ROI

Grade 6-8 STEM Challenge

Decisions, Decisions

Inspired by Nick, a Maintenance Technician in the Indiana Uplands.

GRADE 6-8 STEM CHALLENGE

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Students will learn abou decision trees and how they are used to identify information, objects, and problems.

LESSON TIMELINE

DAY 1
- Show the inspiration video, "Nick - Maintenance Technician" (10 minutes)
- Introduce Decision Trees and the challenge (10 Minutes)
- 20 Questions (as a large group, 30 minutes)

DAY 2
- Small group 20 Questions game, including building their Decision Trees (30 minutes)
- Class discussion and sharing of Decision Trees (20 minutes)

Recommended Supplies

For the class:
- Large classroom or gym (students will need space to move around.)
- Blank paper or decision tree worksheets
- White boards or large paper for writing out their decision trees

CAREER CONNECTION AND LESSON OVERVIEW

Nick is a Maintenance Technician with MasterBrand Cabinets in Ferdinand, Indiana. Nick's job is not only to repair machinery when it breaks down but also to routinely inspect and maintain the equipment before there is a problem. Being able to methodically check one thing at a time is key to being able to accurately and efficiently diagnose problems so they can be repaired. When equipment breaks down, Nick works with the machine operator and other team members to diagnose the problem and get the machine back up and running as soon as possible.

Decision trees are an organized way to identify something— an object, a person, a piece of information, or even a broken part in a machine. For maintenance technicians like Nick, this usually means finding the root cause of a problem and repairing it. In this activity, students will create decision trees that would allow any person to identify a specific item they are thinking of. Decision trees are an excellent way to troubleshoot systems!

IN THIS CHALLENGE, STUDENTS WILL:

- Create and use decision trees to guess the identity of an item in the classroom.
- Make connections between decision trees, data representation, and pattern recognition.

Standards

Science & Engineering Process Standards

SEPS.1 Posing Questions (for science) and defining problems (for engineering)

SEPS.2 Developing and using models and tools

SEPS.4 Analyzing and interpreting data

SEPS.6 Constructing explanations (for science) and designing solutions (for engineering)

SEPS.8 Obtaining, evaluating, and communicating information

Preparing for College and Careers

PCC-2.1 Determine roles, functions, education, and training requirements of various career options within one or more career clusters and pathways

PCC-2.2 Analyze career trends, options and opportunities for employment and entrepreneurial endeavors for selected career clusters and pathways

PCC-2.3 Evaluate selected careers and pathways for education requirements, working conditions, benefits, and opportunities for growth and change

PCC-2.4 Use appropriate technology and resources to research and organize information about careers

Computer Science

6-8.DI.1 Use the basic steps in algorithmic problem-solving to design solutions (e.g., problem statement and exploration, examination of sample instances, design, implementing a solution, testing, and evaluation).

6-8.CD.2 Apply troubleshooting strategies to identify and solve routine hardware and software problems that occur during everyday computer use.

Grade 6-8 Employability Skills

6-8.M.1 Apply new strategies based on lessons learned from feedback.

6-8.M.2 Engage in feedback with peers to seek growth and learning opportunities from others.

6-8.LS.1 Communicate information to audiences in a variety of formats (i.e., large and small group presentations, e-mail communication, interview setting, etc.).

6-8.LS.7 Evaluate decisions and discuss the use of alternatives in decision-making situations.

6-8.SE.2 Demonstrate an awareness of the needs and rights of others.

Planning and Implementation
DECISIONS, DECISIONS

Essential Vocabulary

- DECISION TREES: a diagram or flow chart of questions (nodes) and answers that can be used to identify information or determine a course of action.
- NODES: points on a decision tree where a question is asked. The answer often determines what question will be asked next.
- TROUBLESHOOTING: identifying or diagnosing a problem in a system.
- ROOT CAUSE: the cause, or "root," of a problem or outcome.
- DATA REPRESENTATION: a way of structuring and presenting data or information.

In this challenge, students will:

- Create and use decision trees to guess the identity of an item in the classroom.
- Make connections between decision trees, data representation, and pattern recognition.

Before Class:

- Read the activity outline sheet and leader notes to become familiar with the activity.
- Gather necessary materials. Be sure that you have printed enough decision tree sheets for the group. You may also want to provide students with blank paper and markers for creating their decision trees.

Guiding Questions

1. How do people locate and fix problems in systems?
2. How can we graphically represent information and choices?
3. How can we use decision trees to make choices?

Day 1: Introduction
10 Minutes

Show students Nick's career shadow video, available at https://regionalopportunityinc.org/nick.

Nick is a maintenance technician, a person who keeps manufacturing equipment working and troubleshoots it to find the problem when it doesn't.

Quickly and efficiently identifying a root cause of a problem is crucial to keeping the production line at MasterBrand working. To be able to do this, Nick sometimes uses a decision tree, or a graphical flowchart that uses branching choices to illustrate every possible outcome of a decision. It's also a good tool for troubleshooting a mechanical or computer system to find out why it isn't functioning.

Decision Trees

A decision tree is a tool that maps all the possible outcomes of a system. People use them to look at possible choices, identify objects, or find flaws in a system. It is laid out like a flow chart with a series of decision points, or nodes, and each node is sort of like a test or a question. The branches coming off of the node each represent the outcome of the test and lead to new nodes or questions. By using decision trees, a user can quickly zero in on the exact information they are looking for. In some ways it's similar to a game almost everyone has played: 20 Questions. In 20 Questions, the players try to guess a word or object in 20 yes or no questions or less.

Decision trees are a way to solve problems using data representation and pattern recognition. In this activity, students will learn the importance of breaking down data through a series of simple questions. Then, they will use this information to identify patterns in a given data set. For example, here is a decision tree to identify what animal in a zoo that someone is thinking of:
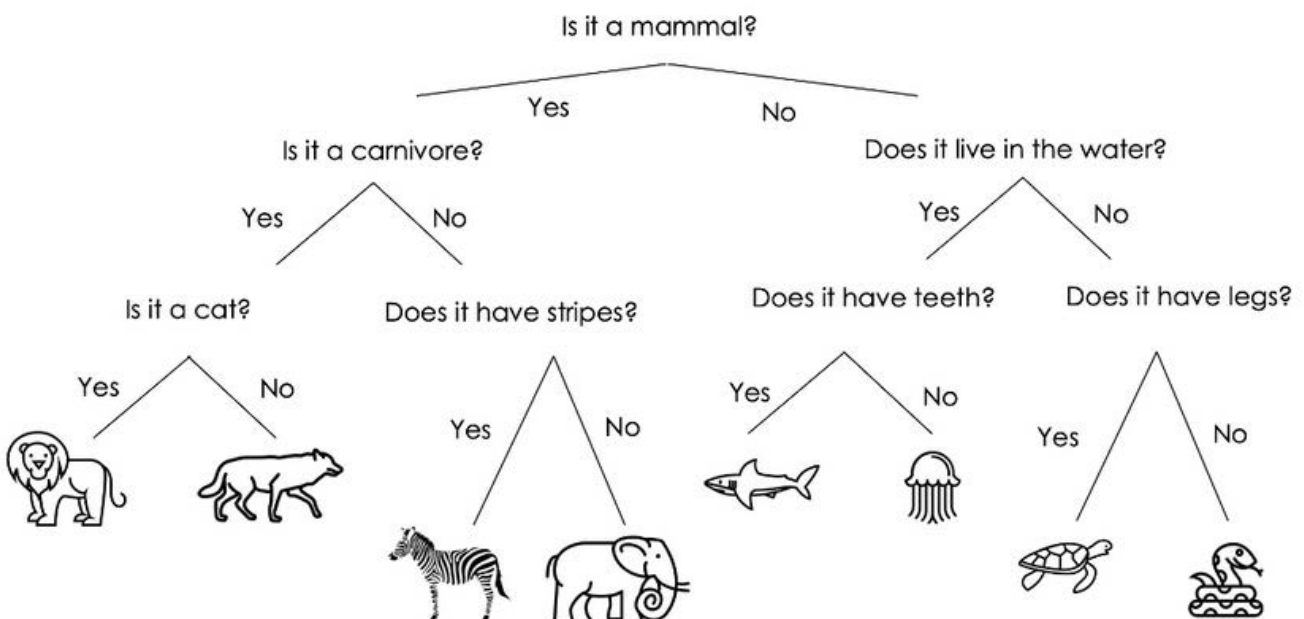
Class Discussion and Demonstration
20 Minutes

Start by asking if anyone in the class has played 20 Questions. If they have, have a student explain the rules. If not:

- One person chooses a word or object that the rest of the group will try to guess.
- The group may only ask yes or no questions.
- The group may only ask 20 questions or the person who picked the object wins. If the group guesses in fewer than 20 questions, the group wins.

The root idea behind tools like Decision Trees and games like 20 Questions is to identify something specific, be it an object someone has come up with or a broken part in a machine. To demonstrate this, present a new challenge to the class:

"Instead of guessing a secret word or object (like 20 Questions) I want you to find a set of questions that can be used to uniquely identify each student in our class. First, we'll brainstorm what makes each of us different— things like eye color, birthday, height, family size, etc. For each question we come up with, the answer must be yes or no."

For smaller classes (15 or fewer) this activity can be done in one group but larger classes may need to break into smaller groups or move the activity to a large area like a gym or playground. Start by brainstorming questions with the class and writing these on the board. When brainstorming, be mindful of questions that might compromise student privacy or make them uncomfortable. Test the selected questions by having students move around the room. "Yeses" should go to one side while "nos" should go to the other. For each question, have the students move to the appropriate side of the room.

Start with the first question (ex: Is your hair brown?) and have students move to the appropriate side of the room. Pick the next question (ex: Is your birthday during the school year?) and subdivide the yes and no groups again. You should, at this point, have four groups (Brown hair and summer birthdays, non-brown hair and school year birthdays, non-brown hair and summer birthdays, brown hair and school year birthdays.) Continue to pick questions and subdivide the group until most (or all) of the students are by themselves.

A note on appropriate questions:

Be mindful of questions that may be difficult for students or bring up past trauma. For example, questions about number of brothers and sisters could be problematic for a child who has experienced the death of a sibling or is from a non-traditional family. Likewise, be thoughtful about questions that can highlight socioeconomic disparities among students or singles them out due to ethnic or racial background. Questions about preferences (likes chocolate vs does not like chocolate) or opinions are good choices. Use good judgment when selecting questions provided by students or develop your own list before class.

Day 2: Build a Decision Tree
30 Minutes

Students will play 20 Questions with each other and design a decision tree to map out their choices.

1. Divide students into groups of 3-4.
2. One student in the group will pick an object found inside the classroom. Here, we are limiting the "data set" to things found in their immediate vicinity.
3. The rest of the students in the group should take turns asking yes or no questions. Encourage them to write these down, either on the worksheet provided or in their notebook.
4. The student who chose the object should keep track of the number of questions.
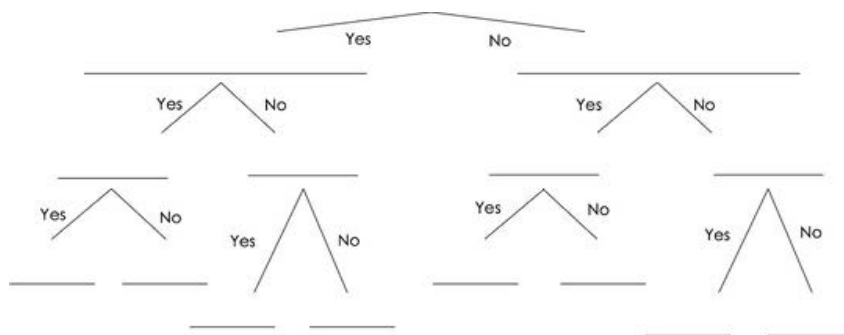
After a few rounds, students will have most likely found a few questions (nodes) that are good for quickly narrowing down the possible classroom objects. Encourage students to begin sketching out their own decision trees on blank paper or use the attached framework on page S4.

Discuss and Report
20 minutes

20 Questions may not seem like a game related to maintenance and advanced manufacturing but decision trees are a valuable tool for finding what has broken in system. If a piece of machinery isn't turning on, is the machinery plugged in? Does the cord work? Does the outlet on the wall work? You don't want to spend a whole day taking a complicated machine apart only to find that the circuit breaker had flipped!

Prompt students to talk about what they noticed while playing 20 Questions:

- Were they able to guess the object? What kinds of questions were better at identifying the unknown object?
- How many guesses did it take? What was the smallest number of questions needed before you identified the object? Was there a strategy or trick that worked?
- Did anyone choose an object that no one was able to guess? What question would have helped?

As a class, start developing a common decision tree for identifying objects in the classroom. Most students will find that starting with general questions (Is it on the floor? Is it on the wall?) and moving to more specific (Is it blue? Is it a piece of furniture?) is the strategy that works best for them. Together, build a decision tree of three levels of nodes (or more!) that reflects their environment and the objects in it.

Ask students to consider how this strategy could be used to diagnose problems in software or equipment.
- How might Nick use a decision tree to determine what's wrong with his company's equipment?
- How could a decision tree help you solve a problem in your life?

Career Exploration and Extension

Ask students to research real world decision trees. What types of jobs can they find that use decision trees?

Prompt students to think about and research what a career as a maintenance technician might entail.

- What does a maintenance technician do all day? What does Nick do?
- What kind of training would a student need to become a maintenance technician? What other types of technicians are there?
- Are jobs like Nick's in high demand? Will more people be hired to be maintenance technicians in the future?
- What kind of education is needed to be a maintenance technician? Where could a student be trained locally for this career? What types of classes are important?

Name: _____

Decision Trees
Student Data Sheet

Decision trees are a way of organizing data and information so you can identify information, outcomes, or objects quickly. For example, this decision tree to determine which zoo animal a person is thinking of:
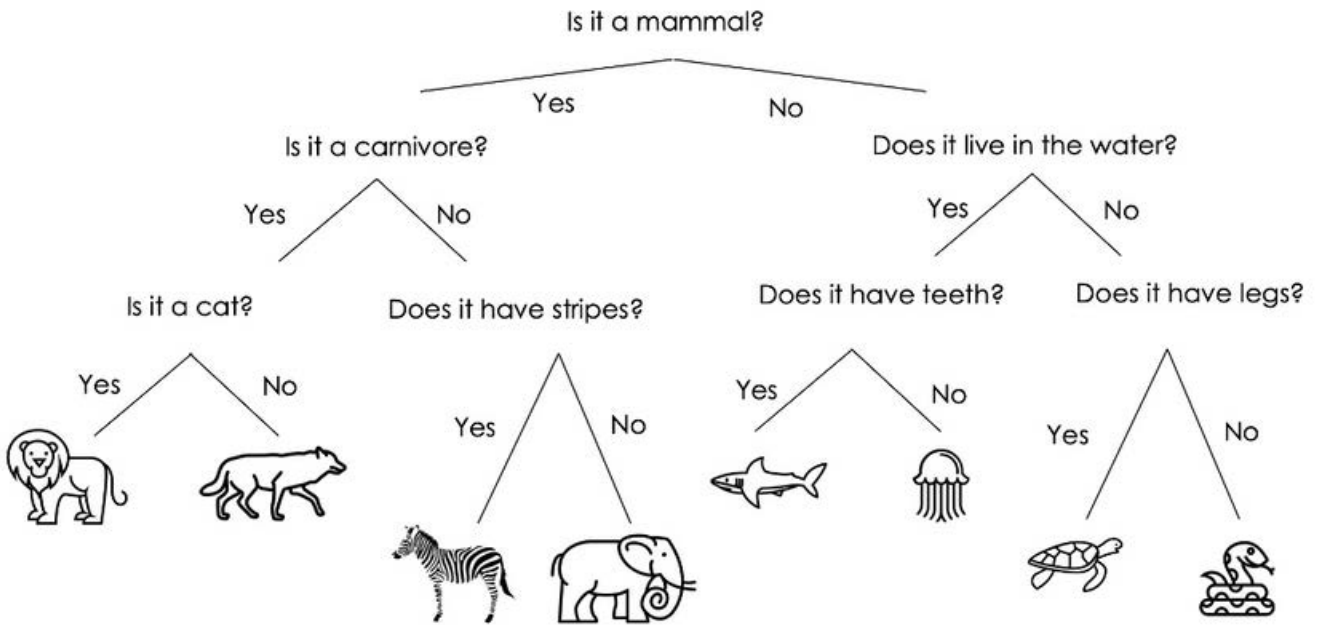
IDENTIFY THE PROBLEM
What are we trying to do?

BRAINSTORM
What kind of questions should we be asking?

PLAN
What questions will you use from your brainstorming?

PLAYTEST
Play 20 Questions to identify objects around the classroom.

Round #	Object	# of Guesses

IMPROVE
Edit the decision tree that your team made to get the correct answer in fewer steps.

Yes   No

Yes   No   Yes   No

Yes   No   Yes   No   Yes   No   Yes   No

Yes   No

Yes   No   Yes   No

Yes   No   Yes   No   Yes   No   Yes   No

Yes   No
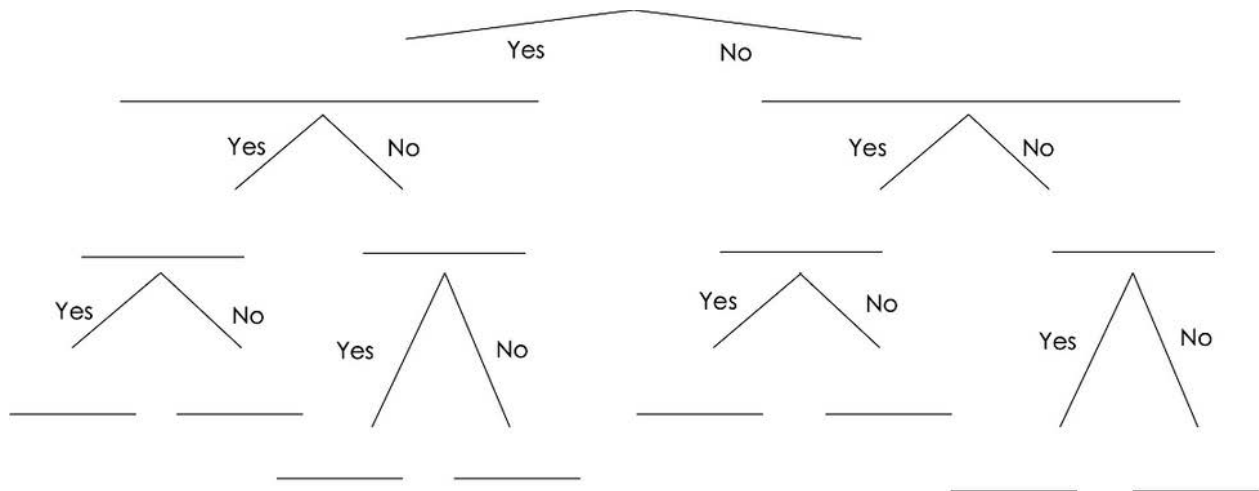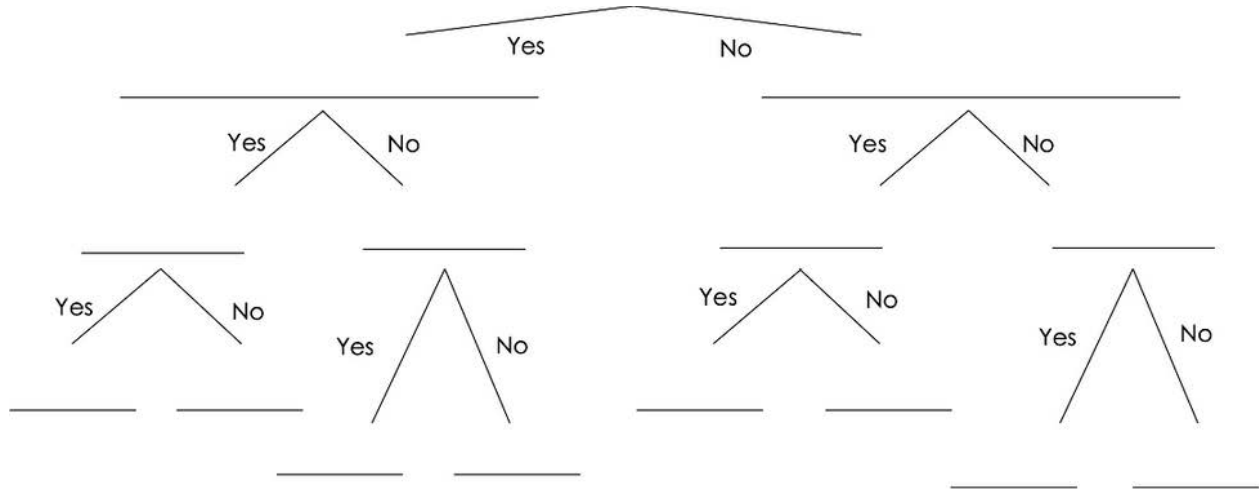
Notes:

SHARE AND COMMUNICATE
Share your final decision tree with the class or a classmate

What was the most difficult part of this challenge?

What was your biggest success?

Name: _____

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Blank Decision Tree

ACKNOWLEDGEMENTS

IMAGE AND CONTENT CREDITS

Images

Content

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