LESSON 4: The Starting Point (For Scientists)

Generating ideas, selecting a topic and formulating a research problem.

This unit addresses the dilemma encountered by most students at the start of the science fair investigatory project and their lack of foundational skills on how to go about a science research project. To begin with, they may have no idea of what they want to do or they may have a very specific idea of what interests them. Either way, they miss the point of research which is to gain new knowledge or understandings. Through the lessons in this unit, students will be guided on how to generate research and project ideas by observing nature, evaluating phenomena, asking questions, reading and analyzing scientific articles; selecting a topic; and formulating a research problem.

Learning Tasks: (What You Will Do)

1. Select 3 science topics that you are interested in. The topics have to be on or above your grade level. Your teacher will review these topics with you to decide on the best and final topic for you to work on.

2. Formulate a research problem based on your topic. The research problem is a statement about an area of concern, a condition to be improved, a difficulty to be eliminated that requires deliberate but careful investigation.

   (Note: Do not start your project until your topic or research problem has been approved.)

Tools: (What You Will Need)

- Preliminary Research Topic Approval Form
- Experimental Design Diagram
- Intel-ISEF Approval Form (1B)
- Science Fair Journal or Log Book

Part 1. Generating Research Ideas (Thinking Like A Scientist)

Have you ever wondered how creative artists, designers and inventors come up with their remarkable ideas? "Eureka moments" are not just for the highly intelligent. They are also available to most of us. It just requires skill and creativity. As Einstein once said, "it's not about being clever but about being curious by constantly asking questions." Idea generation is the process of creating, developing, and communicating ideas which are abstract, concrete, or visual. It includes the process of constructing through the idea, innovating the concept, developing the process, and bringing the concept to reality. You may not be able to "trigger" new ideas to come into your mind but you can put your mind into the right disposition to host new ideas so learn to recognize them and welcome them. Great ideas come as a result of deep thinking and constant refining. But it does not take a superhuman brain to come up with great ideas — it only takes a mind that is receptive to new ideas, dedicated to the pursuit of new information, and disciplined enough to constantly adjust its own worldview and perspectives. Idea generation may seem to be a mysterious and random process but there are several methods that we can apply to help us increase our chances of having great ideas. Here's a few:

- **Draw inspiration from daily observations.**

As casual observers of daily life, we are all constantly collecting data about the world around us. Many research ideas can be inspired by the popular media or our own daily observations. By drawing upon our everyday lives, we can generate new research ideas. Perhaps Sir Isaac Newton would have formulated his theory of gravitation sooner if he spent more time outdoors observing apple trees. So to keep track of your research ideas, keep a research journal handy to capture interesting thoughts, concepts, or theories as they occur to you. You never know when inspiration, or an apple, will strike.

- **Read broadly.**

In this day and age, as more and more information about man and nature become available to us through several platforms, we tend to streamline the flow of these ideas by reading only those that interest us, or we only skim over certain information. However, reading a publication that targets a broader audience or reading extensively on certain topics can help us keep abreast of interesting developments in the field. A broader worldview can also lead to novel research ideas. So read as much as you can about any science topic. Use internet search engines. Browse as much as you can until you find a topic that catches your attention.

- **Find Connections.**

Many times ideas are formed by associating two completely unrelated concepts in unexpected or unusual ways. Johannes Gutenberg, the inventor of the printing press, got his inspiration from a wine press and a coin stamp. Before Gutenberg, all books had been laboriously copied out by hand or stamped out with woodblocks. In 1450 in Strasbourg, Germany, Gutenberg combined two ideas to invent a method of printing with moveable type. He coupled the flexibility of a coin punch with the power of a wine press. His invention enabled the production of books and the spread of knowledge and ideas throughout the Western World. Nearly every new idea is a synthesis of other ideas. So a great way to generate ideas is to force combinational possibilities. The more bizarre the combination the more original the ideas that are triggered. Remember that someone put a trolley and a suitcase together and got a suitcase with wheels. Someone put a copier and a telephone together and got a fax machine. Someone put a bell and a clock together and got an alarm clock. Someone put a coin punch and a wine press together and we got books. So the next time you wheel your suitcase or send a fax or read a book you are benefiting from someone's ingenuity in putting together a combination of ideas.

- **Be patient and follow hunches.**

The opportunity to generate really good ideas is available to all of us. While we may not have good ideas crossing our minds every day, we can create environments and working practices that can facilitate the good idea generation process. Good ideas may come from our hunches (interesting thoughts or gut feelings) which are not fully formed ideas that may even lead us to nowhere but by keeping them consciously accessible to us rather than ignoring them or forgetting them, they may lead us to good ideas if we allow them to collide with our old hunches.

- **Be challenged. Brainstorm!**

Nothing sparks ideas more than being confronted with contradiction, healthy criticism, a spirited debate, maybe a bit of competition. Some people manage to do that by themselves, arguing against their own ideas and improving them. Some may need an "echo chamber" or a "sounding board" ---i.e. someone to discuss things with. If they don't share your point of view, all the better, as they may have unusual/naïve/silly questions or expectations.

- **Be curious!**

Great thinkers and innovators allow their minds to wander. We all have a great ability to explore ideas but it often feels like we spend less time following our curiosity for there is always that task or chore, text, call or email that requires our immediate attention. Daydreaming might

also seem like the most unproductive, inefficient thing that you can do with your time. But counterintuitively, if you allow your mind to drift away and follow your own curiosity, you may just be led to some of your biggest breakthroughs and insights.

Part 2. Selecting A Topic

Selecting a good topic may not be easy. But keep in mind that it just be narrow and focused enough to be interesting, yet broad enough for you to be able to find adequate information. Thus, the ability to select and develop a good research topic is an important skill. When deciding on a topic, there are a few things that you need to consider like avoiding overused ideas or topics that will touch on sensitive human issues like abortion, gun control, teen pregnancy, or suicide unless you feel that you have a unique approach to the topic. As much as possible, avoid topics that will require you to experiment on humans and/or animals as they will require additional paperwork, approvals and supervision by a qualified scientist in a regulated research institution which your school may not be able to facilitate for you. Avoid culturing or growing microorganisms for they will require additional documentation (*think safety risks involved*), approvals, paperwork and to some extent use of sophisticated lab equipment for testing and handling. Ask your teacher for ideas if you feel stuck or in need of additional guidance.

- **Read general background information.**

Read articles about the 2 or 3 topics that you are considering. Reading about your topics of interest enables you to get an overview of the topic and see how your idea relates to broader, narrower and related issues. It also provides a great source of finding words commonly used to describe your topic. These key words will be very useful in your later research once you have finalized the topic that you will be working on. If you cannot find an article on your topic, try using broader terms or ask for help from your teacher. Use Web search engines.

- **Focus on your topic.**

Keep it manageable. A topic will be very difficult to research on if it is too broad or too narrow. Here are some examples:

One way to narrow a broad topic like “the environment” is to limit it by

(a) geographical area – What environmental issues are most important in the Southwestern United States?

(b) time frame – What are the most prominent environmental issues of the last 10 years?

A topic may also be too difficult to research on if it is too narrow like

(a) locally confined – What sources of pollution affect the Greenspoint Bayou? (Topics this specific may only be covered by local newspapers, if at all.)
(b) recent – books, journal articles, websites may not be available

- **Make a list of useful keywords.**

Keep track of the words that are used to describe your topic. Look for words that best describe your topic. Look for them in the articles that you are reading. Take note of synonyms. Use them later when searching data bases and catalogs.

- **Be flexible.**

It is common to modify your topic as you are doing your review of related literature because you can never be sure of what you may find. You may decide that some other aspect of the topic is more interesting and manageable. This is perfectly fine for as long as you inform your teacher of any changes you make. Keep in mind the assigned length of your research paper. Be aware also of the depth of coverage needed and the due date. These important factors may help you decide the kind of modification that you will make. Your teacher will provide you with specific requirements, if not the table below may provide you with a rough guide:

Assigned Length of the Research Paper or Project	**Suggested guidelines for approximate number and types of sources needed**
1-2 page paper	2-3 magazine articles or Web sites
3-5 page paper	4-8 items including books, scholarly articles and Web sites
Annotated Bibliography	**6-15 items including books, scholarly articles, Web sites and other sources**
10-15 page research paper	**12-20 items including books, scholarly articles, Web sites and other items**

(Adapted from www.umflint.edu)

Part 3. Formulating a Research Problem

Formulating a research problem is a difficult task. Research problems range from simple to complex, depending on the number of variables and the nature of their relationship. Sometimes the relationship between two variables is directly related to a problem or questions, and other times the relationship is entirely unimportant. If you understand the nature of your research problem, you will be able to better develop a solution to the problem. During the problem formulation stage, you will want to generate and consider as many courses of action and variable relationships as possible.

Activity on Selecting a Science Research Topic, Investigatory Question or Problem

Direction: Use the following questions to help you generate research ideas. Read the following paragraph (it is an excerpt from a newspaper article on fishing) and answer the questions below.

Everglades City: Fishing guide, Captain Suzi Sinker, reported that fishing season is in full swing. When asked the best way to catch the most fish, she replied, "Time is important; the hour just after sunrise and just before sunset are best." She also said use blue colored bait or six-inch blue plastic worms. Captain Suzi Sinker also thinks weather patterns may affect fishing.

1. Make a list of observations about fishing that you can get from the paragraph you just read.

2. Formulate a problem based on the observations mentioned in #1.

3. Identify variables found in the scenario presented in the paragraph.

4. Fill out an experimental design diagram.