Teacher Information

Curricular goals

Design an authentic learning experience that:

- links engineering practices with content in the biological sciences.
- incorporates the *human empathy* component of the engineering-design process.
- develops higher-order thinking skills by requiring students to take ownership of the research, development, and implementation of their ideas.
- results in a final "solution" which cannot be pre-determined prior to beginning the unit.

Implementation timeline

Day	Topic	Suggested activities	Standards focus
Day 1	Engaging students and introducing the problem	Formative assessment: KWL chart Heart of the Matter (heart disease video) How Engineering is Changing Surgery (Daily Planet video—DaVinci Robot) Project 500—Medical Innovations (article) Optional extension: Disease and steroid use HW: Research heart disease Research and define key words	Design thinking Content background Asking Questions and Defining Problems
Day 2	Establishing empathy	Reading a fictional story Discussing a nonfiction article Interviewing heart-disease patients Video—Telegraph UK HW: Reflective paragraph	Design thinking Crosscurricular with ELA
Day 3	Brainstorming	Complete the "L" from Day 1 KWL chart Brainstorm and sketch One-to-two minute share-out Show supplies that will be available for the next day HW: Complete the design worksheet	Design thinking Developing and Using Models Planning and Carrying Out Investigations
Day 4	Building and testing	Build and test—no design constraints	Planning and Carrying Out Investigations

		Collect data Make on-the-spot modifications HW: Completing the data collection worksheet Students will likely be interested in further researching the topic. If they do, they can incorporate new ideas into their design the following day during the iterative process.	
Days 5 and 6	Evaluating, redesigning, retesting	Self-evaluation (design worksheet) Develop a revised plan (design worksheet) Peer evaluation (with rubric) Redesign, retest, collect data HW: Complete design worksheets, data-collection worksheets, and peer review	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Engaging in Argument from Evidence Crosscurricular connections with mathematics and ELA
Day 7	Evaluating and wrapping up	Present poster and student-made video clips Final write-up and model presentation Watch: TED Talk on "Future of Medicine" Read: Dissolvable stents	Engaging in Argument from Evidence Crosscurricular connections with ELA

Engineering-design cycle

- Empathize
- Define problem
- Brainstorm
- Design
- Plan
- Create
- Test
- Iterate

Materials needed (per group):

For clogged arteries:

- 8 in. of 1 in.-diameter tubing**
- Canned icing (three cans needed per class of 28 students)
- Transparent tape
- Knife

For device construction

- 1 pipe cleaner
- 10 in. thin wire
- 2 long, thin balloons
- 1 small balloon pump

For the "flow" measurement station:

- Stopwatch
- 2-liter plastic bottle
- Wash basins or plastic bins
- Towels (for clean-up)

Step-by-step preparation for the clogged arteries*
(Total prep time 30/minutes)

1. Gather icing, knife, tubing, and transparent tape. Cut enough tubing so that each group has four 2-in. pieces.
2. Pack the icing into each of the tubes until the icing is approximately 1.5 in. deep.
3. Tape the tubes together with transparent tape so that the icing makes one complete section. Make enough "arteries" so that each group has two arteries to work with.
4. Chill the "arteries" overnight in a refrigerator.
5. Using a straw, create a narrow opening in each of the "arteries" to allow minimal blood flow.
6. Clean up. Tubing may be cleaned by placing it on the top rack of a dishwasher and setting the washer to the "light" or "glass" setting. If a dishwasher is not available, tubing can also be cleaned by hand.

** PVC can be used in place of vinyl tubing.

Additional information may be found at www.teachengineering.org, the original authors of this specific activity.

Modifications

Suggested modifications for the learning disabled vary according to the type and degree of the disability. Be sure that groups are evenly balenced. For example, a student with dyslexia should be paired with another student with strong reading skills. A student with ADHD or other disability that makes following multistep instructions difficult should receive frequent check-ins and should be paired with another student who does not find it difficult to remain on task. Reviewing data collection sheets prior to data collection and providing a “first, next, finally” checklist on the board can also be helpful.

Extentions for gifted students include performing the procedure using a stent as well as decreasing the diameter of the tubing. Students may also be asked to use ratios or other mathematics to display their data and compare trials.