Companion Classroom Activities for

Stop Faking It!

Finally Understanding Science So You Can Teach It

Forces & Motion

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Hawker Brownlow
EDUCATION

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[1] A word about the numbering system above: I explain in the Preface that the activities are organized based on the learning cycle. The numbers correlate with the phases of the learning cycle as follows: .1 = Explore, .2 = Explain, .3 = Elaborate. There are also .4 Evaluation sections interspersed throughout the book. Each chapter, with a couple of exceptions, covers one trip through the phases of the learning cycle. Thus "Teacher Guide to Activity 1.1" is the teacher guide to activity chapter 1, Explore phase. A few of the activities cover both Explore and Explain, so the activities are numbered .1/.2 (as in Chapter 2.1/2.2, for example). Got it? Feel free to go read the preface now!

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Preface

From the day the first *Stop Faking It!* book was published, teachers have been asking for books of classroom activities to go with them. So, only eight years late, here is the first book of classroom activities to accompany the *Force and Motion* book. First, let's have a few words about the activities and the structure of this book.

Adjusting to Your Needs

The suggested year level range for these activities is years four to eight. The activities are appropriate for upper primary and middle years physics, as well as upper secondary conceptual physics. With such a wide range of ages and abilities of students exposed to these activities, you will most likely have to adjust to your particular group of students. I have done most of these activities with students as young as year two, so with patience there is little in here your students won't be able to do physically. On the other hand, some concepts might be beyond younger students. Although I strongly believe that you can teach students of any age almost anything given enough time, you might not think it worth the time in all cases. So, you might choose to avoid certain more abstract ideas, especially ones that involve mathematical reasoning. It is ultimately up to you, the teacher, to determine what to include and what to leave out. I should mention that the approximate times specified in the activities are about what one would expect from an average year eight student (if there is such a thing as *average* year eights!). You might have to adjust these times up or down to fit the needs of your students.

Reading Level

This is related to the Adjusting Your Needs section. It's difficult to write explanations that year fours can read and year eights won't find insulting, so I have simply written the student explanations in as clear and entertaining a way as I can. I have found over the years that when you write in the manner you speak, and imagine the audience to whom you're speaking, most students "get it." When you write so as to meet a particular reading level, your writing becomes stilted and boring. So, I've done my best for the given audience. Still, you are free to decide how to handle the readings with your class. You might wish to read and explain the concepts to them or you might wish to have the students read aloud or work in pairs. Whatever works. The main idea is for the students to understand the concepts.

The Learning Cycle

These activities and readings are written using the learning cycle. There are three basic phases of the learning cycle: *Explore*, *Explain*, and *Elaborate*. I outline the purpose of each in the following section, but before I do that you might notice that the labels for these sections are the same ones used in the "5E Learning Cycle". The middle three sections of the 5 Es are, in fact, the learning cycle. I was on the curriculum development team at Biological Sciences Curriculum Study (BSCS) that "fleshed out" the 5 Es. Credit for adding two phases (*Engage* and *Evaluate*) to the Learning Cycle goes to Rodger Bybee, then associate director of BSCS, and the rest of us, along with Rodger, did nothing more than hash out how all five phases would work for us in curriculum development.

So why not use the 5E Learning Cycle? Personally, I find that using all five steps all the time, which is what teachers have come to expect, can be restrictive. It's easier, I think, to focus on the learning cycle and then use the extra steps of the 5 Es whenever necessary. I don't think it's always necessary, for example, to use the *Engage* phase (attention grabber) of the 5 Es, nor is it necessary to *Evaluate* (last stage of 5 Es) every time you have completed a cycle. So, what you have in this book is the learning cycle, using the names of phases incorporated in the 5 Es. Now let's examine the phases of the learning cycle.

Explore

The purpose of this phase is to "set up" the learner for understanding certain science concepts. It usually involves hands-on activities, but not always. It consists of providing a common set of experiences for all the students in the classroom so everyone is on the same page when it comes time to explain concepts. An important part of *Explore* is the "debriefing" of students or student teams, discussing what results they all obtained in a particular activity. The *Explore* phase is *not* the time to explain concepts or provide background material. That might be what one does in more traditional teaching, but not in the learning cycle. Another useful thing to do in the *Explore* phase is to find out what the students know about concepts prior to formal education. To that end, I highly recommend using the formative assessment probes in the book by Page Keeley and Rand Harrington, *Uncovering Student Ideas in Physical Science, Vol. 1*, published in Australia by Hawker Brownlow Education. You can use these probes prior to or during the Exploration activities in this book. You might also use them after the completion of Elaboration activities to evaluate how much your students have learned. Not all of the probes in that book fit nicely with the activities in this book, but many do. It would be worth your while to browse through the probes to discover which ones fit best.

Explain

The purpose of the *Explain* phase is to explain certain concepts in terms of the Explore activities the learner has just done. People understand concepts better when they are anchored in concrete experiences. In this book, most of the explanations are provided in readings, but you can also explain concepts by "drawing out" student explanations for what has happened and gradually leading them to an understanding of the appropriate science concepts. The *Explain* phase is where *traditional* instruction begins, as an abstract presentation without benefit of previous concrete experiences. Research has shown that such traditional instruction is inferior in terms of student learning to the learning cycle as used in this book.

Elaborate

Once the students have been exposed (in the *Explain* phase) to given science concepts, you can't expect them to have a complete grasp of the ideas. The students need to apply these concepts in novel situations, which is what happens in the *Elaboration* phase. The students attempt to perform new activities and apply the concepts they've learned. It's appropriate in this phase for you to let the students struggle a bit as they attempt to apply concepts, but it's also appropriate for you to step in and help them figure things out.

Evaluations

There are sets of multiple-choice items interspersed between activities in this book. You can use these as you see fit. While you might incorporate them in determining marks, these items are just as useful as *formative* evaluations, helping you know where the students are in their understanding as you go through the lessons.

Working in Teams

Each activity has suggested group sizes, but these are only suggestions. I have written curriculum in which not only team size is dictated, but particular cooperative learning roles are dictated. I found that strict dictation of team size and team duties can be rather restrictive for teachers (and for me as a writer!) and that the focus on cooperative learning too often distracts from the learning of concepts. That said, you are more than welcome to incorporate cooperative learning strategies into these activities. There are many good books on the subject, and using cooperative groups can, at minimum, help with potential classroom management headaches that can accompany hands-on science teaching.

Finally, I should mention that although many of the activities here are the same or similar to activities in the *Stop Faking It!* book, some are different. In those cases, I have hopefully provided enough background information to help you figure out what's going on. And in case you're new to science teaching, it's a good idea to figure out what's going on before you do activities in the classroom! I hope you enjoy these activities and that they help improve your students' understanding of force and motion concepts.

Regarding the new activities not contained in the *Stop Faking It!* book, I have the original developers of the curriculum used in the Mickelson/ExxonMobil Teacher's Academy to thank for many of them. Those people are Carla Billups, Sharon Bowers, Justin DeWall, Rich Hogan, Sharon Pearson, and Joe Sciulli.

Teacher Guide to 1.1

Time to Roll

Objectives: Students will be able to determine the time it takes for a ball to travel a given distance. They will also be able to calculate speed using the given mathematical relationship.

Process Skills Addressed: Measuring, observing, estimating, calculating, comparing, communicating

Scientific Concepts Addressed: Scientific inquiry; Properties and changes of properties in matter; Motions and forces

Position in the Learning Cycle: *Explore.* The purpose of this activity is to set the students up for understanding how we calculate average speed and for understanding the difference between *average speed* and *instantaneous speed*. Do not define these concepts prior to the activity, but rather help the students achieve the two tasks.

Relevant Pages in *Force and Motion Stop Faking It!* Book: Pages 11–17

Suggested Group Size: Two

Materials: Masking tape, one ball per team (A golf ball works well, but any other similar ball will do. Do not use a ball that's so light that it will slow down significantly when travelling a metre.), a carpeted surface

Approximate Time: 15–20 minutes

Procedure:

1. **Ask the students to mention things they know that travel fast, slow or in-between.** After a fair amount of input, ask the students how they might determine whether an object is moving fast or slow. You're looking for general descriptions, such as "how far something goes", "how quickly it goes by you" or "how long it takes for it to get somewhere". Accept all answers at this point. You don't want to define speed for them yet.

Teacher Guide to 1.1

2. Call the students' attention to the activity sheet and explain the two tasks. In doing these tasks, it's not important for them to get exact measurements. For example, in using two pieces of masking tape to "measure out" a distance of 1 metre, it's not important that they get exactly 1 metre. Anything close to a metre is good, so taking a "giant step" is fine for determining a metre. You can have them use stopwatches for timing, but that really isn't necessary. Counting "one thousand and one, one thousand and two" and so on is okay, and they can estimate half or quarter seconds.

Why not measure exactly?
Too often in science activities students worry about measuring things down to a tenth of a second or a tenth of a millimetre. After all, isn't it proper to be precise in science? Well yes, there's a place for that. But there's also a place for understanding concepts without worrying about being precise. Precision can in fact be misleading. Students who get results that differ by insignificant amounts nevertheless attach significance to the differences. When exact numbers aren't important for understanding a concept, then it's silly to focus on the numbers. Sometimes you want students to focus on a big idea rather than details.

Task 1: We're used to doing several trials and averaging results in science activities. That's not what the students should be doing here. All they need is one good determination of time for the ball to travel the one metre distance.

Task 2: Once again, the students just need one good trial rather than an average. The twist here is that they must count until the ball stops (hence the need for a carpeted surface on which the ball will come to rest in a relatively short distance) and then measure the distance. As with measuring out the one metre distance, this measurement of total distance doesn't have to be exact. The students can simply "pace out" the distance and estimate the total.

3. **Circulate around the room and help the students as needed.** One common mistake is to begin counting as soon as the ball leaves one student's hand, rather than when the ball reaches the piece of masking tape. Another common problem is that the students don't count at a steady rate, instead slowing down the count as the ball slows down. For students having difficulty with this, suggest that the counter close his or her eyes while counting, with the partner determining when the ball reaches the second piece of tape (Task 1) or stops (Task 2). It's your preference as to whether the students do both Tasks 1 and 2 before you discuss results or do Task 1, followed by calculation and discussion, then Task 2 followed by calculation and discussion. The second method takes more time, but it helps the students keep the tasks separate. Some students find it difficult to deal with estimating the distances and times, insisting they need exact measurements. Try to reassure them that exactness isn't the purpose of this activity.
4. Once the students have finished recording their times and calculations, **ask them to share their time results with the class.** The times will all be different, but they should fall within a reasonable range. Most students will get times ranging from a quarter of a second to two seconds in Task 1, and times ranging from two seconds to six seconds in Task 2. If any teams get times considerably outside these ranges, you might have them demonstrate how they did the tasks. If the out-of-range times are due to extremely slow or extremely fast counting, that isn't a problem unless the counting rates are different for the two tasks. Remember that the particular numbers the students get aren't all that important. Learning the concepts associated with the reading and discussion that follows this activity is the important thing.
5. **Continue by asking the students to share their calculations of**

$$\frac{\text{distance ball travelled}}{\text{time to travel that distance}}$$

Again the teams will end up with different numbers. However, most should get about the same calculated number for Task 1 and Task 2. For teams that get drastically different calculated numbers in Task 1 and Task 2, ask them to demonstrate their procedure. Make sure their counting rate is about the same for the two tasks, and that they followed the correct procedure.