Tips for Starting a Research Project: a Student's View

By Nichole Alexis Borrowes

When selecting a topic, choose one that really interests you. Then, the research and reading will be easier and more relevant.

One

Try to be original in your choice of topic. If someone has done the same thing before you thoroughly analyze their work. Figure out ways to improve on it, to expand the scope, and to correct the mistakes.

Two

If you choose a topic choose a topic that's too broad, spend tine in the library, scanning the literature for any current issues dealing with the topic. In this way you are likely to get a general understanding of your topic as a whole and in addition, find different sub-topics.

Three

When starting your research, your initial goal is to find out who has done research on the topic before you and to study their findings. Have a notebook and folder especially to keep notes, information, or questions concerning the research. Utilize every resource available to you: teachers, newspapers, the vertical file, computer-based research methods, journals, *The Reader's Guide to Periodical Literature*, etc.

Four

Timelines are extremely important. Set dates and deadlines to do research, to work in the library, to interview experts, to design the survey instrument.

Five

If possible, find yourself a mentor—a person knowledgeable in your field of science. Or, interview someone who might know a lot about your topic in order to get ideas, suggestions, and insight you might not have thought about, such as a method to carry out your research and advice about instruments you might use to collect data.

Six

Deadlines are very important. A message to fellow procrastinators: do not put everything off to the last minute. The stress will be unbelievable. Hard work on a consistent basis does pay off in the long run. It did for me.

When you want to quit because your research is not going well, think about the fantastic feeling of accomplishment the completion of your project will bring.

Preparing the Paper

For some competitions you need only a written report; for others, you also have to verbally present your work. A complete project should have a complete typewritten report. Start writing the paper as soon as you know the project hypothesis. Parts I through III can be completed even before you begin experimenting. Don't leave it until the last minute. You've done so well so far, just a little more effort will give your project an edge. The paper should be typed double-spaced on a word processor and if possible printed on a laser printer. Include a cover page, table of contents and a bibliography. Do all graphs on the computer. Proofread everything twice. Don't fall into the pattern of saying, "I don't know" or I" don't have a computer that can graph my work". There are plenty of people out there who will teach you and allow you to graph on their machine. Save two copies of your work on two separate disks.

Include the following sections in your report:

I. **Abstract**: state goals, methodology and results of your work (75-100 words).
II. **Purpose**: state the hypothesis (one page).
III. **Review of the literature***:* use information that deals specifically with the topic (about 4 to 5 pages).
IV. **Procedure-Methodology**: step-by-step description of your work. Be sure to include all chemicals, amounts and concentrations of each.
V. **Results**: include tables and graphs.
VI. **Conclusions**: discussions.
VII. **Summary**: include ideas for further study.

Entering the Competitions

Once you have the project underway and are starting to get some results it is time to look for competitions. Once again speak to your science department head, you science teacher and the guidance department.

The most prestigious high school competition is the Westinghouse Science Talent Search, but it is for seniors only. Send for an application even if you're not a senior just to get an idea of the quality of work they expect and the kind of application involved. If you have followed the plan I have set before you, you will have no problem. The application is due in early December, but it is best to have it completed by November 1st. Make a copy for yourself, then send your project by registered mail or Federal Express. Now you only have to wait for the letter of congratulations.

Many competitions require presentation of the project in a "poster session". Buy the display board at an art store and have them cut the folds in the board so it is self-standing. Get the dimensions from the contest rules and buy the largest size board allowed. In bold large letters include: the purpose, procedure, results, conclusion, and further study. All lettering must be very large and clear. Purchase, the letters, don't attempt to print them yourself. All graphs should be computer generated. Many of the large companies have art departments. Ask the scientist who has helped you with the project to direct you to the art department. Competitions have been won sometimes by a single point awarded because of the quality of the display board.

Getting into the College of Your Choice

Every time your return from a science fair, record your "winnings"! You will need a separate folder to hold all your certificates by the end of your high school years. By senior year your folder will be full of certificates and your many accomplishments.

Include with your college« application a list of all your winnings and a brief description of each project. Ask the scientists or teachers who helped on your projects for letters of recommendation and include them also. Make sure all your prestigious honors are included on every col'ege application you send. Bring this information to your college interview and give a copy to the interviewer. Make it clear that you have worked hard and will be an asset to the institution.

Getting into the college of your choice is going| to be easy. You may be awarded a scholarship. A Westinghouse winner is accepted almost everywhere. And if you've won one of the top prizes your college education will be paid for. Whether you win or not, you can be justifiably proud in the knowledge that all this work has set you en the road to a career science and a lifetime of working at something you love.

Preparation of a Research Proposal: A Means of Introducing the Scientific Method

By Vickie A. Bejda

Vickie A. Bejda is a science teacher at Ocean Township High School (Oakhurst, NJ) with several years experience assisting students with their science projects. Many of her students have received Grants-in-Aid from the Junior Academy of the New Jersey Academy of Science and won awards at science competitions.

As part of my Honors Biology course, I require that students conduct an original research project. In an attempt to simulate the process that a research scientist usually undertakes: students write a research proposal; seek funding through the Grants-in-Aid program sponsored by the Junior Academy of the New Jersey Academy of Science; conduct the research; and then present their results at the annual meeting of the Junior Academy.

The writing requirement of the proposal is a critical component. Preparing a proposal is a good illustration of the scientific method since students go through a process *of* making observations, asking questions, formulating a hypothesis *and* designing a means of testing the hypothesis.

To make best use of the school year, I first meet with interested students late in the spring of the preceding year. I emphasize that the project, in its simplest terms, is based on a question they need to answer. The question should not come "off the top of their head" but from serious reading. To that end, I suggest students read such publications as *Science News, Science Digest* and short research briefs in such publications as *Scientific American* and *Science.* In addition, students are given a summer reading list including selections from authors such as Lewis Thomas, author of *Lives of a Cell, and The Journal of Irreproducible Results* and Stephen Jay Gould (my favorite is "Phyletic Size Decrease in Hershey Bars" in which Gould predicts that a weightless Hershey Bar will cost 47.5 cents in 1998 due to continual price increases and actual product decreases). All of the readings, whether humorous or serious, are chosen to illustrate methodology and/or attitudes concerning scientific research.

Project Ideas

On the first day of school in September, I give a quiz on the readings and ask students to write down their project ideas. They have approximately three weeks to decide on a project. Each time they have a new idea, I ask them to put it in writing. To help students focus, I ask leading questions. For example, when a student proposes to examine the effects of rock music on the development of lobster eggs, I ask such questions as, "Where would a lobster encounter such conditions in nature?" and "How will you know if development is affected?" This feedback seems to help students begin to ask more important questions. When they say that they don't know what to do for a project, I send them back to the library.

Components of a Proposal

Towards the end of the three-week period, we begin discussing the components and preparation of a research proposal (Appendix A) which includes an Introduction, Statement of Intent and Hypothesis, Materials and Methods, Budget and Literature Cited. Activities helpful at this stage include traditional textbook problem-solving laboratory exercises to practice problem recognition and hypothesis formation such as presented in BSCS Biological Science Curriculum Study texts and by Thompson & Hellack (1986), as well as in-class reading of a humorous bogus proposals and published papers. Emphasis is placed on the Introduction,

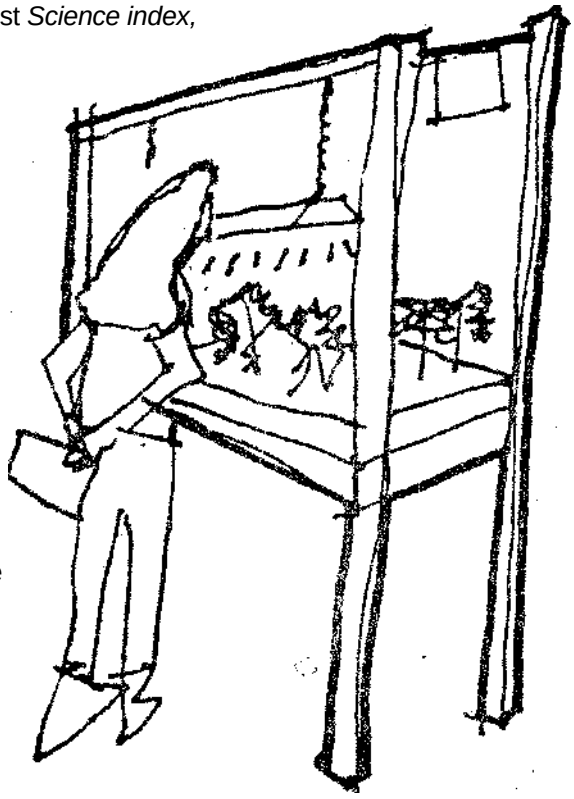
and Materials and Methods (ecology papers work well as they can be more readily understood by students), attention to controls and test groups, and experimental details such as temperature and light conditions, etc. During this discussion, I emphasize that the introduction provides the logical basis and direction for formulating the hypothesis.

Introduction

In developing the Introduction, students are encouraged to conduct a thorough search of the literature pertaining to their topic. In conducting their literature search, students should avoid science reports in popularized literature such as *Time, National Geographic, Organic Gardening* and instead find the original source publication.

Special Aids for literature Searches

Several specialized aids for searching the literature, such as those outlined by Dickerman (1985) are available for student's library research. Of those, I suggest *Science index,* which abstracts several science journals. Each volume is by year and information is listed according to topic. I also give students detailed instructions for using *Biological Abstracts.* Because its "Cumulative Subject Index" is not particularly easy to use, unique or key words related to a project can help. Students can copy the reference number and then search the abstracts for that number. Be sure to caution students that each index covers only a half year.



The *Cumulative Author Index* is most helpful for finding work by a particular author as when a student has read an article in *Science News* without reference to the journal in which the work was published. This index is also useful for finding addresses of authors since I encourage my students to contact researchers personally, especially by telephone, if they have questions.

Once they have found a paper, students should look at the literature cited to find other related papers. Most libraries will request interlibrary loans for papers and books. Students can also write or call the authors directly and request copies of their reprints. I also instruct students on the proper procedure *(*or citing literature using the name and date method, as well as the commonly used format for the bibliography.

Students have approximately one month to complete their research proposal and submit it to the Junior Academy for consideration of a Grant-in-Aid. If I am not knowledgeable enough to review a proposal, I will send it to a scientist engaged in the area of research for comments. I have always found such individuals extremely willing to help, and have learned a great deal about experimental design from their suggestions. This process or the request for information may lead to an invitation for the student to work in the scientist's laboratory.

Reviewing students' proposals allows me to detect deficiencies in their experimental design and helps insure that students have a directed approach to their research. During the remainder of the year, I periodically collect student progress reports. I also include some elementary statistics in my classroom laboratory activities. Altogether I spend about five class periods during the entire year strictly devoted to projects. This approach has been successful. Approximately 80 percent of our students receive research grants from the junior Academy, and 95 percent enter our regional science fair, and many win awards.

Suggested Reading

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_____1933. *Late Night Thoughts on Listening to Mahler's Ninth Symphony.* Viking *Frees,* New York.

Thompson. J.N. & J J. Hellack. 1936. *"Hypothesis Formation and Testing for Beginning Biology Students." Am. Bio. Teacher.* 48 (1): 24-26.

Appendix A: Preparation of a Research Proposal

1, Proposals should focus on intended original research, Ask questions such as, "Why does...?" or "What causes ..?" or "What are the effects of..?" or "Why are there . . . ?"

2, Proposals should be typed, double-spaced, one side only, on 8 ½ x 11" paper with one-inch margins. Be sure to check grammar and spelling. You may use quoted works, terms or a coined phrases. You may not use quoted passages of any length,

3, Illustrations should be neat, legible and original or properly cited if copied. Hand drawn Illustrations must be in black ink. Do not use photocopies.

4, Write in the third person.

5, Proposals should be short and concise and written in the format shown.

A. *Title Page* with title and student's name. The title should be a statement of what you intend to investigate.

B. *Introduction* should include all background information that is necessary and appropriate for the formation of the hypothesis. This may involve some history, research that has been done by others that is related to your own study, the importance of your study, etc. In short, it is the logical evolution of thought in the formation of your intended study and the reason why it needs to be conducted. Be sure to document properly,

C, *Statement of Intent and Experimental Hypothesis* should be a simple straight forward statement of what you intend to investigate. In addition, you must provide a hypothesis — the tentative answer *to* the question you are investigating. It should be based on the information you have gathered, presented and cited in your introduction.

D. *Materials and Methods* should be a detailed description, in paragraph form, of how you plan to test your hypothesis. Someone should be able to conduct the experiment exactly as you intended just from reading your written description. Be absolutely sure to give credit for methods or special apparatus that are not your own by documenting them correctly. Some experimental details that you might consider:

1. Be sure to set up an adequate control,

2. Be sure to use an adequate sample as wed as replicates. It is necessary to have more than one member per group to insure that what you measure isn't just one unusual event or simply due to chance. Controls and test groups should be as large as possible with no less than five samples in each group (more is always better}.

3. Data should be quantitative rather than descriptive. What will you measure? How will it be measured?

How often will you take measurements? How long will the experiment run? Once data has been collected, how will you analyze it to support or reject your hypothesis?

4. Be sure to discuss the experimental conditions in detail. This should include dimensions of fish tanks.

cages, bottles, etc., temperature and light conditions and how those conditions will be maintained. How will you insure that all treatments receive identical conditions except for the one variable that you are testing?

5. Be sure to discuss safety considerations.

E. *Budget.* List *t*he materials you require, their cost and where they will be obtained.

F. *Literature Cited.* On the last page (by itself), list the literature you have cited in your proposal in alphabetical order using an acceptable documentation method.