Science Success:
Teacher Guide

Supporting Student Science Fair Projects

Bay Area Science and Engineering Fair (BASEF)

BASEF

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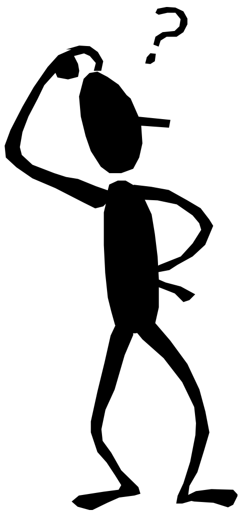
Purpose of This Guide

Science Success: Teacher Guide is intended as a companion guide to Science Success: Student Workbook. Together these booklets will support students and teachers in Grade 7/8 and beyond in preparing excellent science fair projects.



The Teacher Guide is intended to do three things. The first aim is to show you how student projects in science and technology can help you meet curriculum outcomes in science and technology.

The second purpose is to help you walk your students through the process of a science fair project, from selecting a suitable topic, to presenting the results. You will find that the specific content is in the student workbook. We recommend using this guide in combination with the student guide.

Finally, this guide discusses how to run a class or school science fair, including suggestions for parental and community involvement.

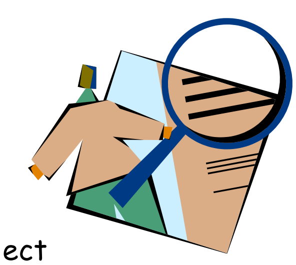
Resources: There are many fabulous resources for science fair projects, including ideas for projects, activities, methods, presentation tips, statistics – in short, everything both you and the students may need. A list of over 20 web-based resources is available at the BASEF site. Consider directing your students to these sites as well.

PART I

What is a Science Fair Project?

A science project investigates a question of interest to the student. There are three primary types of projects in science and technology that are recognized at regional and national fairs.

1) An experiment
2) An innovation
3) A study



It is important for both student and teacher to understand the key components of each type, as a single topic can result in any of three project types depending on the approach the student chooses.

Example: The student might be curious about the different types of birds that visit a backyard bird feeder.

In the explanations below, you will see how this single topic could result in the three different project types.

1) An **experiment** is a science project that uses a contrived situation, with controlled variables, to investigate the question. The student thinks of a question about a topic, makes a hypothesis regarding the answer, and then designs and conducts controlled experiments to test that hypothesis. Experiments are replicated so the results are less susceptible to experimental error. Results are observed, recorded, and analyzed to accept or reject the hypothesis. The goal of conducting an experiment is to understand a particular cause and effect relationship, and the key to a good experiment is identification and control of the variables.

Example: The student decides to investigate whether using different types of birdseed will attract different types of birds.

2) An **innovation** is a project in which the student designs a product or process that solves a particular problem. The student identifies the problem, and experiments with materials to design a solution. Trials are made to test the product, and the student makes improvements in design to better meet the needs of the original problem. The goal of an innovation is the design of a useful product or technique.

Example: The student notes that larger birds seem to crowd out smaller birds at the feeder. The student decides to build a birdfeeder that will favour smaller-sized birds.

3) A **study** is a project in which observations are made about an existing phenomenon and results are recorded. Instead of the student controlling and changing the variables, the student chooses naturally occurring variables for observation. The student focuses on finding a (new) explanation for the recorded observations. Data collected can be either quantitative or qualitative.

A study can also be a meta-analysis, that is, literature research, project in which the student compares work of several others in a field and looks for insights that may have been missed. Both students (and judges!) may need some reminders that this will make as strong a project as the experiment or innovation.

Example: The student decides to study what types and how many of each type of bird visit the bird feeder in relationship to the weather conditions on the day.

How projects help meet curriculum outcomes

In each of the three projects, the student will follow a process of investigation that will provide opportunities to meet a number of curriculum expectations and develop the skills outlined in the Skills Continua. This section will examine that match.

> "Learning takes place when students construct their own representation of knowledge. Facts and formulas will not become part of deep intuition if they are only committed to memory. They must be explored, used, revised, tested, modified, and finally accepted through a process of active investigation, argument, and participation." L.A. Steen

Science projects meet curriculum expectations in a number of ways. While specific expectations of content may be covered depending on the student's choice of question, any well-executed project will demonstrate mastery of of the skill areas on the skills continua: 'scientific inquiry/experimentation skills' and 'scientific inquiry/research skills, (Ontario Curriculum, Science and Technology). Depending again on topic choice, the student's summary of results and implications will likely address expectations under the first set of expectations, 'relating science and technology to society and the environment' and the second set of expectations, 'developing the skills, strategies, and habits of mind required for scientific inquiry and technological problem solving' (Ontario Curriculum, Science and Technology).

Each of the three types of science projects will enable the student to meet a number of expectations and skills. Curriculum expectations and skills are shown in boxes following each step. The chart on page 9 summarizes the skills of the continua met at each science project stage.

1) Experiment

Ask a question

The student recalls that on any day, a variety of birds come to the bird feeder. She or he decides to investigate whether using a different type of seed will attract a particular type of bird.

> *Initiating and planning: asks questions that arise from practical problems and issues, and formulates a specific question to investigate*
> *Understanding Life Systems, Interactions in the Environment: 2.3 use scientific inquiry/research skills to investigate occurrences that affect the balance within a local ecosystem*

The student does some background reading, discusses the issue with others, and forms an educated guess at to the outcome. The student's hypothesis is, "Niger seed will attract a higher number of small songbirds than when mixed seed is used."

> *Initiating and planning: makes predictions, based on prior knowledge from explorations and investigations, about the results of the investigation*
> *Understanding Life Systems, Interactions in the Environment: 2.3 use scientific inquiry/research skills to investigate occurrences that affect the balance within a local ecosystem*

Plan the experiment

At this stage, the student makes decisions about how and what will be measured, and in what units, what materials will be used, and when/where the experiments will be done. The student should be trying to control all variables so that the experiments will be measuring only what the question asks. A source for seed is chosen; enough is purchased for repeated experiments. A schedule is created for the experiments that allow replication to confirm results, and the student prepares a project worksheet for recording observations.

> *<u>Initiating and planning</u>: builds fair testing elements into plans for an experimental procedure designed to answer the question he or she has formulated; plans for safe experimentation, showing some awareness of variables to be considered*

Perform the experiments

The student conducts the experiments exactly as per the plan. If any changes are made, the student makes careful notes as to the changes and the reason for making them. Experiments should always be repeated for accuracy of results!

> *<u>Performing and Recording</u>: selects and safely uses tools and equipment to observe and measure*
> *<u>Understanding Life Systems, Interactions in the Environment:</u> 2.1 follow established safety procedures for investigating ecosystems*

Observe and record data

During the experiment, the student records observations carefully using a prepared worksheet. Notes are made in the research logbook. In addition to number of each species of bird, the student records their observations about the weather, and any other factors that might affect the results.

> *<u>Performing and Recording</u>: records and organizes data using standard measurements in simple tables, graphs, or charts, or in labelled diagrams*

Organize and analyze results

The student organizes the observations and considers the results. Do the observations support the hypothesis? At this stage, observations are organized so they tell a clear story. Perhaps the times will be shown using a bar graph, and the qualitative comments will be presented in a table. The student will have to select an organizing method that tells the story clearly.

> *<u>Analysing and Interpreting</u>: identifies patterns in the data, suggests explanations for discrepancies, and summarizes the data; draws conclusions on the basis of data gathered; evaluates the experimental procedure, explains changes that could be made to improve it, and gives reasons for the changes*

Present results

In writing a report and preparing a presentation backboard, the student demonstrates clear thinking and communicates the process followed so others could repeat it. The student writes about his or her conclusions as well as the implications of the work.

> *Communicating:* *presents steps in and results of an experimental procedure using numeric, symbolic, graphical, and/or linguistic methods*
> *Understanding Life Systems, Interactions in the Environment:* *2.4 use appropriate science and technology vocabulary in oral and written communication. 2.5 use a variety of forms to communicate with different audiences and for a variety of purposes*

2) Innovation

Identify a problem

The student recalls seeing large birds getting the most time at the bird feeder, and thinks about ways of designing a bird feeder that would give preference to smaller birds. The student states the problem as "Design and build a bird feeder that will give preference to small birds."

> *Initiating and Planning:* *identifies practical problems to solve*

Select the best alternative

The student does some background reading, discusses the issue with others, and defines the design criteria as well as constraints, such as cost, size, safety, materials, time available.

> *Initiating and Planning:* *identifies possible solutions to a practical problem and prioritizes them with regard to their potential for solving the problem; selects a possible solution, and provides reasons for the choice that take into account considerations such as function, aesthetics, environmental impact*

Plan the prototype

The student makes drawings or schematics of a proposed solution to the problem, in this case, a bird feeder that only allows small birds to feed. A list is generated of all the required materials, giving specifics for each.

> *Initiating and Planning*: *outlines in detail, including technical drawings and/or diagrams, each step of a plan to solve the problem; contributes to establishing general criteria for evaluating objects or devices designed to solve the problem*

Build the prototype

The student builds the prototype exactly as per the plan. If any changes are made, the student makes careful notes as to the changes and the reason for making them. Safe working practices are followed, and appropriate tools and techniques are used in construction of the prototype.

> *Performing and Recording:* *designs, builds, and tests (on the basis of pre-determined criteria) a device or an object to solve the problem*

Test and evaluate the prototype

The student runs trials to test the success of their prototype, and records observations carefully using a prepared worksheet. Notes are made in the research logbook. In addition to observations, comments are recorded regarding the success and possible changes to the prototype. Design changes are made to the prototype and further trials are run. The student asks, "What problems remain? Can further improvements be made?"

> *Performing and Recording: records results in a variety of ways, such as sentences, technical drawings, labelled diagrams, graphs, and/or charts;*
> *Analysing and Interpreting: explains how well the chosen solution solved the practical problem, using qualitative and/or quantitative data, and suggests possible changes to the criteria and the solution; identifies and explains what changes could be made to the plan and the testing process, and how to improve the solution to the problem, and gives reasons for the changes*

Organize and analyze results

The student organizes the observations and considers the results. Do the observations support the hypothesis? At this stage, observations are organized so they tell a clear story. Perhaps the efficacy of each design will be shown using a bar graph, and the qualitative comments will be presented in a table. The student will have to select an organizing method that tells the story clearly.

> *Analysing and Interpreting: identifies the effects of the chosen solution on himself/herself, others, and/or the environment, considering things such as cost, materials, time, and/or space, and suggests ways in which undesirable effects could be lessened or eliminated*

Communicate the results

In writing a report and preparing a presentation backboard, the student demonstrates clear thinking and communicates the process followed so others can repeat it. In the presentation, the student writes about his or her conclusions as well as the implications of the work.

> *Communicating: describes orally, and using labelled drawings and diagrams, charts, graphs, and/or written descriptions, the problem and how he or she solved it; uses grade-appropriate science and technology vocabulary correctly*

3) Study

Ask a question

The student thinks about the different species of birds observed at the backyard birdfeeder, and decides to investigate whether there is a relationship between the types of birds that come to the feeder and the weather.

> *Initiating and planning: asks questions that arise from practical problems and issues, and formulates a specific question to investigate*

Form a hypothesis
The student does some background reading, discusses the issue with others, and forms an educated guess at to the outcome. Small birds (e.g., chickadees, sparrows, and songbirds will only come to the feeder in calm weather.

> *Initiating and planning: makes predictions, based on prior knowledge from explorations and investigations, about the results of the investigation*

The student makes decisions about what will be measured, and how the measurement will be made. For example, will each birdfeeder visit be counted, even though some may be repeat birds? Since animal subjects are being used, the student applies for ethics approval before conducting any studies. The plan includes repeated days of observation over a period of weeks.

> *Initiating and planning: builds fair testing elements into plans for an experimental procedure designed to answer the question he or she has formulated; plans for safe experimentation, showing some awareness of variables to be considered*

Carry out the study
The student conducts the study exactly as per the plan, and as per ethics approval. If any changes are made, the student makes careful notes as to the changes and the reason for making them.

> *Performing and Recording: selects and safely uses tools and equipment to observe and measure*

Observe and record data
The student records observations carefully using a prepared worksheet. Notes are made in the research logbook. In addition to weather, the student records observations about any other factors that might affect the results.

> *Performing and Recording: records and organizes data using standard measurements in simple tables, graphs, or charts, or in labelled diagrams*

Organize and analyze results
The student organizes the observations and considers the results. Do the observations support the hypothesis? At this stage, observations are organized so they tell a clear story. Results might be shown using a pie chart or a Venn diagram, and qualitative comments presented in a table. The student will have to select an organizing method that tells the story clearly.

> *Analysing and Interpreting: identifies patterns in the data, suggests explanations for discrepancies, and summarizes the data; draws conclusions on the basis of data gathered; evaluates the experimental procedure, explains changes that could be made to improve it, and gives reasons for the changes*

Present results
In writing a report and preparing a presentation backboard, the student demonstrates clear thinking and communicates the process followed so it can be repeated by others. In the presentation, the student writes about conclusions as well as the implications of the work.

<u>Communicating:</u> presents steps in and results of an experimental procedure using numeric, symbolic, graphical, and/or linguistic methods
<u>Understanding Life Systems, Interactions in the Environment:</u> 2.4 use appropriate science and technology vocabulary in oral and written communication. 2.5 use a variety of forms to communicate with different audiences and for a variety of purposes

Skill Continuum and Skill Areas Tied to Science Project Stages

Experiment	Innovation	Study	Continuum and Related Skill Areas
Ask a question	Identify a problem	Ask a question	Scientific Inquiry/Experimentation Skills: Initiate and Plan Technological Problem-Solving Skills: Initiate and Plan
Form a hypothesis	Select a possible solution	Form a hypothesis	Scientific Inquiry/Experimentation Skills: Initiate and Plan Technological Problem-Solving Skills: Initiate and Plan
Plan the experiment	Plan the prototype	Plan the study	Scientific Inquiry/Experimentation Skills: Initiate and Plan Technological Problem-Solving Skills: Initiate and Plan
Perform the experiment	Build the prototype	Carry out the study	Scientific Inquiry/Experimentation Skills: Perform and Record Technological Problem-Solving Skills: Perform and Record
Observe and record data	Test the prototype (make alterations and retest)	Observe and record data	Scientific Inquiry/Experimentation Skills: Perform and Record Technological Problem-Solving Skills: Perform and Record
Organize and analyze results	Evaluate the prototype	Organize and analyze results	Scientific Inquiry/Experimentation Skills: Analyse and Interpret Technological Problem-Solving Skills: Analyse and Interpret
Present results	Present results	Present results	Scientific Inquiry/Experimentation Skills: Communicate Technological Problem-Solving Skills: communicate

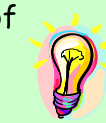
Curriculum Expectations – Grades 9-12

The examples and chart illustrate the direct relationship between science fair projects and curriculum expectations in Grades 7 and 8. This relationship exists even more strongly in upper grades, as students are expected to demonstrate significant skills in question formulation, inquiry, data analysis, and communication of science and technology ideas.

Specifically, students learn to apply scientific investigation skills in four broad areas:

- Initiating and Planning
- Performing and Recording
- Analysing and Interpreting
- Communicating

When creating your assessment plan, keep in mind that science fair projects can be used to satisfy requirements of formative and summative types of evaluation. The consolidation of students' skills makes them particularly appropriate as a summative activity.



Overall goals of the science curriculum relate directly to the process of completing a science fair project. These goals as stated in the Ontario Curriculum are:

Goal 1. To relate science to technology, society, and the environment
Goal 2. To develop the skills, strategies, and habits of mind required for scientific investigation
Goal 3. To understand the basic concepts of science

In addition, generic skills students will be expected to have for university, college, or future careers are developed through science fair projects:

- Organizing and presenting ideas
- Literacy skills of writing and verbally discussing work
- Interview skills
- Multi-media skills

"Man's mind stretched to a new idea never goes back to its original dimensions. "
Oliver Wendell Holmes

Walking Students Through The Process

PART II

This section walks through the process of completing a science fair project. It is also an excellent idea to visit the BASEF web site at www.basef.ca and check under the current year, teacher guide. This detailed resource will provide you with additional background information to support your students through the science project process.

Index of Student Workbook Activity Pages

Activity #1	Page 4	Print p.4	Activity #12	Page 16	Discussion
Activity #2	Page 5	Print p.5	Activity #13	Page 17	Logbook
Activity #3	Page 6	Print p.6	Activity #14	Page 18	Logbook
Activity #4	Page 7	Print p.8	Activity #15	Page 19	Logbook
Activity #5	Page 9	Print p.6	Activity #16	Page 20	Logbook
Activity #6	Page 10	Print p.12	Activity #17	Page 21	Print p.21
Activity #7	Page 11	Print p.12	Activity #18	Page 22	Logbook
Activity #8	Page 11	Logbook	Activity #19	Page 22	Logbook
Activity #9	Page 12	Print p.12	Activity #20	Page 24	Paper
Activity #10	Page 13	Print p.13	Activity #21	Page 25	Logbook
Activity #11	Page 14	Discussion	Activity #22	Page 26	Verbal Practice

Activities occasionally refer students back to a previous workbook page for further work. Due dates for activities could be set so that such pages only need to be printed once.

The best science projects are those that are student-driven and reflect the student's interest. With this in mind, the specific content for this next section is included in the student workbook. This guide will focus on how to guide students through the process.

Activity #1

Award Winning Projects

In activity #1, students are asked to visit the BASEF website at www.basef.ca and write down examples of each of the three project types (experiment, innovation, study). Provide time for students, and remind them to read the abstracts and watch for projects where the category isn't obvious! Other science fair websites or books may also be used, but the intent is to have students look at award-wining work from the start.

Note: It will help students to have one class session to complete activity #1, and a separate session for activity #2. This will build in reflection time for students to assimilate the types of projects they have seen and compare them against their own interests.

Choosing a Topic

Activity #2

Computer access will be helpful for activity #2, in which students are asked to explore topic areas of personal interest. Guiding questions assist the student in exploring possible topics, and students are asked to analyze topics for those that might make suitable projects.

The biggest challenge to students (and teachers who are helping them!) is choosing a topic or problem that is engaging enough to generate a good project. The best projects are those that begin with an area of personal interest. If a student is struggling with topic choice, ask questions about personal interests, or help them explore further resources for ideas. Many students will need reflection and further group discussion time; don't expect every student to have a topic chosen immediately.

Asking the Right Question

Science teaching, in meeting the curriculum expectations, covers a vast array of specific content expectations. Students are familiar with learning science facts and following set experimental procedures, but may be less familiar with generating open-ended questions about topics of personal interest.

"Science is a collection of questions, not a set of facts." Katherine Simmons

Teacher-led Activity

Activity #3

Activity #3 asks students to consider questions on their chosen topics. Suggested question formats for each type of project are given, as well as a blank mind map for recording ideas.

Leading a class brainstorming session can be a good way to help students develop strong questioning skills. Write a topic on the board. Ask the class to brainstorm questions about the topic. Write questions on the board, creating a mind map around the topic. Discuss the typical question formats with students.

Ask the class to suggest several topics. Write each topic on a sheet of flipchart paper. Break students into small groups and give each group one topic. Ask the groups to write down as many questions as they can think about regarding their topic.

The examples aren't intended to preclude other formats, but simply to illustrate the more common problem statement formats. The more frequently you use these types of questions when discussing science, the more familiar the formats will be to students when they come to write their own questions.

Ideally, arrange for the next part to be completed in the school library. Ask students to work at the individual activity #3 in the student workbook. Suggest to students that they scan book titles to get possible topic ideas. Circulate around class to assist students who are having difficulty with choosing a topic.

Other excellent ideas are:

1) Start a class bulletin board of clippings of discoveries (Real Science: Using Projects to Engage Students and Meet the Goals of the Ontario Curriculum, p. 18).
2) Ask students to start a science journal in which they write down their own thinking about work they have done in class as well as other topics of interest. (Real Science: Using Projects to Engage Students and Meet the Goals of the Ontario Curriculum, p. 18).
3) Ask students to write down topics and questions during a field trip to a science centre, ask students to bring in articles from newspapers, magazines, or internet sites about science discoveries or new inventions.
4) Conduct a class brainstorming about the questions that could be asked about that topic.

Students may be concerned about finding a topic of interest to them. Simply reminding them of project options other than conducting an experiment can help them choose something of personal relevance. The student who is not interested in physical science may be fascinated by observed habits of nesting birds. The student may decide to further observe to test his or her assumptions. Another student may wish to create a pulley system to lift a couch up into a tree fort. As long as the student follows an appropriate process, they can answer a personally chosen question, and at the same time, accomplish science and technology expectations.

Does all this really matter?

Yes! While there are other ways of meeting curriculum expectations, educational theory tells us that students engage with learning most strongly when it has personal relevance. Allowing students to choose topics of interest to them does mean they will learn – some of them may really surprise you!

A word of caution – Students may be very interested in something that doesn't at first glance seem like a good topic. Rather than telling them to choose something else, ask instead how could their idea be adjusted to turn it into a good project?

Activity #4

Keeping Track of Resources

In activity #4, students are asked to begin keeping track of resources on the tracking form provided. A recommendation is made to students to have at least as many resources as their current grade level. The school librarian is the perfect resource to assist students.

Activity #5

Refining the Question

In activity #5, students are asked to refer back to questions written down on the mind map from activity #3. Students are asked to assess each of their questions for whether it can easily be answered through resource centre research or whether it would be a good project, and to mark each accordingly. Guiding questions assist students with selecting a question that will make a good project.

Classroom Activity

Encourage students to talk about their questions with others. Provide class time for small groups or partners to critique and suggest questions for specific topics. Sometimes, project partnerships begin here as students discover similar interests.

Activity #6

Stating the Hypothesis

Information is provided for students on the reason for writing a hypothesis. Students are asked to write their hypothesis on page 12 of the student workbook. Students are reminded that their project will not prove a hypothesis, but will suggest accepting or rejecting the hypothesis.

Teacher-led Activity

Discuss examples of stating a hypothesis. You may wish to highlight examples from classroom science work and texts. You can also use the example given on page 4 of this guide.

Safety and Ethics Guidelines

Activity #7

Safety and ethics guidelines are included at this stage in order to have students think about safety issues before beginning their projects. In the student workbook, students are directed to the BASEF website at www.basef.ca to check safety and ethics guidelines for their projects. Those relating to the student's project are to be recorded on the project summary sheet on page 12. A brief overview of safety and ethics information appears in the next two sections: visit the BASEF website for more detail on safety and ethics regulations.

Teacher-led Activity
Present the following material in a class session.

Safety and Ethics

Safety guidelines and laws are in place to protect students and others involved from danger while undertaking science and technology research. In many cases, they are the same as the safety precautions for classroom activities, and some will be familiar to students. The three main areas of concern are hazardous materials, vertebrate animals, and human participants.

The list of prohibited materials for both project work and eventual display is quite detailed, and fairly long. Not all will apply to each project. Regulations for hazardous materials at the BASEF fair can be found at www.basef.ca - please read through these carefully, and you may wish to print a copy to have as a reference for student projects. This content is outlined in detail in the teacher guide at the BASEF web site. Students should be reminded of classroom safety rules; it is expected that all students will abide by safety precautions.

If students are unsure if their project will be approved, and/or if they are thinking about using human and/or animal subjects, they are encouraged to use the Rules Wizard to determine what forms and policies apply. The Rules Wizard for both junior and intermediate/senior projects can be found here: http://basef.ca/rules

Should the student decide to pursue a project involving human subjects, appropriate ethical guidelines must be followed. The overwhelming principle must be one of respect for the human participants.

If human subjects are involved:

- Students will need to apply to the school board ethics committee for an ethics review of the project PRIOR to beginning their work. Projects completed at other sites such as a local university or college must also be reviewed by that ethics review board. The review process can take some time; students should allow time for the approval process.

The Teacher's Handbook, which may be found on the BASEF website at www.basef.ca will walk you and the student through the process of applying for ethics approval.

Starting a Log Book (Journal)

Activity #8

Students are asked to begin a logbook for notes related to their research. Most of the student workbook activities from this point on will be recorded in the research logbook.

Activity #9

Project Summary Sheet

Students are asked to record decisions they have made about their project on page 12. This summary can be printed and handed in.

Activity #10

Project Management: Timelines

Activity #10 asks students to record teacher-assigned due dates for the various project stages. Students are reminded to allow extra time if their project will require ethics approval.

The earlier in the school year the students begin thinking about topics and questions or problem statements, the more time they will have to work on their projects. Student projects are best supported if they are given interim deadlines. The sample assignment sheet is to assist students with time management as they work towards their finished projects.

The main differences between a science fair project and other science assignments will be the depth to which the student explores a topic, and the time it takes to do so. The preferred choice is to give the students an extended time frame, and spend a day or two each week working on a stage in the process, slowly leading the students to the finished project. This also builds reflection time into the process, and students may be better able to connect their projects to other topics in the curriculum.

Teacher-led Activity
Assign timelines for each of the project stages, and ask students to fill these in on page 13 of the student workbook.

Be sure to set timelines so that projects will be done about one week before the school fair, or the regional fair registration date cut-off.

Glossary of Terms

Various terms that apply to science and technology research are explained: subjects; independent and dependent variables; controls and control group; sample size.

Teacher-led Activity

Activity #11

Walk students through the activity book example on page 14 of the student workbook. Explain other terms as needed.

Planning the Procedure or Prototype

This section reminds students of areas of focus for each of the three project types. You may wish to lead a classroom session to present page 15 of the student workbook.

Writing the Materials List & Detailed Plan

Teacher-led Activity

Activity #12

Present the example given on page 16 of the student workbook, and discuss the importance of a detailed materials list and plan.

Activity #13

Students are asked to write a detailed plan for their projects, including a detailed materials list. Students write the plan in their logbooks. A suggestion is made that it may be helpful to refer to the BASEF judging rubric given as Appendix I in the student workbook.

Conducting the Experiment or Study, or Building the Innovation

There is no assigned activity with this section; students should follow the plan created for activity #13. Do, however, remind students to make sure they have all the approvals they need <u>before</u> beginning their work. We recommend following the BASEF application process for required forms; it has been updated to in turn follow the process required by the national and international fairs. In this way, should the student's work be selected to move forward to the regional fair, they'll be all set to go. Experience has shown this is invaluable for the student, and much preferable to last minute scrambling to get forms completed!

Project Tracking Form

Activity #14

Examples of project tracking forms are given, and students are asked to design one for their project. The sample is to be written into the research logbook.

A suggestion is made that if students have assignments in computer applications, they may be able to negotiate using the tracking form for those assignments.

Organizing the Data

This section reminds students of the importance of arranging data using charts and graphs so patterns may easily be seen. Advanced students may wish to use computer software to assist with data analysis and graphing.

Activity #15

Analyzing the Results

In activity #15, students are asked to critically examine the data from their projects. Guiding questions are provided, and students are asked to record answers in the logbook.

Classroom Activity

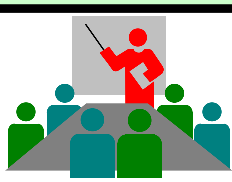
Provide time for students to work in pairs to evaluate each other's work, and specifically, to question the data analysis.

Activity #16

Conclusions

Activity #16 asks students to record conclusions in their research logbooks.

A section in the student workbook discusses the positive side of a project that doesn't work out as the student expects. This can be very frustrating, especially for novice researchers! Students will need reminding that what they have done could still be considered excellent research. You may wish to use the example of the now famous 'glue that didn't work' – Post It Notes™!



Teacher-led Discussion

No activity is assigned with this section. Instead, lead an open discussion of questions and answers about the projects students have done, and brainstorm examples of their relevance and applications. Students could take notes to assist with their own discussion write up.

Activity #17

The Written Report

In activity #17, a checklist is provided on page 21 of the student workbook for students to track their report completion. Page 21 can be printed and handed in as a means of checking whether students are on track.

Activity #18

Preparing an Abstract

In activity #18, students are asked to prepare an abstract for their work. The abstract should be recorded in the student workbook. A list is provided for what to include in the abstract.

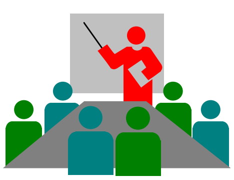
Activity #19

Preparing the Reference List

Students are asked to prepare a project reference list using the notes they have made on page 8 of the student workbook. You may wish students to use a particular reference format. Students are directed to the website https://www.citethisforme.com/guides for tips on APA, MLA, and Chicago style. APA is recommended for projects in behavioural or social sciences. There are many sites and apps that will quickly create references lists for free.

The Display Board

Activity #20



Classroom Activity

Provide students with a large sheet of paper that can used to plan the display layout. A summary of display content is given on page 23 of the student workbook, and a picture of a generic display layout is included in the student workbook as Appendix II. The analogy is given that students should think of the display as a website homepage, with the written report as links from that homepage.

Activity #21

Display Safety

In activity #21 students are asked to visit the BASEF website again at www.basef.ca and re-check any safety guidelines that might apply to their projects.

Activity #22

Discussing the Work

The student workbook finishes with tips on how to prepare for verbal presentation of the project work. A list is provided of judges' favourite questions. Provide class time for students to run mock judging interviews with a partner, as students' confidence can be increased through practice!

A Word About Assessment

A science fair project can be assessed using a method of teacher choice (checklist, rubric, skills continuum) or the BASEF judging rubric provided as Appendix III in this guide, and also as Appendix I in the student workbook.

Projects provide excellent formative evaluation opportunities as students gain practice in developing skills of inquiry and communication. They can also be used as culminating activities. In addition, if you are using portfolios as part of your assessment plan, a science fair project makes an ideal portfolio component.

One of the benefits of science fair projects is student ownership of the work. This ownership can be extended to evaluation as well. Provide the assessment method to the students at the outset, and/or involve them in creating one. Therefore, students are supported in learning to directly meet expectations, and in self-assessing.

The student's project only covers one curriculum strand. How can I give credit for this?
Even though the student may only cover one specific area of knowledge in the curriculum, the skills included in the curriculum that must be covered by your science program have been entirely covered by a science fair project. Science fair projects include most, if not all, of the skills that are required on the continua.

PART III

Planning a Fair

A school science fair is a great opportunity for promoting science throughout the school as well as the local community. Students get the chance to see a variety of approaches to science, and a school fair can also spark the interest of younger students towards future science projects. A fair also give students a chance to practice their communication skills before the BASEF fair!

Planning a fair need not be difficult. Delegation will help spread out the work, and is a perfect way of involving students, parents, the school council, and the community in a collaborative science activity. When planning your fair, keep limitations clearly in mind. How much money can you spend? How many participants do you expect? How much space is available? How much time can you commit? Acknowledging each of these up front will save you from headaches later!

Categories

You may wish to have categories that correspond to those used by the regional and national fairs. These categories may change from year to year, so be sure to visit the fair website at www.basef.ca to check the current year's categories. While categories are not essential for school fairs, they serve as an organizer that allows judges, students, and teachers to compare work being done in similar areas.

Parents

The curriculum encourages parental involvement, but not all parents can actively participate in classroom activities. A science fair project offers a unique opportunity for students to call upon parents' skills and knowledge. Perhaps parents will offer research opportunities for students; perhaps they will help with set-up of the fair; perhaps they will serve on the organizing committee; perhaps they will take photographs; perhaps they will attend and provide support.

Prizes

Consider asking potential donors to donate prizes that are linked to curriculum expectations. For example, perhaps a local software distributor could donate a software package for "The best use of graphs or charts in communicating results." Let students know about potential prizes well in advance, because they do motivate excellent work!

Depending on how much money you have to spend, and on what donations you can get, prizes could range from a framed certificate all the way to all expense paid trips to the National fair. Ideally, a certificate of recognition should go to every participating student to acknowledge his or her success in completing a project.

Prize solicitation is an excellent parent volunteer project, and you will find that community partners are happy to support science fairs by donating prizes.

Physical Project Set-up

The set-up for your fair will depend on how many projects are being entered, how much space you have available, and also whether you will be allowing space for an awards ceremony. You may wish to visit the BASEF site at www.basef.ca to view photographs of previous fairs.

Projects are usually set up in back to back rows, with an additional single row around the perimeter of the room. Sturdy tables that are to hand, such as classroom desks, can be used for project set up. Do let students know in advance the specifics of project size restrictions; check online at www.basef.ca for guidelines for the current fair.

Although it can be tempting to try to fit all the projects in one classroom, plan on 1.25 metres of free space in front of each project to allow for judges, students, and viewing guests to move freely. It may make more sense to use the gymnasium for your fair – more space is better than not enough! It is a good idea to draw a large floor plan and assign numbered spaces to each project. Not only will this make the student's set up run more smoothly, it will allow you to determine in advance that you have allowed enough tables and space.

To ensure set up runs smoothly, consider having a table of tools and supplies that students can sign out for last minute emergencies. The last thing you want to deal with is tired and frustrated students whose projects won't stand up!

Safety

All well-run fairs have strong safety guidelines for the protection of both the exhibitors and the viewing public. It's important for students and teachers to be fully aware of all safety rules, as well as acceptable alternatives when display of certain items is restricted.

Specific safety guidelines may be found on the BASEF website at www.basef.ca . In general, fair set-up safety precautions are established to address the following:

- ✓ Aisles and exits must be kept clear
- ✓ There should be no trip hazards (e.g., all electrical cords must be securely taped)
- ✓ There should be no sharp edges on displays or materials within displays
- ✓ All exhibits must be self-supporting and sturdy in construction

Not allowed for display:

- ✓ No toxic, flammable, or otherwise potentially dangerous chemicals
- ✓ No exposed electrical parts or operating lasers
- ✓ No plant or animal tissue, molds, bacteria, soil, or material that might decompose
- ✓ Latex, peanuts or other allergens may not be allowed

Please visit the BASEF site at www.basef.ca for details of safety and ethics guidelines. Consider also whether there are specific safety rules you will need that relate to your site. For example, if the fair is to be held in a classroom, on visitor day you may need to regulate how many are in the room at any one time.

Safety checks

It is important that an adult check each student project being displayed for adherence to safety guidelines. Once students have set up their projects, they should check in and indicate they ready for a safety check. Safety checks are another excellent task to assign to parent volunteers, who would use a prepared checklist such as the one to be found on the BASEF website at www.basef.ca .

One way to streamline safety checks is to provide students with their own checklist indicating what will be covered during the safety check. Students can then pre-check their own project and remedy some potential problems.

Judging

The BASEF site offers an excellent judges' training manual that can be used for your own judges' orientation. Visit www.basef.ca to view or download this resource. You may wish to hold an informal judges' training session to serve as an opportunity to address any questions. Do provide each judge with marking rubrics and a clipboard and pen, and remember to thank them for volunteering their time!

Awards Ceremony

Celebrate the success! Host an awards ceremony, and consider inviting the local press. This is a wonderful opportunity to showcase all the students' hard work!

Applying to the Regional Fair
Support students in taking their work forward to the regional fair – it's a great learning opportunity for them! The students will find information on how to register at the BASEF site at www.basef.ca They may need some teacher guidance in completing the registration process.

APPENDIX I: Sample Parent Letter

(on school letterhead)
(date)

Dear Parent of a student in (class name),

This year students in our class will be doing science fair projects to help students meet curriculum expectations in inquiry, design, and communication. The projects also provide an opportunity for students to explore areas of personal interest in science and technology. Students will complete projects individually or in teams of two.

Students will spend class time choosing a topic and selecting their project question. While some additional class time will be given for background research in the resource centre, it is anticipated that students may select topics requiring work outside the classroom. Students will begin work next week on their topic choice, and will be expected to present their finished project as part of a class/school fair on (date in late February).

At this time, I'm/we're writing to ask you to consider involvement with this important process. Do you have skills in a particular area? Could your business provide equipment or support of other kinds for a student? I/we would welcome parent involvement in any of the following areas:

1) In class assistance with topic choice and selecting suitable questions.
2) Support for students who may not have access to necessary materials.
3) Conducting safety checks for the fair (we provide a checklist).
4) Soliciting donation of prizes for the fair.
5) Participating in the fair committee.

I am/we are excited about the opportunity for parent involvement in this process. I/we know there are vast talents amongst our parent group! Please contact me/us to tell us how you'd like to be involved!

(teacher name/s)
(school name and phone number)

Name:
Phone number:
Yes! I would like to be involved with the science fair projects ☐
I'm not able to assist at this time ☐
The skills I can offer include:

APPENDIX II: Sample Sponsor Letter

(on school letterhead)
(date)

(Name of company head)
(Company name, address)

Dear (Name of company head),

This year students in our class will be doing science fair projects to help students meet curriculum expectations in inquiry, design, and communication. The projects also provide an opportunity for students to explore areas of personal interest in science and technology. Students will complete projects individually or in teams of two.

Students will begin work next week on their topic choice, and will be expected to present their finished project as part of a class/school fair on (date in early March). Students who do well at the school fair will advance to the regional fair.

At this time, I'm/we're writing to ask you to consider involvement with this important process. Do you have skills in a particular area? Could your business provide equipment or support of other kinds for a student? I/we would welcome your involvement in any of the following areas:

- Donation of prizes for the fair.
- Donation of money or 'in-kind' for the fair.
- Support for students who may not have access to necessary materials.
- Acting as a judge for the class/school fair (we provide a marking rubric).
- Participating in the fair committee.

I am/we are excited about the opportunity for community involvement in this process, and look forward to providing public recognition for your contribution. I/we look forward to discussing this further with you, and one of us will call you personally next week to answer any questions you may have about participating in the (school name/class name) science fair.

(teacher name/s or volunteer parent names)
(school name and phone number)

Appendix III BASEF Judging Rubric

Bay Area Science and Engineering Fair - Judging Form

Project ID:	(Do not write in this space)
Write Project Mark here, and enter it in the Mark Sense Boxes to the right:	Fill box completely, one box per row. Make no other marks in this space. 10 9 8 7 6 5 4 3 2 1 0 **10's** **1's**

A. Scientific Thought (maximum 45 marks)

1. Select whether the project is either an experiment, study, or innovation.
2. Determine the level of the project by matching the description with the project. Circle the deserving mark out of a maximum of 45.

Definition	**Level 1** (acceptable)	**Level 2** (fair)	**Level 3** (good)	**Level 4** (excellent)
Experiment Investigation undertaken to test one or more hypotheses.	Duplication and reporting of an experiment to test a previously confirmed hypothesis.	Extension of a known experiment through modification of its procedure, data collection, analysis or application.	A new approach to the design, modification or application of an existing experiment with control of some variables.	A new experimental approach to a research problem in which most of the significant variables are controlled.
Study A collection and analysis of data showing evidence of a correlation, or pattern of scientific interest. Variables are identified and controlled.	Study and presentation of printed material related to the basic issue.	Study of material collected through compilation of or expansion of existing data and through observation. The study attempts to address a specific issue.	Study based on new observations and research of a previously studied topic. Appropriate analysis of data and correlations made.	A new approach to the study of a problem which correlates information from a number of sources. The report also offers new insights or solutions to the problem.
Innovation The development and evaluation of models or innovative devices, using approaches from the field of technology or engineering.	Building models or other devices that duplicate existing technology; minimal reporting.	Make improvement to an existing technology or use an existing technology for new applications.	Design and build an innovative adaptation of an existing technology for a new application.	Build a novel technology or integrate technologies to form an innovative system that has commercial or human benefit.
Score out of a possible 45 marks.	15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35	25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

NOTE: This form will be machine scanned; please DO NOT FOLD. Use this form ONLY for the Project # printed in the ID Section.	**A**	**Score:**

B. Display (maximum 10 marks)		
• Is workmanship neat and carefully done? • Is lettering clear? • Are colours strong and suitable? • Is the layout complete, logical and self-explanatory? • Is the content clearly and logically presented? • Is the display simple and visually balanced? • Does it capture attention? • Does it have impact? • Is there good balance and use of contrasts? • Do the backboards, table and all displays meld together? Circle: 1 2 3 4 5 6 7 8 9 10	B	Score:
C. Notebook / Work Journal (maximum 20 marks) • Is the notebook clear, concise and neat? • Is it different from the backboard display? • Is it well organized? • Is there a journal summarizing actual work noting both successes and failures? • Is there a bibliography? • Are there acknowledgements? Circle: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	C	Score:
D. Abstract (maximum 5 marks) • Is the abstract present? • Does the abstract contain all aspects of the project? • Is the information concise, complete, and accurate? • Is the abstract well written? (grammar, syntax and spelling) Circle: 1 2 3 4 5	D	Score:

E. Interview (maximum 20 marks)				
Student is unsure of the material or the process of the project and has difficulty answering questions about the project.	Student can summarize the project adequately and can answer the majority of questions about the project.	Student explains the project well and can answer all questions about the project clearly and logically.	E	Score:
Circle: 6 7 8 9 10	Circle: 11 12 13 14 15	Circle: 16 17 18 19 20		

NOTE: Judges marks are not to be disclosed to anyone outside of the Judges Group.

Please note some constructive comments for students.

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