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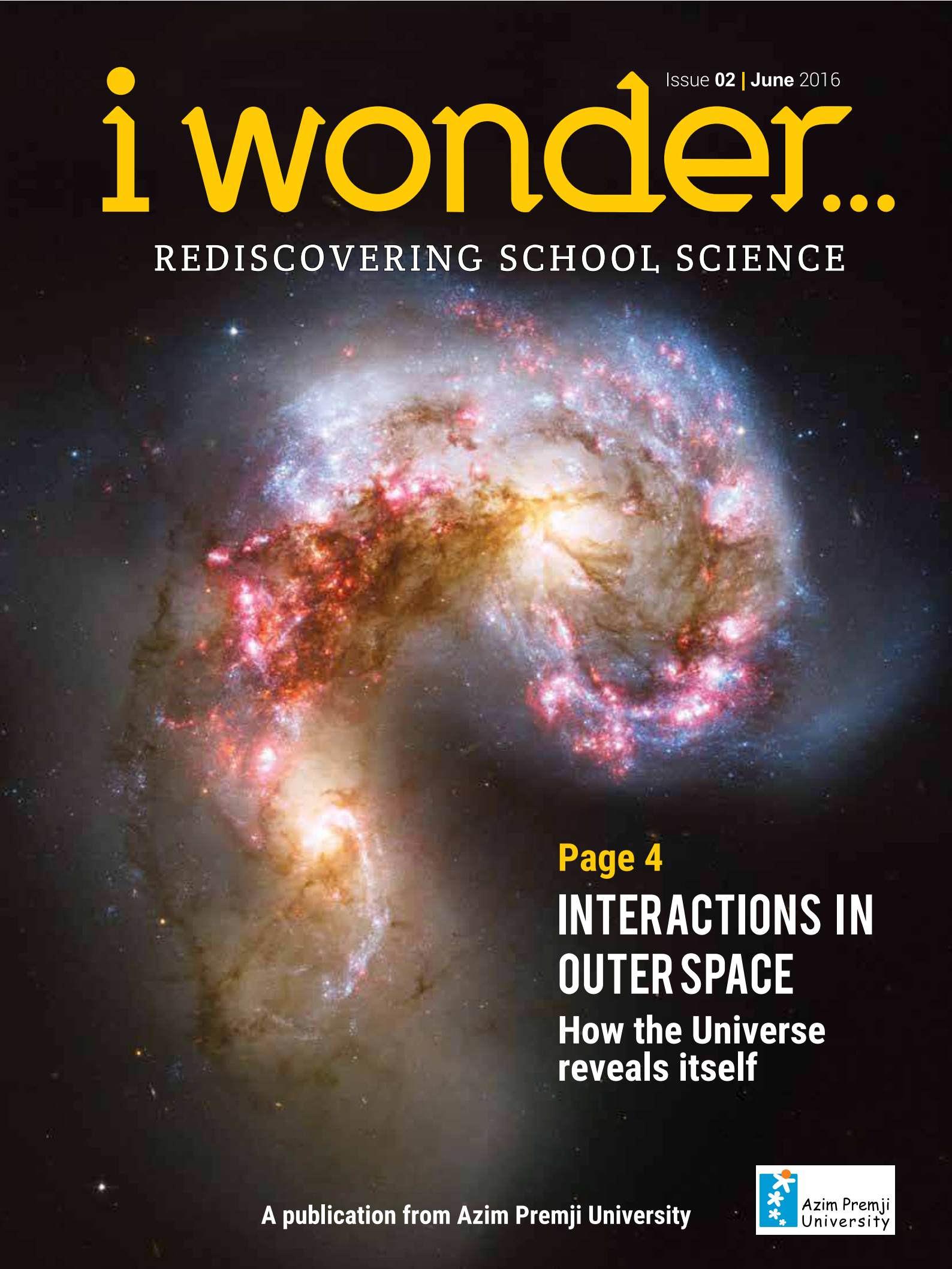
REDISCOVERING SCHOOL SCIENCE



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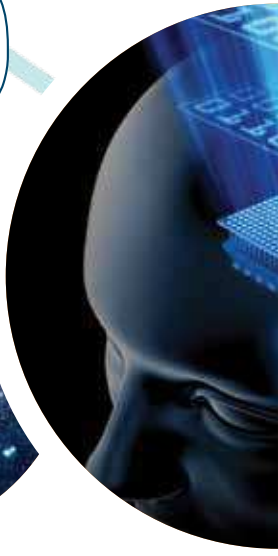

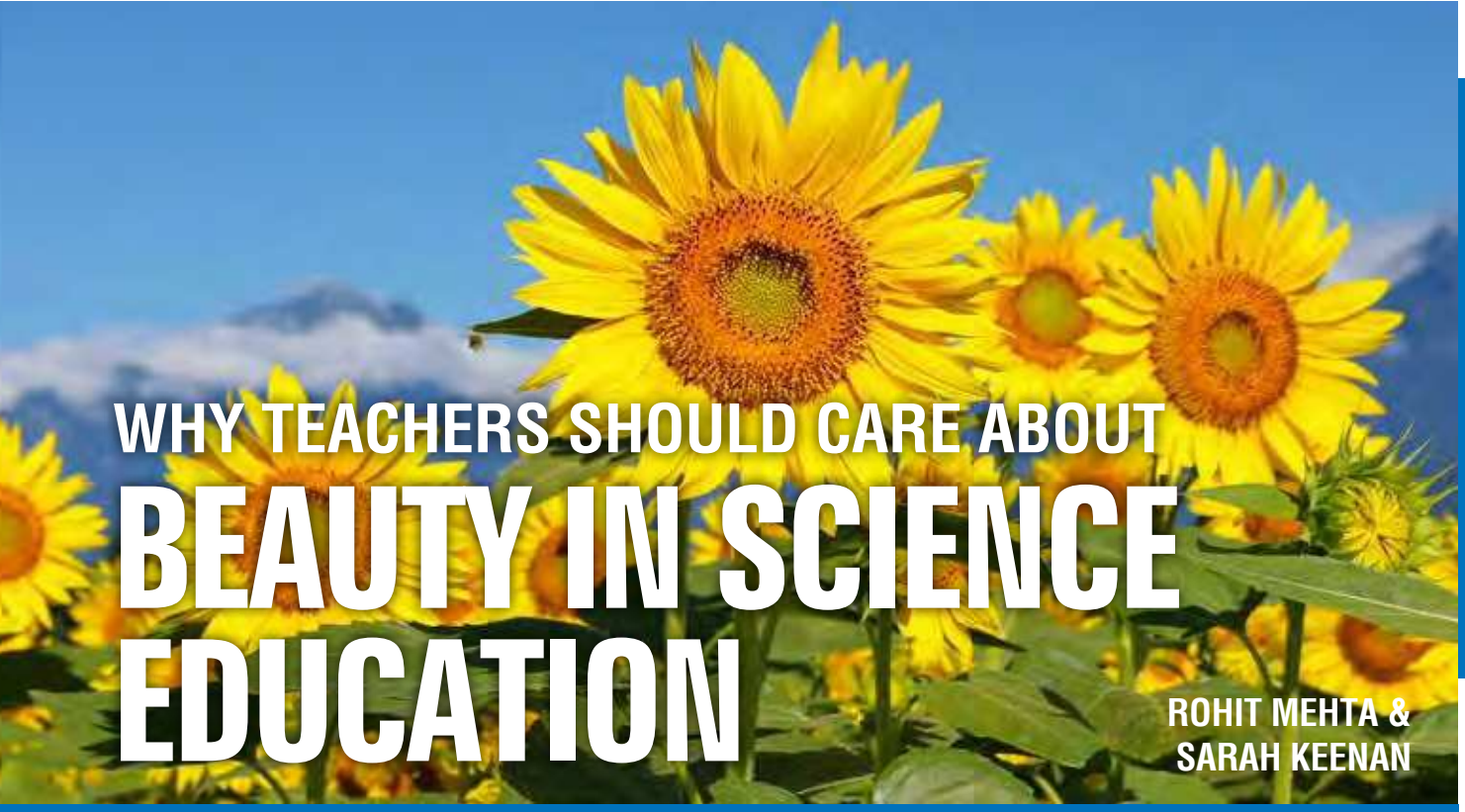

WHY TEACHERS SHOULD CARE ABOUT BEAUTY IN SCIENCE EDUCATION

ROHIT MEHTA & SARAH KEENAN

This article explores the role of beauty in science education. The authors use research in science education to highlight the importance of teachers consciously making connections to aesthetic aspects in science. Caring about beauty in science can inspire a sense of wonder and curiosity among students.

> *"Horses and rainbows make the world seem more exciting, not science"*– student quoted in Mark Girod's dissertation research study
>
> *"He to whom the emotion is a stranger, who can no longer pause to wonder and stand wrapped in awe, is as good as dead – his eyes are closed."*
>
> – Albert Einstein

Scientists often speak of being inspired by wonder and a sense of beauty. They describe the universe with a sense of awe about it and our place in it, the drama in searching for the truth, and the elegance of scientific ideas and structures. Consider this quote by Richard Feynman:

The world looks so different after learning science. For example, trees are made of air, primarily. When they are burned, they go back to air, and in the flaming heat is released the flaming heat of the sun which was bound in to convert the air into tree, and in the ash is the small remnant of the part which did not come from air that came from the solid earth, instead. These are beautiful things, and the content of science is wonderfully full of them. They are very inspiring, and they can be used to inspire others.

Feynman highlights the potential of **wonder** and **inspiration** as he contemplates the world around him and the intricacies of its inner workings. This sense of wonder opens new doors and further questions to pursue; it is the beginning of a curiosity that inspires more questions. Science, he suggests, helps us find answers to some of the most awe-inspiring questions we have about nature. It is not a rigid method, or stuffed with facts and information that we need to memorize to pass an exam; but, rather, a rich and exciting process, an adventure and a journey to solve the mysteries of the world.

This sense of engagement and passion is often in stark contrast to how many students in school think about science. Science is often seen as being full of arbitrary facts, mindless activities and, thus, quite dull and boring (as seen in the quote at the beginning of this article). To be clear, we are not

Figure 1. Science is one of the most powerful ways to engage with the beauty of the universe. We use science to understand the cosmos and, in the process, find beauty in our understandings and representations of it. Credits: Illustration by Punya Mishra. Created with images under Creative Commons licenses, labeled for reuse with modification.

suggesting that scientific facts and theories are not important. Neither do we seek to imply that the scientific method is not rigorous and demanding, or, not in itself a reason that motivates some scientists. Our goal is to point out that what motivates scientists is not just the facts or the method per se, or instrumental reasons (such as economic viability), but also their passions that emerge from the excitement of the chase; the beauty, elegance and explanatory power of scientific ideas. The quote by Einstein, that opened this article, suggests that science is not a dispassionate activity. It is as much about facts as it is about wonder, passion, emotion, and beauty. This is what we call an **aesthetic** perspective.

What does the research say?

What can we do to make science come alive for our students? How can we get them to appreciate the beauty and wonder of scientific ideas? What if we took some of these aesthetic elements that scientists speak of and bring them to the forefront of teaching science? What would happen then? Would students respond differently to what they were learning? Would their ideas of science, and what it means to **do** science, change?

One educational researcher, Mark Girod tried to find answers to these questions. He argued that the aesthetic experience is not just restricted to the arts, but is an integral part of doing and learning science as well. He suggested that by building on the emotional and affective elements of doing science, we could motivate our students to wonder more deeply about nature and science, stimulate their curiosity and interest, and thus transform their experience of learning science.

In his research, Mark studied two 4th grade science teachers. One of these teachers, Ms. Parker, was an experienced and accomplished teacher who taught science in the traditional way, focusing on facts and conceptual understanding. The other teacher, Mr. Smith, was also an experienced teacher, but with a different focus. Mr. Smith's class was designed to foster excitement and interest by organizing content around the power ideas have to inspire and renew perception, providing opportunities for students to experience the world in new ways that consistently highlighted the aesthetic and artful aspects of science. For example, conducting a class in a garden, while admiring the beauty of flowers, and framing questions that help explain, say, where a flower gets its color.

Mark's research showed that at the end of the day, students in Mr. Smith's class not only performed better than the students in Ms. Parker's class on standardized tests, but also showed greater engagement with scientific ideas speaking about how they had discussed these ideas with their family and friends outside of the classroom. In short, students in Mr. Smith's classroom were drawn to wonder, inspired to discuss it with others, and enjoyed seeing the world through the lens of scientific ideas.

How can teachers cultivate an aesthetic classroom?

So what did Mr. Smith do in his classroom? While interested teachers may want to read Mark's study, we offer three suggestions that Mr. Smith successfully used in his classroom.

Guide 1: Frame content around metaphoric ideas and perceptual lenses

While covering the topic of weather and the atmosphere, Mr. Smith did not just describe terminology and facts—he made them real through the use of powerful metaphors. For instance, he had his students lie down on the grass and look up at the sky – and told them about the ocean of air, 17 miles deep, pressing down on them. In other words, he shared powerful facts with his students: ideas of ways of looking at the world in an effort to generate a sense of wonderment. Lying on the grass looking at miles of vast sky and thinking of a metaphoric ocean stirred an aesthetic chord with Mr. Smith's students that a simple lecture could not.

How to implement: When thinking of a metaphor, make sure that you come with an idea that works on similar physical principles. It makes your work as a teacher more powerful when the transferability of the laws of physics makes the experience meaningful for your students. In this example, because air and water are both fluids, the metaphor makes conceptual sense and helps students understand and remember the ideas.

Guide 2: Making it personal and learner-oriented

Mr. Smith constantly tried to empower his student to see and act with science in ways that fit them individually. He had them share science related stories from their lives prompted by questions such as "who thought about wind yesterday? What did you think about?" He pushed them also to 're-see' the world in new ways based on their learning of science. He also modeled for students how **he** saw the world through the lens of science – purposefully using words that demonstrated a connection between art and beauty and science. Even when using traditional worksheets, Mr. Smith included at least one question that allowed students to comment on their personal experiences with science content.

Figure 2. Connecting across scales of beauty. From the grandeur of the cosmos to the intricacies of sub-atomic particles, beauty is all around us. These infinities (of the very small and the very large) are bridged by the human intellect—the beauty of mathematics at work. Credits: Illustration by Punya Mishra. Created with images under Creative Commons licenses, labeled for reuse with modification.

Here, an aesthetic motivation can expand and enhance student experiences in science.

How to implement: A critical thing to consider is knowing what your students care about – getting to know their personal preferences and interests opens a window into their lives. You can then highlight those aspects of science that intersect with their lived experiences, in ways that they may have never thought of before. This makes the concept come alive in their minds, enriching daily life.

Guide 3: Developing group activities that emphasize the aesthetic experience of learning science

Mr. Smith constructed a range of activities in his classroom designed to facilitate emerging aesthetic understanding and new ways of seeing the world. Students were asked to look at how artists use the sky to convey emotion, or to actually have them create artwork that attempted to capture similar ideas. He had them undertake 'fieldtrips'—short walks around school to observe science ideas learned in class. He had them make models from

gumdrops and toothpicks as well as play with make-believe scenarios about upcoming weather events.

How to implement: Scientific ideas are powerful but, often, alien to us. Consider the vastness of space and the scale of the solar system. Making this scale realistic gives students an opportunity to aesthetically experience it and feel a sense of awe and wonder. Get your students to collaborate to calculate the relative distance of the planets from the Sun by embodying the solar system in your playground. Come up with a scale for distance and let one student be the sun, while other students become the planets. How far apart would they be? Is it even possible to go as far as Neptune or Pluto without leaving the school property? If one student becomes a beam of light, how long does it take to go from the Sun all the way to Neptune? And, then, imagine the next closest star being 4 light years away! Have your students attempt to visually and artistically represent these distances and scales.

Conclusion

If science lets us perceive the world around us in new, transformative ways, then our job as teachers is to facilitate that re-visioning process. In fact, there is research to show that a teacher's beliefs about the nature of science are an important factor in how science is perceived by students. We need to step away from rigid curricula that focus only on success in tests, and, instead bring to our classrooms a sense of wonder and appreciation for the beauty of scientific ideas. We hope that the three broad suggestions here are just the beginning of many different ways in which science ideas can come alive in the minds and lives of our students.

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