The Process

Problem Solving

Instructor's Guide

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Developed by the Teaching and Learning Laboratory at MIT
for the Singapore University of Technology and Design

Introduction

When to Use this Video

- In Tech 201, at home or in recitation.

Learning Objectives

After watching this video students will be able to:

- Identify the steps of the problem solving process.
- Recognize that the problem solving process is iterative.

Key Information

Duration: 12:55
Narrators: Lisa Burton & Nadia Cheng, Ph.D. candidates
Materials Needed:
• Paper
• Pencil/Pen

Motivation

- Although students are expected to problem solve throughout their coursework and in their careers, they are seldom taught an explicit problem solving process. This video presents a general and flexible problem solving process that students could use for open-ended problems and modify for close-ended problems.
- While one problem solving strategy may not apply to every type of problem, getting students into the practice of thinking about their problem solving process will help them approach problems in a logical way.

Student Experience

It is highly recommended that the video is paused when prompted so that students are able to attempt the activities on their own and then check their solutions against the video.

During the video, students will think about their approach to problem solving.

Video Highlights

This table outlines a collection of activities and important ideas from the video.

Time	Feature	Comments
1:24	A problem solving strategy is presented.	
3:18	Lisa Burton describes the requirements for the class project that provides the context for the rest of the video.	
3:50	The Marangoni effect is described.	The student project described is this video is based on the Marangoni effect.
5:12	The specific project that Lisa decided to work on, a boat propelled by the Marangoni effect, is described.	Students see a preview of what this boat may look like.
8:44	The use of a 3D printer to create prototypes is described.	

Video Summary

This video presents students with a problem solving process that they might find useful in solving ill-defined problems. Students see how this problem solving process was used by MIT graduate students to complete a class project.

Tech 201 Materials

Pre-Video Materials

When appropriate, this guide is accompanied by additional materials to aid in the delivery of some of the following activities and discussions.

1. Have students think about their problem solving process. You might have them do this in conjunction with a regular homework assignment. Ask them to jot down the steps they go through as they work through the problems. In class, ask a few students to share out some of the steps they go through.

2. Marshmallow Challenge

Materials needed per group:

- 20 sticks of spaghetti
- one meter of masking tape
- one meter of string
- one jumbo marshmallow

Divide students into teams of four. Challenge them to build the tallest freestanding structure they can out of 20 sticks of spaghetti, one yard of masking tape, and one yard of string. A marshmallow has to be placed on the top of the structure. Students are allowed to break the strands of spaghetti if they wish. Give teams 18 minutes to complete the challenge. When time runs out, have groups look around at each others' structures. Remember, they should be freestanding, so students should not be supporting the structures with their hands, books, etc.

Have groups discuss their strategies for designing and building their structures. Ask them to think about what they did first, then second, then third,etc. (e.g., asked clarifying questions, discussed what might make a stable structure, sketched, etc.). Is there a general sequence of steps many of the groups seemed to go through? How do these steps compare to the steps they go through when solving homework problems? What are the similarities and differences?

The Marshmallow Challenge has been conducted by thousands of people all over the world. For more information, go to http://marshmallowchallenge.com/Welcome.html.

Post-Video Materials

1. Marshmallow Challenge revisited

Have students try the Marshmallow Challenge again, this time keeping in mind the problem solving process presented in the video. Remind the students that the problem solving process is iterative and that they can use the information they gathered from their first attempt at the challenge to inform their new designs.

After the challenge, ask students to reflect on whether or not they think using the problem solving process was helpful. Where there steps that were particularly beneficial? Why? Where there particular steps that they found difficult to implement? Why?

Additional Resources

Going Further

As students progress through the university and develop expertise in their discipline, they should be encouraged to consider the underlying physical principles when approaching a problem. Students should be encouraged to process knowledge deeply instead of recalling facts. Providing practice problems that require analysis and synthesis will help with this and help students further develop their problem solving skills.

Students often struggle with open-ended and ill-defined problems. Students should be provided opportunities to define problems and break them into parts to gain comfort with this. This will add to their confidence when approaching ill-defined problems later in their careers.

Experts sometimes have difficulty verbalizing their problem solving approach, but giving students the opportunity to see you solve a problem where you make your though process apparent to them will help them become better problem solvers.

References

The problem solving process referred to in this video is based on that referred to in chapter 5 of the following book. The book chapter also contains many references to the cognitive psychology literature related to problem solving.

- Wankat, P.C. and F.S. Oreovicz. (1993). *Teaching Engineering.* New York, NY: McGraw-Hill. Available from: https://engineering.purdue.edu/ChE/AboutUs/Publications/TeachingEng/index.html

The following citations are related to the science concepts presented in the video:

- Bush, J. W. M. and Hu, D. L. (2006). Walking On Water: Biolocomotion at the Interface. *Annual Review of Fluid Mechanics, 38*, 339-369.
- Hu, D. L., Chan, B., & Bush, J. W. M. (2003). The Hydrodynamics of Water Strider Locomotion. *Nature, 424*(6949), 663-666.