About this Book

As educational professionals, we all need to be able to show in our lesson plans that we are meeting expectations. Many of us do this by citing which standards or which part of a science framework our lesson is addressing. To help with this, I have listed the connections to the ***K-12 Framework for Science Education*** published by the National Academies' National Research Council, and to the ***Next Generation Science Standards***. The K-12 Framework for Science Education focuses on three principal dimensions: ***Science and Engineering Practices, Crosscutting Concepts,*** and ***Core Ideas in Science***. The Next Generation Science Standards are a set of academic content standards broken down by grade level. I will identify each applicable dimension and content standard at the start of each activity.

Throughout the book, you will find that I use ***Bold Italics*** regularly. These words are often vocabulary terms that you will find in the glossary, other times they are points that I wish to emphasize based upon my experiences teaching Astronomy for Educators class at my university. The ***bold text*** helps to call attention to terms and ideas that will help you focus on the essentials and understand the instructions in the activities better.

Although the activities follow a well-defined sequence, each activity in the book is essentially independent – you can thumb through and pick and choose whatever you feel will work in your classroom.

After the standards, each activity begins with ***Facts You Need to Know***. Most of this really is common knowledge (I don't expect to surprise anyone by telling them that the Moon orbits the Earth!) I also limit this section to no more than three to four basic facts. I don't want to overwhelm you with minute details, and I've made a real effort to stick to the essentials here.

After the essential facts, we discuss ***Teaching and Pedagogy***. I have strived not to be heavy-handed but tried not to assume too much about your prior knowledge of science in general (or astronomy in particular!) I have based these sections upon the lectures and classroom discussions with my Education students who take the Astronomy for Educators class here at the University of Arkansas. They are wonderfully bright young people, but as they often remind me, almost universally not 'science people' or 'math whizzes'. As one student told me: "You have to bring the science to us where we are now, you cannot expect us all to be astro-geeks like you!" That got a good laugh all around, but the point was very well taken! I'm going to guide you through these activities as I do my own students – I'm sure you will be as successful as they have been!

Next comes ***Student Outcomes***, beginning with ***What Will Your Students Discover?*** Although this section addresses what your students will achieve, this discovery piece often includes the teacher as well! While we all know such things as 'The Moon orbits the Earth', we don't really know how that fits with other simple facts to make a coherent scientific model or theory. The STEM activities you and your students will create together will help you see how these facts fit into scientific models, and how these models lead us to new knowledge.

If this is your first time dabbling in STEM education, you're going to learn a lot! You will also be learning all this science stuff by building and playing with models such as toy planets and moons – and who doesn't enjoy playing with exciting toys?

What Will Your Students Learn about Science? This section addresses a critical part of STEM education that is often neglected. What do we know about science as a process, and as a human activity? Science in the media, in the classroom, even in semi-professional science publications like Scientific American and National Geographic rarely deal with science as a process. I believe very strongly that STEM activities should not just teach us facts, but about science itself. I want to help your students understand why, how, and when we decide to put our trust in a scientific theory or model – and just how far that trust should go.

How do we know what we know? Why do we accept this theory but not that one? Why do scientists sometimes change their minds about things? Should we believe a particular theory or idea just because "over 99% of the world's leading scientists agree"? Is belief appropriate in a discussion of science at all?

Your students will explore (and recreate!) some of the most famous scientific debates in history; we'll see by experiment and data not only who won, but how and why the new scientific model was accepted and why the old model was discarded. Your students will learn that science is a glorious human activity, sometimes prone to error, but always self-correcting in the long run.

Now that you are thoroughly prepared, we move on to ***Conducting the Activity***. Much as you would expect, this begins with the materials you will need, then moves on to ***Building your model***. Once the model is built, we move on to ***Exploring your model***, a step-by-step to using your model as an experiment, and gathering information from it. The next step is often the most fun – going outside and observing the sky to see if our model actually reflects what we see in Nature!

After building and exploring your model in the activity section, we have ***Discussion Questions***. These questions are essential to helping your students learn to think about what they have done in class. A playful spirit of exploration in the classroom is fine, but we also need to help children think about what they have learned. Don't worry – I have included all the answers to the discussion questions to help you out!

After the activity, I have put in a variety of ***Supplemental Materials***.

Going Deeper is a section especially for the Gifted and Talented student – or anyone who shows exceptional interest in the subject of the activity. This section usually contains either an additional project to work on or an investigation that can further the students' knowledge and interests.

While there is a great national awareness of the needs of special education and ESL students, the gifted and talented children in our schools are often ignored. "She's really smart, she will get along fine," is a common sentiment – but not an effective pedagogy to help these children reach their potential. The Going Deeper section gives you activities and explorations that you can offer to your gifted students to challenge and encourage them. Don't be shy with these activities, you will be surprised when you focus on STEM activities in your classroom, just how many 'gifted' students you have!

Being an Astronomer is a section designed to get your students out and observing nature on their own. Not only is this an opportunity for them to confirm what we have learned in the classroom, it encourages students to actively compare what a scientific model or theory tells them with what they see for themselves in nature. Comparing the predictions of a theory with the actual experimental data and observations we make is a fundamental part of the scientific process. This is also an excellent way to increase family involvement with your student's science education.

Parents and children observing the Moon together in the back yard on a clear and pleasant evening can be a wonderful bonding experience. Parents who are involved with their child's science education are going to become your biggest fans; they will see the good that you – and your school – are doing for their children. This sort of parent involvement transcends cultural and linguistic barriers in a marvelous way; it engages the ESL student and parent in a way few other activities ever do!

I also understand that most families and schools do not have their own binoculars and telescopes. There are sections where I urge you to seek out a local astronomy club; as a member of such clubs for over 40 years, I can tell you that amateur astronomers are almost universally friendly folks who enjoy sharing their equipment and knowledge with members of the community. My own club, the ***Sugar Creek Astronomical Society*** not only holds bi-monthly public star parties, but we also go to local schools quite regularly to help students, teachers, and parents discover the wonders of the night sky. Clubs do almost all this work free of charge as a public service (and because we love this stuff!) Contact your local club today – you will be glad that you did!

Being a Scientist is a section for the mathematically inclined. This is both for the K-8 educator who wants to put a little more math into STEM, but also for the secondary educator who would like to attempt these activities. I have tried to make every activity in this book scalable, that is, to make it applicable for a wide variety of grade levels. One of the ways that we do that is to help teachers and students transition from a conceptual exploration of a topic to mathematical exploration and understanding. Mathematics is the universal language of science all scientific models, and developing a mathematical understanding of an idea is one of the key elements of a sound scientific model of Nature.

Following Up is the final supplemental section. This section is devoted to the enthusiast in all of us. Each teacher has found in their own student experience that one area where their enthusiasm and imagination was ignited by a teacher's lesson. We remember that day, that lesson, that teacher – and the effect it had on us. Many of us remember asking: 'Can we learn some more about that?' For a teacher, this is a golden moment – but also a tremendous challenge. The ***Following Up*** section is my attempt to prepare you to take advantage of one of those precious moments in the life of a child.