SCIENCE CELEBRATION

By Len Reimer

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INTRODUCTION AND OVERVIEW

KEY CONCEPTS OF A SCIENCE CELEBRATION

Four key concepts of a Science Celebration are:

- **support**
- **helping raise the level of the project**
- **sharing**
- **assessment & evaluation.**

Independent science project work sets off great enthusiasm and excitement in the classroom. One of the key concepts of a Science Celebration is that the teacher supports the child through the entire process helping to teach the science processes that are needed to support the child, teaching the skills necessary for the project and then encouraging the child to reach for the next level in an upward spiral of support, encouragement and challenge all in the context of an exciting or at least intriguing project. Subsequent chapters will discuss ideas for getting started, how to evaluate and how to support a student through this process.

Raising the level of a project is another key of the Science Celebration. As the project takes shape inside the classroom, the teacher has the opportunity to present the next level of science processes and skills to the student and to challenge them to reach for the next level. This process is called "Walking Through The Levels" and is discussed later.

Another key of the Science Celebration is that at the "show" or on the exhibit hall floor, the target of the students' attention is other students. Unlike the traditional science fair, where students basically need to ignore the other participants in their focus on the judges, the Science Celebration focuses on the other students. By turning the attention of students to teaching and instructing other students, the final exhibit event becomes a positive, success-oriented memory that can be a catalyst for involvement in science for the remainder of the year and for years to come. How to set this up and how to organize this exciting sharing is discussed in the chapter called "Sharing."

The final key to Celebration is the assessment process. The several ways to do this are discussed in the chapter on "Assessment and Evaluation" but the key concept is that the teacher is assessing each step of the project. By the time the project is finished, the teacher is well aware of what the student has done, what level of process application the student has used and the quality of the skills, precision and the rigor of intent that has been applied to the project. The display board and oral presentation are also assessed in the classroom. When the student "goes public" with the project, the evaluation process has already finished. In the traditional science fair, it has just begun.

Independent science project work is a huge opportunity for learning. The Science Celebration brings this excitement into the classroom and opens the door to reaching a great many of the goals of the science curriculum through a process where everyone comes out excited.

Students learning from students, gaining new insights and ideas, communicating and having fun; these are the results of a Science Celebration.

Science Celebrations are organized to enable students to give their presentations to a supportive student audience. Students are grouped into sections, with displays arranged in order to facilitate sharing with the participants in that section. Students learn from students and everyone is a winner. This format can be used in a single school or used with participants from several schools. It can be the science experience you have been waiting to organize!

Science celebrations have proven to be successful forums for involvement in science at the elementary school level, especially for schools which want to emphasize involvement in science or which are just beginning independent science projects. Combine the elements of the celebration with cooperative learning and your curriculum can lead to an exciting, meaningful experience that will keep your students coming back to science next year and for years to come.

What Is the goal?

The purpose of a Science Celebration is to involve the students in a science project that will not only motivate them to focus in one area but will also complement and meld with the existing program. Given this purpose, it is possible to see how Science Celebrations can grow out of an environmental studies unit and how the writing process and integration with the arts and mathematics can be introduced.

Another benefit of this program is that students are not expected to perform at levels that are vastly different from their classroom experiences. To ask that middle grade elementary students demonstrate good experimental control is potentially going to accomplish three things: reveal the students with a talent for science experiments, alienate and discourage eager minds from applying their talents to science, and cause competitive, anxious students to rely on the processes developed in their parents.

By keeping the project expectations at the level of the students, by being very flexible in realizing that there are eager, very talented students capable of excellent scientific investigations and experiments, students will receive success through getting their toes wet in science.

The goal is not to have a winner. It is to encourage the practice of the science processes and to involve the entire eligible group in science; in other words, to celebrate science. What is needed is a Science Celebration!

The Flexibility of the Concept

The celebration organization has been used in elementary classrooms, schools and in multi-school organizations.

Participants were divided into sections of six to ten projects. Each section's participants were carefully chosen to allow for a variety of schools (or class divisions) and a variety of categories of science. There was a deliberate attempt to avoid having two projects on the same topic in the same section; although we might have easily decided to group all the same topics together.

Section participants were given a number which designated their position in the section and their presentation order.

When it came time to present, the five or six students in a section moved into a position to hear the first presenter. Presenters were given ten minutes to present and field questions. This allowed them to give their entire formal, well-prepared and practiced presentation to a group of their peers. This delighted the presenters, fascinated the participants and resulted in a good deal of positive feelings and definitely a good deal of learning. It also allowed for communication of science concepts and results of investigations; each presenting student was turned into a scientist for that moment.

Students then heard the full presentation of the other students in their section. The projects in the other sections were viewed, with informal summary presentations given.

Viewing was done by releasing partners to tour the site and alternating individuals. Sections or half of the participants were released at one time. This technique works with a classroom of 30 and with a full gymnasium of 300.

The goals, the emphasis, and the results were communication and learning.

In summary form, here are the main elements:

- students work on their own, in pairs or in cooperative teams to create a science project;
- students display that project with an attractive, informative display;
- students present their findings at a vocabulary level appropriate for that audience;
- students all get a chance to share their results;
- projects are not judged on the display floor and projects are not in competition with each other on the floor;
- evaluation is done away from the display floor and can be partially done through self-evaluation and goal setting and through peer as well as teacher evaluation;
- students all come out to be winners, all are encouraged by their efforts, all have the experience of using science in their daily lives;
- students have a stronger chance of choosing science and math as an element in course and career choices.

Many teachers list the following elements as important goals within their overall science program needs:

- children should experience the science processes;
- vocabulary should be understood and applied if possible;
- students should experience many hands- on activities;
- the program should be inherently interesting and exciting as well as individually challenging;
- the program should provide for individual differences;
- it should provide challenges for those capable of accepting them;
- the program should provide some sequential process of reading in the content area;
- the program should develop an interest in science;
- the program should result in students applying a scientific or sequential process to solving problems;
- the program should be real to students and have real life applications that are visible to students.

The Science Celebration addresses each of these program elements.

The event can be modified in several ways to maximize learning. To get started, select the approach you will take (theme, individually selected, display, experimentation, research or a combination-flexible approach). Decide on how and to what degree this will be integrated into other curriculum areas (writing, reading, arts, socials, etc.). Decide on the scope of the celebration (classroom centre, class as a whole, several classes, whole school, and several schools). Decide on your in-class evaluation approach. Set your timelines (when you want to announce, book facilities and display space, dates for different elements to be reported to you, event day).

A Science Celebration organized for several schools can be used as a reward system for the pursuit of excellence at your own school's celebration as well as a super technique to promote science in your area.

The Science Celebration is also a very flexible procedure that can be applied to a class project, a school-wide event or an event in which selected students from several schools attend.

What is a Science Celebration Versus a Science Fair?

On the surface, the projects at the two events may be identical. The differences come in the way the event is organized and the priorities of the organizer. In a Science Celebration, learning, teaching, sharing and enjoying science is the priority; for many in a traditional science fair, impressing an adult judge is the priority. The good news is that anyone who is beginning the Science Fair process in an elementary or middle school can shift to the Science Celebration model.

What are the components involved?

Students have the four elements of an individual science presentation.

- project (research, model, innovation, duplication of experiment, computer program/application, variable-controlled experiment, or combination of these approaches);
- presentation aimed at a peer student level (including carefully defining or explaining new vocabulary and concepts);
- display (on table tops or following the science fair guide-lines of a display board that stands on a table);
- an understanding of the project including background knowledge.

Science fairs are evaluated on the day of the fair and are often separate from the curriculum. Science Celebrations are evaluated over at least three months and are an integral part of the process skill development of your students.

Science fairs are generally judged events where students remain by their projects and are visited by adult judges who often are the only people to whom the student communicates a well-prepared oral summary of the project and its results. There is a definite place for science fairs and competitive science forums with tangible rewards; I believe that place comes after students have mastered the science processes and not as the first experience of a project display forum for younger students.

Science celebrations have no judging during the event (the assessment has taken place prior to this public presentation). The adults stand back and the children have the spotlight. Students are the audience for the fully prepared oral presentation. It is at the student level that the students must communicate, explain and define the concepts and processes. The result is that students enjoy participating in a science project, understand their project well enough to explain it to children, practise the science processes and have the added bonus of learning from their fellow classmates in a non-competitive forum.

The key to the Science Celebration event day is sharing. Students from a defined section of the display room come to hear the full presentation of that student or team. Each in their turn will have an opportunity to present.

The final section of this reference deals with individual project development and evaluation.

THE DON'TS: FOR PROFESSIONALS, SUPERVISORS AND ADVOCATES

There are some practices that have built up over the years connected with science fairs that should not happen. Hopefully you will not see these happening in your school.

- Unsupported students being put in a public evaluation process.
- Students using material that has not been approved and in some cases that parents are unaware are being used.
- Teachers allowing a project to proceed without ensuring the equipment or chemicals are safe.
- Parents not being informed that their child is doing a science experiment that may involve home time, materials and equipment.
- Use of heat, fire and explosive devices.
- Standing a student in front of the class to give a project report without having delivered the report to a small group of peers and the teacher before hand.
- Worse, standing a student in front of the class to give the project report and critiquing the project and inviting critiques from peers in front of the entire class (this is a recipe for turning a student off science and an invitation for bullying that simply does not belong).
- Having all students give their oral reports to the entire class. This is a complete time waster. Create a peer nomination process and allow a select number of projects voted by their peers to present (with the teacher ensuring excellent projects are not left out). This avoids embarrassment, controls the quality of science being exposed to the entire class and is a goal some students will strive for.
- Relying on the Science Celebration to be the only hands-on experience in the school year.
- Finally, my pet peeve: making a big announcement and having nothing to do with the project until an exhibit date. Even for secondary teachers heavily involved in secondary science fairs, this is not the practice. Even working scientists have project supporters and supervisors who expect to be informed of the progress; surely we should expect no less for elementary children.

SUMMARY

The Science Celebration concept has spread over Canada. It is the concept used in many towns and cities. Districts have realized that a non-competitive public display of students committed to a science project has huge benefits for the students as well as the school and district. We all benefit when students have a successful experience with learning.

SHARING – THE HEART OF THE CELEBRATION

The sharing time of the celebration day opens so many possibilities for learning and improvement.

Why would a chapter on sharing precede chapters on getting started? The reason is the sharing component of a Science Celebration is critical to the entire process. The final "show" or exhibit of a Science Celebration is the opportunity for students to become reporting-out scientists – or teachers.

That this is the goal will change the conversation leading to this final product and will cause a chain of decisions along the way. A student cannot simply memorize great sounding words but must understand the very concept of the project he or she has done. Not only that, they must explain the process of their project and the concept behind it to their toughest critics: to their peers and to the most challenging audience of all: younger students.

As Joseph Joubert has said, "To teach is to learn twice." This explains why the sharing component of the Science Celebration is very powerful.

How To Share

The most important event that takes place on the celebration day is students giving their entire presentations, explanations and/or demonstrations to other students. Adults take a background role at this time.

Students are placed in a deliberate manner at pre-set positions to maximize interaction, sharing and discovery (see ROOM ORGANIZATION). They are grouped in sections with approximately six projects per section. Each position in that section is identified as colors, names of scientists, names of inventions or simply as letters. Within the section, places are numbered; a student might be placed at the "Canadarm 2" or "Banting 3" position, for example.

Each section has an older student or adult "section coordinator" whose role is to monitor the group and to step in to assist during question asking and answering. Students in the first position stand by their project while other students form a semicircle around them. This is happening in each section.

The requirements of the sharing time depend on your objective and the level of the students. Here are some examples:

- students carefully listen to the presentation; The presenter then asks the group three questions about the information covered;
- students carefully listen to the presentation and following the groups' sharing, are partnered up with the same numbered position in a different section. They then take their "partner" on tour through their section and explain the key points of three projects; presenting students place three cards up before they present. These represent vocabulary words or key elements in their project. At the end of the presentation, they ask the group to respond to each of the three cards (to answer or explain what the results of that element were);
- wording of the presentations should be geared to students, there is no advantage to using sophisticated vocabulary to impress students. The need is to inform. Define words and use a presentation style geared to ensure understanding;
- students may be required to complete a questionnaire or response that is either standard or created by the presenter,
- the coordinators could lead the group in summarizing the key points of the presentation;
- following the initial sharing students may be asked to bring visiting students through their section and explain three or more of the projects to a small group;
- listeners could review the positive points of the research or experimentation techniques;
- coordinators can elicit the good things about the project from students and give their own opinions. (Remember the philosophy that each presenter has learned from this experience and should be recognized for that learning.)

Students can participate in evaluation if you wish to turn the celebration into a science fair (not a bad idea for older elementary students as long as you have monitoring of the questions. These ideas are discussed in the EVALUATION section.

How To Organize Class and School Visitations

The traditional group presentation of science projects to visitors is to simply let the student or parent visitors enter the room and effectively "go window shopping" for something that catches their eye. As anyone who has worked with science projects knows, some excellent projects just don't have "window shopping appeal."

One assumption of the "let students free to wander" is that they won't learn anything from more than a few projects. Often they will gravitate to the "sales pro" who may only have a great delivery, the attractive display or (far too often) to a neighbor or friend.

Take control and respect the visiting class by providing a quality science learning experience and provide the hosting class with the respect they deserve for all the work they have done.

As the class comes in, divide them into groups of 5 or 6 (the art of grouping the class I'll leave to you but recall it is an art). Send them strategically to the beginning of a set of 5 projects and ask them to move in the same direction (that is move to the left). Have them stay at one project at a time so the student with the project can go over the entire presentation. This method has had excellent results for respect, behavior and learning. At some time, the students will have time to wander but they have fulfilled the key objective of learning from their school-mates.

I have used the same system with parents. Generally, send them to their child and ask them to talk to at least three projects next to their child. The children themselves become excited about introducing the Celebration neighbors.

HOW TO GET STUDENTS INVOLVED IN SCIENCE PROJECTS

The outcomes of a Science Celebration are positive and long-lasting and will have benefits in the child's life and in your science program.

The first suggestion is not to tell students that they are doing an independent science project, Science Celebration or Science Fair project until they are already committed to the topic. This avoids students running to the lowest denominator choices, the easy ones, and coming up with very run-of-the-mill projects. If you really want to incorporate this phenomenon in your science program, keep it in your room so you can help students begin the project and only after the student has chosen the topic and is committed to the project, reveal the extent to which you will take this. This keeps you involved with the project and does not "farm it out" to other sources, such as parents. Involving parents in a student's work is always a good thing, but if you are integrating this with your program, if you are going to make meaningful suggestions and if you are going to raise the levels of some of the students, then you want to have the project developed in your classroom.

Students will respond positively to both the expectations and the objectives. Those objectives are to involve students in a science project where they will be able to do real science with real problems:

- use and apply the processes of science developed through the curriculum;
- allow students to be creative;
- provide each of them with an opportunity to share the results of their learning with other students and to learn from other students;
- provide an opportunity to show their efforts in science to their parents and to other teachers, parents and relatives at a celebration night (if you organize a Science Celebration event);
- provide an opportunity for something interesting, exciting and meaningful.

A teacher can introduce the project through one of the integrated techniques discussed in PRIMARY FOCUS, INTERMEDIATE FOCUS, and INTEGRATION. It can be the theme for the current science unit. It can be simply made a mandatory expectation. Consult with the TIMELINES section to establish a starting point.

There are two subtle elements that one must keep in mind. First, the science project is not an isolated event. It will be perceived as being tied to SCIENCE and several opinions and reactions to science will be formed as a result. It is important that the experience be positive.

Next, the expectations for student projects must be related to the process level of the students. If you want high-level, multi-variable, controlled experiments, then you must ensure or determine that the students have the level of processing required (keeping in mind that all students are stretched during these exciting events).

The environment during the process and presentation must be safe, reassuring and understood.

Safety factors must be considered first. Students are asked to take risks during a science project; keep those risks restricted to problem-solving, exploration into new topics and presentation. Ensure that no student is allowed to work with dangerous materials or materials dangerous to other people or animals.

Each child must not only be treated with respect and rewarded for efforts through recognition and equal opportunity to present; he or she must be assured and reassured that this will be done.

Students will enjoy the project work and will get far more satisfaction out of the process if they understand it fully. If you are expecting students to keep to a first level of project (see LEVELS), then they must have experience and direction at duplicating a project or in research. These sub-skills are often compensated for through the tremendous motivation inherent in a Science Celebration.

If you are expecting students to conduct experiments with controlled variables or several controlled variables, then give them some guided practice in identifying variables and problem-solving as to how those variables could be controlled. This can be done in conjunction with your regular program or you could create a demonstration project and move students through the levels of science projects.

One aspect of science projects that is often overlooked is the importance of selecting the correct question or purpose and selecting an appropriate hypothesis. Neither one should be done before the students have investigated the topic or used the materials involved. Students need to become involved in the topic and have some background knowledge and experience with elements of the project before they make these important decisions. This will ensure a deeper level of involvement and a more positive approach to the topic.

Group formation is often perceived to be difficult in such events. The most effective way of grouping is by using the cooperative learning model. This does require the teacher to have spent some time introducing this model to the students and to have guided the students in positive interaction, positive problem-solving/decision-making and discussion practices.

If you have decided to have group selection based on a model other than cooperative learning, interview members individually on occasion and consider your evaluation procedures (see GROUP EVALUATION).

TOPIC SELECTION

Generally, students are more than eager to have the opportunity of completing a science project. There is a great deal of enthusiasm in working with an interesting topic.

This section is meant to give a general outline of procedures you may use to have students select a topic that is not related to a current theme or predetermined by yourself.

Some ideas are:

- Have students make a list of those things that truly interest them. On a day following, bring out that list and have them pare it down to three. On a day following, select one thing. Now be creative and see if there is a science topic that fits their interest area or is there a project they can invent by themselves. This method does take experience and knowledge but it does result in creative applications of science – the real goal of the exercise.
- Review current newspapers and magazines for topics that are in discussion;
- Consider a need that exists or a recent event that may be worthy of investigation (the oil spill in Vancouver harbor generated a number of excellent regional science fair entries on mopping up oil spills, and oil spill prevention);
- Investigate the properties of something familiar to you or that has intrigued you; allow the project to grow out of something you have enjoyed doing or considering;
- Begin with a suggestion from a library or other source and investigate its properties, then begin to design your experiment;
- Build on previous experiences either in class or in other projects.

Good elementary school projects rarely pop up with a full multi-variable experiment all ready to go. Generally it takes a length of time to become familiar with the topic, its components and variables. WALKING THROUGH THE LEVELS (a subsequent chapter) is a very effective way of allowing a project and a student's science ability to mature. Beginning with some simple investigations and some background research are excellent ways for projects to unfold.

PROJECT TYPES

Aside from the myriad of topics that may be selected for a science project, there are several different levels of projects possible. By adapting the levels generally accepted in science fairs, it is possible to see the spectrum of project qualities.

This spectrum may be used in:
- suggesting appropriate project elements;
- assessing students;
- giving suggestions and directions for improvement;
- determining whether your students have progressed to a point where they are demonstrating the range of science processes independently.

The Youth Science Canada website suggests that projects can be of three different types: an experiment, a study or an innovation. Many projects may demonstrate each of these things.

Experimentation

In experimentation, the levels often reflect the following steps:
- Doing a "cook book" experiment, that is, following the instructions given in a source reference. Generally the science element is the manipulation and measurement of the materials.

  This may range from a step-by-step guide as in a book for primary children or may reflect the reproduction of a complicated project at a higher level. In an experiment, if none of the ideas or procedures are unique or new and if the hypothesis is totally predictable (if the instructions are followed), it is a beginning level experiment.

  This level is excellent for primary grades where the task is manipulation and measurement (such as cooking). It also offers excellent opportunities for a follow- up experiment in which the student modifies the procedures, which is the next level.

Modification of a "cook book" recipe for experimentation.
- The student changes an element in the procedure and thereby is required to make a hypothesis that is not necessarily predictable. This type of project can become quite sophisticated and is certainly a suggestion for intermediate students.

Original experimentation is the next level and requires that a student makes a solid effort to identify the variables involved, establish a control (if appropriate) and manipulate one of the variables while the others are being held constant.

This is a superior intermediate project. Combined with a good deal of research into the field, this would make an excellent project.

The highest level of experimentation is one in which the student has not only identified the variables involved in an experiment, but proceeds to manipulate more than one of these to determine the most significant or purposefully controls more than one variable.

Each of the above levels of experimentation can be done from mediocre to masterful levels. As the experiment gets more complicated, more trials are needed to verify the hypothesis. Care in preparation, procedure, identification and selection of manipulated variables become important factors. One key to a remarkable project is that it deals with the problem in a unique manner or the data analysis shows excellent analysis or interpretation.

Study

A study is more than a report in that it generally requires an element of data analysis.

A beginning level of study is to report what has been found through reading. This is an excellent beginning to many levels of projects and certainly is appropriate for primary students where the gathering, recording and presentation of the results are the central goal.

Combining research and personal observations is generally considered the next level of study. This can become a very complicated, long-term and excellent project. Often such a project invites experimentation to prove the observations and, presto, you have a combination project well on its way to becoming a superior level.

The next level of study combines observations and research in the investigation of different methods of dealing with an issue (pollution, for example). Statistical analysis enters into older students' repertoire in this level.

The final level of study will use several sources to analyze the effect of different solutions to a problem through research and observations. The variables have been identified (although not controlled) and appropriate statistical analysis has been performed on the effects of each of the significant variables.

Innovation

Innovations are inventions, applications and designs. They may really work, or they may be models or designs.

- The first level would be the building of something already invented. The quality is demonstrated in the construction, not the concept. This is a very satisfactory goal for primary and some lower level intermediate students.
- A second level would be the improvement or demonstration of a new application for existing technology. This may result in a very significant project. The concept and construction or design is important.
- A third level is the design or invention of new technology or a very significant improvement or application of existing technology.
- The fourth level of innovation is the integration of several technologies, designs or inventions or technological systems into an application, design or invention that is significant (either for commercial application or benefit to humankind).

Combination Projects: the best of all choices

In the competitive world of science fair projects, a project that combines Experimentation, Study and an Innovation has a clear advantage. As students gain more and more experience with independent projects (that is have more than one opportunity), they may be encouraged to begin to combine these levels to create a truly strong project. Emphasis must be placed on experience. Expecting an inexperienced younger student to combine these genres of project work would be as frustrating as not giving any support at all.

Follow The Leader Projects

Some teachers encourage their students to research project titles that have won recognition in other science events. If you just want your students to complete a project and perhaps to receive low level recognition in a science fair, this method works. They consistently produce students who use a rote method of science that rarely produces long lasting commitment. The presentation often lacks commitment or excitement. For those who are actually teaching application of process work or who want their students to have successful competitive science fair experience, encourage your students to create unique projects.

The Science Celebration by Len Reimer, copyrighted 1994.

PRIMARY FOCUS

The Science Celebration model is an excellent procedure for primary grades. Some suggestions and modifications that teachers have made are very useful to keep in mind. Independent, unrelated activities are difficult for students if that demand has been placed upon younger students.

Some suggestions to solve the selection process are:

- Integrate the project with your program. Select a theme, then select topics and projects within that theme that your school has the resources and references to support;
- Keep an interest log or journal of topics that the students have found interesting. These may have come from reading, family interests, class discussions, television or out of the blue;
- Develop a topic library where students may go and select a topic that you have determined to be appropriate or for which sufficient resources are available for your students;
- Brainstorm — taking the risk that students will come up with a topic that is both doable and backed up with sufficient school resources has the added benefit of being the student's own. Keep in mind that with younger children there is the risk of selecting a topic that you will have to help modify or suggest avoiding—let your experience be your guide;
- Create a class project in which allstudents have a similar project and use the Science Celebration model to allow them to demonstrate this to other students in different classes;
- Create large class teams where two, three or four projects are attempted, then use the Science Celebration model as a procedure of sharing the project procedures and results;
- Have an on-going science centre with changing topics. Gather the completed projects during the year and use the Science Celebration event as an opportunity for the students to review their findings and share them with other students. Some teachers have described the students' reaction as having "found an old friend" when their project is returned. This technique allows students to have several projects and, with your guidance, to select one for the event;
- Select from a list of primary science ideas. These have the benefit of being tried out with primary students (but may not be as inherently exciting as one chosen by the students with your help).

In all cases, your teacher-librarian and science coordinator will be of great use in your planning and operating of whichever method you choose.

INTERMEDIATE FOCUS

There is no question that the best ideas that generate both the most enthusiasm and dedication are those that students have developed themselves.

By involving intermediate students in a Science Celebration, you are giving them an opportunity to combine the strengths inherent in a science fair with the positive learnings and outcomes associated with a Science Celebration. Science Celebrations provide the option of including the science experience in a myriad of other classroom activities. The celebration is not a hands-off fair; it can be an integral part of your science process instruction.

The Science Celebration allows the project to become a group, cooperative project in the classroom, an independent activity centre in the science room or an extracurricular challenge.

The key to the celebration concept is that the process is as—if not more.—important as the final event. For example, by having students demonstrate and report the processes as their project develops you have several options:

- evaluation of the processes used by the students;
- use the discussions as opportunities for Socratic discussion, challenging them to be aware of their own knowledge and direction;
- design lessons within your current science program to build needed skills;
- provide connections with other groups, your teacher-librarian, audio and visual resources, and community resource people;
- use the project as a catalyst for further strengthening of specific processes within experimentation;
- take advantage of the natural opportunities to web this process to other processes in your curriculum;
- develop a checklist (see EVALUATION) for having students rate their own or another group's level of science processing and/or background knowledge as the project is unfolding.

Where Do the Ideas Come From?

There is no question that the best ideas that generate both the most enthusiasm and dedication are those that students have developed themselves. That development may stem from things around them, from areas in which science is currently leaning, or from catalysts such as magazine articles or television shows.

There are other sources that can lead to great dedication and interest:

- teachers' suggestions (within the parameters of selected units or themes), including school-wide themes;
- student council or advisory committee generated topics or themes;
- themes that reflect the local community interests or industry.

Your teacher-librarian can identify several books that will allow students to either duplicate an existing procedure or experiment, to change the variables, hypothesis or procedures in an existing procedure or experiment or use suggestions as a catalyst for a new variable-controlled experiment.

INTEGRATION WITH OTHER CURRICULUM AREAS

The Science Celebration can be integrated into each area of the curriculum. Here are some ideas:

Science

The Science Celebration can be an on-going "practice ground" for the processes you are working on within your current science curriculum. After applying the process with guided practice to the current topic, students may be challenged to apply the process to their individual projects.

The celebration can be used as an independent activity at the end of a unit in the curriculum.

The celebration can be on-going and an independent station with changing timelines and expectations throughout the year until an event time is established or until the students feel the project is complete.

Projects completed throughout the year may be kept on hand until an event day is set, then one project may be selected to be up-graded or revised and used as the celebration presentation. The Science Celebration can be used as an option for students. In this regard, it could be evaluated as an assignment, or as a replacement for "lowest score", or as a sharing time for class and perhaps parents and administrator.

Language Arts

The Science Celebration is in many ways a language arts activity. It involves oral language, listening skills, reading in the content areas and writing reports or content writing.

Reading

- Cooperative groups or classes may select themes to approach through reading centers, interest groups or individual selection.
- Stories and poems can become part of the expectation for background reading.
- Science fiction can become a topic that both supports science and becomes a source for topics to be investigated.
- Problem-solving can be a unifying theme to tie science and reading (and a great many other areas) together.

Listening

- Listening skills are required during the celebration event. These can be evaluated and strengthened through awareness, guidance and requirements of well- organized, peer level vocabulary on the presenter's part.
- Listen to summaries and state or write the key concept.
- Listen for new vocabulary.
- Listen to presentations and then guide another person to the project and explain it.
- Interviewing resource people and taking notes can be a powerful technique for sharpening the listening skills (you might be one of these resource people, or people from a secondary school, university or local industry are good sources).

Speaking

- Presentations require careful organization and care that vocabulary is explained at least at a peer level. Students often find the organizing of the presentation - its order and vocabulary definitions - to be far more challenging than the presentation itself.
- Students can be requested to give short summaries of their projects to date.
- Formal presentations reviewing background sources or biography of a particular person in the field are often very motivating.
- Small group communication within the cooperative group or between cooperative groups are powerful speaking opportunities.

Mathematics

- Mathematics is often termed the forgotten science during science fairs and celebrations. Mathematics-related presentations are definitely a part of any science project forum. The solving of a problem using a mathematical technique or procedure or the application of such a procedure must be recognized as an integral part of a well-rounded curriculum.
- Geometry often plays an important part in a biological structure. Challenge your students to look for specific geometric patterns in their projects.

Social Studies

- Aside from the obvious integration of geology, mapping and location, there are several other socials-related integration possibilities.
- Is there a cultural or current application for your project?
- How could it change the way people relate to each other or carry out their daily lives and careers?
- Apply the socials problem-solving/ decision-making techniques to selecting the next step in the project.
- Study the culture and events during the invention or discovery of the core element in your project.

Physical Education

- Challenging students to create an active game based on the workings of their project involves both problem-solving and usually a great deal of movement (as long as you control the space between elements).
- Develop a game in which students have several cards with their topic or key vocabulary word. Other students have to meet classmates and exchange topic cards and keep going until they have collected a determined number of different topics. Exchanges can only be done in specified areas of the field or gym. Only one exchange per stop.
- You can vary this and request ten different cards be collected, but only give students five to exchange, forcing teams to be created and for those teams to rid themselves of duplicate cards.
- Honeybee treasure hunts can be used to collect a list of science words or topics. Students are allowed no words or pointing. One student at a time in the group is given a card with the number of steps and the obstacles to be gone over, under or through. At the end of the sequence, a vocabulary word is posted. Students must tell their team how to get to the next word through body actions similar to a honeybee's dance. You can demonstrate movements or have groups develop their own signals for up, down and distance but require that, like a honeybee, only abdomen shaking, wing fluttering and walking movements be allowed. When the team finds the next word, one member comes to a central person to receive the next set of instructions.
- The physics of ball bouncing and the muscle/skeleton structure of the human body are other sources of integration.

Music

- There are several suggestions in science resource books for the integration of music in science. The science of music and the mathematical relationships between notes are two of the suggestions.
- There are wonderful compositions that have accompanied movies recently, including classical symphony scores in some successful science fiction releases.
- Rap music with appropriate creation or accompaniment of musical instruments and a borrowed chorus verse can be used to have students give a musical summary of their project.

Art

- The display boards can become works of well-crafted art and graphic art and also reflect some powerful problem-solving if students are required to decorate, paint or "mural" the entire display board area. This may result in swirls, collections of diagrams or beautiful, interpretive creations giving suggestions of the topic of the project. (Neat, well-decorated display boards are highly regarded at science fairs.)
- The diagrams required in a good science project display demonstrates the skills developed in the drawing element of the art curriculum.
- Science yields bountiful examples to be used in the art program. Mechanical devices are natural models for the use of shading and perspective. Given required elements of an art composition or three-dimensional art display, the problem solving steps can be considerable.

Drama

- Drama is a natural outlet for science. Both the high drama involved in a science fiction-related presentation and the oral communication skills required in presenting the project to a group can be developed through systematic drama involvement.

These are only some of the possibilities for integration. Hopefully, at the least, they will act as starting points.

BEYOND THE CELEBRATION

Application and Alternatives

The Science Celebration aspect could easily be incorporated into a formal science fair. This could lead to more sharing at the event, more discussion, breaking the formal barriers that competition may bring on. It has been suggested that a "students' choice" award could be given.

The Celebration could focus on one area of science and become a sharing of research and experimentation on a similar topic. The concept of the Science Celebration could be also altered by restricting the participants to a theme. For example:

- ecology fair;
- invention fair;
- physics fair;
- kitchen chemicals;
- weed fair;
- research fair;
- machine fair;
- rock fair.

The organization technique can also be used in other subject areas:

Social Studies:

- discovery fair (transportation, biography, discoveries, lifestyles of explorers);
- lifestyle fair (new innovations in modem living);
- cultural fair (examplesof research, created artifacts, clothing of other cultures).

Language Arts:

- enchanted island fair (life on an imaginary land);
- author fair (looking at an author's theme and style);
- book fair (displaying self-made books).

Art:

- display of art;
- display of results of particular techniques and media.

Mathematics:

- display of interesting math techniques and proofs;
- geometry fair.

Science:

- inventors' fair (research and displays related to inventors);
- inventions' fair.

And a big *et cetera*.

SAFETY

Ensure that you have reviewed the safety regulations and have investigated each project.

Common sense, anticipation of allergic reactions, anticipation of inquisitive young visitors making the wrong choices, anticipation of your students not managing equipment like a trained adult, and health and fire regulations drive most of these safety precautions.

Do a preliminary project discussion with each student before they begin to do the investigations and experimentation. Students are often naive about the dangers of electricity, chemical batteries, combustibles and the danger to animals of improper treatment. I have also found that some parents remember chemical combinations from senior secondary or university that are far beyond the safety limits for a 10 to 12 or 13 year old.

Listed below are the generally accepted guidelines for projects at an elementary level.

1. Think first.
2. Work carefully, do not proceed at a hectic pace or act in a reckless manner.
3. No flame, no heat. Most schools simply say no to any heat or flame experiments. If seen as necessary, any experiments requiring heat are to be done only when approved and supervised, away from the combustible display boards and never be allowed to be put on the exhibit floor. Making a digital recording to be shown on a monitor or laptop computer is as close as heat and flame should get to the exhibit floor.
4. Treat all living matter with respect.
5. Equipment used is approved by a parent or teacher.
6. Work in a room with adequate light and ventilation.
7. No blood, body fluids or scrapings.
8. No vertebrates (unless observations of normal behavior patterns).
9. In life science experiments, use the highest ethics. Just "because we can" or are curious is not a good reason to tamper with live animals.
10. No unnecessary or indiscriminate experiments on live animals are to be performed.
11. Be very aware of ventilation, protection and cautions surrounding fungi and mold experiments.
12. No inflammable substances, combustibles, caustic substances. Have ALL chemicals approved by your teacher before proceeding. Teachers may need to contact the head of the chemistry department in a near by secondary school, university chemistry department or secondary science fair organizing committee for support.
13. Discuss the use of electrically-operated equipment before proceeding. Use only when supervised.
14. Have your project and its equipment approved before proceeding. Get approval for any new equipment or procedures used as the project develops.
15. Any hazardous moving parts are covered (this is especially so that younger and overly-inquisitive visitors are not put at risk).
16. Any electrical connections are safe.
17. No high voltage is being generated.

Often an elementary teacher may need to check with the local secondary science department, university science faculty or the organizing committee for the nearest secondary science fair.

Body fluids and scrapings (cheek, for example) need to be approved. Due to concerns about diseases passed through body fluids, these are generally not allowed. Some older elementary students are interested in DNA demonstrations that do require body samples. Ask what DNA is first. If the student does not know what it is, where it comes from and what it indicates, this may be just playing with science. Separating DNA is simply a step by step procedure – of course so is surgery. Make certain the student has an awareness before proceeding.

This is not a complete or comprehensive list of safety regulations, merely suggestions. Check with local regulatory bodies. Local and national science fair committees have compiled a more comprehensive list.

ORGANIZATIONAL TIMELINES

If a teacher is going to limit the exposure of projects to the single classroom, then the timeline does change as there is no need for the material for public display (no tables and displays can be limited to posters that can be taped to the front of desks. However, if this is a multi-class event culminating in a public presentation night (which is truly a great deal of fun!), these are timeline suggestions for organizing a Science Celebration.

Six months to a year before event:

Concept planning

- Decide which you are ready to pursue:
  - a classroom-based project
  - classroom-based with visits from another class or two
  - a school visitation with parents invited
  - an event where other schools are invited
  - a school-based event plus selected students will be chosen to move on to a multi-school event

Physical site planning

- Set a date.
- Arrange for use of display facility (often gymnasium).
- Order tables, extension cords, table covers (if desired)

Student readiness planning

- Ensure that you are doing many hands-on science activities within the science program.
- If you have not already done so, begin to discuss extensions to classroom investigations and experiments. How could we change this? What could you do on your own to learn more about this?
- Have students do a simple demonstration bsed on material you have supplied. Learning the skills and steps of doing an investigation or experiment is important for student success in the pending independent project.
- Ensure that students are aware of the science process for their age level and one or two steps beyond (a hand written poster on the wall will suffice).
- Do some science challenges, science "Olympics," problem solving experiences.
- Raise the awareness for science through a science bulletin board (real or virtual on a class website).

One, three or six months before event

(lower primary one month, middle elementary three months, upper elementary six months):

- Begin the Science Celebration process as discussed in the chapter "How to get students involved in projects".
- Ask students for an approximate area of study. (I encourage students to tackle a subject they are personally interested in, although there are many suggestions available in your library or from your science contact person).
- Have students select topic, walk through the safety check.
- Although some students may be leaning toward a report, have them begin preliminary research then meet to encourage an experimental or at least demonstration element (sometimes this involves changing the focus altogether.
- Ensure that all students have a topic but discourage students who have just selected the topic from committing themselves to a specific question or hypothesis until they have become familiar with the variables, the concepts and the materials. This experience is again different from the "one shot" traditional science fair, but is certainly a component of good science.

- Begin the investigation, invention, study or experiment.
- Coincidently, ensure that the student begins a lab book or Science Celebration journal.
- Have students keep track of vocabulary words and concepts critical to the project. Ensure that these are defined and explained.
- Have the student record new skills that have to be learned. Looking back on the personal growth is part of the journey through the Celebration process.
- After the students have been working with the materials and have done preliminary experimentation, review their procedure and hypothesis.
- As the project develops continually check with students as to their progress. Begin the process of "Walking students through the levels" and encouraging a strengthening, deepening and raising of the level.
  - Once projects are established and the process has begun in earnest, announce both to students, the school and parents the extent of the Science Celebration journey.
- Send full information to parents. It is critical that parents be informed of the approach being taken and that the process is a class-room based project. The "check-in" points built into this timeline help the teacher both gather assessment data, support the student as well as offer opportunities for raising the level of the project.

Seven weeks before event:

- For intermediate students, request a point-form summary or formal written report on relevant background knowledge. I prefer a point-form summary as the report writing can take time away from working on the project and reduce enthusiasm.

Intermediate: Four weeks before event:

- Project up-date; project should be fully underway
- Students involved in multi-variable experimentation should be able to state a number of variables involved and suggest procedures for identification
- Students working on invention should have planned the device or procedure.
- Make arrangements for personnel and materials if you are arranging for a guest demonstrator or for science challenges.

Six weeks before event:

- Project up-date. If an experiment, report on procedure and hypothesis.
- Other types of projects have their own unique requirements. Check for research into area and knowledge of topic.
- Students involved in experimentation should be able to identify major variables.
- You may wish to invite VIP guests to give your students a knowledgeable audience. Often, this will include people who are at least four years older than your students (that is, upper intermediates if you teach primary; secondary school students if you teach intermediate). Ensure that you have informed them that their role is to review the projects and encourage the students, not to judge, critique or evaluate.

Primary: Two weeks before event:
Intermediate: One month before event:

- Announce the due date for all finished projects and experiments.
- This allows for full evaluation, changes and within-class sharing time.
- Invite other schools to the Celebration, if you wish. We sent a form letter of invitation to the schools so they could reproduce copies for their parents.

Three weeks before event:

- Project up-date.
- Project should be winding down. Report on findings and use of data.
- Report on construction if a model or engineering project.
- If students haven't repeatedly performed the experiment, remind them of the necessity of sufficient data to support any conclusions.

Two weeks before event:

- Report on progress of display board.
- Report on data and conclusion.

One and one-half weeks before event:

- Written summary due.
- Display board well underway. (Display boards may be requested for approval or evaluation/counseling).
- Oral presentation organized (summary may be requested).
- Organize the display space on paper.
- Determine any special needs of students (electrical outlets are generally the most important priority).
- Assign a display number or alpha-numeric code to each display
- Plan the exhibit room.

One week before event:

- All elements complete, oral presentation being practiced.
- Projects may begin to arrive for counseling and final evaluation.
- If this is a multi-class or school-wide event, set up mini-celebrations within classes to ensure that peers see all presentations.
- Teacher assesses the performance of the oral presentation.
- Final assessments complete. At this point the class assessment requirements of the Science Celebration are fulfilled. From this point forward, the goal is performance, student to student and student to parent teaching.
- If you are inviting special VIP guests, ensure confirmation.
- Remind parents of the event night.
- Arrange for a photographer (use parents or students or other teachers).
- If you wish, contact local newspapers.

One or two days before event:

- All projects must be at school.
- Last-minute changes demanded (usually in display).

Afternoon before event:

- Set up tables.
- Put display codes on tables

Science Celebration:

- See CELEBRATION DAY section for details of the day.

Next day:

- Ensure that all tables have been taken down, equipment returned, all projects stored or taken home.

PARENT INVOLVEMENT

FOR TEACHERS AND PARENTS, INCLUDING OF HOME SCHOOLED STUDENTS.

Why parents get involved:

Like any significant school project requiring a home time or home work component, parents need to be involved. It often is up to the teacher to ensure that the parents are getting involved for the right reasons. Many people with science project experience have tales of parents taking over a student project resulting in what may be a good product but a complete waste of time for the learning of the child. This is a process that needs to be done to be learned. Ensure that students are comfortable in their choices before moving to material gathering and experimentation.

Sometimes parents feel they must assist their child in the process. They know their child best and this relationship and support can be the beginning of a new level of learning and working around the home.

However, there are some wrong reasons for parents getting or needing to get involved:

- Parents are not informed of the philosophy of the Science Celebration and assume it is a science fair with end-product-only evaluation.
- The project or the entire process is perceived to be too difficult by the child;
- The child has been given inadequate assistance in selecting a topic;
- An inappropriate topic is chosen resulting in little or no information or support at the student's level;
- The assessment process is not understood by parents. If parents are under the assumption that the final product only is being evaluated, then they put their child at risk of getting failing marks on each of the preliminary assessments. By that time, no matter how spectacular the end product, or how well rote-memorized the presentation, the student will have failed the assignment (or at least in my room they failed). Communicating the process-based assessment to parents is critical. This can be avoided through communication and regular update meetings throughout the timeline.
- Doing the science project is more fun for the parent than the child (it should be fun for both).
- Parents are unaware of their role in the process.

This may seem like a daunting list, but be assured, reasons for parents positively being involved with the children through this process is a much longer (and happier) list!

Parents must first ask what their goal is in supporting their child.

This section has three distinct parts. One is general context, the second is for parents whose children are in a school setting and the third is for parents who are either home schooling or have a child who wishes to tackle a science project independently from school support.

Parent goals

There is one clear understanding that has emerged from working with children, students and parents. This perspective has been developed as a parent of children who have entered Science Celebrations and competitive science fairs, as a teacher working with students preparing for Celebrations and Fairs and from the perspective of a university science education instructor judging projects. Parents must be clear of the goal of supporting a child doing an independent science project. If it is for the product, for the end result, you are on the wrong track. For an elementary school student, the goal of support should be for the process: the development of skills, understanding of the processes of science, the development and opening of new pathways to thinking. It is the process. In order to support the development of the process, the child must take the leadership of the project. No matter how excellent looking a project may be, the real test is the impact it has in the months and years to come. If done well, even if that means considerable struggling and development, the experience can pay rich dividends for years to come. If just a project that looks good, even if a supplied and well memorized oral presentation comes with it, it will not have the same potential for long term growth as one done by the child "from the ground up." But then, most parents know this going in.

School Context

In the best of learning environments, your child is already committed to a science project through a classroom-based process and has had many opportunities for hands-on or activity-based science. The teacher has developed a plan whereby your child has identified a project that both intrigues and inspires and the beginning stages of the project have begun. You learn about the project either through the excited description from your child or a letter or note informing you that your child is engaged in a science project that will be in public view on such and such a date. If all has gone well, your child needs you only as a reflective listener and as a resource locator.

In the more common but still good learning environment, your child will need you to resource and to source. Not ideas but apparatus to support the idea; methods of ensuring appropriate repetitions, samples or observations have been made; perhaps that the correct glue has been used; or, perhaps that proper power tool use has been either supervised or assisted if potentially too dangerous for the child's age. In other words, support but not with the base concept or idea: that has been established and your junior scientist just wants help making in happen.

If your child has either had the task of developing an independent science project thrown at him or her with no context development or if your child is home schooled and you have put the task on the table, then you become the teacher. Use this book to help you support your child in locating a topic and then in "walking through the processes" to increase the quality of the product.

Two cautions before proceeding. One, science is inherently exciting but it also demands rigor, focus, precision and creativity. That is, if done well, it is not easy. Please support your child both in the project and in the attitude. Pressure, demands and lack of recognition for hard work has no place in supporting your child. **Out of struggles and encouragement to do the best, great experiences emerge.** I have seen "ugly" projects and "failed" experiments that have led a student to a burning interest in a previously unrevealed field of interest. Focus on the quality of the experience, not the look of the project… that will follow. Now expecting an effort and hard work is all part of parenting, this caution is to avoid negativism and making this potentially amazing experience be positively memorable.

The second caution comes from bitter experience; bitter both for this author and for the child to whom it happened. Parents must resist the temptation for doing the project themselves. Science Celebrations can develop so many skills and good attitudes that will bring benefits for years to come if the child has ownership of the project… struggles and all. Support the learning, the rigor and the child, not the physical project. My bitter experience is of a student who had a delightfully creative science idea. It was unique and well organized. It demonstrated some excellent science processes and skills. Most importantly it had been developed by the child and her face beamed when she talked about it. True, it would not be published in science journals around the globe, but she was learning a great deal through the experience and it was on the way to being her best academic project of the year. That was Friday. On Monday, the day of the presentations, she walked in with an incredibly beautiful display (which experience had demonstrated was beyond her artistic and engineering skill levels) based on a totally different and far overdone topic. As she had no real experience with the concepts being displayed and no understanding of the science involved, she went from having a strong, independent project to receiving a failing mark for the project as she could not explain what she was forced to display. It is not the physical product or even a memorized script; **it is the learning that is the key to true science project success.** The goal is not immediate gratification; the goal is years down the line when that curiosity is still burning in a young person's mind; when he or she can positively reflect on standing in front of a project and confidently explaining it and the background information. That growth can never be taken away. It truly can help your child become more, reach higher levels and have an exciting experience to reflect upon. Of course, like any other major project a parent will assist, will push and will support their child to learn and ensure that they have tried hard. Science Celebration projects often lead to unforeseen avenues of interest. Sometimes just the exposure to people appreciating what you have accomplished, people listening intently to your ideas is enough to spark a whole series of confidence growing activities. We have seen children change through this experience. Handled with care, this can be a very powerfully positive experience.

Home Schooled Students and Independent Minds

Home schooling, students away from a school setting with a tutor and students choosing to do a science project in a setting where there is no school-based guidance are three scenarios that are rapidly growing in numbers. This section is a quick recap of the entire book and is intended as a quick reference or starter page for parents and students embarking on an independent science project. The first section is part of this section written for students since they are the key to the project. Parents will need this information to help along the way.

Equipment

I will confess to admiring "basement science" experiments. That is, experiments that are created using apparatus around the house. This does not always satisfy the needs of a growing scientist however. Local schools may be able to provide a time to come in and use the equipment. If a project is well designed, secondary schools, colleges and university laboratories can sometimes be accessed.

If purchasing equipment is required, there is often a science center that has some in supply. Contacting the local school and asking what supply company they use for their supplies, looking up the equipment on the web and, with the school's permission, ordering equipment to be delivered in your name to the school works. Make certain the office is aware as often supply companies will call to verify an order. Sometimes science supply companies have outlets surprisingly close and you can order in person. If you are home schooling your child, bring in verification to ensure education/academic pricing.

THE A, B & C OF A GOOD INDEPENDENT SCIENCE PROJECT

Part A: The project

Before starting:
Safety:

Be mindful throughout the process of safety. Chemicals need to be researched. Sharp apparatus needs to have safety guidelines. Heavy objects need to be secured. Molds and microscopic organisms need to be treated with respect (and research). Do not make assumptions with unknown materials. For example, alkaline batteries should never be opened at home, strong acids or bases should not be used by a child. If you don't know what it is or how it will react, find out first. A question is a far cheaper sacrifice than losing an eye over an experiment… sadly not an idle comment. Always think safety first, review the project for health and safety concerns regularly. In this book there is a more comprehensive safety checklist. Parents, this is your prime concern and role.

Ethics

Treat all living things with respect. Unnatural confinement, adding foreign chemicals, using intrusive external devices or doing live dissections (of worms or insects, for example) are not ethical procedures.

Be prepared:

Have four log books or binder sections prepared. One for notes as the project proceeds. This is the log book.

The second for research, information and advice. The third for other approaches to the project that occur as you are trying one idea. Always complete an experiment if possible and practical before switching, but don't lose those insightful ideas and alternate approaches that pop up. Today it is possible to digitally record yourself over a two to several hour period. This would allow you to just dictate the idea and keep working.

The fourth for "discoveries." Sometimes things seemingly completely unrelated to the project will pop up. On occasion, these are "golden ideas". That is, an idea stronger then the original project and one that no one has come up with before. Don't be afraid to consider exploring a golden idea.

Become part of the "science community":

The science community supports each other very well. If you have a specific question (vs. a general or vague idea); if you are about to try something and are unsure of the danger or the appropriate process; or, if you have need of an apparatus far beyond purchase or rental price of an individual, contact the "science community." This could be a local school, industry, independent research lab or university lab or faculty. If you have an intriguing idea that is well formulated and a specific use for the equipment, it is amazing how generous with time the science community can be.

Be prepared to research:

Research is a key ingredient into understanding the principles, reactions and properties of the material and equipment you are using. Spend time in libraries, on-line or in discussion with a knowledgeable person. A completed science project should come with "spherical knowledge". That is knowledge about the apparatus, the materials, the experiment and previously learned knowledge from all angles: spherical knowledge. Excellent science is having fun but knowing what you are working with and being able to explain. Depending on the age of the child and the time frame parents may help source out applicable material. In some cases the material needs "translating" from university text to Grade 6-ish.

Step One: The idea

Although there are hundreds, even thousands of ideas for science projects available in books and on the Internet, in the end it is the child's curiosity that will drive the project. The first question to the child is, "What interests or concerns you?"

Brainstorming is a good first step. That is, the child just thinks about what things are of interest or concern. Write down a list of about 10 items. Often this list will get added to in the next one or two days. For most children, their minds could generate hundreds of items, but there is always a time limit on getting started. Give yourself or your child a week. At the end of the week, the child circles three things that really are of interest. Leave it for three more days. If nothing stronger than those three comes to mind, develop some questions for each one. Do a little reading on each topic of interest. Often the "I didn't know that!" affect will happen and an idea just takes off. Now review what specifically about the topics would you be interested in? At this point, don't be thinking about apparatus or TV experiments, just go with the creative flow. Ask the child to honestly reflect: What do you want to discover?

Generally one idea tends to take form. If all three have the same interest and possibility set, then it is decision time. Which one do you want to devote a minimum of one month, three months better or even a year investigating? If still all three generate the same level of interest, either merge them into one or more practically throw a dart, flip a coin, pick one out of a hat. Usually when left to chance a person looks fondly at one that was not picked and realizes where the interest really lies. Which ever path is taken to get you to this point, you have chosen a project topic. My stern advice at this point is, after a day, don't look back. You can always go back to an idea, but treat the chosen topic as a "cause" as a "calling" and "go for it hard." Flip flopping ideas is a sure way to generate confusion, frustration and ultimately apathy. Don't go there.

This approach is generally far more satisfying than just choosing a previously done project and replicating it. That type of project does teach skills of science, but does not stretch or develop the processes—unless you walk it through the processes (below).

Step Two: "Fiddling" with the materials and research

The next preparation step has two sides to it. Side A is assembling and working with the topic. This may be discovering strengths of structures or construction variations, observation of the phenomenon, manipulating and discovering properties of the apparatus. This both develops a familiarity with the apparatus as well as might result in a different application of the equipment (if safe). Either way, it is important to get to know the material you are using. If this is a chemistry project, then a parent or child needs to have ensured the safety of the chemical. Check into known properties (web pages, a secondary school, science center, college or university can often help). Include reactions to heat as well (you don't want surprises). Do not mix unknown chemicals together without research. I have called this discovery phase "fiddling with the material." It needs to be done cautiously and when discovering properties. Have fun. Be safe. Keep notes.

Side B is to be researching the background of the topic. Which scientist has "been this way before?" What do we know about the topic. It is not uncommon for an idea or question to be asked by a student and for no one to have recorded an answer to that question. It is also not uncommon for a student to "stumble" upon an important discovery. Keep notes.

Step Three: List and discover the factors involved with the pending experiment

What are the things that are truly involved in the experiment? Not only record what is obvious, look around. Notice the light, the air movement, the equipment you have chosen or have at hand. Scientists in laboratories not only try to reproduce known experiments, they also try to determine if other factors have caused the particular conclusion. Think like a scientist.

Step Four: Design the experimental approach

You should not just jump into the experiment, but, having said that, in the fiddling with the materials step (above) you most likely have tried certain aspects of the experiment out just to see what happens (but not chemicals, please). Read the experiment section in this book to get a clear handle on the process and the role of an hypothesis.

If you are planning on an engineering model, the experiment will test the device's strength, properties or effectiveness. Engineering always requires a two step process.

Diagram the experiment. Often committing it to paper will help understand it.

If the project is based upon observations of natural phenomena (animals in the field or lab setting) or large object movements (bridge traffic flow), then be prepared to take very careful notes. Digital recordings can help.

Step Five: Gather the stuff

Organize things prior to the experiment. Physically set things out. Mentally walk through the experiment so you know where to reach this, where to turn that. Have log book or research assistant handy (parents again). Check for sufficient air flow if chemicals or living things are involved. Try and rule out unrelated factors (make sure the desk will not shake at the wrong time or that someone may flip a switch that shouldn't be). What do you have to help with the observations: good eyes, digital camera, measuring devices (mass scales, capacity containers, thermometers, and so on).

Step Six: Experiment

Follow procedures outlined earlier in this book. Record. Take notes.

Step Seven: You have just begun.

Repeat the experiment several times (5 to 20) before changing strategies.

Step Eight: Analyze

Take the data collected and put it in a manageable setting. Graph data if possible. Use Excel or a similar program and do at least two different graph types (for example line and bar, scattered and interval). Write down EVERYTHING you noticed, keep an "eye open" for things you did not expect. That may be the "golden idea."

Look over your data and comment on what you have done and seen. Sometimes your own comments can spark a deeper understanding.

Step Nine: Summarize

Look over your notes, consider the hypothesis and respond to the hypothesis in a conclusion or summary statement. Add to that statement possible sources of error, what you could do to "tighten up" the experiment (sometimes this involves noting the need for equipment either not available to you or perhaps not yet developed). Also reflect on what you would do next time.

Step Ten: Conclusion and Error Analysis

The conclusion of an experiment must go back to the hypothesis. For younger students this is simply, "I thought this would happen. It did/it did not." For more sophisticated and older students, it states whether the hypothesis was correct or not.

It also includes reasons why the experiment may not have been accurate, what things would need to change if possible. This list of errors in procedure, process, measurement, observation, quality of equipment, quality of approach, time available vs. ideal, restrictions due to availability (and expense) of materials, analysis approaches and so on are all part of error analysis. In a secondary or an elementary competitive fair, this is a critical part of the process. It is especially important to let an evaluator know that the child truly understood the limitations of the project and even more important, what he or she would do next (given time and resources)… in that is the making of a true scientist.

Step Eleven: Are you a real scientist?

If you are a real scientist, you will look over this experiment, revise it, adjust the equipment and do to all over again. You might explore any golden ideas that have come up or you may practice Thomas A. Edison's time acknowledged "secret" to good science – it's based on 99% perspiration. Do it again. Look for possible errors, note them, and correct them. Try again.

Part B: The Display

At some time in a Science Celebration or science fair project, you must declare the project finished. Next, you move on to the display. How can you best communicate the project to a reviewer, judge, younger or peer students and to parents?

Start at the same place the project started: What was the question? What was the spark of interest that brought you to this project. That will be centered with a brief explanation as to why you took the project on.

The concept flow of your display should move from left to right. Question, hypothesis, material, procedure on left. Pictures, designs, data and results in the center. Conclusion, sources of error, future modifications, acknowledgements and references on the right. Lab book with all the parts on the table. Possibly a display of apparatus as well (this may be a monitor showing a digitally recorded view of the apparatus and experiment). The paper displayed is best framed in an attractive manner.

Some creative people color the display board with a wash a single color or an artistic or graphic design. Putting craft, butcher or construction paper over cardboard is out. Not only is it a fire hazard, it does not look nice.

"Sell the project" through the display. The test here is would a person who knows nothing about your project be attracted to the display?

The title is often the last thing decided. Snappy, intriguing titles are great; good old fashioned "tell it like it is" titles work just fine.

Review carefully the requirements of the setting to which the project will be taken. Do you need electricity… is it provided or do you need battery power? No exposed wires. Generally no heat source may be brought (digitally record it and show on a monitor which you will bring). Do not bring ANY chemicals. If the show is deemed necessary, fake it with water and food coloring and seal the container. Take a picture of plants and either bring the picture or plastic/synthetic plants. Use your imagination, just ensure the display is safe. The test is, can a 3 year old get hurt if left alone in front of your display… hey, it happens.

Part C: The Talk

To be effective at a Science Celebration or science fair, you must have four levels of oral presentation ready.

Really, really know what you are talking about. Have your research committed, if not to memory (which is best by far), then at least within a short distance away. Who did this kind of research before? Whose theory are you using as an assumption to proceed? How did you learn about the properties of the material you are using? Have the reason why you embarked on the project ready. Have the equipment and apparatus and how it works well learned. Know your hypothesis and why you chose it over an alternate. Know your procedure, including choices you made along the way to revise it (really important). Know your data and analysis of that data. Know your results. Know what you would do differently if you had time to do it again or had resources to experiment more deeply. Know who helped, how much and why. Know what you have discovered and why that is a really neat thing. In other words, really, really know your stuff. Explain it carefully. If the reviewer's eyes glaze over, ask if they have heard enough. Some want to walk through every avenue you took, every choice you made, every discovery you came up with and every frustration that confronted you. Remember, they may have done this walk at your age or just last week in the lab. A scientist loves to hear about science.

Have an "abstract" or a summary comment for parents and interested adults who pass by. Be enthusiastic. Often you need to "engage them out of boredom." They may have seen 50 other projects before yours. Act like a salesperson and think that your project is the only one worth seeing. Give them the highlights and let them react. Often an adult will spend half an hour on a project and pass right by high quality projects that don't match their interests.

Have an explanation ready for children who are younger than you are. Review the vocabulary you are using and explain words that are technical. Try and have a demonstration (even if that demonstration is pouring water from one plastic container to another (glass is frowned upon in some events). It is even better if you plan to let them do something. Have a set of questions they can be looking for on your display board that you can pass them. Interview them to see if they have an interest in the topic. Entertain them… from their perspective it is all about them, not all about you.

Finally, have "the show." This is a very well prepared, well orchestrated and very, very well practiced explanation of the project. The format is simple: walk them through the display board. Follow the same steps as you used to put the board together. Recording yourself with a video camera and watching (as painful as self-analysis is) is very useful. Eliminate the things that are distracting, emphasize clear explanation delivered honestly.

However, there are some keys.

Always stand up when doing "the show". This is for reviewers, judges, neighbours and friends. The reality is that you are being assessed from the moment you walk on the display floor until you leave. In science fairs, the most significant judging is always done when students are the most tired. Tiredness cannot exist while you are on the display floor.

Make eye contact, focus on this person, block out the rest of the exhibit floor. Do not look at your display except to point out something specifically when a gesture of the hand in the general direction will not suffice. By the time you are reviewed, you should know that display board without looking at it. Those who look have not worked hard enough (remember this is "the show" and much more than just an explanation).

Be prepared to engage them in questions. Not every reviewer is experienced. "Do you have any comments on the data or the hypothesis?" is a good starter. At this level the reviewers are suggested to consider the processes used. Engage them in a discussion.

BE HONEST. BE SINCERE. BE ENTHUSIASTIC. One of the descriptors for an excellent science fair presentation is "delivered in a manner that is as much entertainment as informative." That takes practice. Remember this part is a show. You can be an actor and become someone else when you deliver these lines. Just always be prepared to extend into the level of detail discussed in part 1 of this ("the Talk) section.

MAKING IT BETTER

Science projects are learning processes. Refer to the section that describes the "processes of science." In schools, these processes are emphasized at different grade levels beginning with observation and moving to designing models. At each grade level the processes "below" the one introduced are all to be incorporated in science for that grade level. However, it is not uncommon for a young child to have an understanding of all the processes.

To make a science project better, there are a number of steps to be taken. The first and basic one is to "walk through the processes."

Walk through the processes. Using the list of processes as a guide, review the project and ensure that each process has been addressed. Begin with observation. Have all observations been done cleanly, carefully and recorded properly. Was observation equipment (microscopes, thermometers, barometers) used appropriately, cleaned, set properly. Have notes been taken well. Have diagrams been drawn?

Move on up the list of processes. Each becomes slightly more sophisticated. While it is true that not all may apply to a specific project, many do. Applying some processes may take significant reorganization of the project. Be mindful of time, talent and energy but strive to move the child through the processes up to the suggested grade level. Going beyond should be a choice of the child... many can go quite far.

Rigor. Increase the number of repetitions. Collect and record the data faithfully. Review procedures and try and eliminate any sources of error. Redo each time a source of error has been detected but keep all records for comparison. Some identified "sources of error" are actually keys to the success of the experiment and the child needs to come back to a previous starting point. That's all science.

Increase the quality of the equipment. After the initial planning or even experimenting, source out higher quality equipment. This may be found in local schools, colleges, industry labs. Having the plan and the initial findings, the goal of more precise experimentation is always respected (if there is time). Keep the original notes and findings and make certain to compare the results of "coarse" equipment with the new elegant set. Sometimes the revelation is how accurate 'invented" equipment is.

Locate a mentor. Locate a person who has trained experience in the field. Bring in the experiment and the results and discuss the hypothesis (always start there), possible sources of error in assumptions or processes. Ask what areas of research or what particular writer or area of science might add insight to the concept, experiment or conclusion.

Evaluation:

Assistance in evaluation and self-evaluating projects is available elsewhere in this book.

Finally, Have Fun:

Science Celebrations and science fairs do require work to move from ideas to completion. Giving the presentation to reviewers or judges takes preparation, concentration and (sometimes forced) enthusiasm. However, each event has a wealth of learning opportunities. Enjoy learning what others have discovered. Remember, sometimes "good science is ugly." Don't pass by projects too quickly.

Often an event will have activities, challenges and even entertainment for the participants. Enjoy, learn, have fun.

Most importantly, in some way every single person on the display floor has at least one thing in common: a science project. That is an instant starting point for conversations with new people. Often networks of friends develop from a Science Celebration experience. Sometimes there is just a lot of learning and fun. By the time you get to the display floor, you certainly have earned it.

In my experience, the one consistent factor with every scientist that I have met, young, experienced and "retired" is the passion for their chosen field of science. Don't be afraid to show your passion. Passion and curiosity drive science.

Sample letter to parents:
Dear Parents!

Exciting things are about to happen: we have begun the process of having a **Science Celebration!**

Science has become an increasingly important part of our society and will be of even greater importance in the future. This is an opportunity for your child to participate in the science process first-hand. Parents and other members of the community will have an opportunity of viewing the projects on (date).

The assessment and evaluation of this project will occur during the period leading up to the celebration event—there will be no judging on the day of the celebration and no competition between students. The evaluation will be based on the processes used, discovered and understood by the students. The competition is within themselves, not each other, although this process is excellent for preparing students for competitive science events in years to come.

Your child will receive a timeline with indications of reporting times and expectations. It is important that these timelines be respected, although some flexibility will be allowed. Students will be required to develop some background knowledge related to their selected topic as well as complete the project.

On the event day your child will be required to have:
- a completed project;
- a display;
- an oral presentation (maximum 5 minutes; no pre-recorded presentations allowed).

On the event day, your child will be sharing his/her presentation with students and the community (including, we hope, yourself).

Parents are often unclear as to their role in projects of this nature. Below are some guidelines.
Parents may:
- ensure the project is conducted safely (no open flames, dangerous chemicals, poisons or experiments with vertebrate animals are to be done);
- assist with transportation of the project to and from school;
- complete technical work on construction of display board material and use of electric equipment as directed or needed by your child (this is allowed due to the safety factor);
- give advice;
- help establish a topic or direction;
- assist in collecting material;
- watch the progress of the project;
- give a great deal of moral support.

Parents should refrain from the temptation to:
- dictate what the notes say;
- provide or locate all information to be used;
- draw diagrams;
- do the project.

Please detach, sign and return the acknowledgement below.

I am aware that my child ___________________ is participating in a Science Celebration. I agree to provide supervision for activities that are conducted outside of school.

____
signed

CELEBRATION DAY

The date has arrived and you are ready for an exciting event!

If you are not doing a school-wide celebration, the sharing techniques used are easily transferable to a single classroom setting. In fact, I use the techniques in the classroom to train students into the procedures of the celebration day.

By this time, your evaluations are finished. You have completed assessing the students and today is the celebration. The pressure is on the students for only one purpose - to communicate - and in the tradition of the stage, the performers will not let you down!

Try and keep the tone of the day relaxed yet business-like. Too rigid an atmosphere will detract from the goal of students learning from other students, too relaxed opens the possibility for breakage and injury.

Here are some things to have arranged before the day begins:

- Walk through the site before projects begin setting up to ensure that all tables are secure and the pattern is organized properly (see ROOM ORGANIZATION);
- Ensure that parents and other teachers are aware that once the sharing begins (see THE KEY TO THE CELEBRATION) no classes or parents will be allowed in the display area;
- Who is in charge? Someone, or a team which communicates constantly, should be designated. Do not let this event just unfold as there are several decisions that will happen on site that will affect placement of students or announcements;
- All projects have been evaluated. If you have not had the opportunity of evaluating particular projects, then arrange to do so either unobtrusively or after the event;
- Be prepared to refuse to allow a project with new or previously unrevealed components to be set up. Some students will have failed to communicate to you an element of their display that may be dangerous. Seek a compromise but be firm on the safety aspect;
- Have the room physically set up the afternoon or evening before (see ROOM ORGANIZATION);
- Ensure there is a working microphone and speaker system (or you have a good projecting voice);
- From time to time, announcements will need to be made. Think ahead how you are going to interrupt the event to make those announcements (including the evening event with parents and community members present). For example I use a technique mlodified from the Scout/Guide movement. I make a sound (either ring a bell or tap the microphone) then raise my hand. It is a painless, effective way of interrupting a crowd;
- Arrange to have a messenger working with you. They could be a set of students who are not presenting or a volunteer parent or teacher. You will need to send messages and get information during the event.

The students' day begins!

8:30 Begin set-up of projects.

- During your evaluations, you should have identified those projects that will take extra time to set up. Have those students arrive earlier to begin. Generally, this is 8:30 of a 9:00 day. Other students can arrive at 8:45 and even 9:00.

  If students are arriving from different schools, arrange a place for coats and lunches to be stored.

Set-up time differences.

- Either have students remain at their projects, have an opening activity, or have students return to their room to ensure that there is no unacceptable behavior at the start of this exciting day.

9:30 Opening instructions.

- By now it is hoped that all students would be familiar with the format of the celebration sharing. The instructors should review the procedures and remind and reinforce the objectives of the day: to celebrate each others' efforts in science and to learn from each other.

- In these opening remarks, remind students of the exits in case of the need for emergency evacuation. Also, evacuation and disaster procedures should be reviewed.

9:45 Sharing.

- Before the sharing begins, I place students back at their display positions and identify the first presenters in the group (these will be numbered "one" and will be students I feel I can rely upon to give a good presentation despite being first). I then ensure that each section knows the order of presenters.
- See THE KEY TO TIlE CELEBRATION for details on sharing and follow up cooperative activities. No outside groups should disturb this activity.
- In-depth sharing begins.

10:30 Recess

10:45 Presenter to presenter visiting.

- Following the in-depth sharing, arrangements should be made for touring the rest of the site (see SITE TOURING for details).
- Morning Kindergarten visitations.
  - Hopefully have the happy situation of having Kindergarten children as part of your celebration. If not and you have a morning-only Kindergarten, this is also a good time for them to visit the site.

11:30 Science challenge or guest demonstration.

12:00 Lunch.

Depending on your day and your choices, this might be the end of the first day. Generally, Science Celebrations involving the entire school go on until the evening just because the space is difficult to reserve.

The entire above scenario could be done in an afternoon as well.

1:00 Classes not involved in the celebration may begin visitations.

- Parents who cannot attend in the evening should be allowed to attend at this time.
- Participants have most likely not completed their site tours and should be allowed to do so.

2:30 All visitors should leave the display hall. Participants should return to their projects and ensure that all is in presenting order. If there is an evening community opportunity, meet with all participants and review the procedure for evening visits.

Dismiss the participants to their rooms or schools. Ensure the display hall is empty and accesses locked.

6:30 Open the display hall for evening visitations.

- Suggest to parents that they visit their child first and then visit at least five other projects.

8:00 Bid goodnight to all visitors and participants. Ask all students to take home as much of their projects as possible.

ROOM ORGANIZATION

The arrangement of the room can assist in the sharing and communication of the celebration.

The arrangement of the room can assist in the sharing and communication of the celebration. If you are expecting a large number of participants or a large crowd of visitors, then arrange the tables in long rows to ensure maximum space usage and ease of movement.

If you have the luxury of a smaller number of participants, then forming the tables into groups of U-shaped sections aids in defining a section and encouraging sharing.

Tables or display space should be arranged the afternoon or evening before the celebration day. This task takes too long to do on the morning of the fair.

Divide the room into sections of at most ten displays. Six is a better number. Label each section in some manner.

We originally used the names of famous Canadian scientists and had the "Best" Section, the "Herzberg" Section, the "Bell" Section, etc. Students were required to familiarize themselves with the biographies of the particular scientist whose section they were placed in. This could be done using any of a number of themes (animal names, cloud types, or plant species).

In a group, not as familiar with each other or with a large gathering, using colored paper coverings or simply labelling sections by letter is very effective.

Each position for display is issued a section label and a presentation number (Al, A2 or Herzberg3, Herzberg4).

A valiant attempt should be made to place displays that need outlets near a wall plug. If you are dealing with other schools, my experience is that at least one student will not have indicated the need for a special position and you must be prepared to switch presenter positions. (If that happens, select one that has little set-up time requirements.)

Students are placed as heterogeneously as possible. Each section has a variety of grades, topics and schools. This could be changed to sections with the same topic if you feel students would benefit from seeing the different approaches taken to a similar subject. My feeling is that the variety keeps the interest, excitement and celebration factor at a maximum.

Vary the sequencing of numbered positions within sections sharing the same walking-through space to try to ensure that there is no bottleneck at the centre spot when both middle numbers are presenting. To avoid this, number one section consecutively from one end to the other, begin your numbering of the adjacent section in the middle. That is, number one section Al, A2, A3, A4, A5, A6 while the adjacent B4, B5, B6, B1, B2, B3 (please be more creative than A and B!) Try different methods and still be prepared to alter the sequence of a group if both sides of a walkway are presenting in the same vicinity.

A microphone and raised podium on stage are useful features.

CELEBRATION HELPERS

In an event such as a Science Celebration, it is important to get a great deal of help and helpers.

On the day of the Science Celebration, assistance is needed for the small jobs and duties. These may be filled by teachers, parents, students not involved, presenters temporarily released from their display position, or secondary school students.

Here is a list of some of the people you will need:

- one or two messengers;
- section coordinators;
- visitor escorts;
- people to help escort young children and VIPs through the site.

Section Coordinator
Ideally, each section has an adult Section Coordinator. The role of this person is to act as an assistant during set up and take down, to monitor the group during the sharing and to control any inappropriate behavior and questioning.

During the sharing, it is important that students not be intimidated by questioning and that the flow from project to project be efficient.

You may have chosen a sharing option that requires the listening group to respond to questions from the presenter or to pre-set questions. Often students can handle the questioning well, but with certain groups and ages, an adult allows for less tension and more in-depth answers.

Section Coordinators may be teachers, administrators, parents or members of the community. One could bring in the police liaison officer, school board trustee, local business people, etc. In reality, teachers used to science often make the best coordinators.

Ensure that all coordinators know that this is a celebration for the students. It is not an opportunity to teach a lesson or offer detailed explanations or related interesting facts. Let the students come first.

The Coordinator should receive a list of expectations and guide-lines both for the students, the celebration and for themselves. Give each Coordinator a map of their section with the project position names, student names, wash-rooms, and emergency procedures.

Responsibilities of the Coordinator

- Supervise the students (ten displays) in a section.
- Assist the students when necessary.
- Supervise the orderly movement from one presentation to another.
- Ensure your section speaks quietly.
- Ensure that questions are appropriate for the project and the presenters' abilities to answer.
- Ensure each presenter is applauded and that remarks are positive.
- Be a reference point in the confusion for the students. They have been directed to contact you if they have a question or request (they will seek your permission for washroom use, for example).
- Enjoy and participate in the learning going on around them!

General Organization

- The students will be seated around each presenter in your section in turn.
- The starter's position will be designated before you arrive (by position in the room to ensure minimum noise for each presenter).
- Each presenter (or group) is allowed five to ten minutes to present (adjust this range for younger students). Questions take a further five minutes. This means each presentation is allowed about 10 to 15 minutes. Hopefully not all students will need this much time.
- At this rate (with one or two minutes for changing position), the group should be finished by noon. The students will be given a recess break.
- In the afternoon, your role changes so you can join the students in enjoying the displays.
- Each section will be invited to go on tour and view the other presentations. The students have been asked to prepare a short version of their presentation for this time. Other classes and other schools will also be invited to tour the area.

SITE TOURING

Prime your presenters before the visitations begin. They must be prepared to talk, grab passers-by and be open to questions.

It is a good idea to establish a touring direction to ensure smooth movement during crowded times.

Alter the sharing time is over, participants will want to see the remaining exhibits on the floor site. Also, visiting classes will want to view the presentations. These two requests require different approaches. Participant touring offers opportunities for cooperation, listening and learning not to be missed.

There are a number of methods of having students tour the site:

- Ask teams of presenters to identify who will tour first and who second. For individuals, try and release a section, row or simply the odd numbers.
- Ask adjacent presenters to be prepared to explain their neighbor's project.
- When dealing with several classes or schools, release a section and simply close off the section until that group returns and continue this process. This ensures security of equipment and safety of projects.

When other classes are visiting, there are other procedures to keep in mind:

- All visitors must be reminded of the "No Touching rule";
- For young groups of visitors, I arrange for one member of paired or grouped presenters to serve as tour guides. They each take a small number of students to predetermined starting points;
- Divide older visiting classes into groups of four and send each group to an area on the floor. Remind them of the direction of traffic;
- When parents are visiting, all presenters must be reminded to stay at their display and try and talk to as many parents as possible;
- Often parents are shy about talking to science project presenters. The presenters must realize they are being good hosts by engaging the parents in a discussion of their projects.

TAKE DOWN AND CLEAN UP

The procedure you use to instruct students to take down and dean up will have a good deal to do with future Science Celebration successes.

Take Down

- Request that all students take care of their projects and treat them with respect as they take them home.
- You may have occasion to have selected students to present their project in another forum (a local shopping mall, another school, a Regional Science Fair).
- Have a number of students prepared to assist others in transporting cumbersome materials to waiting cars or to a holding place until transportation can be arranged.

Clean Up

- Try and get parent help in taking down the tables, although it is possible you will not be able to take down the tables until the next day.
- Ensure that you are returning the correct number of tables and electric cords.

Acknowledgements

- Thank you letters to those who assisted are always appreciated.
- Generally such events are supported by the school administration, the custodial staff and the parent group.
- A letter to students and parents is a good idea.

PROJECT DEVELOPMENT

WALKING THROUGH THE LEVELS

One of the exciting advantages of the Science Celebration is the opportunity to work with students and to challenge them to move their thinking and their project to the next level.

In some cases the next level is the next process of science. Each province and state has defined the processes of science in their curriculum guides. Generally they all start with observation, move through experimentation and on to formulating models to explain phenomena. I gave students a quick lesson on these processes and after their first attempt, had a discussion on how a student could improve their project through using another level of process thinking.

The same applies for use of equipment for closer observation, measuring and data recording. If you feel it is appropriate and the student capable, then expose them to the equipment and invite them to use it in their project.

The third way of "Walking Through The Levels" is to consider the chapter on Levels of Projects. Use it as a guide to help a student consider a more sophisticated approach to problem solving in their project.

This type of progress can be used with a single class challenge that you continue to work on as the year progresses or as a basis for designing lessons requiring progressively higher levels of processing as the year unfolds.

This Walking Through The Levels can empower students with an understanding and a love of science that can last a lifetime. Success, feeling successful and receiving comments on their work are all contributers.

I have found that by assisting a student in developing a project, it can be the best project they have done all year; in some cases in their school career. This is a very powerful tool for positive change.

QUESTION AND HYPOTHESIS

Developing the question (or purpose) for an experiment is perhaps the most important step. Students should not jump quickly into this decision. Here are some suggestions leading to selection.

The teacher must first decide how much freedom and responsibility the students are to have in question selection:

- is the project to be an out-growth of a current curriculum topic;
- will these students need assistance in selection;
- are the questions to be pre-set.

If the students are to select their own questions, then there are some steps they may follow:

- put down on paper those things that interest them;
- web ideas from each one;
- shortlist those that interest;
- consider what is involved in having each of the selected questions developed into an experiment;
- work with a topic within the current class topic;
- use experiment source books and lists of suggestions for idea sources.

Students should work with the selected question keeping in mind that it may change as they become more involved in the project and as they develop more skills and knowledge. Students should expect to change their project question as they get more familiar with the factors, reactions and properties involved.

PROBLEM-SOLVING AND DECISION MAKING

This model can be practiced in several curricular and real playgrounds or class interaction situations.

- consider what the problem is;
- who and what is involved who and what will be affected;
- what variables are affected;
- does a decision have to be made here;
- what do we need to know before we can make a decision;
- where do we get the information;
- gather the information needed;
- evaluate the information;
- what are the possible alternatives or tentative solutions
  - brainstorm creatively;
  - consider suggestions from research gathering;
- what are the consequences (plus, minus and interesting points) for each suggestion;
- shortlist ideas that appear to be beneficial;
- what do you need to know about each alternative to help make a decision;
- evaluate the alternatives;
- select one;
- implement the decision.

Or, in abbreviated form:

- What's the problem?
- What can we do?
- Which idea is best?
- Do it.

Hypothesis

Students often make the mistake of assuming that a guess will suffice for a hypothesis. That is often an error that leads to a mediocre investigation or experiment. A good hypothesis (for older students) includes possible reasons and explanations; or at least supporting theories.

As outlined earlier, students should work with the materials and concepts and develop some base of knowledge before settling on their first working question (or experiment purpose). Students should then proceed in the same manner with the specific question in mind before settling on their first working hypothesis.

The hypothesis defines the direction of the experiment and should be considered carefully.

Some simple questions to ask before suggesting hypotheses are:

- what are the variables that are involved;
- what would be involved in testing each variable;
- what can I learn by reading about this subject;
- what do I know about this question, the materials, the interactions and reactions.

A web of ideas should then be created:

- what are possible outcomes;
- what variables would be tested, which deliberately held constant;
- what procedures would be used to test for the specific outcome;
- what materials and controls are needed.

When these factors are understood or at least considered, then shortlisting and selection of hypothesis should begin.

Hypotheses may be incorrect but still yield excellent experimental results. They may also be abandoned and a new direction taken. The caution is that students understand something of the topic before rushing in to commit themselves to a specific hypothesis. Also, that hypothesis should be based on information gathered on the topic or experiment; it should not be a wild guess.

The hypothesis forms the basis for part of the conclusion of the experiment.

OBSERVATIONS AND CONCLUSIONS

Observations

There are a great many excellent sources suggesting good data gathering, measurement and observation procedures, recording procedures and data analysis.

Students should keep a well-documented log of their results.

Conclusions

Conclusions vary depending on the level of the project and the level of processing of the student. They may be as simple as we made the pinwheel turn to a full explanation of all factors listed below.

Full experimental conclusions usually have a number of parts: response to the hypothesis, results from observations, comparison to research, application of discoveries, directions for further research.

Response to hypothesis:

- The hypothesis sets the direction of the experiment. The conclusion should answer if the hypothesis was correct;
- Suggest reasons that support the correctness of the hypothesis (answers should be framed in terms of variables and which ones were responsible for the effects);
- Suggest reasons why the hypothesis is incorrect;
- Respond to which variables may have had an affect on the hypothesis not anticipated at the beginning of the experiment.

Results from observations:

- Interesting, significant or unexpected results arising from the observations (measurements, observations, indications and results from data analysis).

Comparison to research:

- Reference to similar experiments conducted and reported should be made:
  - are the results similar;
  - are there any differences (suggest why);
  - were different variables tested in your experiment;
  - do your results demonstrate a property or principle indicated in the research.

Application of discoveries:

- where can the results be applied;
- what suggestions do you have for application of existing processes or products;
- what precautions or decisions are suggested.

Directions for further research:
New questions arise out of your experiment;

- what refinements would you suggest if the experiment were to be redone;
- what changes are suggested:
  in variable control;
  in hypothesis;
  in question;
  in materials;
  in procedure;
  in measurement;
  in data gathering and analysis;
- What similar or related questions might be investigated?

The Science Celebration by Len Reimer, copyrighted 1994.

DISPLAYS AND DISPLAY BOARDS

Displays for Youth Science Canada events must have display boards that are between 1 metre and 3.5 metres In height and a maximum of 12 metres in width. I strongly urge you to keep display boards at and below this level. The large billboard displays that take up a full (or even two!) tables are not appropriate.

Display boards must be made of non-flammable material. Often local stores supply such products. Paper and cardboard suppliers can often ship a set of appropriate boards.

Display boards usually contain the elements of the experiment. There is no pre-set placement requirement on the display board, although by insisting upon such a placement for all students, it provides a very appealing, easy to understand set of displays for visitors and for easier evaluations.

In science fairs, display boards are evaluated on their attractiveness and neatness, visual communication and the degree to which they inform the observer of the important elements and results of the experiments.

PRESENTATION

The goal of the presentation at the Science Celebration is to inform other students of the processes used and the discoveries, inventions or conclusions.

Presentations should be enthusiastic, informative and understandable. As they are aimed at students the vocabulary must be controlled and well explained.

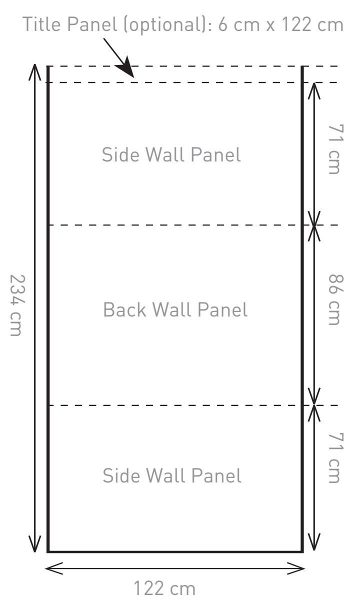
The presentation should be a well-rehearsed demonstration that flows smoothly and even dramatically.

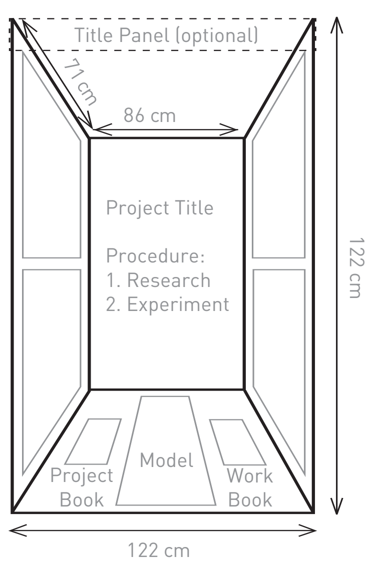
Expectations During Presentation

One of the advantages of the celebration is that you can design the type of interaction between participants.

Here are some suggestions that you may want to consider for your next celebration:

- students present their purpose, procedure and results in a manner they choose;
- students must explain all unfamiliar vocabulary;
- students must involve the participants in questions or in activities;
- students must have posters illustrating their presentations;
- students must prepare a separate presentation each for adults and younger students;
- students must focus on a particular aspect of their investigation, such as identification and control of variables, use of equipment or conclusion;
- participants must listen and ask at least one question relating to the project;
- participants may give an evaluation score;
- participants must comment on one aspect of science that was well done, and so on.





ASSESSMENT METHODS FOR SCIENCE CELEBRATIONS

A key to the success of the Science Celebration Is that evaluation be done before the celebration day.

Evaluation of the Science Celebration before the celebration day allows not only for more careful assessment but also lets the day become a celebration day where the students sharing and learning are at the forefront.

The evaluation of any endeavor at school must be based upon the objectives of the activity. Science Celebrations fit in with the current process-based curriculum and it is these processes that must form the basis of our evaluations.

Process evaluation should be both a system of assessing the processing levels of the students and of assessing the directions and needs of our classroom curriculum. For this purpose, I suggest the Timeline Evaluation system is the most appropriate to use.

Evaluations

There are at least four types of evaluations possible:

- process/product evaluation at project completion;
- student evaluation;
- self-evaluation;
- process evaluation, and
- assessment on a timeline basis.

It is certainly possible to use all four types during the span of the celebration. Each of these is discussed in turn.

Process/Product Evaluation

This evaluation is done just before the celebration when the project is complete. Using a form that describes the processes of science and forms used to evaluate the project (samples of these are included in this section); the teacher conducts interviews with students.

Student Evaluation

Students cooperating with and evaluating other students either on a process/product approach or on a timeline basis is an excellent way of strengthening their understanding of the science processes and recognizing the processes in others. It not only demands and results in excellent listening skills, it also allows students to see in detail how other students have gone about their project work. The evaluations may be on a numerical basis or through the use of comments on the strengths of the process used and the presentation given. Sample forms are in this section.

I kept a log of teacher/judge scores during a science fair and then compared their results to the results of student evaluations. The results were virtually identical. Occasionally a student would have presented a project with great pizzazz but little substance or would present an excellent, well-conducted experiment with little enthusiasm; both of these scenarios led to discrepancies between adult judges and student evaluators. On projects that were selected as finalists in the fair, both adults and students rated them equally high.

I found that most students, even in a competitive forum, judged fairly and consistently. It was important that a set of students judge and in turn be judged by the same group. The Golden Rule of judging was usually adhered to: judge others as you wish to be judged yourself.

Response sheets can include questions such as:

- What are the strengths of this project?
- What are three things you learned from this project?
- What part of the presentation was the most interesting?
- What are the independent and dependent variables?
- What was the control in this biological experiment?
- Was the data presented clearly and well; was it graphed?
- Were all parts of the experiment displayed well?
- Was the presentation easy to understand?
- Was the presentation interesting and presented in an enthusiastic manner?
- Do you understand what the project set out to do?

- Do you understand if the project met its intended goals or identified unanticipated goals?
- Did the presenters give an application for the project?

These suggested questions can be reviewed before the event and distributed at the event so students have time to review their own presentation highlights.

Student Self-Evaluation

We are increasingly familiar with the advantages and effectiveness of metacognition and self-evaluation and analysis. If students are presented with a clear set of criteria, one of our first assessment tools should be to gather their analysis of their own project's strengths and weaknesses. This can assist greatly in developing a good attitude to self-improvement. This technique is very important in all curricular areas and is necessary on a long term project where process development is the objective.

The student is asked to complete a set of evaluations at each step in the project development. I find that if students are allowed to rate their performance then they will be encouraged to improve any lower quality scores (rather than simply accept them as being accomplished).

Discussion of the results of this evaluation may be done through student groups and/or with the teacher. At each evaluation, the student may need (or request) practice with a specific process. This allows you to address the development of processes with a very meaningful, motivating student objective.

Timeline Evaluation

Science Celebrations are process—based science project events. The evaluation is also process and development based.

Timeline evaluation is a key to a successful Science Celebration. Used in conjunction with Student Self-Evaluation and Student Evaluation (discussed earlier), Timeline Evaluations can result in a comprehensive assessment with these benefits:

- clear understanding of the student's level of processing;
- indications to you of the needs of individual students and your assessment group;
- allows you the time to assist students who are having frustrations, difficulties, or lack of direction and motivation;
- basically eliminates the concern of parental over-involvement;
- clear understanding of the progress of student/groups and the type of project;
- allows you to develop process skills in your curriculum in conjunction with the development of the project;
- gives you indications of trouble spots in the process that you can note for next year's (or next time's) celebration;
- assurance that projects are being conducted in a safe manner.

Science Celebrations are process- based science project events. The evaluation is also process and development based. Timeline Evaluation is done over the full timeline of the project from selection of topic to display and presentation. All evaluations are concluded before the celebration day.

Below is a suggested sequence for Timeline Evaluation for a celebration period of three months. Timelines will understandably be altered if the project is a centre approach or an on-going project throughout the year.

Some Science Celebrations involve projects that are non-experimental (research, duplication of investigation or experiment, invention) or, if experimental, are more closely defined by the teacher before beginning. This approach, or variations of the approach, is recommended for student/groups in their first Celebration or, in many cases, primary students. As a result, the student/group will begin the timeline at different stages.

At each phase of the Timeline Evaluation, student/groups that have an unsatisfactory element should be asked to correct it and an interim date set to report to you. Be very diligent about safety violations.

To get the greatest benefit from the Timeline Evaluation, combine the interviews with Student Self-Evaluation, wherein students complete a scaled list of the questions you will be asking one or two days before the meeting. This often will ensure that students take ownership of the processes required and begin to make modifications.

Interview students at the suggested intervals; in some cases ask them to demonstrate and explain parts of their experiment. Interview students individually on occasion to determine their personal understanding of the processes and procedures involved. At certain stages, written responses are required; these allow you to determine and document the understanding of the processes by the students.

Eight to ten weeks prior to celebration day
(or as soon as a topic is selected):

- request a topic from student/groups;
- ensure all student/groups have a topic;
- discuss the approach to be taken in the project:
  - remind student/group of the type of projects possible;
  - ensure the project will be safe;
  - encourage student/groups to tackle or consider tackling a more challenging approach (if appropriate);
  - discuss sources of materials;
  - suggest scientific principles to be considered;
  - suggest to student/groups that very general topics be narrowed;
  - direct a student/group to work with the topic and its materials;
  - direct a student/group to research the background knowledge with the goal of selecting a more specific topic;
  - provide the student/group with some relevant information about the general subject, perhaps suggesting approaches taken previously;
  - suggest alternatives or options;
  - provide the student/group with the processes involved or expected with the particular level of project.

Six to eight weeks before event:

- request a point-form summary of relevant background knowledge (orally, in writing, or as a formal report);
- request project question (to date, this may change);
- review the selected hypothesis;
- preview procedures, including:
  - parameters of experiment (time, amount of material,
  - height, measuring instruments, etc.);
  - materials to be used;
  - procedures to be followed;
- keep safety in mind;
- review the levels of science projects with students to determine if this student/group and project should advance to the next level (for example, moving from a research project to one including an investigation or demonstration, moving from an investigation to a single-variable controlled experiment, moving to a multi-variable controlled experiment).

Four to six weeks before event:

- review of project;
- specifications of question and hypothesis should be complete;
- report on construction of model or engineering project;
- preliminary data report, including:
  - data collection procedures;
  - data recording procedures;
  - project log use;
  - type of observation comments being recorded;
  - number of repetitions to be attempted;
- review the levels of science projects with students and pairs of students to determine if this student or pair and project should advance to the next level;
- ask students to write the steps in the procedure.

Four to two weeks before event:

- full review of options and expectations for the specific type of project;
  - discuss data analysis including:
  - interpretation of results;
  - graphing or display of results;
- preliminary plans for display board discussed (assuming display boards are to be used);
- ask students to write the question and some preliminary observations.

One to two weeks before event:

- evaluate written summary and lab book;
- ask students to complete a draft of an experiment write-up without reference to notes (this can be done with you transcribing).

Week of the Celebration:

- Consult EVALUATION FORMS;
- evaluate project in its final form including:
  - the processes used as demonstrated by the final form;
  - the quality of the product;
  - the care and precision taken;
- evaluate the originality of the project;
- evaluate the display board;
- evaluate the oral presentation;
- if not using the cooperative learning model, you may wish to determine the weighting of each student's contribution (see EVALUATING GROUPS).

After Celebration:

- review trouble spots in process;
- determine needs to support the Celebration in future including:
  - curriculum;
  - school library;
  - school (teacher reference material, forms, equipment, supplies);
  - community;
  - personal;
- ask students to help review the successes and frustrations including;
  - scope of next Celebration:
  - classroom;
  - category;
  - whole school;
  - area (several schools sending representatives);
  - linkage with Science Fairs and Regional Science Fair.

EVALUATING GROUPS

If the Timeline Evaluation technique is applied, the teacher can often be aware of the process level of the group members (and have intervened to help). Nevertheless, there will be a final evaluation on the overall project; it is that evaluation where group weighting can be of assistance.

To solve this problem, I have left the decision up to the individuals with myself as final mediator and judge.

Here is the procedure I have used:

- Ask the members of the group to write down the relative contribution of each member. Score each out of ten;
- often they will agree with the weighting;
- usually you are aware of the relative efforts, sometimes students contribute in ways that are subtle. I try and solve most groups with an even split;
- If groups disagree, you need to discuss details with each partner and make a weighting decision;
- When that decision is made, one student will have his/her mark slightly lowered. Before that is done, the teacher should have been aware of the problem and have suggested ways of solving it;
- Overall project quality marks are not raised.

The overall emphasis of the Science Celebration should put more emphasis on the process than the product. Therefore, the final product evaluation should be only one entry in the overall record of marks for this project. Score the oral presentation together.

Here is a suggested way of having students be part of the planning for the next year.

Science Celebration Evaluation

Please spend some time responding to these questions to help us plan for the next Celebration. Circle your preferred choice and/or make comments.

1. Was the location appropriate for such an event? yes/no
2. Was the time of year appropriate for this event? yes/no
3. Was the organization of the room appropriate, convenient, and functional? yes/no
4. Was the organization of the sharing with other students smooth and satisfying for all students? yes/no
5. Were there any safety problems? (Please be specific; make suggestions for Improvement.)
6. Was the organization for visiting classes (or schools) appropriate, safe and sufficient? yes/no
7. Are there any things that should be changed?
8. Additional comments.

Thank you for your time.

THE PROCESSES OF SCIENCE

For those unfamiliar with the generally accepted processes of science, here is a very quick summary. Excellent commercial explanations and examples are available and most school boards have working definitions.

Observation (K—7)
Observation is the key to all science. This foundation involves more than the five senses, it includes observation using instruments that sense things for us.

A Grade One child could be expected to describe a phenomenon or objects in terms of the five senses, using appropriate comparisons or vocabulary to describe each so another can understand the sense described. A Grade Seven student might describe in far more detail events that are the result of a reaction, long-term events, "invisible events" described only by instrumental interpretation.

Classification (K—7)
A Grade One child might group a set of objects by common attributes. A Grade Seven child may use diagrams, use or make classification keys or use a process with several stages in the classification process.

Quantification (measuring) (K-7)
Younger students might use counting, simple instruments, measuring in centimetres.

Older students may use more sophisticated instruments (double beam balance, precise thermometers, barometers), energy, circulation flow.

Communication (K-7)
This can be one of the most exciting elements of science at the elementary level. One key element that should be included in each communication package (the teacher's delivery included) is a sense of enthusiasm for the topic. This can be translated to doing one's best, to adding colour, to speaking with that edge in your voice.

Grade One students may draw pictures, make simple graphs, describe events orally.

Grade Seven students may draw line or three-dimensional graphs, write and illustrate precisely, give oral presentations with multimedia descriptions of events and reactions.

Inference (1-7)
Grade One students may infer from patterns and sequences previously observed on cause-effect relationships. Grade Seven students may infer reactions resulting from specific conditions.

Prediction (4-7)
Prediction is part (only part) of the process in making hypotheses. Predictions should be based on previously collected or inferred data. It is important that students practice appropriate predicting (versus simple guessing) at all ages.

Students in the primary grades are generally not expected to have mastered this skill to a great degree. Grade Seven students may use prediction as part of the creation of a hypothesis.

Control of Variables (4-7)
Variables are those things that can vary or change. In an experiment, several factors can influence the result. Good experimentation at the elementary level eliminates the change of as many factors as possible, enabling the focus on one independent or manipulated or key variable.

It is vital to good science that students become aware that scientific conclusions are often drawn on single-variable experimentation. This involves controlling all the things that can affect a particular action, reaction or result, except one. Young students learn this easily, but need constant practice to reach the application level.

Generally, primary grade students are not expected to have reached a working level with variable control (although, hopefully, they have experience with it).

Grade Seven students may control variables including identification and control of variables in an experimental model.

Experimentation (5-7)
Good experimentation demands the use of most of the skills of science including both in the planning, construction, completion and analysis of the results.

Students generally graduate from teacher-directed investigations, to book-directed to self-initiated experiments with variable control.

It is important that students identify an experiment as a self-generated, variable-controlled procedure and classify all other directed activities as investigations. **It is a sad event when a student considers science as doing someone else's experiment and the joy is based only on how well they can reproduce, record and communicate the predictable results versus experiencing the joy of discovering the results of a self-generated experiment.**

Experimentation at the Grade Seven level should include formulating an hypothesis and analysis of data (perhaps the two most challenging elements for elementary students).

Experimenting need not be predicated upon a complete experiment write-up in the traditional sense. Teachers may wish to use a specific communication or data analysis technique as the focus and key element in the reporting of results.

Data interpretation (5-7)
The interpretation of data patterns and results is a key element in higher levels of science. This process has roots in math as well as the social sciences and provides an excellent integrating factor to these subjects and science.

In the early stages, it can include interpreting results of data table collections of simple phenomenon. More sophisticated levels bring analysis tools to the results (beginning with graphing and proceeding to extrapolation and various forms of graphing and statistical analysis).

Formulation of hypotheses (5-7)
A more thorough description is in the section titled "Individual Project Development."

Operational Definition (5-7)
This challenging-sounding title can in simple terms be translated to explaining how something works and demonstrating understanding of terms and processes.

Formulation of Models (6-7)
This process translates observed or inferred relationships into a formula, drawing, diagram or model.

Showing how a cold front is formed and results in rain through diagrams or model construction is one example, life cycles and chemical equations are others.

The expected sophistication of this skill will surprise many teachers who may have had students draw life-cycle diagrams. The mastery of a process involves the ability of a student not just to interpret the model but to create the model out of discovered or interpreted data. That ability is one that requires practice and one that can be incredibly exciting and rewarding.

This information and the chart below may be useful in determining the processes in a science unit or the extent of the processes used in a student project.

The scale can be used to indicate a student who is beginning to use the process appropriate for the particular grade or a student who is using the processes at a grade-appropriate mastery level.

Observation (K—7)	|_|_|_|_|_|
Classification (K—7)	|_|_|_|_|_|
Quantification (K—7)	|_|_|_|_|_|
Communication (K—7)	|_|_|_|_|_|
Prediction (3—7)	|_|_|_|_|_|
Control of Variables (4—7)	|_|_|_|_|_|
Experimentation (4—7)	|_|_|_|_|_|
Data interpretation (5—7)	|_|_|_|_|_|
Formulation of hypothesis (5—7)	|_|_|_|_|_|
Operational Definition (5—7)	|_|_|_|_|_|
Formulation of Models (6—7)	|_|_|_|_|_|

REFERENCE LIST

This is only a brief listing of several of the excellent books available on the topic of Science Fairs when this book was first published. I encourage the reader to investigate the many sources that have become available since.

Baal, Harold
Where's The Book?
Communication Planning Consultants
Box 327
Lakefield, Ontario KOL 2110

Belier, Joel
So You Want To Do A Science Project
New York: Arco Publishing, 1982

Moorman, Thomas
How To Make Your Science Project Scientific
Canada: McLelland & Stewart, 1974

Smith, Norman
How Fast Do Your Oysters Grow?
Investigate and Discover Through
Science Projects
New York: Jullian Messner (Subsidiary
of Simon & Shuster), 1982

Stepp, Ann
Setting Up A Science Project
Toronto: Prentice-Hall, 1966

Science Fair: Organization
Science Fair: Judging
Science Fair: Regulations
Science Fair Evaluation Form
(all published by Youth
Science Foundation)
Youth Science Foundation
Suite 805, 151 Slater Street,
Ottawa, Canada K1P 5H3

Sciencefare—A Practical Guide
for Parents and Students
Sciencefare Press Inc.
Markham, Ontario

Van Deman, Barry and Ed McDonald
Nuts and Bolts: A Matter of Fact Guide
to Science Fair Projects
Harwood Heights, Ii: The Science Man
Press, 1980

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Sincerely,
Len Reimer

Science Fair Foundation BC

ABOUT THE AUTHOR, LEN REIMER

Len Reimer, B.Ed., M.Ed., has worked with Kindergarten to University students. As an elementary teacher and subsequently as a principal, he taught science most of his career in Vancouver, British Columbia. Soon after Len began to have his students engage in science fairs, he created a new application of the idea and called it the Science Celebration. This concept brings the excitement and commitment into the elementary classroom as a teaching and learning tool. It also expanded beyond his classroom to inviting several schools to participate and finally to a District-wide event. This led Len to write the ideas in a print copy that has been found its way to many parts of Canada. The copy you are reading is the first revision of that book.

At the time of this revision, Len is on the faculty of the University of British Columbia teaching elementary science education. Len has had several roles on District committees in Science, Math and Social Studies in Vancouver. Through the teaching, Vice-Principal, Principal and now university phases of his career, Len continued to support students engaged in independent science projects.

Len was the creator and first chair of the Grade 4 to 7 Vancouver District Science Celebration. Also, he was the creator and first chair of the Grade 7 to 12 Vancouver District Science Fair. He has been the chair of the Greater Vancouver Regional Science Fair, a highly competitive Fair for Grade 7 to 12 students. He was a charter Director of the Science Fair Foundation BC that supports science fairs throughout the province of B.C. Len was on the executive committee of the 1991 Canada-Wide Science Fair in Vancouver and was the Registrar and the official Newsletter Editor of the 2005 Canada-Wide Science Fair also in Vancouver. He has given workshops on teaching science, science fairs and the Science Celebration across B.C. as well as at national and international conferences.

For his volunteer contributions in encouraging science involvement in the District, the Vancouver School Board honored Len with the "Vancouver Recognition Award" making him only the second principal to receive this award.

In 1996, Len received national recognition by the Youth Science Foundation Canada when he was presented with the "Distinguished Service Award." Len was born and continues to live in British Columbia, Canada. He and his wife have been married over 30 years and have three children.

Appendix

B.C. Science K-9 Curriculum (2016)
Correlation to Science Celebration Handbook (2007)
This correlation reinforces that the process of doing Science Fair Projects addresses many of the Curricular Competencies on Inquiry and Project-based Learning.

LEARNING STANDARDS		
Curricular Competencies		
Questioning and Predicting		
Students are expected to be able to do the following:		
K-2	○ Demonstrate curiosity and a sense of wonder about the world	p. 8, 11, 23, 34
3-4	○ Demonstrate curiosity about the natural world	p. 8, 11, 34
5-9	○ Demonstrate a sustained curiosity about a scientific topic or problem of personal interest	p. 8, 34
K-4	○ Observe objects and events in familiar contexts	p. 8, 11, 34
5-6	○ Make observations in familiar or unfamiliar contexts	p. 8, 23, 34
7-9	○ Make observations aimed at identifying their own questions about the natural world	p. 8, 23, 34
K-2	○ Ask simple questions about familiar objects and events	p. 8, 11, 34
3-4	○ Identify questions about familiar objects and events that can be investigated scientifically	p. 8, 11, 34
5-8	○ Identify questions to answer or problems to solve through scientific inquiry	p. 8. 23, 34
9	○ Make observations aimed at identifying their own questions, including increasingly complex ones, about the natural world	p. 8, 23, 35
1-2	○ Make simple predictions about known objects and events	p. 9, 11, 23, 34
3-4	○ Make predictions based on prior knowledge	p. 9, 11, 23, 34
5-8	○ Make predictions about the findings of their inquiry	p. 9, 23, 35
7-8	○ Formulate alternative "If... then..." hypotheses based on their questions	p. 9, 23, 35
9	○ Formulate multiple hypotheses and predict multiple outcomes	p. 9, 23, 35, 36

Planning and conducting		
Students are expected to be able to do the following:		
K	○ Make exploratory observations using their senses; ○ Make simple measurements using non-standard units	p. 24
1-2	○ Make and record observations; ○ Make and record simple measurements using informal or non-standard methods	p. 24
3-4	○ Suggest ways to plan and conduct an inquiry to find answers to their questions	p. 24
3-6	○ Consider ethical responsibilities when deciding how to conduct an experiment	p. 22
4	○ Make observations about living and non-living things in the local environment	p. 24
5-6	○ With support, plan appropriate investigations to answer their questions or solve problems they have identified; ○ Decide which variable should be changed and measured for a fair test	p. 24
7-8	○ Collaboratively plan a range of investigation types, including field work and experiments, to answer their questions or solve problems they have identified; ○ Measure and control variables (dependent & independent) in fair tests	p. 24, 34
9	○ Collaboratively and individually plan, select, and use appropriate investigation methods, including field work and lab experiments, to collect reliable data (qualitative & quantitative)	p. 24, 34
K	○ Safely manipulate materials	p. 24, 34
1-2	○ Safely manipulate materials to test ideas and predictions	p. 24, 34
3-4	○ Safely use appropriate tools to make observations and measurements, using formal measurements and digital technology as appropriate; ○ Collect simple data	p. 24, 34
5-6	○ Observe, measure, and record data, using appropriate tools, including digital technologies; ○ Choose appropriate data to collect to answer their question	p. 24, 34
7-8	○ Observe, measure, and record data (qualitative & quantitative), using equipment, including digital technologies, with accuracy and precision	p. 24, 34
7-9	○ Use appropriate SI units and perform simple unit conversions	p. 24
9	○ Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data	p. 24, 34

7-9	○ Ensure that safety and ethical guidelines are followed in their investigations	p. 16, 22, 34,
9	○ Assess risks and address ethical, cultural and/or environmental issues associated with their proposed methods and those of others	p. 16, 22
Processing and analyzing data and information		
Students are expected to be able to do the following:		
K-9	○ Experience and interpret the local environment; ○ Apply First Peoples' perspectives and knowledge, other ways of knowing, and local knowledge as sources of information	
K	○ Represent observations and ideas by drawing charts and simple pictographs	p. 24, 34
1-4	○ Sort and classify data and information using drawings, pictographs and provided tables	p. 24, 34
3-4	○ Use tables, simple bar graphs or other formats to represent data and show simple patterns and trends	p. 24, 34
5-6	○ Construct and use a variety of methods, including tables, graphs, and digital technologies as appropriate, to represent patterns or relationships in data	p. 24, 34
7-8	○ Construct and use a range of methods to represent patterns or relationships in data, including tables, graphs, key, scale models, and digital technologies as appropriate	p. 24, 34
9	○ Construct, analyze and interpret graphs (including interpolation and extrapolation), models and/or diagrams	p. 25, 34
1-4	○ Identify simple patterns and connections	p. 13, 34
5-6	○ Identify patterns and connections in data	p. 13, 34
7-8	○ Seek patterns and connections in data from their own investigations and secondary sources	p. 13, 25, 36
9	○ Seek and analyze patterns, trends, and connections in data, including describing relationships between variables and identifying inconsistencies	p. 25
K	○ Discuss observations	p. 25, 36, 37

1-2	○ Compare observations with predictions through discussion	P. 25, 36, 37
3-4	○ Compare results with predictions, suggesting possible reasons for findings	p. 25, 35, 36
5-6	○ Compare data with predictions and develop explanations for results; ○ Demonstrate an openness to new ideas and a consideration of alternatives	p. 25, 35, 36
7-8	○ Use scientific understandings to identify relationships and draw conclusions	p. 25, 36
9	○ Use knowledge of scientific concepts to draw conclusions that are consistent with evidence	p. 25, 36
Evaluating		
Students are expected to be able to do the following:		
1-2	○ Compare observations with those of others	p. 35, 36
3-4	○ Make simple inferences based on their results and prior knowledge; ○ Reflect on whether an investigation was a fair test	p. 35, 36
5-6	○ Evaluate whether their investigations were fair tests; identify possible sources of error; ○ Suggest improvements to their investigation methods	p. 27, 35, 36
7-8	○ Reflect on their investigation methods, including the adequacy of controls on variables (dependent and independent) and the quality of the data collected; ○ Identify possible sources of error and suggest improvements to their investigation methods	p. 27, 35, 36
9	○ Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions; ○ Describe specific ways to improve their investigation methods and the quality of the data	p. 27, 35, 36
3-4	○ Demonstrate an understanding and appreciation of evidence	p. 35, 36
5-6	○ Identify some of the assumptions and given information in secondary sources; ○ Demonstrate an understanding and appreciation of evidence	p. 35, 36
7-8	○ Demonstrate an awareness of assumptions and bias in their own work and secondary sources;	

	○ Demonstrate an understanding and appreciation of evidence (qualitative & quantitative)	
7-9	○ Exercise a healthy, informed skepticism and use scientific knowledge and findings to form their own investigations to evaluate claims in secondary sources	
9	○ Demonstrate an awareness of assumptions, question information given, and identify bias in their own work and secondary sources; ○ Critically analyze the validity of information in secondary sources and evaluate the approaches used to solve problems	
1-2	○ Consider some environmental consequences of their actions	
3-4	○ Identify some simple environmental implications of their and others' actions	
5-6	○ Identify some of the social, ethical, and environmental implications of the findings from their own and others' investigations	p. 16
7-9	○ Consider social, ethical, and environmental implications of the findings from their own and others' investigations	p. 16
9	○ Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modeled; Consider the changes in knowledge over time as tools and technologies have developed; ○ Connect scientific explorations to careers in science	
Applying and Innovating		
Students are expected to be able to do the following:		
K-2	○ Take part in caring for self, family, classroom and school through personal approaches	p. 27
3-4	○ Take part in caring for self, family, classroom, school and neighbourhood through personal approaches	p. 27
5-6	○ Contribute to care for self, others and community through personal or collaborative approaches	p. 27
7-9	○ Contribute to care for self, others, community and world through personal or collaborative approaches	p. 27
3-8	○ Co-operatively design projects	p. 9
K-9	○ Transfer and apply learning to new situations	p. 9
K-9	○ Generate and introduce new or refined ideas when problem solving	p. 9

9	○ Contribute to finding solutions to problems at a local and/or global level through inquiry; ○ Consider the role of scientists in innovation	p. 9
Communication		
Students are expected to be able to do the following:		
K	○ Share observations and ideas orally	p. 5, 13, 37
K-2	○ Express and reflect on personal experiences of place	
3-4	○ Express and reflect on personal or shared experiences of place	
5-6	○ Express and reflect on personal or shared or others' experiences of place	
7-8	○ Express and reflect on a variety of experiences and perspectives of place	
9	○ Express and reflect on a variety of experiences, perspectives and worldviews through place	
1-2	○ Communicate observations and ideas using oral or written language, drawing, or role play	p. 5, 13, 37
3-4	○ Represent and communicate ideas and findings in a variety of ways such as diagrams and simple reports, using digital technologies as appropriate	p. 5, 13, 37
5-6	○ Communicate ideas, explanations and processes in a variety of ways	p. 5, 13, 37
7-8	○ Communicate ideas, findings, and solutions to problems using scientific language, representations, and digital technologies as appropriate	p. 5, 37
9	○ Formulate physical or mental theoretical models to describe a phenomenon; ○ Communicate scientific ideas, information, and perhaps a suggested course of action, for a specific purpose and audience constructing evidence-based arguments and using appropriate scientific language, conventions, and representations	p. 5, 37