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CARTOONS— AN ALTERNATIVE LEARNING ASSESSMENT



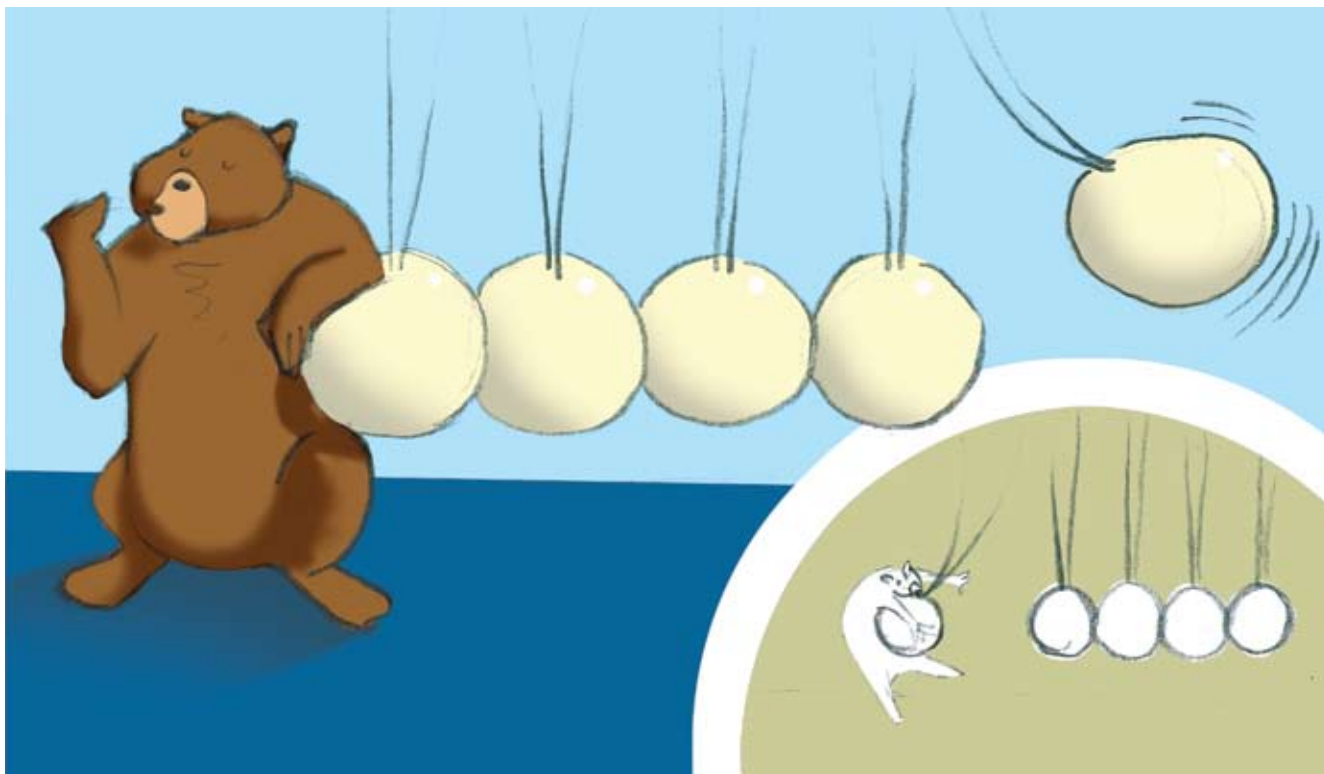
Wait! Before you grab that comic book out of some student's hands, maybe you should ask what that comic book does for the student that you haven't done. Perhaps you haven't tried to teach with some humorous cartoons? Nah, we all try that; many teachers are stand-up comedians in training. But have you thought about using cartoons and comics for assessing your students' science learning?

Science education reform documents in the United States, such as the *National Science Education Standards* (NRC 1996), envision that all students learn science with understanding. How do we, as science teachers, know that our students understand the science presented in the classroom? Our own teaching experience as well as research on science learning has provided evidence that assessment of student learning is much more than just giving paper-and-pencil tests and grades. In order to fully understand student learning, we science teachers need to know the ideas that students bring into the classroom. Plus, good assessment calls for ongoing evaluation of students' progress and difficulties with learning on an everyday basis.

This approach to assessment emphasizes the inclusion of alternatives to traditional paper-and-pencil evaluations, that is, "alternative assessments." (See "Cartoon Initiated Conversations" on page 50 to find additional ideas for using cartoons to reveal student misconceptions.) By using these, science teachers

can obtain information about students' strengths and weaknesses in science while the learning is taking place. Alternative assessments can include portfolios, journals, concept maps, oral interviews, and so on. Cartoons are one tool that has been used successfully as a means of assessing student learning in science (Perales-Palacios and Vilchez-Gonzalez 2005). They can be used at the beginning, middle, and end of a unit to assess students' prior knowledge and new learning. Recognizing the value of cartoons, we developed strategies for using them as an alternative assessment tool in middle school science.

We chose a unit on force and motion to use cartoons because research has shown that students come into a physical science class with preconceived notions about the topics, and have difficulties understanding these concepts (Wandersee, Mintzes, and Novak 1994). Alter-



native assessment strategies using cartoons can help science teachers to assess students' ideas, old and new, and difficulties they experience as they learn the force and motion concepts. (For additional examples of using cartoons in the classroom, see "The Laughter-Learning Link" in the May 2004 issue of *Science Scope* and "Light in the Media Spotlight" from the July 2006 issue of *Science Scope*.)

Assessing the ideas students bring to the classroom

In order to assess what students already know about a specific concept, we use a "concept cartoon," a term first coined by Naylor and Keogh (1999), to refer to a cartoon-style format that includes competing views or explanations of a specific phenomenon. To develop a concept cartoon, the teacher selects a science concept that will be explored in depth and for which they would like to see students' preexisting ideas. Then, the teacher draws or finds a cartoon that includes an everyday situation. To either of these, the teacher now adds several alternatives that depict students' common conceptual difficulties or confusions relevant to that concept. Teachers can decide what kinds of situations should be included in the cartoon based on their own experiences or the research literature. The cartoon should include three or more different ideas that students could have about the situation.

For example, Figure 1 is representative of a concept cartoon in our selected context. This cartoon illustrates the concept of inertia. When the cart hits the rock, the pig is supposed to keep moving in the same direction of the moving cart according to Newton's first law of motion, often referred to as the law of inertia. When a concept cartoon is used as a kind of pretest, students are given a copy of the artwork at the beginning of the lesson. Three or four students work together in a group and for a few minutes discuss each viewpoint represented in the cartoon until team members reach a consensus about a particular position. Once each group has arrived at a consensus, they take a minute to share the idea they have selected and explain their choice using a scientific rationale. After each group presentation, all students should be provided time to ask questions of the presenting team members.

Once this is completed, explain the scientific ideas contained in the cartoon to students. According to Newton's first law of motion, inertia is defined as the tendency of objects to resist changes in their state of motion; that is, an object in motion tends to stay in motion and an object at rest tends to stay at rest when no force is exerted on it. However, when students see this cartoon, different groups will express different viewpoints based on their prior knowledge and preconceptions. Through the above process, students should become aware of their own ideas, practice justifying their claims, consider

alternative explanations, and finally adopt the scientific concept. In addition, while preparing the cartoon, we had the time to reflect on our own conceptions and became more familiar with common alternative conceptions our students would be likely to hold.

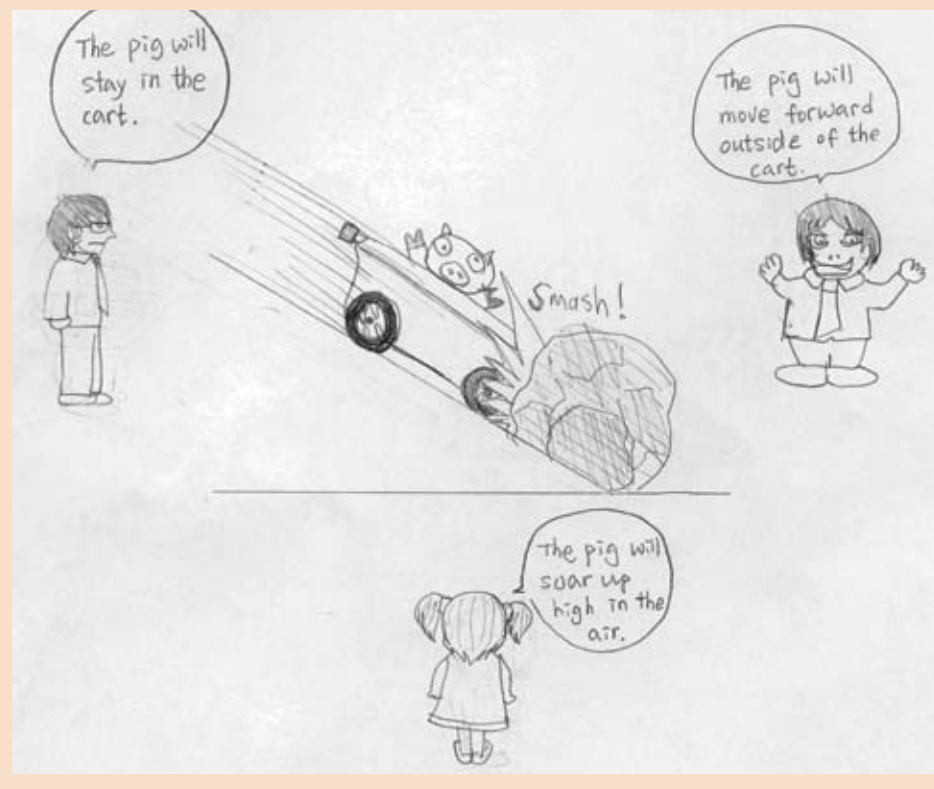
Assessing students' progress and difficulties

Cartoons are especially effective in engaging students in scientific dialogue. Even the quietest students in class can be motivated to talk when a familiar cartoon character becomes the protagonist of their dialogue. Active dialogue facilitates student understanding of scientific concepts and also provides a context for teachers to recognize student progress and learning.

A second way of using cartoons is more open than the concept cartoon. In this approach, science teachers use a *cartoon cut*, that is, one extracted image selected from a cartoon strip, comic book, TV animation, or other similar artwork. In order to have students articulate their thinking about a specific concept, teachers present a cartoon cut that contains a situation in which one or more scientific concepts are applied or misapplied (see Resources for suggestions). The difference between a concept cartoon and a cartoon cut is that a cartoon cut does not provide alternative viewpoints about a specific science concept within the cartoon. Rather, students have to find a "hidden" science concept. Furthermore, each group has to come up with their own scientific explanation about the situation instead of supporting one established viewpoint.

For example, many middle school students are likely to be familiar with the Warner Brothers' animations of Road Runner and Wile E. Coyote. In the animation, the Coyote often falls faster than other objects so that he gets into trouble when hit by other falling objects. Students who understand free-fall motion in relation to Newton's second law can argue that the situation is nonscientific because all free-falling objects, which are

FIGURE 1 Concept cartoon



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falling under the sole influence of gravity, fall with the same acceleration regardless of their mass.

This example can be used to assess student learning while the concept of free-fall is being taught. After having students watch a six-minute animation of Road Runner and Wile E. Coyote (see Resources for samples), the teacher can provide the cartoon cut or ask students to reflect on a situation that contradicts the scientific concepts illustrated in the film clip. Then, students can be asked to develop a scientific claim and list evidence to argue for and support their idea. In such contexts, the teacher has the opportunity to ascertain students' levels of understanding in relation to the concept, and students have the opportunity to reflect on their own understandings, and practice communicating their scientific ideas.

One of the advantages of using a cartoon cut, especially ones familiar to middle school students, is that it is effective in motivating ongoing discussion. The cartoon cut can provide teachers with information about where students are located in their learning, and how the unit should progress. Furthermore, the cartoon cut can be used to assess how well students observe,

gather facts, and then hypothesize which “laws of nature” are found in this cartoon universe, and how they may or may not differ from ours.

Assessing students’ application of science to everyday life

Cartoons can also be used to assess students’ learning outcomes and their ability to apply a science concept to everyday situations. We developed a cartoon project that provides students with an opportunity to draw

cartoon strips and create stories. Figure 2 illustrates a sample of a cartoon project guide. Teachers may adapt it to any science unit. The situation, which should contradict one of the science concepts they have learned, can come from students’ lives or other cartoons such as TV animations, favorite comic books, and so forth. However, the actual situation must violate the principles underlying the concept. Students are asked to bring the situation to class by taking or copying a picture, or drawing the scenario. In the classroom, students share their examples in small groups, discuss the situations, find plausible alternative situations, and finally make a cartoon strip and write an underlying story that corrects the flawed science of the original situation. All students’ cartoon strips are exhibited, and their peers are asked to write an opinion about each cartoon strip in terms of the scientific plausibility and interest of the ideas. Each student’s peer evaluation is useful as a supplemental means to further understand the writer’s level of understanding. The entire process is assessed by a summative assessment rubric.

FIGURE 2 Cartoon-project guide

The cartoon project is designed to apply the scientific concepts to your everyday life. In this project you will create your own cartoon strip and story.

Procedures

1. Find a situation that contradicts the science concepts that you have learned. Your sources can be anything that you could observe, such as a real-life situation, TV animations, favorite comic books, and so forth. Make sure you cite the source.
2. Bring that situation into the classroom by taking a picture of it, copying it, or drawing the scenario.
3. In your group, share and discuss your situation and find alternative situations that match with scientific conceptions.
4. Based on your group’s discussion, make a cartoon strip with an interesting story as a group. You can either choose one particular situation and add more cuts or use all the situations that your group members bring and mix them. When you make a story, use the scientific terms that you have learned.
5. After making your cartoon strip, tape it to the wall. Then, write your opinion about the other groups’ work based on two criteria: scientific plausibility and interest of the ideas.

Figure 3 illustrates an actual sample that was drawn by a group of students as part of a cartoon project in a force-and-motion unit. Students found the situation in a TV animation in which two animals (the pursuer and the pursued) suddenly stopped on the edge of a cliff. Students thought that this situation contradicted the law of inertia since the animals could not stop immediately. Therefore, they drew a cartoon strip in which two animals fell down rather than halted, with a humorous ending.

In addition, the rubric in Figure 4 can be used to evaluate the entire process of a cartoon project in a force-and-motion unit, such as assessing students’ ideas about force-and-motion concepts, the completeness of their work, and their creativity. Each student’s written story can also be used as a supplemental assessment to

FIGURE 3 Students’ sample work



further understand the student’s conceptions. Teachers can modify this rubric for any science unit.

Assessment

Using cartoons as a summative assessment tool in the project is effective in many aspects. First, it is relevant to students’ interests. Second, it promotes students’ skills of observation, establishment of hypotheses, and inductive thinking. Third, it enhances students’ abilities to apply scientific knowledge to their real lives (who can deny that TV animations and comic books are a part of children’s lives?). Fourth, it stimulates students’ curiosity, creativity, and desire to express themselves by having their ideas represented in the form of interesting drawings and comic stories. Finally it offers an opportunity for teachers to assess student understanding in an authentic way.

Concluding thoughts

We have introduced three ways of using cartoons as an alternative assessment tool in middle school science classrooms: assessing students’ prior conceptions, students’

progress and difficulties with learning, and students’ learning outcomes. The use of cartoons in a middle school fits several characteristics of young adolescents (Forte and Schurr 1993). They are curious about the world around them, so they need varied situations for exploration. Young middle school students are more likely to be agents of their learning if they can use a familiar medium. Active over passive learning activities are preferred so hands-on learning experiences are necessary. Students also need opportunities to express their creativity.

Cartoon strategies for assessment are useful for teachers as well. Students’ abilities to discuss, draw, and write their own cartoons provide science teachers with a more complete picture of how their students understand scientific ideas. Besides assessment, these approaches can function as a powerful learning tool for students to interpret and synthesize scientific knowledge and to apply what they know. Using cartoons is much more exciting than simply providing facts. Though our examples involve a force-and-motion unit, we feel sure other areas of science can be assessed in this same way. ■

FIGURE 4 Rubric for a cartoon project

	Outstanding	Good	Needs more work
Cartoon strip and story			
Use of scientific terms	Student often and correctly uses scientific vocabulary.	Student correctly uses a couple of scientific terms.	Student never uses or misuses scientific terms.
Understanding of Newton’s laws of motion	Student shows evidence of clearly understanding Newton’s laws of motion.	Student shows evidence of partially understanding Newton’s laws of motion.	Student shows little evidence of understanding Newton’s laws of motion.
Writing skill	Student organizes the story well and explains the situation clearly.	Student explains the situation clearly.	Student misses some parts necessary for the communication of the story.
Completeness	Student elaborates the drawing and finishes it.	Student creates a story but does not finish the drawing.	Student does not finish the drawing or the story.
Creativity	Student’s ideas are sophisticated, humorous, and original.	Student’s ideas are humorous and original.	Student’s ideas are not original.
Peer evaluation			
Completeness	Student completes all the other groups’ evaluations.	Student completes all but one or two groups’ evaluations.	Student completes evaluations for less than half the groups.
Use of criteria	Student evaluates peers’ products in terms of scientific plausibility and interest to others.	Student evaluates in terms of scientific plausibility.	Student evaluates in terms of interest to others or based only on the drawings.

References

- Forte, I., and S. Schurr. 1993. *The definitive middle school guide: A handbook for success*. Nashville, TN: Incentive Publications.
- National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.
- Naylor, S., and B. Keogh. 1999. Constructivism in classroom: Theory and practice. *Journal of Science Teacher*

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- Wandersee, J., J. Mintzes, and J. Novak. 1994. Research on alternative conceptions in science. In *Handbook of research on science teaching and learning*, ed. D.L. Gabel. New York: Macmillan.

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Resources

- Cary, S. 2004. *Going graphic: Comics at work in the multilingual classroom*. Portsmouth, NH: Heinemann.
- Concept Cartoons—www.conceptcartoons.com/index_flash.html
- Gonick, L. 1991. *The cartoon guide to physics*. New York: HarperCollins.
- Paul Hewitt's Conceptual Physics media—www.conceptualphysics.com/books.shtml
- Video clips featuring Wile E. Coyote—www.youtube.com (Search for Wile E. Coyote.)

Copyright concerns

Even if it doesn't explicitly say so, every creative work, including cartoons, is copyrighted. This doesn't mean, though, that you can look but not touch. Guidelines for "fair use" in educational venues are found in the U.S. Copyright Office's *Circular 21*, "Reproduction of Copyrighted Works by Educators and Librarians" (www.copyright.gov/circa/circ21.pdf).

Briefly, teachers may make multiple copies for classroom use. No more than one copy per student. Usage must be at the "instance and inspiration of a single teacher" and when the time frame doesn't allow enough time for asking permission. Use it only for one course in the school and do this kind of copying no more than nine instances per class, per term (current news publications such as newspapers can be used more often). "Consumables" can't be copied. Don't use the cartoon every term; if you plan to, write for permission before your next usage. Higher authority cannot compel you to use it. Copying can't be substitute for buying the original resource and you can only make copies from legally acquired originals.

As for video clips, teachers may use these materials in the classroom without restrictions of length, percentage, or multiple use. The material must be legitimately acquired (a legal copy). It must be used in a classroom or similar place "dedicated to face-to-face instruction" and is not for use as entertainment or reward. The use should be instructional. The place should be a nonprofit educational institution. You should check with your own local media committee for its policies as well. (For more information, see "Issues in Depth" in the July 2006 issue of *Science Scope*.)

Students have slightly more liberal guidelines than teachers; they may incorporate portions of copyrighted materials when producing projects for specific courses. The usage limits for them are no more than 5 images from one artist, and no more than 10% or 15 images from a collection, whichever is less. So if a student photocopies a cartoon from one of his or her books to show you, it's apparently ok. Students must cite their sources.

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Finally, there is no prohibition on displaying the original illustration in front of the class, on a document camera, Elmo, or opaque projector and adding your alternative choices for the cartoon cut on your own separate paper, blackboard, or PowerPoint slide. And nothing stops you from taking inspiration and doing your own cartoons with your own characters.

—Larry Krumenaker