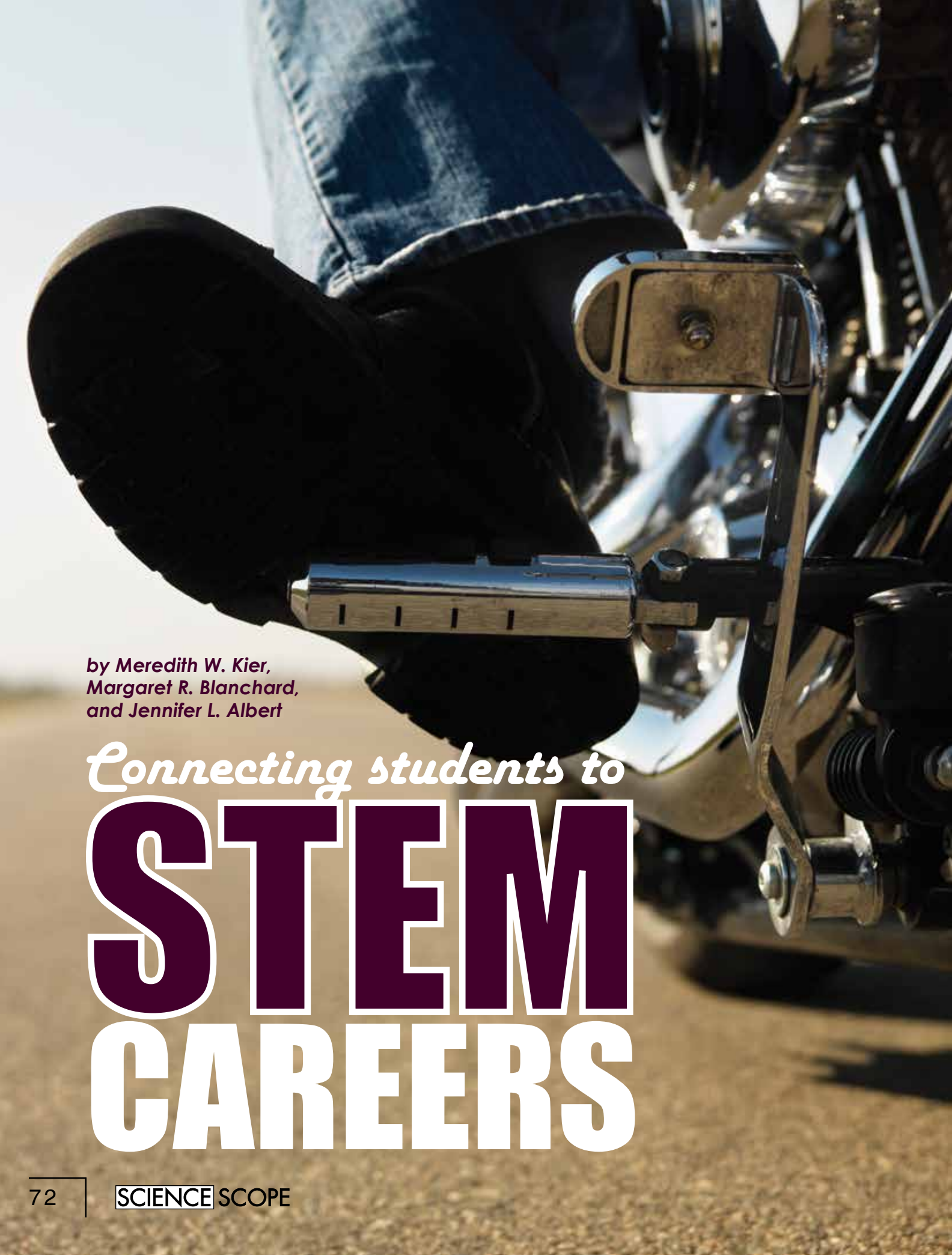


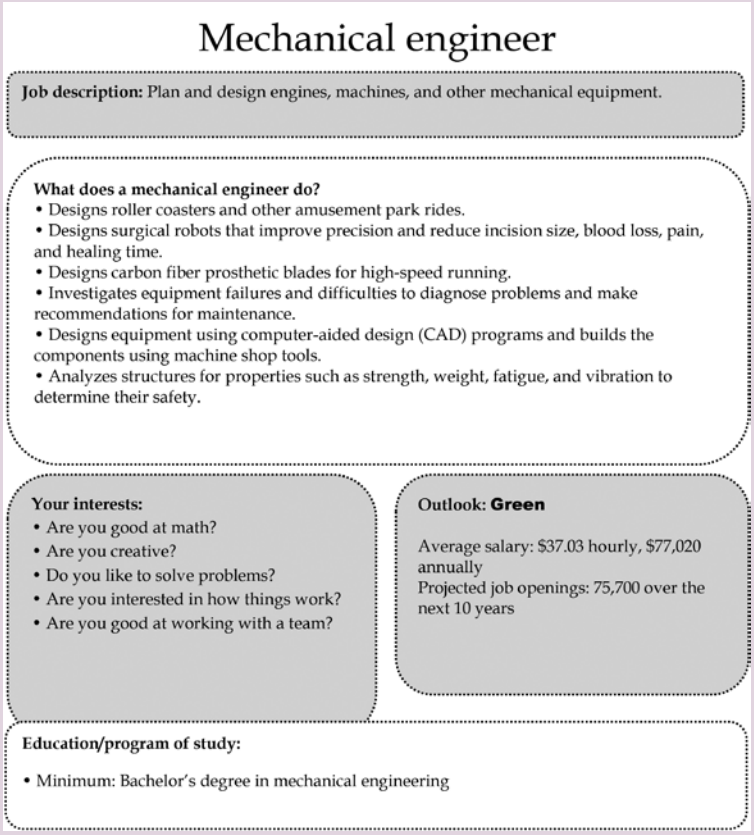
by Meredith W. Kier, Margaret R. Blanchard, and Jennifer L. Albert

Connecting students to STEM CAREERS

As students enter the classroom, the atmosphere is energetic. It's a Friday, which in this science class is STEM Career Day. The screen at the front of the classroom projects an image of a motorcycle designer, whose engineering career will be featured at the beginning of class. The teacher, Ms. Aguilar, and her eighth-grade students are participating in the STEM Career Awareness Project, which is designed to raise awareness of careers in science, technology, engineering, and mathematics (STEM). Ms. Aguilar selected this mechanical engineering video from a large database that features minority and female STEM professionals in up-to-date settings, with catchy soundtracks and lots of action (see Resource).

Eighty percent of students at Ms. Aguilar's rural school are African American, and 92% receive free or reduced-price lunch. At the beginning of the year, students in Ms. Aguilar's class were similar to most middle and high school students in that they thought of scientists primarily as white males working alone in a lab, whose jobs are less creative and people-oriented than other careers (Masnick et al. 2010). These misconceptions about scientists make students less likely to pursue STEM careers; exposing them to diverse role models and careers is recommended to enhance their perceptions of scientists and engineers as people who use technology, are women, and are individuals with diverse ethnicities (Buck et al. 2008; Koch et al. 2010). Students in Ms. Aguilar's classroom may relate to the minority and female role models and professionals featured in the films because they look similar to them (Sheehy 2012).

FIGURE 1 Mechanical engineer fact sheet



Mechanical engineer

Job description: Plan and design engines, machines, and other mechanical equipment.

What does a mechanical engineer do?
- Designs roller coasters and other amusement park rides.
- Designs surgical robots that improve precision and reduce incision size, blood loss, pain, and healing time.
- Designs carbon fiber prosthetic blades for high-speed running.
- Investigates equipment failures and difficulties to diagnose problems and make recommendations for maintenance.
- Designs equipment using computer-aided design (CAD) programs and builds the components using machine shop tools.
- Analyzes structures for properties such as strength, weight, fatigue, and vibration to determine their safety.

Your interests:
- Are you good at math?
- Are you creative?
- Do you like to solve problems?
- Are you interested in how things work?
- Are you good at working with a team?

Outlook: Green

Average salary: $37.03 hourly, $77,020 annually
Projected job openings: 75,700 over the next 10 years

Education/program of study:
- Minimum: Bachelor's degree in mechanical engineering

The high-quality videos were compiled by researchers at North Carolina State University from various sources (including PBS for Kids Dragonfly videos [*http://pbskids.org/dragonflytv/scientists*] and NASA videos [*http://women.nasa.gov*]). They are short enough (3 to 10 minutes) to fit into any class period and are connected to national math and science standards so that teachers can relate their current topic of study to STEM careers. The featured careers also include those requiring diverse educations, from technical training or a two-year associate degree to four or more years of college. Students can watch the videos individually on iPod Touches, iPads, or computers; the videos can also be projected for whole-class viewing. The STEM Career Awareness Project website is free and accessible to teachers and students. It currently hosts 89 career videos as well as mathematics and science standards and fact sheets (Figure 1) and covers topics that link to a wide range of middle school science content.

A sample lesson

Ms. Aguilar begins class by reminding students of what they had worked on the day before—the class had studied simple machines, made drawings of the machines in their science notebooks, and come up with hypotheses of what the machines could do. She tells students that the man on the screen at the front of the class is Bruce, an engineer who designs motorcycles.

"How many of you know someone who owns a motorcycle?" Ms. Aguilar asks. About one-third of stu-

dents raise their hands. "They're loud!" a student comments.

"True, especially Harleys," Ms. Aguilar laughs. "Can anyone tell me what a motorcycle engineer does on a daily basis?" The class is silent for a few seconds.

"Draws or makes motorcycle models for other people to create?" a student suggests.

Ms. Aguilar smiles and nods. "Good! What else?"

"Test-drives Harley-Davidsons?" another student offers.

Ms. Aguilar nods her head and calls on a student who rarely raises his hand. "Doesn't a motorcycle engineer have to work with a lot of simple machines to make the motorcycle work?" he asks.

"Good point," Ms. Aguilar says. "Motorcycles are compound machines that are made up of a series of simple machines that we talked about yesterday." She tells students that they will be watching a web clip of Bruce, an engineer who designs and tests motorcycles; the video will include several of the simple machines students have learned about in class. Students are instructed to find the drawings they had made in their science notebooks and next to those drawings record the examples of simple machines they see in the video.

In the fast-paced, two-and-a-half-minute video (Figures 2 and 3), Bruce talks about how he helps to design motorcycle parts and does test-driving before the motorcycles are available to customers. There are scenes of Bruce working on a Harley and designing motorcycles on a whiteboard while talking about how he has always liked tinkering with things and enjoyed math classes. Students are quietly attentive as they watch; some imitate revving a motorcycle with their hands as they watch Bruce take off for a test drive. When the video ends, Ms. Aguilar asks students what they thought of it; student responses include the following:

- "Those Harleys were awesome!"
- "I liked the music."
- "I like how Bruce talked about his interests."
- "I didn't know that engineers worked on motorcycles. My uncle has a motorcycle, but it's not a Harley. Those are expensive! I bet that dude makes a lot of money."

When Ms. Aguilar next asks for volunteers to name simple machines they saw in the video, students begin shouting responses:

- "Levers!"
- "Pulleys!"
- "Wheels and axles!"

Mrs. Aguilar asks students to raise their hand if they think they might want to pursue a career like Bruce's one day, and how they would go about doing so.

"I bet I could apply to a technical program after high school and learn how to work on motorcycles," one student says.

Another student adds, "I'm really good at math. Maybe I could go to a four-year university and major in engineering."

Post-video instruction

After students watch the featured STEM career video as a class, they read a fact sheet about mechanical engineers (Figure 1). In Ms. Aguilar's class, student pairs have access to iPod Touches; Ms. Aguilar gives them a QR code that links to the fact sheet, which they read online. Students can also access the fact sheet using an iPad or computer, or teachers can print them for students. STEM career fact sheets can be found with the associated STEM career video on the project website. All fact sheets were adapted from information from the Department of Labor and modified to be appropriate for middle school students. The fact sheets contain a basic job description, details on the day-to-day tasks seen in the job, student interests that are associated with the job duties, the projected job outlook, and the amount of education needed to obtain the career. After they have read over the fact sheets, students participate in a 10-minute class discussion during which they talk about whether they would be interested in doing the featured career and what they liked and disliked about the job.

Next students use the iPod Touch to answer a brief, online, seven-question STEM Career Exploration

FIGURE 2 Still images from the DragonflyTV video showing Harley Davidson motorcycle designer Bruce Roberts and a sample of his work.

USED WITH PERMISSION FROM JOAN FRIESE: *HTTP://PBSKIDS.ORG/DRAGONFLYTV/SCIENTISTS/SCIENTIST9.HTML*.

Sheet online (Figure 4), that stores individual students' feelings about the career that they watched. This information allows researchers to add more STEM careers to the website that are tailored directly to students' interests. Ms. Aguilar then directs student pairs to visit the STEM Career Awareness Project website and find one career video that they think relates to simple machines. As they watch the video they select, student pairs work together to fill out the worksheet. (Note: Teachers with enough computers in the classroom may have students type directly on the exploration worksheet and save it with a new file name.) Students chat excitedly as they scroll through the website searching for a video they believe connects to what they learned about simple machines. The goal is for students to see how what they are learning in school can help them with their future careers, which may help increase students' internal motivation to do well in science.

Why talk about STEM careers?

While new jobs in STEM fields are expected to greatly increase in the next 10 years, studies indicate that many students lose interest in STEM in the transition from middle school to high school (Van-Leuvan 2004). Students often see STEM careers as too difficult and requiring too much schooling, and hold negative stereotypes of STEM professionals as socially isolated and noncreative (Masnick et al. 2010). This suggests that in order for students to consider STEM careers, teachers should begin discussing them at the middle school level. There are so many careers in STEM fields that little about them is known by teachers and students. Students in rural areas or in underserved populations may have even less exposure to STEM careers and STEM career professionals. Therefore, classroom initiatives are important to encourage the awareness and interest of students in STEM careers.

Teachers who don't have a whole day to devote to the exploration of STEM careers can add video clips to daily or weekly instruction by projecting a video for the class. Most video clips are only three to five minutes long and add real-world connections to classroom instruction, making them appropriate almost anywhere in the curriculum. One of the new three Rs promoted by Bill Gates (2005), relevance (the others are rigor and relationships), is addressed by students understanding how what they're learning is connected to the real world.

Students often... hold negative stereotypes of STEM professionals as socially isolated and noncreative.

Teachers participating in the STEM Career Awareness Project do not stop at using the videos, career sheets, and exploration worksheets. Some have organized a whole school STEM Career Day or arranged for STEM professionals to visit

the classroom in person or virtually. Also, students can take virtual field trips to check out career sites or follow the steps of a STEM professional. If students connect with a STEM career, they may be more likely to see the relevance of school and be internally motivated to succeed in science, technology, engineering, and mathematics courses. (See "Tracking Science: Following the STEM Trend" and "How to Organize a STEM career day" in this issue.) ■

Acknowledgments

The authors wish to thank Cecilia Aguilar at Warren County Middle School in Warrenton, North Carolina, for her enthusiastic support of the STEM Career Awareness Project, and all of our project partners in the Weldon City, Bertie County, Northampton County, Warren County, and Hertford County school districts in North Carolina.

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Resource

STEM Career Awareness Project—*http://stemcareerawareness.wikispaces.com*

FIGURE 4 STEM career exploration worksheet

What did you find out about this career?

_____

_____

Daily activities: _____

_____

Salary: _____

Education needed: _____

How do you feel about the activities, salary, and education?

_____

_____

What are three things that you like about the career seen in the video?

_____

_____

_____

What are three things that you do not like about the career seen in the video?

_____

_____

_____

_____

Could you see yourself in this career? Why or why not?

_____

_____

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