A Note to Teachers

When teachers see these explorations for the first time, some believe them to be too challenging. My experience has been different. I believe that we tend to underestimate our students. It is true that they will not typically be able to complete every problem in an activity. They are unlikely to answer most questions perfectly. Certainly, they will not finish quickly. They will sometimes struggle, and they may need your support during that process. But your students *can* be successful with the explorations—and so can you!

Often, when our students struggle, especially in math, we tend to believe that our job is to fix the "problem" by explaining more clearly or in a different way. But, in fact, it is when our students are struggling with mathematical ideas that there is the greatest potential for deep learning. Our job is not so much to explain as to ensure that their struggle is productive.

Your keys to success in this endeavor are patience, curiosity, an open mind, and a certain level of trust (perhaps even a leap of faith!) in yourself, your students, and the activities. Building this type of deep learning into your teaching practice takes time. Think of it as a *process* of learning and growing along with your students. Do not take on too much at the beginning. Assign fewer problems, and listen closely as your students talk and write about their ideas. As you reflect and come to understand how they are thinking about the problems, you will learn more about the math and about how to facilitate conversations that help students become authors of their own learning.

from *Advanced Common Core Math Explorations: Ratios, Proportions, and Similiarity*,
by Jerry Burkhart. Prufrock Press, 2016

In the end, it is the *thinking* that creates the real learning. Talented students (really, *all* students) who develop a habit of thinking hard about challenging problems and ideas grow their mathematical capacity in deep and powerful ways. The times when they hit a wall and feel that they are making no progress are probably the times they are learning the most. Time and time again, my students come to class bursting with excitement, telling me, for example, that they were riding the bus home when the answer to a question they had been thinking about for days suddenly came to them. I love it when this happens, because they are able to see that their brains were engaged with the problem even when they were not aware of it! But the breakthrough occurs only because of the work they did while they felt stuck.

As powerful as it is, this way of learning can be "messy." Ideas do not come tied up in neat packages. You and your students gradually learn to live with ambiguity as you consider multiple strategies and make connections between different ways of thinking about problems. You begin to see that deep understanding develops gradually over time as your mind knits together various strands of ideas. In fact, this tolerance for ambiguity is a chief characteristic of successful mathematicians! The presence of uncertainty and confusion as you work toward understanding is an inescapable and wonderful part of the process of doing mathematics.

That is not to say that you normally leave things in this state of uncertainty. When students are working toward specific learning goals, it is important in the end to organize, clarify, and summarize what was learned. But this happens *after* students have wrestled with the ideas and *at the level* that they are prepared to make sense of them. The

from *Advanced Common Core Math Explorations: Ratios, Proportions, and Similiarity*,
by Jerry Burkhart. Prufrock Press, 2016

"debriefing" process described in the Eight Motivation Strategies of the introduction to this book will help you make this happen.

Teachers as well as students begin these activities with different levels of comfort and confidence. Some teachers do not think of themselves as "math people." Interestingly, those who fall into this category are often more successful than others in making the explorations work. They may be more open to thinking of math in new ways and more comfortable with the idea of learning from their students. They *become* math people! This is not to say that knowledge of mathematical content is unimportant. The more deeply you understand the math you are teaching, the more effective you can be. However, as I suggested before, this learning occurs over time, and you do it best by listening to your students and reflecting on your practice. I can personally vouch for this. My own understanding of mathematics has been completely transformed by my work with elementary and middle school students.

I cannot promise that using these explorations will be easy at first. Nor can I promise that all of your students will love doing these types of activities right away. Some will thrive immediately. Many will adapt fairly quickly. But, understandably, a few will initially (and sometimes stubbornly) prefer what is familiar and comfortable.

What I can say is that, with a little faith and persistence, doing activities like these can change students' approach to math in profound and positive ways. They find themselves slowly drawn into this type of thinking and begin to miss it when it is not present! It can be a transformative experience. Students may leave your class with an entirely new understanding of mathematics as a discipline and of themselves as

mathematicians. Personally, watching this transformation take place has been the greatest joy in my work. I wish the same joy for you.