Solve a Problem Using Design Thinking

Description
Design thinking is a way of looking at the world in a way that sees possibilities and solutions rather than obstacles and problems.

This lesson introduces the idea of using design thinking to tackle real-world problems. By using this process, students will come to understand an effective way of finding solutions and how they can be implemented using robots. Ideally, students will be in groups of three to four per robot for this lesson, but this could be adjusted depending on class size.

Lesson Outcomes
Students will be able to:

- Understand and apply the iterative nature of the design process
- Effectively communicate and work in a team
- Apply their understanding of robotics systems and components

Assumptions
Students will:

- Have little experience using the design thinking process (empathize, define, ideate, prototype, test, repeat)
- Have some experience with solving problems in groups
- Have some experience with building and programming robots
- Understand the basics of robot sensors and their functions
- Hold a basic understanding of programming structures as they relate to robotics and their specific platform

Key Terminology

- **Bumper switch**: allows a robot to detect an obstacle or limit the movement of a component.
- **Colour sensor**: allows a robot to measure colours.
- **Design Thinking**: is an approach to solutions-finding that considers the desired end-result or experience. A Design Thinking approach is often iterative, starting with the definition of a problem, empathetically considering the experience or impact of that problem from multiple perspectives, considering multiple approaches to potential solutions, then narrowing down the solution through prototyping or experimentation. The chosen approach to the solution is then selected and implemented.
**Distance sensor**: allows a robot to measure distance using ultrasonic waves.

**Gyro sensor**: allows a robot to measure turn rate and angles.

**Limit switch**: similar to a bumper switch but with a flexible lever arm triggering the switch. It allows for more flexible mounting options than the bumper switch.

**Potentiometer**: allows a robot to determine the position and direction of rotation of a shaft.

**Prototype**: an early model of a product built to test a product or process.

**Reflective object sensor**: similar to a colour sensor, but includes a light source and detects the presence or absence of a reflective object at very short range (typically < 5 mm). An arrangement of two or more reflective object sensors can form a **line tracker**.

**Robot controller**: the brain of a robot that can be programmed using software. A robot controller sends instructions to the components of a robot and receives input from sensors.

**Estimated Time**

Approximately 4 hours:

- 30–60 minutes for the design thinking process
- 30–60 minutes to redesign/customize/build a robot that is tailored to the proposed solution
- 2 hours to test the prototype and repeat the design process until an adequate solution is found

**Recommended Number of Students**

20–25 students

**Facilities**

A computer lab with programming software or reasonable equivalent is required to complete this activity.

It is also recommended that tables be arranged in pods so that groups of students can work together during the design thinking process.

**Tools**

Ideally there should be an assortment of standard classroom supplies that will aid the students in their problem solving.
Electronics and Robotics

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Materials

Each small group should have:

- A design-thinking worksheet for each member to think through the process (see example at the end of this activity)
- A robot and associated sensors
- A computer with the appropriate programming software

Resources

A video that briefly explains what design thinking is:
https://www.youtube.com/watch?v=a7sEoEvT8l8

A TED talk by Tim Brown that discusses design thinking and encourages designers to think bigger:

An in-depth explanation of the design thinking process from Stanford University:

Procedure

1. Divide the class into groups of three to four, or divide the class into the same number of groups as the number of robots available.

2. The teacher can briefly introduce the idea of design thinking and how it makes peoples’ lives better. See videos in the “Resources” section for some suggestions.

3. Hand out the Design Thinking Worksheet to each student. These will be handed back to the teacher for assessment at the end of the activity; it is recommended that the teacher communicate this to the class. This structured process is intended to honour all voices in a group, to hold each team member accountable for their creative contributions and for the teacher to have a record of the design process of each student for the purposes of assessment at the end of the activity.

4. Using the Design Thinking Worksheet, students are to start with the first box, “Empathize/Define,” and think about problems in everyday life that could be solved using the available robots. It may help to prompt students by asking, “Why is this a problem?” Teachers will likely need to encourage students to focus on defining the problem rather than jumping to solutions-finding at this point.

5. Students should share the problems they identified in the group. Ensure that everyone’s ideas are given equal time. After each member’s problem ideas have been shared, groups can take approximately 10–15 minutes to discuss and decide which problems they would like to tackle for their robot design.
6. The groups will then move on to the second box, “Ideate,” where they will brainstorm possible solutions to their problems. This can take anywhere from 10 to 20 minutes, depending on the creativity of the group. Students are encouraged to focus on why their solution might work rather than why it might not, focussing their attention on possibilities rather than obstacles. Remember that it can be quite challenging to think creatively within a time boundary, so be aware that some students may struggle with this phase. Encourage each student have at least one idea to share at the end of the time period.

7. Again, students will take approximately 10–15 minutes to share their potential solutions to the chosen problem. If a group can’t decide which idea to move forward with, it is acceptable to advance to the Prototyping phase with more than one possible solution. Having multiple solutions to prototype can help trigger creativity.

8. Each student should then come up with at least two if not three different prototypes. Students should consider the available robots and components when prototyping. Allow 15–30 minutes for this phase. Again, each student shares their ideas with the group; the group decides on the direction they will take.

9. Allow for 30–45 minutes for groups to build and modify their robots according to their design.

10. Once their machine is built, groups should begin testing their design for effectiveness. Steps 9 and 10 should be repeated in as many iterations as necessary until they have solved their problem to their satisfaction.

11. To culminate the lesson, each group should present and demonstrate their chosen problem, their ideation process and the solution to the class.
Assessment

The evaluation of this lesson is based on the three outcomes outlined above.

Prior to teachers using the evaluation grid it is recommended that students perform some form of peer assessment and self-assessment after they have presented their work to the class.

<table>
<thead>
<tr>
<th>Outcome 1</th>
<th>Understand and apply the iterative nature of the design process</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Produced ideas at all three stages of the design process.</td>
</tr>
<tr>
<td>1.2</td>
<td>Contributed during the testing/modifying phase.</td>
</tr>
<tr>
<td>Outcome 2</td>
<td>Effectively communicates and works in a team</td>
</tr>
<tr>
<td>2.1</td>
<td>Contributes to a solution-oriented environment.</td>
</tr>
<tr>
<td>2.2</td>
<td>Demonstrates effective communication and teamwork during prototyping and testing.</td>
</tr>
<tr>
<td>Outcome 3</td>
<td>Apply their understanding of robotics systems and components</td>
</tr>
<tr>
<td>3.1</td>
<td>Uses controller/motors/sensors to solve the problem.</td>
</tr>
<tr>
<td>3.2</td>
<td>Uses software to modify program during testing.</td>
</tr>
</tbody>
</table>

Total Points:

6  Completed successfully at the exceptional level  Exemplary
5  Completed successfully at higher than the expected level  Accomplished
4  Completed successfully to the expected level  Emerging
3  Attempted successfully at the minimum level  Developing
2  Attempted - Unsuccessful - Close to Successful  Beginning
1  Attempted - Unsuccessful  Basic
0  Not Attempted  N/A

Comments: