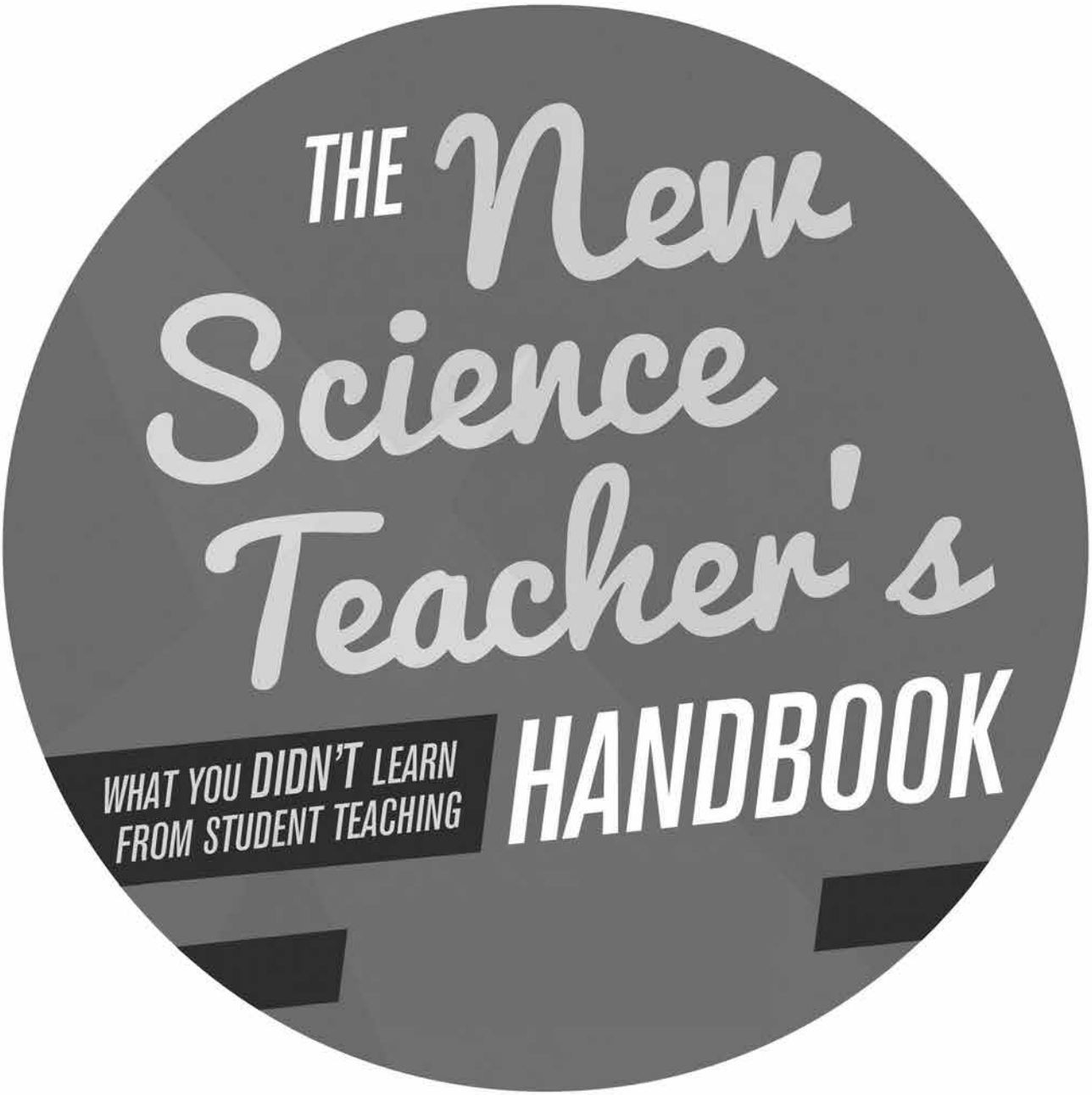
# THE New Science Teacher's HANDBOOK

WHAT YOU DIDN'T LEARN FROM STUDENT TEACHING

SARAH REEVES YOUNG
MIKE ROBERTS

NSTApress
National Science Teachers Association



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# INTRODUCTION

One of the first activities that I ask new science teachers to do in my methods course is to think of a memorable science activity from their past. Whether it's creating an exploding vinegar and baking soda volcano, dissecting a frog, or building a mousetrap car, new teachers relish their memories from school. Beyond the projects themselves, we also discuss the teachers who facilitated these learning experiences, focusing on how they inspired their students to develop a passion and curiosity for science. Once this is established, I ask my students the million-dollar question: "How are *you* going to become one of those teachers?"

Every teacher dreams of inspiring the next generation of students, and these aspirations are an unmistakable driving force for new educators. Often, this is one of the primary reasons they have chosen to enter the teaching profession. However, as with many dreams, achieving this goal can be challenging. There are many elements that have to happen before a teacher can feel confident entering that first classroom. Whether it's the courses in education pedagogy and science teaching methodology or the student teaching experience, it is a long road of hard work, learning, and preparation.

And that's where the real challenge begins.

As a new teacher, you are expected to command a classroom, implement new curriculum, and inspire future scientists. Added to this, you're supposed to do all this with the poise and confidence of a seasoned educator. It is hard to find another profession that expects near perfection in skills from those just entering the field. The first few years are difficult enough with trying to learn the schedule, understand school procedures, and mastering classroom management. Not to mention that you are also responsible for connecting with the students, establishing positive parent communications, and developing relationships with all your new colleagues. And, oh yeah, and then there is that whole "teaching" thing you're expected to do!

But as science teachers, we emulate the great scientists by never turning away from a challenge. Instead, we do what scientists do best—we use our resources.

*The New Science Teacher's Handbook* highlights 14 steps that you can take toward becoming a skilled classroom teacher. It identifies various challenges that new science teachers often experience, and highlights ways to prepare for and grow from them in order to become a master teacher. This book addresses areas that are often underrepresented by prevalent science methods pedagogy textbooks. By focusing

on the work that takes place in the day-to-day life of a teacher, this book will prepare new teachers by reassuring them that all the unfamiliar and challenging experiences that they are going through are common among first-year teachers. In addition, this book provides resources and action plans explaining how to best prepare and take on these common classroom challenges. This text is educational for those who are preparing for a new career in teaching science, and fills the void that exists between pedagogy and the classroom.

Each chapter of *The New Science Teacher's Handbook* presents scenarios and time-tested ideas from both within and outside the classroom. The setup for each chapter is as follows:

- **The Story:** These are actual experiences that happened within either Sarah's or Mike's classroom. Any "I" statements are in reference to what happened to us individually within our classrooms. As a new teacher, it's always nice to know that someone else has had a similar struggle. These true stories demonstrate that even those who go on to write books on best practices in the classroom didn't start off as perfect educators.
- **The Moral:** What we learned from the aforementioned story. Similar to a fable, there is a moral to each story that addresses the theme of the struggle and sets the stage for moving beyond the challenge.
- **Steps for Success:** Here we present strategies to help teachers overcome situations similar to those presented in "the story." There are multiple solutions presented so teachers can choose those that work best for their specific concerns and school environment.
- **What Does Success Look Like?** This section examines how the classroom looks after implementing the "steps for success." This is the "light at the end of the tunnel" to help new teachers see that common challenges can end with positive results that benefit both teacher and students.
- **Resources:** Here we present resources to consider for additional support in organizing the classroom for those teachers who want to explore the topic in more detail.

Whether you are on your way to becoming a new science teacher or a teacher in the early years of your career, we feel confident that the ideas presented here will help you become the teacher you've always wanted to be.

# ABOUT THE AUTHORS

## Sarah Reeves Young

Sarah Reeves Young is the K–12 Science Specialist for the Utah State Office of Education. Young provides technical support and leadership in the development and improvement of science education in the elementary and secondary schools of the state.

Prior to moving into this role, Young was an eighth-grade physical science teacher at Rowland Hall Middle School in Salt Lake City, Utah. Aside from her work in the classroom, Young was involved in the academic realm as an adjunct professor for Westminster College, where she taught their masters students in secondary science methods, and was also the program director for the Teacher Training Institute.

Young earned a bachelor's degree in environmental, population, and organism biology from the University of Colorado at Boulder in 2004. She then pursued her master's degree in education at Lesley University in Cambridge, Massachusetts, and earned her degree in secondary science education in 2005.

Young has published in NSTA's member journal *Science Scope*, presented at regional and national conferences, and participated in several professional development institutes. She previously published a book with NSTA Press titled *Gourmet Lab: The Scientific Principles Behind Your Favorite Foods.* Young is dedicated to inspiring the next generation of scientists.

## Mike Roberts

Mike Roberts currently teaches eighth-grade English at Rowland Hall Middle School in Salt Lake City, Utah, where he has educated students for the past 14 years.

Roberts earned both his bachelor's degree and masters in education from Westminster College in Salt Lake City, Utah. Aside from his work in K–12, he has also presented as a guest lecturer to new teachers at Brigham Young University and Westminster College. Roberts has also served as the program director for the Teacher Training Institute at Rowland Hall.

Additionally, Roberts has also been recognized in the community for his work engaging students with a neighborhood garden as well as senior citizen centers. He regularly brings in young adult authors to speak to students, and coordinates their visits to a network of local schools to share the experience with students and teachers from across the Salt Lake Valley.

In addition to his work with the community, Roberts has spent the past several years writing a regular column for the *English Journal*, identifying teaching ideas connected to contemporary young adult literature. Additionally, Roberts presents locally and nationally about best teaching practices for the classroom. He has won numerous awards for his innovative and engaging teaching methods including the American Stars of Teaching Award in 2008 and the National Council of Teachers of English Hoey Award for Outstanding Middle School Educator in English in 2009. Roberts has also has served on many educational committees, and currently is the assistant chair for the middle level section of the National Council of Teachers of English.

# ACKNOWLEDGMENTS


## Sarah Reeves Young

To my first student, Elizabeth, for letting me practice being a teacher early on, and educating me about family and friendship.

To all of the teachers who helped me get from Chapter 1 to Chapter 14, including those from Lesley University where I completed my teacher preparation. Specifically, to my coauthor Mike, for his simply stunning passion that never fails to inspire me.

Finally, to my five-year-old Jake, for asking me questions everyday. I will always grow while surrounded by your curiosity.

## Mike Roberts

I want to thank my kids (Luke and Lily) for making me a better person, my grandma for teaching me to work hard, and Sarah for helping me be the best teacher I can be.

Chapter 4

# STARTING CLASS THE RIGHT WAY

## STARTER ACTIVITIES

A successful class period is often made within the first few minutes, and this chapter will detail effective and engaging science-based starter activities. These 10-minute teaching ideas, including "Admit Slip, Please!," "Inner/Outer Circle," "The Top Ten," and "Circle Time," are easily adapted to fit into any teaching unit.

## THE STORY

I was weeks away from my very first summer vacation as a teacher. The school year had been long and difficult, but I was feeling good because I had consistently turned out units that my students found engaging. I had used all the tips and tricks that my education classes had taught me (differentiation, multiple intelligences, using pop culture to make connections, and so on), and I pretty much had things dialed in at this point in the year.

Or so I thought.

After filling the board with notes in a rainbow of colors, my first period began to filter in one by one. Kristen, one of my better students at the time, casually walked in the room and, upon seeing the notes on the board, said, "More notes today?"

Ouch!

Now she didn't say this with a tone or with an attitude, but she was merely making an observation … one that hit me pretty hard.

## THE MORAL

Starting your class in an engaging way is a key component to a successful class period. What I failed to understand that first year is that I had things backward. Rather than boring my students early with loads of science facts and figures and then hoping to reel them back in with some excitement such as an experiment or demonstration at the end, I now understand that the first 10 minutes of class often determines the success or failure of the entire class period. And if you can get your students to buy in to what your selling within those first few minutes, they will follow you wherever you take them for the rest of the period.

## STEPS FOR SUCCESS

### 1. ADMIT SLIP, PLEASE!

As students leave your room, hand them a 3 × 5 card and let your students know that this is their "Admit Slip" for tomorrow's class. Explain to them that their slip

should include one comment ("One thing I learned from my homework was …") and one question related to the homework ("One question I have about my homework is …"). In addition, let them know that they should be prepared to discuss whatever they write down.

The next day, stand at the door and collect the slips. As the students hand them to you, pick five comments that you think best summarize the main science concepts from the homework. When class starts, read these aloud as a way of solidifying the essential parts of the homework. You can also ask clarifying questions from the information they provide to check for understanding. When possible, allow the student who wrote it to lead the discussion.

Next, pick five questions from the slips to address aloud. Since there will often be many similar questions, this allows you to clarify and explain any hazy topics from the homework. Again, try to let the students play an active role in this by having them discuss the question with their classmates.

Please note that this assignment can be used both as a whole-class or small-group assignment depending on your students.

### *WHY THIS WORKS*

First, it puts the kids in charge of the learning and the teaching. While we as teachers do our best to get inside the minds of our students, we sometimes miss the mark in seeing the work through their eyes. This activity solves the "guessing" we do.

Next, while the class is essentially covering everything I would have written on the board, it is being done in a discussion that is more engaging and less overwhelming. Regardless of how conversational we try to make our classes, when students see a board filled with notes, they tense up. This is a great way to have students lead the discussion on misconceptions, and it allows you the opportunity to assess their understanding by the way they respond and participate in the discussion.

Finally, my students love being recognized for their questions and comments. It gives them a "buy-in" to the learning, and it makes them *want* to be part of the class discussion. One of my favorite things to see is when kids start trying to one-up each other with the quality of their questions. I absolutely love when a student turns in an admit slip and announces to me, "My question is awesome!" This activity brings the curiosity and questioning back to the forefront of the science classroom, and it allows students to drive the inquiry learning.

## 2. INNER/OUTER CIRCLE

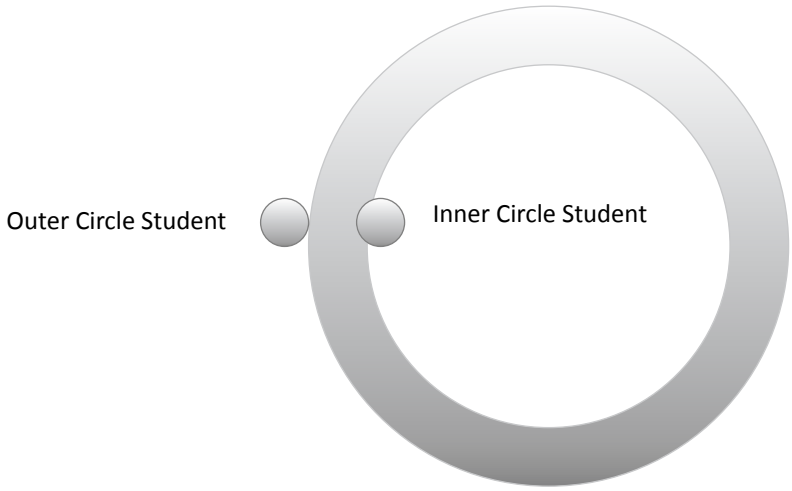
Prior to class, write 10 or so questions on the board related to the topic at hand. (I usually connect it to ideas from the homework, but this can also be used as an

anticipatory activity to a new unit.) It's important to use questions that require a discussion or explanation, as opposed to a quick yes/no/single vocabulary word answer, For example:

- Can scientists predict earthquakes? Why or why not?
- Was the change in yesterday's experiment a physical or chemical change? What observations do you have to support your answer?
- Would you rather have mitosis that is out of control or meiosis that is out of control? What is the number one reason that made you choose your answer?

Next, have the kids stand up and move their desks to the outer portions of the class. After this, have half of the kids stand up and create a giant circle (facing outward) in the middle of the room. Ideally they should be about an arm-length away from each other, but this doesn't always work in larger classes. This is the inner circle. Finally, have the other half of the students stand up and face one member of the inner circle. This is the outer circle. This is diagrammed below in Figure 4.1.

### Figure 4.1. Inner and Outer Circle Setup




Once the inner and outer circles have been established, position yourself in the middle of the circle. Next, let the students know that the person in front of them is their discussion partner. Students will generally stand in front of one of their friends, so they will usually be psyched when you say this. However, if it is early in the year, I often ask that they introduce themselves to their partner. Once this is all in order, ask the first question from the board.

Give the students 30–60 seconds to talk with one another about the question. Be prepared—it's going to be loud. And while your teacher instincts may kick in at this point, resist the urge to tell them to be quiet. Interactive learning is supposed to be loud!

Once time is up, I have the students thank one another. I then ask the outer circle to rotate one spot to their right. Once there, they introduce themselves to their new partner, and you throw out question number 2. Repeat until all your questions have been discussed.

### *WHY THIS WORKS*

Students love to talk, and this gives them that chance in a way that is meaningful and educational. Additionally, by putting the questions on the board *and* saying it out loud, both visual and auditory learners will have the benefit of receiving the question in the way that works best for them. Finally, students are hearing a different perspective on every question. This, to me, is the greatest strength of this activity. Rather than hearing the same ideas from two or three people over and over (as happens in small groups), students are continually hearing fresh voices and viewpoints. This gives students the opportunity to engage in scientific discussions where they can use data and observations to support their answers. This type of reasoning supports the discourse that is common in the science community and mirrors effective argumentation strategies that are essential to the science process.

From a teaching perspective, by listening to the responses given, you will discover what concepts are, and perhaps more importantly, are *not* being understood. This will then allow you to later emphasize any concepts that need additional clarification, and address misconceptions without directly pointing out a specific student in the group setting.

Again, let me stress that this one is going to create some noise. And while it might seem chaotic to someone who passes by your room as you are doing it, this activity not only gets the students involved in their learning, it also allows you assess the content knowledge of each student.

## 3. THE TOP 10

As class begins, divide your class into 10 small groups. Once the groups have been established, have each group spend two minutes creating a list of 10 words (single words, not phrases) that best summarize or relate to the topic at hand. Students should discuss and justify their choices with one another.

Next, have each group select the *one* word from their list that they feel is most important, and have them write it on the board. Let them know that there can be no repeated words on the board!

Finally, after all the groups have shared their word, go through the list, having each group explain the importance of their word. When they are finished, ask the other groups how many of them had that word as one of their top 10 words.

### WHY THIS WORKS

First, it gets the kids talking about the subject. Plus, it challenges them to critically think about and justify why they selected the word(s) they did.

Next, it allows you the opportunity to assess what the students understand in a non-test manner. After each word has been discussed, you can also add your insights to the subject. And if there are any concepts left out, you can easily add your own words to the list to make sure the students get the information you need them to have.

Additionally, it allows students to see similarities and themes that exist within the science concepts that are addressed. For example, just because you had an experiment with DNA and followed it up with an activity on genetics, it doesn't mean the students see the connection between the two topics. By having them share important words, it can spawn a discussion on how those words are related to help students see the connections that exist. When looking for themes, crosscutting concepts listed in the *Next Generation Science Standards* provide an excellent resource for overarching themes in science that you can draw from to create connections.

I like to use this activity as part of an end-of-the-unit review. While it can be used for smaller segments of learning, make sure you have enough information to cover at least 10 key elements. It's better than your standard, "Here is a list of words to define" for the review, and really helps to emphasize the thematic connections and relevancy in science.

## 4. CIRCLE TIME

As a homework assignment, have the students write out three "would you rather" questions. Two of these questions should be related to your topic, while the other one is up to the student to make up.

The next day, as students walk into the door, collect these questions in a plastic bag. Once class has started, move the desks to the outer portion of the room, and have the entire class (and you) stand in a circle. Reach into the bag and read one of the questions. If students agree with option A of the "would you rather" question, have them step into the center of the circle. Those who opt for option B would remain

where they are. Allow 20–30 seconds for kids to discuss why they feel the way they do, emphasizing the use of data and observations to support their reasoning.

Depending on how animated the kids are, you should be able to get through 20–25 questions in 10 minutes.

### WHY THIS WORKS

Put simply, circle time works because it's fun. Students love justifying their answers, and they really have to make some complex comparisons in order to make their questions effective. Beyond academics, this activity allows students to see the commonalities they share with their classmates. Plus, students really get creative on the one they get to make up. Having a question related to your class followed by one related to pop culture, sports, or food keeps the kids excited to hear each question.

This activity really helps to start and maintain a discussion-based culture in the classroom, where students feel safe sharing their opinions, questions, insights, and ideas. It also helps to set the precedent and expectation that answers and opinions need to be supported by data and evidence. This type of argumentation is central to science. It also helps students recognize that science isn't just a set of facts, but instead is a community that is involved with interpretation and argument that evolves as more information becomes available.

Examples of circle time questions include:

- Would you rather be friends with someone who is described as stable or someone who is described as reactive?
- Would you rather live in an area that is prone to tornados or an area that is prone to earthquakes?
- Would you rather be a tree or a rock?
- Would you rather live forever or never feel pain?
- Would you rather be described by numbers or by words?
- Would you eat only protein or only sucrose?
- Would you rather continuously evolve or stay the exact same?

## WHAT DOES SUCCESS LOOK LIKE?

Those three simple words, "More notes today?" completely changed the way I begin my class.

While I initially made sure to not take up *all* period droning on in front of my students, Kristen's simple comment made me realize that taking notes was my standard way of starting class each day. And yes, I would lead discussions, guide presentations, and oversee projects (among other things) with the rest of the period, but that one sentence made me realize that no matter how cool things turned out later in class, the first 10 minutes of my class were a complete and total bore.

And the positive effects of these activities extend beyond the first 10 minutes. Once students have "bought in" to a class, they are much more willing to put forth their best on any forthcoming assignments or projects.

By implementing these starter activities into my daily routine, my class now begins on a positive note, one where students look forward to being engaged in the learning. I have learned that having a schedule where the starter activities are posted for the week actually gets students to run to my classroom so that they don't miss out on the discussion and interaction with their peers. The culture has grown so much that former students from years past even stop by on Wednesdays because they know it's going to be circle time, and they want to participate. Additionally, beyond getting the students excited, these activities also lessen the amount of prep I have to put into setting up my class. The bonus of this is the fact that while I'm putting in *less*, my students are gaining *more*.

## RESOURCES FOR MORE INFORMATION

Finton, N. 2011. *Science question of the day: 180 standards-based questions that engage students in quick review of key content—and get them ready for the tests.* San Francisco, CA: Jossey-Bass.

A few minutes a day is all it takes to get students ready for the science tests! Use this collection of short, thought-provoking questions to introduce or review key topics, such as animal adaptation, ecosystems, weather, the solar system, matter, and energy.

Yoder, E., and N. Yoder. 2008. *One-minute mysteries: 65 short mysteries you solve with science!* Washington, DC: Platypus Media.

Not an ordinary mystery book, *One-Minute Mysteries* makes science fun! Each mystery (solutions included) exercises critical-thinking skills while covering Earth, space, life, physical, chemical, and general science. A bonus section includes five mysteries from their upcoming title in the series, *One Minute Mysteries: Solve 'em With Math!* This entertaining and educational book is great for

kids; grown-ups; schools; educators; homeschoolers; and anyone who loves good mysteries, good science, or both.

Wolke, R. L. 2000. *What Einstein told his barber: More scientific answers to everyday questions.* New York: Dell Publishing.

Do you often find yourself pondering life's little conundrums? Have you ever wondered why the ocean is blue? Or why birds don't get electrocuted when perching on high-voltage power lines? Robert L. Wolke, professor emeritus of chemistry at the University of Pittsburgh and acclaimed author of *What Einstein Didn't Know*, understands the need to ... well, understand. Now he provides more amusing explanations of such everyday phenomena as gravity (If you're in a falling elevator, will jumping at the last instant save your life?) and acoustics (Why does a whip make such a loud cracking noise?), along with amazing facts, belly-up-to-the-bar bets, and mind-blowing reality bites, all with his trademark wit and wisdom.

If you shoot a bullet into the air, can it kill somebody when it comes down? You can find out about all this and more in an astonishing compendium of the proverbial mind-boggling mysteries of the physical world we inhabit.

Arranged in a question-and-answer format and grouped by subject for browsing ease, *What Einstein Told His Barber* is for anyone who ever pondered such things as why colors fade in sunlight, what happens to the rubber from worn-out tires, what makes red-hot objects glow red, and other scientific curiosities. The book also includes a glossary of important scientific buzz words and a comprehensive index.

Mitchinson, J., and J. Lloyd. 2007. *The book of general ignorance: Everything you think you know is wrong.* New York: Crown Publishing Group.

Think Magellan was the first man to circumnavigate the globe, baseball was invented in America, Henry VIII had six wives, and Mount Everest is the tallest mountain? Wrong, wrong, wrong, and wrong again.

Misconceptions, misunderstandings, and flawed facts finally get the heave-ho in this humorous book of reeducation. Challenging what most of us assume to be verifiable truths in areas like history, literature, science, nature, and more!

*The Book of General Ignorance* is a witty "gotcha" compendium of how little we actually know about anything. It'll have you scratching your head wondering why we even bother to go to school.

Revealing the truth behind all the things we think we know but don't, this book leaves you dumbfounded about all the misinformation you've managed to collect

during your life, and sets you up to win big should you ever be a contestant on *Jeopardy!* or *Who Wants to Be a Millionaire?*

Besides righting the record on common (but wrong) myths like Captain Cook discovering Australia or Alexander Graham Bell inventing the telephone, *The Book of General Ignorance* also gives us the skinny on silly slipups to trot out at dinner parties (Cinderella wore fur, not glass slippers, and chicken tikka masala was invented in Scotland, not India).

# INDEX

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"One of the first activities I ask new science teachers to do in my methods course is to think of a memorable science activity from their past. Whether it's creating an exploding vinegar and baking soda volcano, dissecting a frog, or building a mousetrap car, new teachers relish their memories from school. Beyond the projects themselves, we also discuss the teachers who facilitated these learning experiences, focusing on how they inspired their students to develop a passion and curiosity for science.

"Once this is established, I ask my students the million-dollar question: 'How are you going to become one of those teachers?'"

— *From the Introduction*

By reading *The New Science Teacher's Handbook*, you will learn 12 specific steps that will help you on your way to becoming a skilled classroom teacher. The authors make each chapter both helpful and fun to read by including:

- *The Story*—actual experiences that happened within one of the authors' classrooms. As the authors note, these true stories demonstrate that even those who go on to write books on best practices in the classroom didn't start off as perfect educators.
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Grades K–12

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