Stories in Science

This year, the mood in our science workshops was incredibly jovial, with the teachers infusing a cooperative and merry spirit into our work that served as a great reminder that science can be a collaborative and fun effort, not something to take too seriously or to attempt in solitude. The laughing and singing and lightheartedness amongst our colleagues each day exemplified the fun that we hope is also present when the learners are in the classroom. Since this year's workshops focused on senior phase science, grades 7th through 9th, we were particularly interested in having teachers share their wisdom for how to make science accessible to their young learners. Science in South Africa's educational system is compulsory only through 9th grade; beyond that, pupils can opt to stop studying science altogether. This option is often selected by learners who have experienced difficulty in their Senior Phase science classes and thus feel as though they don't have the capacity to be successful in further scientific study. Since a student's Senior Phase science experience is instrumental in determining whether or not that learner will opt in or opt out of further science education, our workshops intentionally focus on sharing methodology for making science fun and approachable, not intimidating. Many teachers reported finding success by using stories and analogies to make a confusing new idea more relatable. We had great fun sharing these examples amongst our group. In explaining the properties of metals, one teacher got up and said, "they are shiny, like my teeth!" and earned raucous applause from the room when he opened his mouth in a wide grin to demonstrate the veracity of his statement.

This photo shows a young middle school teacher who was excited to share how she teaches kids to balance equations with a story. She told a parable in which she compared balancing equations to visiting a friend's house. The rest of the teachers in the room immediately understood when she explained that one should approach the front door and not enter directly into a friend's backyard, as their dogs would inevitably attack. The teacher then connected this sage advice with students' common error of changing the subscripts at the end of a chemical formula instead of the coefficients in front of the chemical formula, a mistake that many other teachers in the room agreed

that their learners also commonly made. She creatively pointed out that changing a chemical's subscript was just like going to the back door, which would provoke a dog bite, and thus is to be avoided at all costs. This insight made her colleagues chuckle. She then pointed out that changing the coefficient in front of the chemical formula is the same as going to the front door, which is the correct protocol to follow, and the whole room eagerly nodded in agreement. Her fellow teachers praised this somewhat silly analogy as exactly the thing their students needed to make a tricky concept approachable and meaningful. The lighthearted mood of our cohort helped reinforce a sense of vast potential for demystifying science and encouraging learners to engage with the material. With so much levity in our workshops, our teacher colleagues continually reinforced the joy of learning and made the week a festive and memorable experience for all of us.

Serendipitous Discoveries

In our chemistry sessions, we did several practical activities to investigate the properties of acids and bases. These teachers extracted the dye from a purple cabbage for use as an indicator solution to visually determine whether substances were acidic or basic. They then used it to carry out acid-base neutralization reactions. They combined a dilute solution of pool cleaner, hydrochloric acid, and drain cleaner, sodium hydroxide, with the ultimate goal of creating a neutral solution. However, the base was more concentrated than the acid so the more dense solution sank instead of mixing with the acid to create a neutral solution. The addition of the purple cabbage indicator solution rendered the horizontally layers of the solution strikingly different colors, clearly demonstrating that the more dense base was on the bottom of the beaker. Earlier in the week, a tangent had popped up about whether it is possible for two aqueous solutions to have different densities and we hadn't followed up with an experiment to address that query, so this unexpected color layering result was a welcome resolution to that earlier discussion, providing easily interpretable visual evidence and sparking great conversations about what steps one could take to flip the order of the color pattern in the beaker. While this effect was an unplanned surprise, it became an auspicious new direction for our workshop, genuinely placing the teachers in charge of following their interests via further conversation and experimentation. The natural curiosity with which teachers dove into this unplanned discussion demonstrated the capacity for creative innovation present inside each teacher. We were thrilled to harness the power of hands-on activities to unlock each individual's latent delight in hypothesizing and experimenting with dramatically colored solutions.

Veteran Educators

One of my favorite aspects of our workshop is how our cohort of teachers from a wide variety of ages and backgrounds bond together in only a week. This year, teachers from all over the Free State attended our workshops, some driving from 6 or more hours away to join us, leaving their homes at 2 am on Monday morning for a six-hour ride in an unheated bus to join us at Tsoseletso High School. At the start of our work, I met Mshome, pictured here, and learned that he has been teaching science for the same number of years that I've been on the planet. Despite his prodigious experience in the classroom, he was wonderfully open-minded about trying new experiments and was eminently willing to consider familiar concepts from a new point of view. During our chemical reaction with acetic acid and calcium carbonate, we used vinegar and eggshells for the reactants. While we could easily see that a reaction was occurring because of the gas bubbles being produced, some teachers mentioned that it would be difficult to convincingly demonstrate to their learners that the original substances were used up and there were new substances produced. We used our purple cabbage indicator solution to test the acidity of the solution before and after the reaction. This allowed us to determine that the original solution was acidic but the final solution was neutral. However, both solutions were clear, so some of the teachers asked how we could additionally demonstrate that water was present in our final solution. Mshome pointed out that we could use dehydrated copper sulfate to test for the presence of water. Many of the other teachers were unfamiliar with this experiment, so Mshome led the group in doing a quick experiment to demonstrate his point. Copper sulfate, often called bluestone in South Africa, is commonly available in local pharmacies and is a great resource for many different chemistry experiments. Mshome used a torch to heat a blue copper sulfate solution and thus drive off the water in the sample, rendering the remaining substance white. We could then use the anhydrous sample to test a solution for the presence of water, as the sample would turn blue in aqueous solution. This is a common experiment that is often performed quantitatively but here it was a useful way to make a qualitative color observation. The teachers were very impressed with the color

change from blue to white and Mshome was delighted with the success of his idea, proud to share part of his vast experience with the group of colleagues.

Innovating Young Learners

In our final week in Bloemfontein, I spent some time working with adolescents at Central University of Technology, where a winter school camp was providing supplementary science classes for 8th, 9th, and 10th graders from all over the Free State. The students were selected to attend this week-long program based on their results on standardized tests. Learners who demonstrated promise but were not yet earning top marks were invited to participate in hopes that the program would help them excel. The kids were absolutely extraordinary; they woke up at 4 am to get a hot shower before breakfast, attended classes from 8 am to 5 pm, and spent their evenings doing homework, and repeated this grueling schedule all week. Their steady concentration during these long days was astonishing; dozens of students sat in the same classroom all day and paid attention during their lectures, each of which was 2 hours long. Despite the long days, the students professed tremendous gratitude at being able to attend this program, declaring that giving up their school break to attend extra classes was worth it in exchange for a chance to improve academically. The kids described how their teachers at home often didn't fully understand the science themselves, making their science classes an ineffective environment for learning, so the students would need to study independently in order to understand the material that would be on the tests. For my part, I collaborated with the winter school teachers to supplement their lectures with hands-on activities to demonstrate the concepts they were teaching. In my electricity activities with the 8th graders, we categorized common materials into conductors or insulators. In this photo, the students are determining that the metal scissors blades are effective conductors and can thus complete their circuit. They also tested the plastic scissor handles, their coat buttons, pencil lead and a host of other materials, creatively investigating everything at their disposal. Though they already knew which materials fell into which category, they were still genuinely excited to see the results of each test, impressed that their theoretical understanding matched their practical results. The genuine delight with which the kids dove into this work was far greater than my students in the USA would have for a similar project, but the winter school students just didn't have

access to this sort of basic experiment in their usual educational experience and thus were downright gleeful at getting to do hands-on work.

Local Leadership

Grace Setlhare is a science teacher at Tsoseletso High School, the school where we conducted our TABSA workshops for teachers from all over the Free State. She proved to be an incredible asset during our work, rapidly establishing herself as a leader amongst the other teachers attending our workshops. Grace's content knowledge was top notch, her sharp investigative powers led her to extend our experiment ideas in novel and worthwhile directions, and she often helpfully clarified nuances of the South African CAPS curriculum for the other local teachers. In this photo, she's explaining a high school concept to the middle school teachers about the functional differences between batteries and bulbs in series and parallel. Her keen contributions significantly improved the quality of the workshops for everyone, including the TABSA facilitators.

After saying goodbye to Grace at the end of the week's workshops we were happily surprised to run into her again the following week at winter school, where she'd been hired on as a last-minute substitute teacher. In that role, she was tasked with teaching students from all over the Free State province many of the same concepts for which we'd done experiments the previous week, so she was full of fresh ideas and excitement about how to conduct her classes in a more interactive manner. Seeing her willingness to make her teaching more experiential and her interest in immediately putting what she'd learned in our workshops to use with the winter school students served as a tremendous vote of support for TABSA's work. We were able to provide her with basic supplies from our workshops so that she could reprise the activities. The experiments turned out to be an enormous hit amongst her winter school students, who raptly focused on participating and learning during the hands-on work. Ultimately, we said goodbye to Grace, knowing that she'll continue inspiring her students and colleagues with her sharp scientific acumen, her enthusiasm for doing practical experiments, and her belief in the capacity of every individual.