The Need for Speed

INTRODUCTION:

Have you ever watched a first grader try to get a drink from a tall drinking fountain? If they are thirsty, they will find a way to reach the faucet and get the water turned on. They had a problem, and worked at it until they figured out a way to solve it. The need to be a problem-solver starts young. You probably had to solve several problems already today. You can probably reach the drinking fountain but there are other problems that you have to solve. Probably so many that you don't even think or that you are aware that you are doing it.

When we think of problem solving we tend to think of scientists, engineers, or inventors who are trying to discover the mysteries of the universe or create some new device. Many careers require problem solving. In fact, it may be safe to say that every job requires some type of problem solving ability.

In this activity, you will be introduced to a method to solving problems. It is called DAPIC. By using the DAPIC process, you can identify exactly what problem has to be solved and determine the best ways to solve them. DAPIC will help you design ways to gather data and discover patterns. You then will be able to apply the DAPIC process to many everyday problems.

ACTIVITY OBJECTIVE:

Upon completion of this learning cycle, you will be able:

- Create a table to organize data.
- Create a graph from a data table.
- Control and manipulate variables in an experiment.
- Use method for problem solving.

EXPLORING I:

In real life, a vehicle is designed to fit particular purpose or function. This purpose may vary. Think about what you can do with a car or truck or SUV. Why would you buy a sports car? Everyone knows that sports cars are designed for speed. How would that car look? How would its mechanical design be suited for its purpose? Other cars are designed for comfort, gas efficiency, and long distances. How would that car differ in look and performance from a sports car? A third vehicle might be use for off track all-terrain travel. How would that vehicle differ from either of the designs? How would the tires vary? How would the shape of the vehicle vary? How would you test such a car to fit its use? If you wanted a truck to haul sand or other material, what kind of design would you need? Where is your truck going? Would it have to go up hills and such?

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How would that design differ from a vehicle that was pulling like a sled, trailer, or boat?

Decoder alert: *Variables:* any factor or part that can change in an experiment

Once a design is formed, it must be tested to performance. The performance and design must match to the purpose to be accomplished. You will be conducting an experiment with the mousetrap car using the DAPIC solving problem process. Your problem is to test a design for the mechanical parts of this car to do a particular job, such as the examples that we just mentioned. For instance, test one of these designs:

- Sports car
- Gas efficient luxury car
- Off road/ all terrain vehicle
- Work vehicle in the mountains
- Vehicle to pull sled, trailer, or boat
- Any other purposes that aren't mentioned

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You will learn the steps of the DAPIC process as you work through the experiment.

Define
One step in the DAPIC problem-solving process is to define the problem. It helps anyone find out what he/she wants to know. This helps to better understand the problem and parts of the problem, which later leads to solutions.

Write down your purpose or problem that you want to solve about the car. This can be in the form of a question or a statement. It may help you to look at the following question before you define your problem.

- What do you want to know about car?
- What do you want it to do?
- What combination of variables will get the results you need?

Assess
Another step is to assess the problem you defined. You want to learn as much about the parts of the problem as possible. Will the solutions that your team provides solve all of the parts of the problem? What are some different solutions?

- What do you already know about the car?

What do you think will happen when you try your ideas? What do you think will be the results? This is the prediction. Why would thinking about the possible results ahead of time help you solve the problem?

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- Besides the parts of the car consider the other two parts you will have to measure: distance and time. How will you measure, record and collect this information? You need a system that should show accurate results. This is data collection.

- How will you know if your measurement was a fluke, a stroke of luck, or just as accurate as it possibly could be?
- How can you think about these results to make some bigger comparisons to other similar ideas in the world? This is generalizing.

Plan

Another phase of the process is to plan how your team will accomplish this task. In the planning phase, your team reviews the options and the assessments that they have made and determine one solution. Next comes the planning, of how to put this plan into action. Who is going to do what? When will it be done? What do you need?

- One BIG problem that a scientist can encounter during testing is changing too many variables at once. Why would this be a problem? How can you tell which variable you are testing? How often should you change the variables? This is part of the experiment.

You will want to do some variable testing first. For the sake of that testing you may want to limit your use of option to see trends. To do this, only use the 2 or 4-centimeter hub, the 10 or 20-centimeter wheel, and the 10 or 20-centimeter armhole.

- Build a method into your test that will help to sort this problem out, such as multiple trials. What would be an appropriate number of trials in this situation? This is using multiple trials in data collection.
- How do you know when you have enough accurate information? How can you organize the information to make some comparisons? This is also data recording and drawing conclusions.

Using the questions above, make a written plan explaining all parts of the experiment. Set up the experiment according to your plan. Predict what you think the results will be of this experiment.

Implement

This is the phase where everything comes together. This is the phase where your team carries out their plan. Collect data systematically according to the plan and analyze the data. You may find that you have to go back to a previous DAPIC step to do more investigating to answering your original question.

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Conduct the experiment and record the information using a data table.

Conclude and Communicate
In this phase, the results of your implementation phase are now examined and you and your team will need to make sense of what you have collected. For example, what is your conclusion? Once you have made sense of this information, you need to share it with others. Determine how you will present the data. Will you select one spokesperson or will you share this information as a group? What visual aids will you use? You will be reporting the results of the experiment and your thought patterns as you went through the experiment.

Within your group talk about these questions:

- What conclusions can you draw from the data?
- How will you know that the measurements and data are accurate?
- What variables did you manipulate or change? What variables did you control?
- How did your experiment method compare to your original question?
- Did you measure what you had asked?
- What did you want to know or what was your problem?

You may need to make some adjustments in your experimental design, procedure, or data collection. If you think you should go back, make changes, and conduct the experiment again. You are always free to go back to a previous step and make changes when you find ideas that don't match or make sense. Don't be afraid to do this at any time.

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What was better about the first revision?

Communicate your results with your class. Discuss changes and problems you encountered and how you solved them.

GETTING THE IDEA I:

1. How did your curiosity lead to an experiment?
2. What parts of the experiment was controlled?
3. What is a variable? Why is it important to change just one variable at a time?
4. How can taking multiple trials help to find accurate results?
5. How would you explain the differences you found in the data?
6. How can organization of data, good experiment methods, and accurate measurement help to assure better results?
7. How can predictions help to design the experiment?
8. What kinds of tools helped you in your experimentation?
9. Why are experiments or investigations important in solving a problem?

10. How does potential and kinetic energy change as you make modifications to your car design?

EXPLORING II:

Wow! That last Exploring involved a lot of numbers! Now what should we do with them? That is the next step. Figuring out what all of these numbers mean and how these numbers can help you increase the performance of your mousetrap car. Let's summarize some of these measurements by finding some averages.

1. Using the data you collected in Exploring I Write the result for each trial on a separate small square sheet of paper.
2. Group together numbers that represent the same measurement (like acceleration distance, total distance, speed) **and** use the same variables (arm length, wheel size, hub size).
3. Choose one group of trials. Give each person one of the numbers.
4. As a team, figure out a way to "even out the numbers". For example, if Person A has 1 cm, Person B has 2 cm, and Person C has 3 cm, each person could have 2 cm if Person C "gives" 1 cm to Person A. You can pretend that each centimeter is a penny. Think about how you could make everyone have an equal number of pennies.
5. By "evening out" these numbers, you are finding the average for your trials. Take another set of trials and find the average, using the method you created in step 4.
6. Continue to find the average for each set of trials and work to improve your method. Look for shortcuts.
7. How can you check your work? Figure out a way to prove that your answers are correct.
8. Share your findings with the class.

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GETTING THE IDEA II:

1. Why would you want to average a set of numbers?
2. How did you find the average the first time?
3. How did your method change as you continued to work with other groups of numbers?
4. What shortcuts did you discover in finding the average of a set of numbers?
5. How would you tell someone to find the average of a set of numbers?

EXPLORING III:

The fastest car is going to win the race, right? What happens to the speed of the mousetrap car while the arm is moving? Patterns can be found in lots of ways. Sometimes patterns can be more easily seen in a graph, which gives you a picture of the data. Let's see how this can work for you.

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1. Make a graph to show how acceleration distance, the distance the car travels before the arm snaps, and speed interaction. Do this together as a team. Get several pieces of graph paper and try your ideas as you think about the ideas below.
2. Which side of the graph is the x-axis? Which side of the graph is the y-axis? How do you know? How can you remember?
3. Label acceleration distance on the x-axis. With what unit is acceleration distance measured? Make sure to include this information.
4. Label the y-axis as speed. With what unit have you used to measure speed? Make sure to include this information.
5. What numbers should you use to label the x-axis and y-axis? Do they have to be the same? Why or why not?
6. Where does zero go? How high do your numbers have to go? Look at your greatest value for acceleration distance and your greatest value for speed. Remember that the distances between the spaces on the graph are equal. Your numbers have to be equal distanced apart too.
7. Plot your points on your graph for acceleration distance and speed. Find the location for a value of the acceleration distance on the graph first. Then go from that point to the location for the value of the corresponding speed.
8. After all of the points have been put on the graph, look at the entire graph and describe what you see. How does changing the acceleration distance affect the speed of the car?

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GETTING THE IDEA III:

1. How do you know which side of the graph is the x-axis and which is the y-axis?
2. How did you know what numbers to put on what lines along your x-axis and y-axis?
3. What other ways could you have labeled each space along the x-axis and y-axis?
4. What would happen if the numbers were not evenly spaced along the x-axis and y-axis?
5. What did you begin to notice as you were plotting the points on the graph?
6. What pattern did you find? How can you use this pattern to win the mousetrap car race?
7. How can graphs help you to find a pattern?

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APPLYING THE IDEA:

What Does It All Mean?

How does collecting, organizing, and analyzing data help you to understand the performance of the mousetrap car?

1. Based on all of the information you have gathered and analyzed, what wheel size, hub size, and arm length would you use to win a 2-meter mousetrap car race?

2. If you could have any size for the wheel, hub, and arm length, what would you choose? Explain your choices in writing. Include what you would expect the acceleration distance and the speed of this car, based on the patterns you have found.

Team Reflect
Think about how you have worked together to complete the activities. Write a paragraph that responds to the following topics:

Describe how each team member contributed to the process?
Usually, every person has a strength that they contributed to the group. List ways that everyone contributed positively to the situation.
How could you improve the group process next time with the same or different team members? What would help your team focus better? How can conflicts be turned into positive outcomes?
What was effective about the problem-solving process? How willing was the group to try different ideas?
How well did the group stick with the plan and follow through on the strategies?

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EXPANDING THE IDEA:

- Research tractor designs used for tractor pulling competitions. Why have they been divided into weight classes? What do the competitors do to their wheels to increase traction? Design a mousetrap tractor and a sled for a "trap-tor" pulling competition. Conduct the competition with your classmates.
- How would you modify a mousetrap car so that it will climb the steepest incline possible?
- What sports require the averaging of scores, times, or distances? Are any of the numbers thrown out before being averaged? Why are they averaged?
- Look for examples of graphs in newspapers or magazines. Why are graphs used? Are there different types of graphs? Why is a particular kind used for particular data?
- Read the Making Connections information immediately following this learning cycle.

CAREER CONNECTIONS:

Laboratory scientist
Census Bureau employee
University researcher
Homemaker