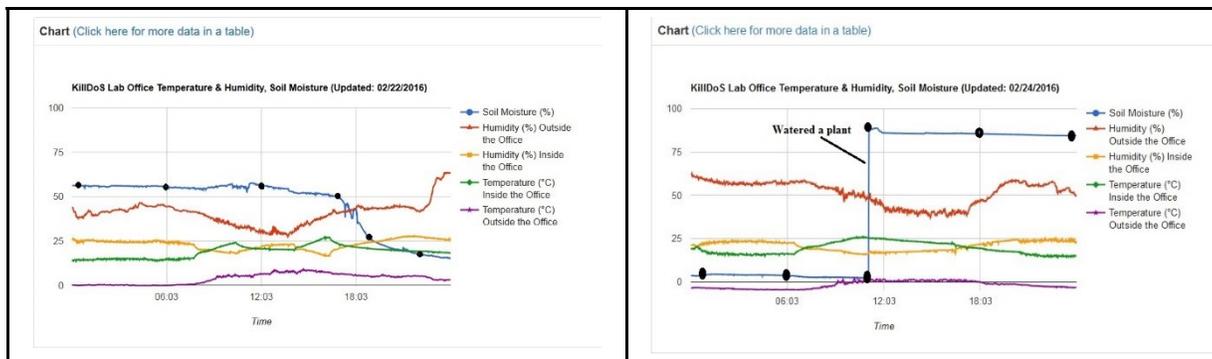


Figure 6: An Example of the Low and High Soil Moisture

- Have students discuss and conclude how one can best figure out the right time to water a plant in a room. As seen in Figure 6, somehow the soil moisture line *drops quickly as it reaches the time* when the plant needs more moisture. Therefore, one should keep an eye on the change of soil moisture, especially when one takes care of a memorable and expensive plant.
- Figure 7, next page, presents the group of students who are working on the tracked graphs of soil moisture, temperature, and humidity, and the pictures of a potted plant through the SM project homepage.

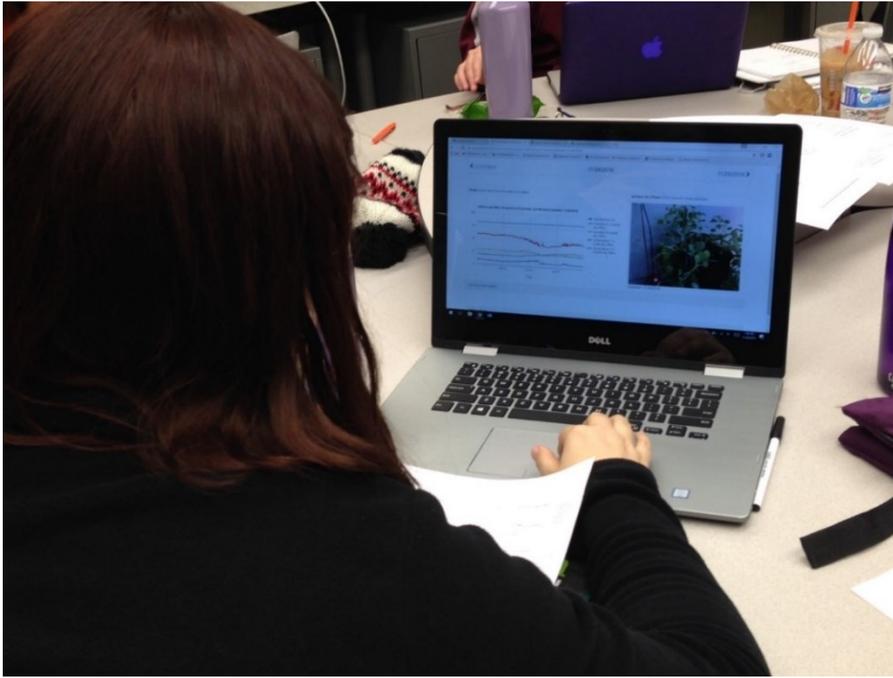


Figure 7: The group of students who are working on the SM project by collecting data from its homepage.

3. Explain: Reviewing Main Concepts and Digging Deeper

- Looking at the month of data, for example, from January 8 to March 3, 2016 (see Figure 7 for student engagement and Figure 8 for IoT graph data), students may find a pattern of change regarding temperature, humidity, and soil moisture in a potted plant. Before digging deeper, the teacher should make sure that the students clearly understand the following concepts so that they can apply them to their explanations or theories when they propose an explanation to the inquiry question of this investigation. Temperature is a comparative measurement of hot or cold, which is objectively measured with a thermometer involving thermometric material, detection of thermal radiation, or particle kinetic energy. Humidity is the amount of water vapor in the air, which is in the gaseous state of water. Humidity functions as an indicator of precipitation, dew, or fog. In the SM project, humidity refers to relative humidity, which measures the current absolute humidity *relative* to the maximum humidity for that temperature. Soil Moisture is “a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration.” (see <https://en.wikipedia.org>) Because of its role, soil moisture is perceived as an important factor in developing weather patterns. As seen previously, these three parameters of the weather are in a ‘functional relationship’ in which one variable varies as a second variable changes. However, the establishment of the exact relationship is beyond this study.
- Have students discuss the benefits of Arduino in our daily lives and, at the same time, extend its application to industrial sectors and the world market. Have each group come up with more than three ideas and share them in class, which could lead to the next stage, “Elaborate.”



Figure 8: Graph of the Soil Moisture, Temperature, & Humidity of a pot plant from Nov. 21 until Nov. 28, 2016

4. Elaborate: Applying and Inquiring Further

- Have students elaborate on what they have learned and apply it to new situations, for example, by discussing how to design an Arduino greenhouse with a water control system or Arduino farming.
- Have each group design the new system above (either an Arduino greenhouse or farming) and present to the class (a) a brief description of their plan with a drawing of the design and (b) how to make it a reality (including materials and costs).
- As a further inquiry activity, suggest a project that investigates the same topic in other seasons that is significantly impacted by the humidity and temperature to see if there is a different pattern of change.

5. Evaluate: Assessing students' understanding

- Evaluate students' learning on the three objectives using formative and summative assessments.
 - For Objective 1, evaluate if they can collect and read the graph data reasonably from the web-based data bank and find a pattern of soil moisture consumption of the plant (group evaluation).
 - For Objective 2, evaluate students' artifacts, models, discussions, and explanation as they work on finding a pattern of change of the weather parameters (group evaluation).
 - For Objective 3, have students individually write and share a paragraph or so about the following questions: What is the benefit of Arduino? How would you predict the pattern of three weather parameters (temp. humidity, & soil moisture) to change during autumn and why? (individual evaluation).

6. Reflect: Better Instructional Strategies

- Reflect the process of students' investigations as well as the teachers' instructional practices which leads to being more aware of students' understanding. Based on the reflection, figure out how to better respond to students' needs, thus stimulating deeper learning in each of the 5E.

Final Remarks

The SM project is an interesting topic for teaching Science, Technology, Engineering, and Mathematics (STEM) education. As shown above, the Internet of Things (IoT) is a good topic for teaching inquiry-based lesson integrating STEM, NGSS and CCSS. Although students might encounter technical difficulties setting up an IoT device on their own, teachers can help by learning how to set up for the lesson. Teaching state-of-art technology in classrooms should no longer be a loft goal, but an everyday teaching practice so that the next generation can readily adapt to the advanced society, especially the IoT dominating society in the future.

About the Author:

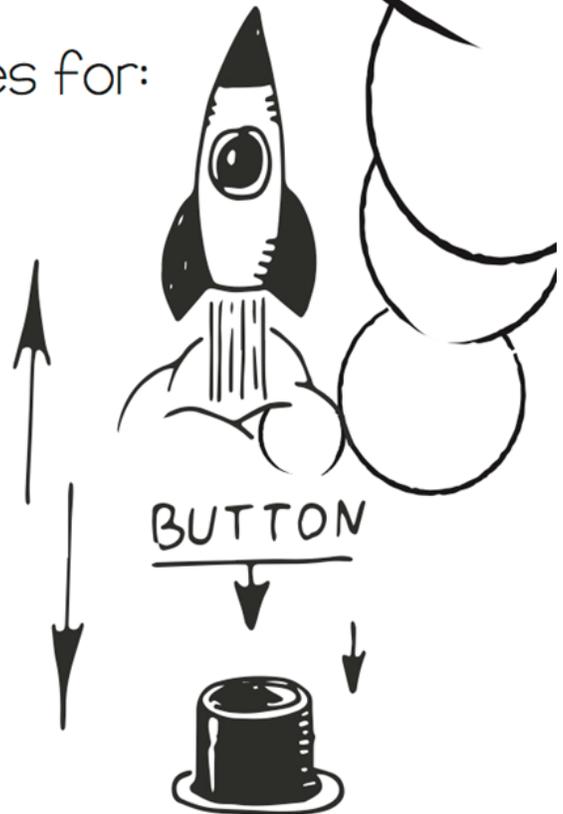
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Equity in Science Education

Required High School Physics for All Students As A Method of Increasing Under Represented Minority Physics Majors in Higher Education

Stewart E. Brekke

Retired Teacher, Chicago Public Schools

As a former high school teacher of African American and Hispanic students in the inner city high schools of Chicago, I can positively state that there is great under-represented minority physics potential there. In a recent unpublished study by the American Institute of Physics (AIP), it was found in a poll of 2015 graduating physics majors that 59 percent of the respondents indicated the high school physics course inspired them to major in physics in higher education. Additionally, in another recent unpublished AIP study, the percentage of high school students who will have taken at least one high school physics course in 2013 is approximately 58% for Asians, 42% for Whites, 29% for Hispanics, and 28% for Black students. AIP statistics show that physics bachelor's degree numbers for African Americans remained flat despite a 58% growth in the field overall. The statistics above show that fewer African Americans and Hispanics are taking physics in high school than Whites and Asians, and therefore fewer African Americans and Hispanics are majoring in physics in higher education. It is my belief that a required course in high school physics—preferably with a mathematical component—for all students would not only improve the lives of all American students, but also generate more minority physics majors in the process.

Physics, far more than any other high school subject, teaches quantitative and analytical reasoning skills, provided the course has a mathematical component. And while mathematics is a tool, physics makes mathematics “real” if mathematics is used in the course. Not only that, but physics is a prerequisite for nearly all careers in engineering, chemistry, biology, environmental and earth sciences as well as the medical and veterinary sciences. Students with physics training enter careers in finance, management and economics. These careers are also generally high-paying and provide an upward pathway for the socioeconomically disadvantaged. This is how a required high school physics course with mathematical component can begin to improve many American lives, both majority and minority.

Women and minorities are underrepresented in STEM fields according to a Cornell University study. Women are under represented by a factor of 2 and African Americans are under represented by a factor of 4. According to this study, most of the “leakage” from the STEM career pipeline takes place in high school and in the transition from high school to college itself. Most students who do not take high school physics never enter the STEM track. Therefore, encouraging school districts to require a mathematically based high school physics course of all students will benefit the students and incidentally increase the number of physics majors from the minority community since as stated above, the positive experience in the high school physics course is the generator of the college physics major.

My experience in teaching inner city African American and Hispanic students, especially in a high school with mostly average African American students, has shown me that all kinds of students can do well in a mathematically based course. I was in a high school in which all students, average and better, were required to take 4 years of math and science because of desegregation requirements. To teach a mathematically based course required much extra work on the part of the teacher, but I found out that not only academically-oriented students, but others such as pregnant teen mothers, football players, and even some learning disabled students could succeed at a mathematically based course with lots of problem solving assistance from the teacher.

Since many of my inner-city students were weak in their mathematics, I took one problem from the text from the section I was teaching and gave drills and practices on it on worksheets I generated. For example, for average speed $v=d/t$, I generated 3 problems solving for v , 3 problems solving for d and 2 problems solving for t . Using this approach, I was able to develop general problem solving skills among most of my students if I went around the room helping them solve the problems on the worksheet. Repeatedly doing this technique, the students in general mastered basic problem solving. In lab work I usually went around the room helping the students set up their experiments after showing them how to set up the lab apparatus at the beginning of the period. The lab data was sometimes modified so that the data could be modeled. For example, we modeled the data based on four fundamental curves: $y=kx$, $y=kx^2$, $y=k/x$ and $y=kx^{(1/2)}$. This method enabled me to pass the majority of my students each semester while many teachers in the school were failing the majority of their students, especially in mathematics courses and chemistry courses.

By always helping my students, they felt that I was always available when they had difficulty with the coursework, and I thereby helped to generate a positive physics experience for them. I do not know how many went on in physics, but one student that majored in chemistry in college told me that my course was the only course he used from his high school experiences. I believe that using this teaching method, or a similar method of problem drills and practices with lots of problem solving, help students of all backgrounds and abilities succeed in high school physics courses. In this manner, many STEM career opportunities for minority students can materialize through success in a mathematically-based high school physics class.

At present only about 1/3 of all US high school students take physics in comparison to countries we compete with which require all high school students to take physics. To require all US high school students to take physics would require at least a five-fold increase in the number of high school physics teachers. Furthermore, it is not enough to have a high school teacher of physics, it is mandatory that the high school physics teacher be highly-qualified. Approximately 1/3 of all high school physics teachers have a degree in physics or physics education and about 1/3 of all high school physics teachers have taken less than 3 college physics courses. The result of having poorly-qualified high school physics teachers may result in poor initial high school physics experiences which can dissuade and demoralize capable students from taking physics in college. Further, not having a mathematical high school physics course may impede a prospective physics major in his college physics courses. However, in the three graduating classes I know about from my high school, four physics PhD's were generated as well as at least 3 high school physics teachers—our high school physics course was non-mathematical, but we all took 4 years of high school mathematics and our high school physics teacher was a certified physics teacher.

Teaching physics to under-represented minority students in the inner city may have some low points. Two of my physics students were shot and killed in the neighborhood. The two were doing well and were B students. A third student, one who I was targeting for my physics class, was also shot and killed. A fourth student was doing well in my mathematical physics class, but started to become regularly absent from class. He had to stay at home rather than go to school in order to guard his house which was being burglarized when everybody in his house went to school or work. A fifth physics student, an honors student, was being threatened as he walked home from school every day. He went to another school. Whether he took physics ever again I do not know.

In conclusion, by requiring high school physics for all students, average or better, not only will this requirement increase STEM opportunities for many students, it will certainly increase the number of college physics majors, from majority and minority groups, since it has been determined that the high school physics course generates in large measure the college physics major. To require high school physics will require many more high school physics teachers who are qualified—i.e. degreed and/or certified. The curriculum must be modified to reach all enrolled students possibly using drills and practices in problem solving specially if the students are weak in their math. Finally, the teacher must be accessible at all times with problem solving help to support a positive high school physics experience.



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Monday Workshop Descriptions

Elementary Petro Science with Common Core Math Component - Professional Development for Illinois Science Teachers
 Understand the process of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems as it relates to the Illinois Crude Oil and Natural Gas Industry. Topics include: Ordered pairs, rock ID, porosity, flow rate of oil, pulleys, oil / water cohesion, crude oil, plastics recycling codes, formation of oil & natural gas, and common core math problems.

Middle School Petro Science - Professional Development for Illinois Science Teachers
 Understand the process of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems as it relates to the Illinois Crude Oil and Natural Gas Industry. Topics include: oil & natural gas formation, microorganisms, sound waves, locating crude oil, reservoirs / production, separation process, safety, petroleum-based products, energy conservation.

Core Energy Math Middle/ High School- Professional Development for Illinois Math Teachers
 Understand and utilize Common Core Mathematic standards to define, evaluate and solve real world problems as they relate to the Illinois Crude Oil and Natural Gas Industry. Topics include: Well site clean-up and restoration, directional and horizontal drilling, finding lease locations, oil and natural gas revenue / expenses, and word problems directly tied to a common core standard.

High School Core Energy Science - Professional Development for Illinois Science Teachers
 Understand the process of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems as it relates to the Illinois Crude Oil and Natural Gas Industry. Topics include: The structure of hydrocarbons, effects of elevation on flow rate, flow rate of a fluid, fractional distillation and a study of bio-remediation. Labs reinforce the major concepts.



Book Reviews

Teaching in a Networked Classroom, and Immortality Factor

Thomas Hansen

Adjunct Professor & Education Consultant

Review of *Teaching in a Networked Classroom*,

by Jonathan Savage & Clive McGoun.

Routledge: New York. 2015.

This text could provide good general background and be a nice resource for presenting professional development (PD) sessions to teachers and administrators who do not yet have much experience using online resources through networked computers. This book provides definitions, examples, and some clear uses of various tools and applications that can be used by students for their contemporary projects in the networked classroom or laboratory.

A general introduction, with a good deal of personal opinions, the book provides ideas for teachers to use a variety of online resources. The PD presenter can provide some hands-on activities to make some of the explanations more practical for the teachers.

The book includes British terms, phrases and spelling (e.g., difficult to see the wood for the trees, enquiring, affordances). The book also uses many examples of applications and web sites that seem to be used more often in the UK than in the US. This is okay, though, for the PD presenter can always mention a few of the more common American sites, show them on the screen, and include them in the PD materials distributed or emailed to participants beforehand for them to review in preparation for the sessions.

There is another good new title that can be used for more advanced hands-on sessions. A new ASCD title by Savage and McGoun can give you the nitty gritty for the next level of training and more hands-on activities PD sessions that can follow a more general introductory session. One direction to go at more advanced levels involves teaching students to use online resources to do research.

For more specific ideas, resources, and direct application of technology for research and classroom projects, I would recommend the following book by Erik Palmer: *Researching in a Digital World: How Do I Teach My Students to Conduct Quality Online Research?* (ASCD, 2015).

If you wish to focus on students doing research in the classroom, this book can provide a great deal of resources. Erik Palmer provides a lot more specific information for more advanced PD sessions in this brief but resource packed paperback book in the new Arias series from ASCD. The ARIAS titles are short books that pose an important educational question and propose a variety of practical solutions.

The value of the Palmer book lies many resources for teachers, from web sites to blogs for students. Palmer provides some ideas on how to limit searches and get better results. The author also defines plagiarism in terms of web resources and explains how to teach students to document the sources they have used in conducting their research.

Review of *The Immortality Factor*,
by Ben Bova.
New York: Tor-Forge/Tom Doherty Associates. 2012.

Ben Bova is an actual scientist and he uses his knowledge to create a thrilling and captivating story here about research on the regeneration of human body parts. Bova takes us into the world of science, explaining all technical factors as he goes, and wrapping us into the debate of whether or not humankind should try to extend life. If so, how much?

Bova organizes the book into short chapters by characters and by events. At the core of the book is a trial in a national science court, designed specifically to look at pressing issues in research. The trial gets many chapters of its own, and it tells us how people are feeling and how they are interacting.

Something I really enjoyed—and marveled at—is that not only do we not get to understand each character's thoughts and motivations but we also get to learn what they think of the other characters. Bova goes further by telling us what characters project as the other characters' motives. He even uses the word "projection" for the educated reader so that he is acknowledging what he is doing.

In addition to the topics at hand, Bova is able to pack this book with other subtle (some not so subtle) issues and concerns for the reader. Bova has strong opinions about religion, government, law, and society. The author makes sure all of these receive comments and evaluation in the book.

This is a lengthy paperback and meaty. I wanted a book with some content to it to think about as I read. I was surprised by what a great book it turned out to be. I am hoping to read some more of his work.

Bova is a prolific writer, and readers can go to www.tor-forge.com to see more of his work. Bova has written a clever, witty, important book here. I hope readers will get a copy and get ready to do some thinking as they experience the exciting events and interesting conversations the book provides.

About the Author:

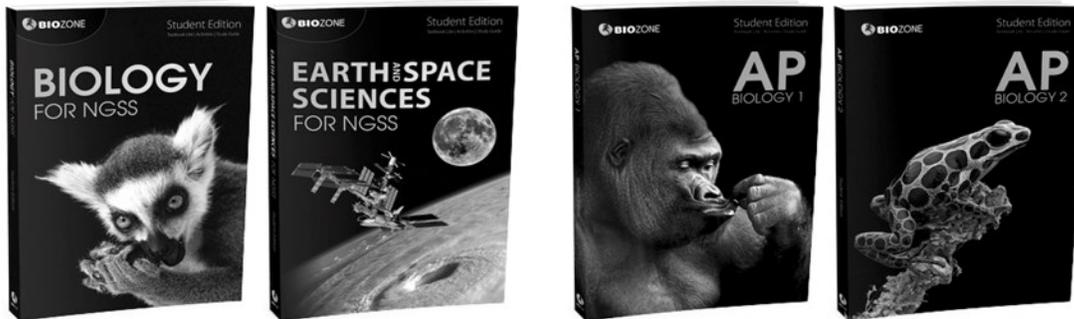
Thomas Hansen, Ph.D., is an Independent Consultant with a variety of roles in Education and Advocacy. He is a former State Supervisor for Foreign Languages for Illinois K-12 schools. One of his current areas of work is Grant Writing and another is Grant Reviewing. He also teaches courses in Education and Teacher Certification as an Adjunct Professor. He has written well over 100 articles, book reviews, and essays.



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