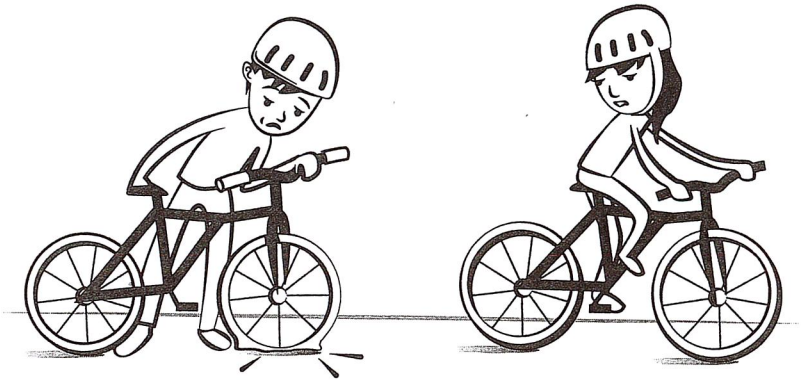
What's the Problem?



Daniella and her friend Tyson are about to leave for school. Tyson finds out his bicycle has a flat tire. He's worried he will be late for school. Daniella and Tyson have different ideas about what is the most important problem to solve first:

Tyson: We need to figure out how to fix my tire.

Daniella: We need to figure out how to get to school on time.

Who identified the problem that should be solved first? _____ Explain your thinking.

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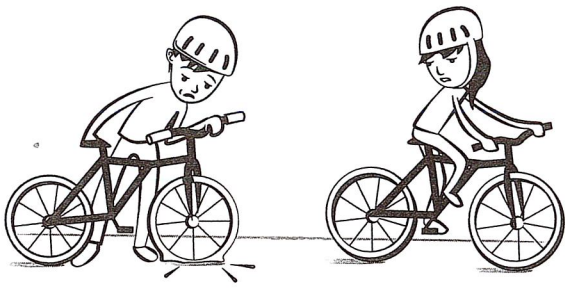
What's the Problem?

Teacher Notes



Purpose

The purpose of this assessment probe is to elicit students' initial response to an ill-defined problematic situation. The probe is designed to reveal whether students recognize that in a problem situation, there is sometimes a more important problem that needs to be solved first.

Type of Probe

Opposing views

Related Key Idea

- It is important to analyze a situation to determine the problem that needs to be solved.

Explanation

The best answer is Daniella's: "We need to figure out how to get to school on time." It is likely that many students will focus on the image of the bicycle, and immediately assume that the problem is the flat tire. However, the more important and immediate problem to be solved is how to get to school on time. Stopping to repair the bicycle will likely make them even later. This kind of situation can also happen with seemingly straightforward engineering problems in which a problem situation needs to be more clearly defined. Sometimes an important or immediate problem needs to be addressed first, before the more obvious problem can be solved.

Administering the Probe

This probe is best used with grades 3–12. The probe can be extended by having students describe what they would do to solve the problem.

Connections to the Three Dimensions (NRC 2012; NGSS Lead States 2013)

- DCI: ETS1.A. Defining and Delimiting Engineering Problems
- SEP: Asking Questions and Defining Problems

Related Research

- Crismond and Adams' (2012) review of several hundred studies of how students solve problems found that "beginning designers feel that understanding the design

challenge is straightforward, and a matter of comprehending the basic task and its requirements. By perceiving the design task as a well-structured problem and believing there is a single correct answer, they can act prematurely and attempt to solve it immediately. Informed designers start by trying to learn as much as they can about the problem and delaying design decisions until they understand the problem fully. They set out to learn through research, brainstorming, and doing technological investigations of what the critical issues are in order to frame the problem effectively. They will later return to assess this framing after attempting to solve the challenge in case they need to modify the problem definition" (p. 747).

- Watkins, Spencer, and Hammer (2014) had fourth graders use fictional texts as a basis for identifying, scoping, and designing solutions for an engineering problem that the characters face. In contrast to Crismond and Adams' findings, the investigators found that the students did not treat design problems as well-defined straightforward tasks. Rather, they demonstrated promising beginnings of the ability to define a problem.

Suggestions for Instruction and Assessment

- Lead an all-class discussion as a follow-up to this probe. It is likely that students will disagree about what needs to be done. In that case, encourage more discussion.
- If all students believe the tire needs to be fixed, you can guide students to consider the other problem—getting to school on time. For example, you can ask students what happens when they are late for school, especially if they have been late several times before. How would their experience with being late for school inform how they would approach this problem?
- If most students say that the tire should be fixed first, ask them if they ever fixed a bicycle tire or watched someone do it. What is involved in fixing the tire? How long might it take to fix the tire? Then ask if they still think Tyson and Daniella could fix the tire and still get to school on time.
- Have the students share information about how they come to school in the morning. Do they ride the bus? Does a parent take them? Do they walk or ride a bicycle to school? What would they do if their usual means for getting to school failed? How would they solve the problem of getting to school?
- Have students come up with their own examples of a problem that at first seemed straightforward and easy to solve, but, on further examination, there were underlying problems that needed to be addressed first.
- Ask students to compare how this problem situation might be similar to problems that engineers encounter. Encourage them to guess about a situation, as any answer is a good start.
- Once students have completed this probe, have them discuss the problems involved in this situation. Initially, they may think that fixing a tire is an engineering problem and getting to school is not. However, a more accurate description is the reverse. Fixing tires is simply a step-by-step mechanical task that does not require design skills. However, solving how to get to school on time could be an engineering problem as students will need to define the problem, brainstorm multiple solutions, compare them, and select the best solution.

References

Crismond, D. P., and R. S. Adams. 2012. The informed design teaching and learning matrix. *Journal of Engineering Education* 101 (4): 738–797.

National Research Council (NRC). 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas.* Washington, DC: National Academies Press.

NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states.* Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards.*

Watkins, J., K. Spencer, and D. Hammer. 2014. Examining young students' problem scoping in engineering design. *Journal of Pre-College Engineering Education Research* 4 (1): 43–53.