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THE SCIENCE EDUCATION REVIEW

Ideas for enhancing primary and high school science education

Did you Know?

Wartime Self-Sacrifice of Scientists

Not all wartime science has been wicked. Potentially fatal chlorine gas was used during World War I, and the effectiveness of different respirators needed to be tested. Father and son biologists J. S. and J. B. S. Haldane chose to do such testing, in the process inhaling chlorine gas while at the same time obtaining data that saved the lives of thousands of troops.

The son went even further during World War II by breathing different proportions of nitrogen and oxygen, and subjecting himself to different rates of decompression, in an effort to help British navy divers swim deeper and longer underwater without getting the bends. As a result, he suffered both short-term torture and longer-lasting injuries. He would sometimes be thrown into a seizure, and reported suffering "extreme terror" as he attempted to escape from the decompression chamber. A set of convulsions left him with permanently-compressed vertebrae, and a decompression experiment perforated his eardrums. By the end of the war he could blow smoke from his ears!

Source

Brooks, M. (2011). *Free radicals: The secret anarchy of science*. London: Profile Books.

Teaching Ideas

Techniques, demonstrations, activities, alternative conceptions, critical incidents, stories, and other ideas

Paper Slide Videos

An authentic way for students to demonstrate their understanding of concepts (e.g., at the end of a unit on, say, plate tectonics) is to have them publish creative, low-tech, paper slide videos. Show students some examples that can be obtained by searching *paper slide* or *paperslide* on YouTube. Invite them to write a script, illustrate it with a series of slides hand-drawn or printed on 8.5" x 11" paper, and recite the script while videoing the paper slides in a single-take fashion. A tripod to hold the camera still will help. The final slide should include an assessment question to assess understanding of the content of the video or to extend it.

The videos may be viewed and discussed as a class or in small groups, with the creator of a video facilitating discussion related to his or her assessment question. Paper slide resources and handouts are available from FIZZ Education (n.d.). It is motivating for students to be told that some of their work may also be made public.

Reference

FIZZ Education. (n.d.). *FIZZ: 1-take video resources*. Retrieved from http://fizz.fi.ncsu.edu/1-take-video-resources/ .

Source

Brunsell, E., & Horejsi, M. (2013). Paper slide videos. *The Science Teacher*, *80*(4), 8.

Speaking to a Mobile Device

While communicating with a digital device using a keyboard, mouse, or touchscreen is common, mobile apps such as Apple's Siri (Apple, 2013) and Google's Voice Search (Google, n.d.) now provide for voice-command communication. Consider the following examples of tasks that can be achieved by speaking to a device:

- Request a web search.
- Open an app with an "open (app name)" command.
- Have Siri provide an answer to "what is the speed of light in water?" or "what is 23 plus 19 plus . . .?" in text or speech.
- Display answers to mathematical questions using a calculator, web search result, or response from Wolfram Alpha (Wolfram Alpha, 2013), an online computational engine.
- Dictate speech from a hand-held device to a computer, which displays the corresponding text (e.g., in a word processor, email, or tweet).
- Ask for a weather prediction.

Voice-command communication can be a time-saver. It can also make hand-held devices even more useful in the lab (e.g., setting timers, alarms, and reminders) and potentially help students with visual or motor-skill difficulties. In a noisy classroom where the noise can interfere with the voice commands, students might use earbuds that contain a microphone in the wire that connects the ear plugs to the device, but with only one ear plug fitted so as to allow them to still hear the teacher.

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Wolfram Alpha. (2013). *Wolfram Alpha*. Retrieved from http://www.wolframalpha.com/ .

Source

Brunsell, E., & Horejsi, M. (2013). Meet Siri, your new lab partner. *The Science Teacher*, *80*(5), 8.

Students' Alternative Conceptions: Skin Cancer

Students' alternative conceptions have been variously called misconceptions, prior conceptions, preconceptions, preinstructional beliefs, alternative frameworks, naive theories, intuitive ideas, untutored beliefs, and children's science. The tasks in this regular section of *SER* are based on the literature and may be used at the beginning of a constructivist learning segment to arouse the curiosity of students and to motivate them, while simultaneously eliciting their ideas or beliefs. They are designed to address areas about which students are likely to have an opinion, based on personal experiences and/or social interactions, prior to a specialist learning sequence, or areas that might be considered important for the development of scientific literacy.

Answer *true* or *fals*e for each of the following statements:

1. Dark-skinned people do not get skin cancer.
2. Using a tanning bed to tan indoors is safer than tanning outdoors.
3. You cannot get sunburned on a cloudy day.
4. Skin cancer is not found in teenagers.
5. An SPF (sun protection factor) 30 sunscreen provides twice the protection of an SPF 15 sunscreen.
6. Glass does not allow ultraviolet (UV) radiation to pass through it.
7. A healthy way to protect your skin from sun damage is to get a base tan. (A base tan refers to the slow, gradual tanning of the skin under either natural or artificial sunlight.)
8. Sunscreen is not necessary on a cold day.
9. Applying sunscreen once a day is all that is necessary.
10. Some types of ultraviolet (UV) rays are safe for your skin.

Answer: All these statements are false. The statements are adapted from the Tanning Survey (Bratsis, 2013b). Bratsis (2013a) recommends having students administer the survey to other students, compile the results, identify the top myth or myths, and educating the community by sharing related facts via videos prepared for school assemblies, audio clips for school PA announcements, or posters/brochures for school hallways or local community centres.

Reference

Bratsis, M. E. (2013a). Shining a light on skin cancer. *The Science Teacher*, *80*(5), 76-77.
Bratsis, M. E. (2013b). *Tanning survey*. Available from http://www.nsta.org/highschool/connections.aspx .

Students' Alternative Conceptions: Fuel, Food, and Energy

Which of the following statements about fuel, food, and energy are acceptable? (There may be more than one.)

A. During burning and respiration, energy is produced when new chemical bonds are made.
B. When the energy-rich chemical bonds in fuels and food break, energy is released.
C. Burning a fuel, or respiring a food, causes energy in it to be released.
D. The energy produced when a fuel is burnt or a food is respired is not contained in the fuel/food itself but rather is associated with both the fuel/food and oxygen.

Answer: Statements A and D are acceptable. While it is common, and convenient, to use expressions such as "energy-rich foods," "fuels contain energy," and "energy is passed along food chains," they do reinforce the misconception that fuels and food contain energy. Rather, the energy associated with fuels and food resides in the fuel/food-oxygen system that is created during photosynthesis when oxygen is dragged away from water and carbon dioxide in green plants. During combustion or respiration, a fuel or food, respectively, recombines with oxygen and releases energy.

So, a label on food packaging saying that the food contains energy is misleading. It would be better to refer to the energy-value of the food or to the energy available when the food is respired. Best of all, though, would be to talk about the fuel-value of a food. In addition, while digestion requires energy and does break food down, we should not say that food is broken down during respiration. Rather, respiration is a building-up, or construction, process that uses oxygen to make water and carbon dioxide.

Source

Ross, K. (2013). Fuel and food are not made of energy – a constructive view of respiration and combustion. *School Science Review*, *94*(349), 60-69.

Science Poetry

Reading and/or listening to poems composed by other children their own age can inspire and reassure students as to their ability to understand and write poetry, and the science poems in this regular section of *SER* may be used for this purpose. Please find information about the *International Science Poetry Competition* at http://www.ScienceEducationReview.com/poetcomp.html .

A Chemistry Tale

Chemistry makes the world how it is
with ways to find out how chemicals fizz.

They bubble and splash and gurgle and fly
in ways unknown to the human eye.

The elements are organized into the periodic table
in columns and rows; on the right side they're stable.

When different elements don't get along
it's called a reaction; I've put it all into a song.

Iron and oxygen mix and combust
forming red and flakey rust.

Hydrogen and chlorine, together they gel
creating the acid known as HCl.

Magnesium and oxygen when they burn bright
make a magnificent luminescent light.

Hydrogen and oxygen we all know
produce water or H_2O.

Inside the atom there's a lot to see
a million times more than you'd expect there to be.

Protons with a positive charge and neutrons with none
lurk in the nucleus having lots of fun.

Electrons orbit in shells all around
for them a negative charge has been found.

An element is made of all the same atom type
but now alas the time is ripe.

Now as I finish my poem I hope your brains more buff
about the periodic table, reactions and other fun stuff.

You'll find it more enjoyable when you study it at school
because chemistry is really amazingly cool!

Aimee Saunders, 13 years
Australia

Testing: Is Carbon Present?

Come now, copy this prac into your book,
Now now, what's with the sour look?
Do not hesitate to move with pace,
Bring your book with a smile on your face.

When heating the Bunsen burner,
Be very careful you are only a learner.
Remember to wear your apron and goggles,
What you can do will make your mind boggle.

Place the cement mat on your bench,
Warning - this experiment may create a stench.
Putting the Bunsen burner on your cement mat,
Make sure the surface is smooth and flat.

You have metal tongs at your station,
We could make the discovery of the nation.
Please collect your solid substances,
To test for carbon's survival chances.

With a large range of solids chosen to test,
They vary widely; we have no clue which are best.
From paper, biscuits, polyester and cotton wool,
To glass, aluminium foil as well as steel wool.

Turning on the gas as you strike the match,
Keeping long hair tied back, so on fire it doesn't catch.
Then one by one we held them out straight,
At the top of the blue flame; now just the wait.

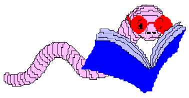
We observed each solid and recorded the outcome,
Of which had changed and what they'd become.
Will it burn; black or not, that was the test,
Some answered "no" and others a "yes."

We found carbon was present when the solid burnt black,
It was in polyester, biscuits, cotton wool and the sugar block.
Though carbon wasn't present in all of the solids tested,
There was zero in glass, aluminium foil and the steel wool, we'd questioned.

My favourite was the little white cube made of sugar,
When it met the heat it was like the sweet lollie nougat.
It melted and dripped into the barrel of the burner,
My goodness what a mess, we are certainly learners.

With recorded results in our books,
There was not another sour look.
We had been put to the test and completed the task,
As for the teacher we had no need to ask.
The benches were cleaned; we left no traces,
Then we exited the lab with smiles on our faces.

Georgia Mawson, 13 years
Australia



Research in Brief

Research findings from key articles in reviewed publications

Caution With Online Periodic Tables

The following are the 10 most visited online periodic tables: *Chemical Elements.com* (Bentor, 2012), *Chemicool* (Stewart, 2013), *Dynamic Periodic Table* (Dayah, 1997), *It's Elemental: The Periodic Table of Elements* (Gagnon, n.d.), *Periodictable.com* (Gray, Whitby, & Mann, 2010), *Periodic Table Live!* (Banks et al., 2010), *Periodic Table of Elements: LANL* (Los Alamos National Laboratory, 2011), *The Periodic Table* (AVS, n.d.), *Visual Elements Periodic Table* (Royal Society of Chemistry, 2013), and *WebElements* (Winter, 2012). Izci, Barrow, and Thornhill (2013) evaluated and compared these periodic tables for accuracy, the categories of information they contained, and the types of links provided on the basis of how the following four elements were treated: argon, carbon, gold, and plutonium.

The accuracy of the data presented was evaluated using up to11 different attributes (e.g., density, enthalpy of fusion, and electron affinity) and comparison with the *CRC Handbook of Chemistry and Physics* (Haynes, 2012). The 10 periodic tables varied widely in accuracy. The most accurate was *Chemicool* (67% accuracy), followed by *WebElements* (61%). One half of the sites were less than 50% accurate. So, if one is seeking raw physical data about an element, the authors suggest that an online periodic table may not be the best source. *Chemicool* and *Periodictable.com* provide the most comprehensive information about attributes, addressing more than 80% of them.

WebElements, *Chemicool*, *Periodic Table Live!*, and *Periodictable.com* covered the most information categories (e.g., the meaning of the name, uses in society, and electron affinity) of the 22 categories used to compare the periodic tables. Finally, online periodic tables typically provide links to things like the history of the elements, everyday uses, videos of chemical reactions, and charts and graphs that explain trends. *WebElements* provided the most diverse types of links, with *Visual Elements Periodic Table*, *Chemical Elements.com*, and *Periodictable.com* not far behind. *The Periodic Table* provided one type of link only.

Each of the online periodic tables has its strengths and deficiencies, so a teacher should consider using more than one to facilitate student learning. For example, *Visual Elements Periodic Table* might be a good starting point because it is reasonably accurate, provides much information and many links, and also offers non-written ways to study information, such as imagery and music. On the other hand, *Periodic Table Live!* allows users to chart and graph information.

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Winter, M. (2012). *WebElements*. Retrieved from http://www.webelements.com/.

Choral Repetition to Build Language

Hohenshell, Woller, and Sherlock (2013) studied the effect of using choral repetition, an oral language learning technique, on 22 teacher education students (11 male, 11 female) during a 3-week animal physiology course. Nine words or phrases that, based on prior experience, were considered difficult, complex, and hard to pronounce were targeted. When each term or phrase appeared in the lecture, the instructor modeled it orally and asked students to repeat it three times as a group before elaborating on its meaning.

The students overwhelmingly supported the use of the technique, recommending that it also be used with younger students. It helped them to pronounce new and difficult terms, to remember the terms, and to identify course content goals. Some students adopted the technique themselves during subsequent independent reading and writing tasks.

Reference

Hohenshell, L. M., Woller, M. J., & Sherlock, W. (2013). On the road to science literacy: Building confidence and competency in technical language through choral repetition. *Journal of College Science Teaching*, *42*(6), 38-43.

Inquiry/Language Arts Professional Development Increases High-Stakes Test Scores

Shymanskya, Wangb, Annettac, Yored, and Everette (2013) implemented a 5-year professional development (PD) programme in 33 school districts across Iowa and Missouri, USA aimed at having K-6 teachers learn science concepts and inquiry teaching strategies associated with a selection of science inquiry kits and how to adapt the science inquiry lessons to teach and reinforce language arts skills. The PD comprised regional summer workshops, district-based leadership teams, and distance delivery technologies. The PD programme made a significant positive impact on the achievement of Year 3 and 6 students on both the Iowa Test of Basic Skills-Science (ITBS-S) and Missouri Assessment Programme-Science (MAP-S) high-stakes tests.

Reference

Shymanskya, J. A., Wangb, T-L., Annettac, L. A., Yored, L. D., & Everette, S. A. (2013). The impact of a multi-year, multi-school district K-6 professional development programme designed to integrate science inquiry and language arts on students' high-stakes test scores. *International Journal of Science Education*, *35*, 956-979.

Reasons for Choosing to Study Physics at University

Rodd, Reiss, and Mujtaba (2013) analysed the interview data of 7 first-year physics undergraduates attending UK universities to determine their reasons for choosing to study physics. An important element in making this decision was identification with a key adult who represented physics, and typically a teacher or family member. It is common for activities such as projects and competitions to be used to motivate students toward further participation, so it was somewhat unexpected that no evidence was found for these learning experiences having played any key role in the students' decisions to continue to study physics at university.

Reference

Rodd, M., Reiss, M., & Mujtaba, T. (2013). Undergraduates talk about their choice to study physics at university: What was key to their participation? *Research in Science & Technological Education*, *31*, 153-167.

Supporting Fourth Graders' Ability to Interpret Graphs

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Technology use is rampant in todays' society. According to the Pew Internet & American Life Project (Pew Research Center, 2005), more than 80% of students between the ages of 12 and 17 years use the Internet regularly. Yerrick (2009) reported 75% of teens using at least two digital tools regularly and spending an average 6.5 hours a day with media. For this reason, it is incumbent upon teachers to incorporate technological advancements in their current teaching practices. Grades 5-12 content standards for science as inquiry emphasize that technology should be used to collect and analyze scientific data. However, Grades K-4 content standards for science as inquiry emphasize the importance of using simple tools such as magnifiers, thermometers, and rulers without any reference to technology (National Research Council [NRC], 2000). This gives an implicit message that use of technology may not be appropriate at the elementary grades. The efficacy of using real-time graphing technology to teach science in Grades 6-12 is well studied, but there is a need for studies investigating the efficacy of using real-time graphing technology at the lower elementary grades (Zucker, Tinker, Staudt, Mansfield, & Metcalf, 2008). Real-time graphing technology allows students to measure temperature, light, force, sound, and other physical phenomena in science lessons, and this technology immediately transforms measurements into real-time graphs so that students can immediately see the impacts of their manipulations on the graph.

The purpose of our study (Deniz & Dulger, 2012) was to explore to what extent inquiry-based instruction, supported with or without real-time graphing technology, improved fourth-grade students' ability to interpret graphs related to the physical science concepts of motion and temperature. To address this issue, we taught graphical interpretation skills to fourth-grade students in two different classrooms of the same charter school in Las Vegas, Nevada. One of the classes was randomly selected as the technology class (19 students; 9 male and 10 female) and the other class was assigned as the traditional class (20 students; 11 male and 9 female). The average age of students in both classrooms was 10 years. Students in the technology class learned how to interpret motion and temperature graphs with the help of real-time graphing technology. Students in the traditional class produced graphs about motion and temperature with the help of the teacher using traditional tools such as rulers and thermometers. Students in the traditional classroom practiced graph interpretations skills after they constructed their own graphs. At both the beginning and end of the study, the students in both classrooms were given the same six-question, multiple-choice test measuring their graphical interpretation skills.

We found that at the end of the study students' ability to interpret graphs in the technology class was significantly better than their graphical interpretation skills at the beginning of the study. However, there was no significant difference between the pretest and posttest results of students in the traditional classroom. In this study, the combination of real-time graphing technology and the inquiry-oriented lesson planning was found to be more effective than the combination of inquiry-oriented lesson planning with conventional laboratory instruments in improving the ability of fourth-graders to interpret graphs.

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Readers' Forum

In Defense of the Scientific Method

I was shocked by the content of Brown and Kumar's (2013) recent attempt to dismiss the scientific method, as it does not appear to reflect a contemporary understanding of the scientific method nor a familiarity with key contemporary literature involving it. My criticisms of their piece include the following:

1. The scientific method does not aim to describe "a general procedure for scientific investigation" (p. 10). The authors do not seem to appreciate that science can investigate both causal questions (i.e., why does this happen?) and non-causal questions and that the scientific method applies to the answering of the former only (Eastwell, 2012).
2. "The laws of experimental science had to be established as generalizations (hypotheses, theories) induced from experimental observations" (p.10) incorrectly equates a law in science (i.e., a statement that summarises an observed regularity or pattern in nature) with an explanation (i.e., a hypothesis or theory); two very different forms of scientific knowledge.
3. The steps of the contemporary scientific method are not "formulate the problem, collect data, generalize, predict, and verify" (p. 10). Rather, the scientific method comprises the steps of asking a causal question about a puzzling observation, advancing a hypothesis (i.e., a proposed scientific explanation for what is observed), generating a prediction from the hypothesis based on the assumption that the hypothesis is correct, designing and conducting a test to check on the prediction, and drawing a conclusion as to whether the results of the test support or contradict the hypothesis.
4. The scientific method is not an inductive process. To the contrary, it is commonly referred to as the hypothetico-deductive (HD) approach. In fact, the inference of enumerative induction that some have claimed generates general conclusions from limited cases (i.e., reasoning from observed particulars to general statements, or "laws," or hypotheses) is probably a reasoning process that does not exist (Lawson, 2005; Popper, 1965). At best, enumerative induction might suggest a descriptive claim that is in need of deductive testing (Lawson, 2010a).

5. I agree that serendipity can play a role in science, and that it can involve chance and opportunity, but I cannot see how the example given of a scientist tossing a solution into a sink in frustration can possibly be linked with intuition and inspired thought. However, these can be features of the scientific method, as explained in the next point.
6. Use of the scientific method does not stifle creativity. Indeed, the steps of proposing hypotheses and designing tests to check on predictions that follow from them can be so highly creative that they distinguish great scientists from good ones.
7. I disagree that there is no evidence for the scientific method having been used by prominent scientists. Lawson (2010a) provides examples. We do need to note, though, that the scientific method can, and has, been used unconsciously, but that does not detract from the fact that it does exist.
8. The scientific method can certainly be used in disciplines other than science, including the social sciences. Lawson (2010a) provides examples from human history and engineering, and Lawson (2010b) argues that the more explicit use of the steps of the scientific method in science education research should result in better research efforts and reports. Indeed, HD reasoning really just reflects the common-sense reasoning that humans use in their everyday lives; our brains appear to be hard-wired for it.

At its core, science is about seeking explanations for natural phenomena (i.e., answering causal questions) and it is the scientific method that provides the mechanism for doing so. The scientific method is therefore central to the way science is done and to the way the field of science progresses, and an understanding of the scientific method is fundamental to an understanding of the nature of science (NOS), which in turn is an integral component of scientific literacy. It is unfortunate that NOS is typically not treated explicitly in either school or university science courses and that aspects of the scientific method are not well understood (Eastwell, 2010). The more explicit and frequent use of causal questions in science classrooms would be highly desirable for the development of a better understanding of the scientific method and hence a better development of scientific literacy.

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Canoes and Ropes

In a circus performance many years ago, I first saw a man standing part-way up a hanging rope and wondered how he managed it. Observing closely, I saw that the vertical rope to which he was grasping went down over his abdomen, between his legs, around one knee and calf, over the instep of the foot (he was wearing boots), and hung downwards below him. The sole of the other foot pushed down on the part of the rope passing over the instep, thus acting like a brake. An elaboration, including photographs, of this technique that is used by marines, navy seals, and army rangers may be found in Wood (2008).

It is commonly known that a rope wound around a stick can be used to propel the stick, and even to hurl it at an enemy. But I would like to tell a story about when we applied our knowledge of ropes and friction to retrieve a canoe that was on the bottom of a river some 10 meters deep. We learned that it capsized and sank to the bottom, quite far from both banks, with all the money, documents, and luggage of the passengers going with it. Thank goodness, the passengers got safely to the bank. We had two canoes, 6 meters and 5 meters long, at our disposal and a lot of ropes. The problem was to lift the submerged canoe, 5 meters long and filled with water, from the bottom. First, we located the submerged canoe by having a passenger dive to it. He fixed a rope to a section of its frame by turning the end of a rope, with a mass fixed to it, around the frame. Then we passed the other end of the rope between our two canoes and fixed it to the oar that straddled the canoes by placing the free end of the rope along the oar and winding the rope once or twice around the oar and over itself. After that we just rotated the oar using the paddles and wound some ten turns of the rope around the oar. Our rescue device first began to sink under a heavy load applied to it via a rope connecting us and the canoe on the bottom. But then the submerged canoe came away from the mud on the bottom and our device experienced a little jump upwards and we were able to lift the submerged canoe to the surface and move it to the bank. All were happy when we found everyone's belongings inside the retrieved canoe. This story is actually another example of the application of the capstan (or belt friction) equation (Attaway, 1999).

Figure 1 expresses Amontons' friction law for a flexible belt. This relation, often called the capstan equation, connects the hold-force (T_1) and the load-force (T_2) when a flexible rope is wound around a cylinder. Because of the interaction of frictional forces and tension, the tension on a line wrapped around a capstan may be different on either side of the capstan. A small holding force exerted on one side can carry a much larger loading force on the other side, and this is the principle by which a capstan-type device operates. The other quantities in Amontons' friction law are μ, the coefficient of static friction between the rope and capstan materials, and β, the total angle swept by all turns of the rope and measured in radians (i.e., with one full turn the angle $\beta = 2\pi$). From this brief outline we see that, in our case of rescuing the canoe, we employed capstans on both ends of the rope as we did not use any knots.

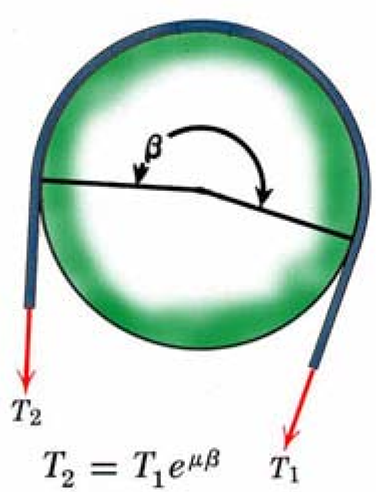

Figure 1. The capstan.

Acknowledgement

The author would like to thank Peter Eastwell for discussion and helpful advice on this contribution.

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? ? ? ? ? Your Questions Answered ? ? ? ? ?

This section of *SER* responds to readers' queries, so please submit your question to The Editor at editor@ScienceEducationReview.com . Have that long-standing query resolved; hopefully!

Hair on Van de Graaff

On some occasions the standard clump of hair or string supplied for my Van de Graaff generator stands up impressively, as it should, while at other times it appears to stick to the dome of the generator; either fully or partially. What is causing this sticking behaviour and what can I do to get the hair or string to stand up reliably, please?

A charged plastic ruler can be used to lift pieces of paper from a desk. The paper is an insulator, but the presence of the charged ruler near it induces charges in the paper (the electrons in the paper become slightly displaced in their orbitals), thus causing the paper and ruler to be attracted to one another. By analogy, I hypothesized that the same phenomenon was at work in the puzzling observation mentioned in this question; that is, the hair and string were acting as insulators, and probably as a result of being dried out too much.

To test this idea, I predicted that making the hair and string conductors of electricity would cause them to stand up readily, as they would then gain the same electric charge as the Van de Graaff dome and be repelled. I was able to access both hair and string accessories, for a Van de Graaff, that had been stored in relatively dry conditions for a long period of time and was delighted to find that they both stuck to a charged Van de Graaff!

To try to make them conductors, I recalled that fabric conditioners/softeners play an antistatic role by increasing the electrical conductivity of fabrics, so I dipped both in a solution of fabric conditioner and allow them to dry. Presto, the string stood up beautifully on the Van de Graaff, although the fabric conditioner had no effect on the behavior of the hair. I also observed, though, that the effect of the fabric conditioner on the string had dissipated after about 3 rather dry and hot days. I am wondering if using a more concentrated solution of fabric conditioner might be beneficial here.

In a second attempt to make the string a conductor, I decided to dip it into vinegar. I do not know what the string is made of, but it has a soft, woollen-like feel. After the string dried, it once again stood up very impressively on the charged Van de Graaff. I am yet to see how long the effect of the vinegar lasts. Vinegar again had no effect on the hair.

Enquiring about the hair accessory, I was told it was actually artificial hair used to make wigs but I do not know precisely what the material is. However, nylon will absorb water (i.e., it is hygroscopic), but at a relatively slow rate. So, if the hair is made from nylon or some other material having a similar water-absorbing property, soaking it in tap water for a few days, or hot water for a few hours, may cause it to become conductive and stand up on a Van de Graaff, but I am yet to try this.

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Laboratory Safety Guidelines

This section presents a series of 40 laboratory safety guidelines kindly provided by Dr James A. Kaufman, President, The Laboratory Safety Institute (LSI), USA. Please visit http://www.labsafety.org for further information, products, services, and publications.

#20 of 40. *Develop Plans and Conduct Drills for Dealing With Emergencies Such as Fire, Explosion, Poisoning, Chemical Spill or Vapor Release, and Personal Contamination*

The list is incomplete. Let's add bleeding, burns, medical situations, electric shock, and weather emergencies. One of my biggest surprises was discovering about 20 years ago that teachers do not have written emergency plans and that they don't discuss these issues in their science departments. When questioned about these two points, only about 5% of science teachers say yes. What about your company? Most are not much better! I've ask about 50 000 scientists and science educators. Yikes!

The only good way to prepare for an emergency situation is to think through how you should respond and then practice doing it correctly. Regular drills and exercises are essential. In most cases, the first decision involves deciding whether to evacuate or not. No one will ever fault you for saving your students and losing the facilities.

If you are starting from scratch in your department, have an emergency of the month. Assign one of the above emergencies to a pair of teachers/employees and ask them to draft a model response to be discussed at the next department meeting. The following month, pick a new emergency and a new teacher/employee pair. In small departments/companies, invite the arts, physical education, industrial arts, and office and maintenance people to join with you.

One last word of advice: PRACTICE. You can't get good at anything without practice. Dealing with emergencies is no exception. Each month, ask the folks in one of your labs to decide what would be the worst thing that could happen in their lab. Let them stage a mock event and have everyone else respond (hopefully) appropriately. Afterwards, sit down together and ask two simple questions (Brian Tracey's Platinum Questions):

1. How did we do?
2. How can we do it better?

An Emergency Preparedness Review is available from LSI. In addition to assisting in the planning for emergency responses, this publication covers many safety program topics.

Further Useful Resources

iCell (http://hudsonalpha.org/education/digitaleducation/icell) Free software to allow students at all levels to explore living cells; animal, bacteria, and plant. Also available on the App Store and Android.

Molecules View, manipulate, and store ball-and-stick and space-filling models of large molecules. Free on the App Store from Sunset Lake Software.

GoSkyWatch Planetarium Free on the App Store from GoSoftWorks. Point your device to the sky and see the stars, galaxies, and constellations located and named.

Sample End-of-Course Student Survey (http://www.nsta.org/highschool/connections/201307SampleCourseSurvey.pdf) Helps a teacher gauge his or her learning style.

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Please visit ***The Science Education Review*** at http://www.ScienceEducationReview.com . ***SER On-Line*** offers individuals and institutions password and/or IP authenticated access to the content of all issues of *SER*.

Contributions are welcome, as are expressions of interest in joining the Editorial Review Board. The latter role requires the periodic review of submitted contributions, and is not onerous. Comments, questions, and article proposals may be sent to The Editor, Dr Peter H. Eastwell, at editor@ScienceEducationReview.com .

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