SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Design a North Star Finder

Technology and the Skilled Trades

Grades: 9 and 10

Lesson Plan – Prototype

Learning Goals

- Gain an understanding of fundamental technological concepts underlying technological education through hands-on, project-based learning while developing technical skills.
- Develop a level of technological proficiency that will allow students to be critical consumers and producers of technological solutions.

Overall Expectations

A2. Designing and Performing — Develop projects that involve creating products and/or services, using a variety of resources and techniques, and record the development of their projects.

Specific Expectations

- **A2.1** Use project management skills to develop a process to create a product and/or service.
- **A2.2** Identify factors that could impact the development of their projects and apply appropriate strategies to increase the probability of a positive outcome.
- **A2.3** Describe properties and characteristics, including sustainability, of materials, and justify the selection of the materials and other resources they are using in the creation of products and/or services.
- **A2.4** Select, use, and maintain tools and equipment appropriately as part of creating products and/or delivering services.
- **A2.5** Use a variety of industry-related documents to guide the creation of products and/or the delivery of services as part of their projects.
- **A2.6** Create products and/or deliver services, documenting their development process using appropriate industry terminology.
- **A2.7** Select appropriate units of measure and tools to make accurate measurements using relevant measurement systems (e.g., metric and imperial), and convert between systems and units.

Description

This lesson is the third instalment in a series that follows the Ontario Tech Ed curriculum. In this lesson, students will create a prototype of the idea that they created and refined in the first two lessons (*Empathize and Define* and *Ideate*). Students will explore the engineering design process as they create their star-finder prototype, test it, refine it, and finally code their Micro:bits to make a functioning star-finder. This lesson is followed by *Reflect and Communicate*.

Materials

- Various materials to build students' ideas could include:
    - 3D printer and filament
    - Wood and tools (power tools or hand tools)
    - Lego
    - Recycled materials
    - Other materials the students might request for their projects
- Micro:bits and batteries
- Grid paper
- Rulers
- Pencils and erasers
- Computers to access makecode.microbit.org
- Sticky notes
- Coding Guide (from Additional Resources)
- Building Examples and Instructions (from Additional Resources)

Introduction

There are many ways that students might choose to make their star finder. Each star finder should be a physical object that can hold a Micro:bit and move it up/down and around so that, when coded to detect Polaris, students are able to move it around.
Throughout this project (spanning all five lesson plans provided), students will create a star-finder by following the steps of the engineering design process. This lesson spans the *Designing and Performing* and the *Analyzing and Refining* parts of the process: students create a process for building their prototype, build it and code their Micro:bits, then test and refine their prototypes.

Step 1: Choosing an Idea

Have each group pick an idea from the ones they narrowed down in the last lesson. The idea should be something they can feasibly create in the allotted time frame with materials at hand. In the next steps, students will create a design plan, drawing, and materials list. If they realize at any point that their project will not be feasible, they can return to Step 1 and choose another idea from the previous lesson.

Step 2: Planning and Designing

In this section, students determine their process for building their star-finder and the materials they will use.
Once each group has chosen an idea, they will draw their design to scale on grid paper. The design should include measurements, labels, and any other needed elements, depending on the construction method (for example, if 3D printing, include the separation between pieces so it is printable).
Have students create a design plan: a list of step-by-step instructions for building their star-finder. What will be built first and last? Identify dependencies between components (e.g., base first, then moving arm, then Micro:bit holder). Include coding the Micro:bit and testing the star-finder as the

final steps. This plan guides students through the *Designing and Performing* and *Analyzing and Refining* sections of the Engineering Design Process.
The next task is to choose materials and do a materials analysis. This may already be decided based on the design. Each element of the design should have a material listed on the design plan. Verify each group's plan to ensure the materials can be acquired.

Step 3: Project Management

Assign a leader to each section in the group's step-by-step instructions so someone is in charge of that part of the process. While building is still done as a group, each leader oversees their step and ensures it runs smoothly, giving each student the chance to act as a project manager.
Have students plan how they will complete the project: will they build during class time, meet after school, etc.? Identify barriers to finishing (e.g., scheduling conflicts). Collaboration and teamwork are key parts of project development, and this stage provides an opportunity to practice those skills.

Action

In the action stage, students build their star finders and code their Micro:bits. This may take several classes, depending on the depth of their designs. An additional step may be needed to source materials for construction.

Step 4: Building Star Finders

Following their designs and plans from the previous steps, students begin constructing their star finders. Ensure students follow relevant safety protocols when using tools (see the additional lesson plan on safety). For inspiration, refer to the examples in the Additional Resources section and the accompanying video.

Step 5: Coding Micro:bits

Each group will need a Micro:bit with batteries/battery pack, a computer, and a USB cord. Students log on to makecode.microbit.org. They may want to create an account so their code can be saved and accessed later.
See the Coding Guide in the Additional Resources section for a tutorial to code the Micro:bits as star-finders. If students have prior coding/Micro:bit experience, they can try creating their own code. The provided guide includes step-by-step pictures and instructions for coding the Micro:bit.
Once students have created their code, they can download it onto the Micro:bit and attach the Micro:bit to their star finder.

Consolidation

As per the engineering design process, the next step is to test star finders and analyze results. Remind students that even if it feels like a final product, refinements can still be made to improve it.

Step 6: Testing Your Star Finder

Have each group test their star finder. Ensure all pieces are functional, the star finder can move horizontally and vertically, and it can hold the Micro:bit. Use Stellarium to locate the North Star as a reference point for testing. Have students make notes about anything they wish to improve.

Step 7: Gallery Walk

Have students set up their star finders around the room. Each group can have one person stay with their project while the others walk around. Students should bring a pen and sticky notes; as they view other groups' projects, they write comments on sticky notes and place them next to the projects. Comments should be positive or constructive. Discuss what constructive feedback looks like.

Step 8: Refining and Adjusting

Students adjust their projects based on feedback from classmates and their own observations. The time needed will vary by group.

Step 9: Reflection

Have students reflect with their groups on some or all of the following questions:

- How do you feel about the star finder you created? Are you proud of how it turned out?
- What changes would you make to your star finder if you had no limit on tools and resources?
- How did your group work as a team? What went well? What could have gone better?
- What kind of impacts will your star finder have on different communities and audiences?

Additional Resources

These will be on the website with the Lesson Plan.

- Building Examples and Instructions
- Coding Guide

If you are an All-Access Pass member, check out the introduction to Micro:bit asynchronous lesson to learn more about basic Micro:bit functions. The asynchronous ICE (Innovation, Creativity, and Entrepreneurship) SHSM workshop is also available online through the All-Access Pass, and the middle chapters go into more detail with video content.