Is It an Engineering Problem?

People encounter all sorts of problems every day. Some can be solved effectively with an engineering design process (EDP); others require a different approach.

Can these problems be solved by an EDP?

Problem Situation	Yes	No	Maybe
1. Earbud cords get easily tangled when placed in a pocket.			
2. Cafeteria trays are slippery, so when students take their trays to a table, they often spill their drinks.			
3. A student has to decide whether to put money from her summer job into a bank account paying interest, or buy a bicycle to ride to an after-school job.			
4. Plants for a science project need to be watered every other day, but school will be closed for a week.			
5. When students get box lunches for a field trip, they waste food by throwing out items they don't like.			
6. A local food bank doesn't have enough food to feed all of the families that need help.			
7. A group of people wants to change the name of a school, but other people want to keep it the same.			
8. On rainy days, students track mud into the school.			
9. Inspectors found dangerous levels of lead in drinking water from many of the city's elementary schools.			
10. Elm trees in communities all over the country are dying from Dutch elm disease.			

Explain your thinking. How did you decide whether a problem is best solved using an EDP?

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Teacher Notes

Problem Situation	Yes	No	Maybe
1. Earbud cords get easily tangled when placed in a pocket.			
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Purpose

The purpose of this assessment probe is to elicit students' ideas about how to approach a problem. The probe is designed to gain insight into how students think about an engineering design process (EDP) and the kinds of problems that it can be used to solve.

Type of Probe

Justified list

Related Key Idea

- It is important to identify which problems are good candidates for engineering solutions and which are not.

Explanation

There are no absolute right or wrong answers to these questions. An EDP can be applied to any of them. However, some are much more likely to be addressed with an EDP than others. Here are some thoughts about each of these situations. Can these problems be solved by an EDP?

Problem Situation	Possible Answers
1. Earbud cords get easily tangled when placed in a pocket.	Yes. A device could be designed to hold the cord so it does not tangle.
2. Cafeteria trays are slippery, so when students take their trays to a table, they often spill their drinks.	Yes. A different kind of tray can be designed to hold the drinks better. Also, the current trays can be treated so they are non-skid or easier to hold firmly.
3. A student has to decide whether to put money from her summer job into a bank account paying interest, or buy a bicycle to ride to an after-school job.	Maybe. The student could use a systematic process to consider the need for a bicycle, or use math to see which decision gives her more money. However, instead of using these engineering processes, the decision could be based on how much the student wants a bicycle.

Continued

(*continued*)

Problem Situation	Possible Answers
4. Plants for a science project need to be watered every other day, but school will be closed for a week.	Yes. A device could be designed to provide water to the plants every other day automatically.
5. When students get box lunches for a field trip, they waste food by throwing out items they don't like.	Yes. Different solutions are possible, such as students picking the foods for their own box lunches. Each solution has different economic and social benefits that can be calculated.
6. A local food bank doesn't have enough food to feed all of the families that need help.	Yes. There may be other sources of food, such as unused food from nearby schools, or other types of food that are available at lower costs in bulk. An EDP approach would need to calculate the trade-offs between positive benefits such as lower costs and any negative impacts such as lower nutritional content.
7. A group of people wants to change the name of a school, but other people want to keep it the same.	Maybe. The cost of new signs or other changes could be taken into account when weighing different options systematically. However, such decisions are usually made through discussion and democratic votes.
8. On rainy days, students track mud into the school.	Yes. Once the source of the mud is known, different solutions could be proposed and tested, with each solution having different benefit/cost trade-offs.
9. Inspectors found dangerous levels of lead in drinking water from many of the city's elementary schools.	Yes. Inspectors would need to track down the source of the pollution, evaluate different options for cleaning or replacing the equipment containing lead, and select the solution with the best benefits and lowest costs for the city.
10. Elm trees in communities all over the country are dying from Dutch elm disease.	Maybe. Scientists and engineers can work together to determine how the disease is transmitted, seek and evaluate possible remedies, and recommend various methods with different benefits and costs so that people can choose suitable options for their community trees.

Administering the Probe

This probe is best used with students in grades 5–12. The best way to use this probe is to have individual students check off their answers first and then form pairs to discuss their ideas. Following the pair discussion, conduct a class vote on each problem, asking volunteers who voted for different answers to share their reasoning.

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

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

Related Research

- By asking students which kinds of problems can be solved with an EDP, we are also learning what students think engineering is all about. English, Hudson, and Dawes (2011) studied the results of a short engineering lesson in Australia in which students discussed engineers they know, watched a DVD about engineering, interacted with websites about engineering, and researched famous engineers. After these experiences, students expressed the idea that engineers are creative, future-oriented, and artistic problem finders and solvers; planners and designers; seekers and inventors; and builders. The students also described them as adventurous, decisive, community-minded, reliable, and smart. Although students displayed a broader awareness of engineering than existing research suggests, there was limited knowledge of engineering fields and still a strong perception of engineering as largely involved in construction.

Suggestions for Instruction and Assessment

- Following the class vote and discussion (as described in the Administering the Probe section), have students summarize in one sentence when they think an EDP is best used in a problem situation. Guide students toward understanding that it is best used whenever a systematic approach would be helpful.
- The probe can be extended by having students describe how an EDP could be used for each of the problems they felt could be best solved systematically. Do not share the sample answers in the Explanation section until students have had an opportunity to explain their own ideas about how an EDP is applied to each problem situation.
- Have students extend the list by generating their own examples of problems to solve. Students could exchange their new problem ideas with others who would respond with yes, no, and maybe when it comes to deciding whether the problem could be solved by engineering. Have them justify their reasons for the yes, no, or maybe approaches.
- Have students identify a problem they encountered in real life in which an EDP was not used to solve the problem, but the problem could have been solved more effectively with an EDP.
- Ask students to name a few problems for which an EDP would obviously *not be a good approach* (such as naming a baby, or deciding what flavor of ice cream to order). Make a list of these on the board. Then do the same with problems for which an EDP *is clearly a good choice.* For each list, ask the students to describe, in one sentence, what all of the problems on the list have in common. Record these ideas. Finally, have the students explain, in their own words, when an EDP is and is not a good method for solving a problem.

References

English, L. D., P. B. Hudson, and L. A. Dawes. 2011. Middle school students' perceptions of engineering. STEM in Education Conference: Science, Technology, Engineering and Mathematics in Education Conference.

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

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