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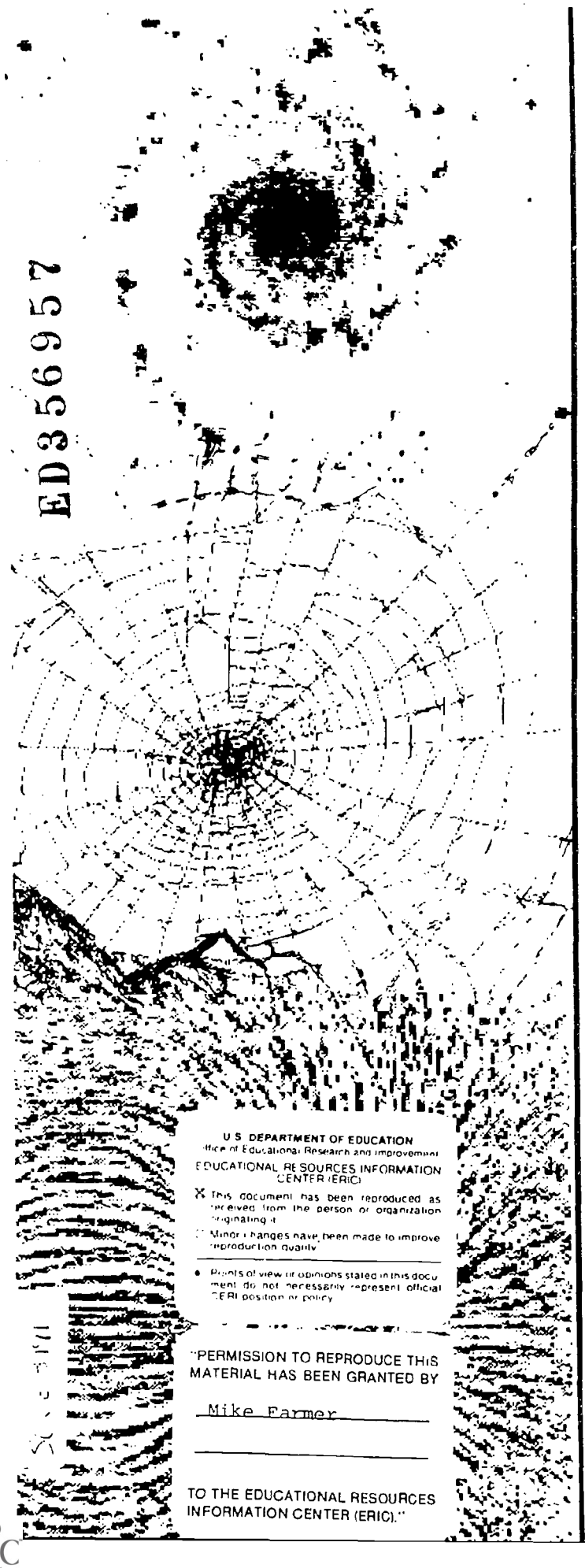
ABSTRACT

This guide is intended to be a manual for directing students in the formal presentation of science-project research. Because the results of science research are expected to be presented in an understandable form that persuades the reader that the conclusions drawn from the experimentation are correct, it is important that students follow established formats in their writing. To be convincing, papers should be clear, concise, and accurate. The guide contains guidelines for the eight distinct sections that are usually part of a scientific paper: (1) title page; (2) abstract; (3) introduction; (4) method; (5) results; (6) discussion and conclusions; (7) bibliography; and (8) acknowledgements. The content and purpose of each section is described. Additional suggestions, hints, and samples of award-winning papers are discussed. Guidelines for submitting papers to the "Journal of High School Science Research," and the addresses of where to send papers are included. (MDH)



Writing Science Projec: Research Papers:

A Step-By-Step Approach

by Mike Farmer, Editor
Journal of High School Science Research

Written by:
Mr. Mike Farmer, Teacher

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WRITING SCIENCE PROJECT RESEARCH PAPERS: A Step-By-Step Approach

This guide is intended to be a manual for directing students in the formal presentation of science-project research. Because the results of science research are expected to be presented in an understandable form that persuades the reader that the conclusion(s) drawn from the experimentation are correct, it is important that students follow established formats in their writing. To be convincing, papers should be clear, concise, and accurate. The significance should be obvious. The reporting of the research is as important as the project itself.

A scientific paper usually contains eight distinct sections. These include:

I - Title Page	V - Results
II - Abstract	VI - Discussion & Conclusion
III - Introduction	VII - Bibliography
IV - Method	VIII - Acknowledgements

The content and purpose of each of these sections are described under the boldface headlines below. Additional suggestions, hints, and samples of award-winning papers are also included.

Once the paper is finished, a student might want to consider presenting it at a science fair or Academy of Science meeting. If the student wishes to have his paper printed in a national publication, he might submit it to the *Journal of High School Science Research.* (Requirements and submission data are included in this manual.)

I - TITLE PAGE

1. TITLE - A title should stand alone. It should concisely state the topic and clearly identify the dependent and independent variables.

2. AUTHOR'S IDENTIFICATION - The student's name, grade level, school, and school address should be included.

SAMPLE TITLE PAGE:

The Effects of 6000 A and 4000 A
Light on the Respiration Rate of
Common Corn Seeds

By
Joe Dokes
Grade 11

Riverside High School
Route 8
Greer, South Carolina
29651

II — ABSTRACT

The abstract could be the single most important paragraph in a scientific paper. It should be:

(1) ACCURATE - The dependent and independent variables and the research technique used should be included. It never includes information not included in the body of the paper.

(2) BRIEF - The International Science and Engineering Fair abstract is 250 words or less.

(3) NONEVALUATIVE - It should report facts rather than draw conclusions.

SAMPLE ABSTRACT:

The below example uses the format recommended by the ISEF for preparing an abstract.

THE EFFECTS OF 6000 A AND 4000 A
LIGHT ON THE GERMINATION
OF CORN SEEDS

Joe Dokes, Riverside High,
Route 8; Greer, S.C. 29651

The purpose of this project was to determine if the respiration rate of corn seeds is affected by 6000 angstrom and 4000 angstrom light.

The approach was to expose a group of seeds to 6000 A light and another group to 4000 A light for 24 hours, and then measure the rate oxygen is evolved for each group of seeds using a volumeter.

The two groups of respiration rates were compared using the "t" test and a statistical difference was found at p=.001.

III - INTRODUCTION

The body of a scientific paper begins with the introduction, which should contain answers to four specific questions.

The questions are given below with some additional hints. A good introduction will contain the answers to each question in a paragraph or two. It clearly describes how the work was done and what the results were.

Students, ask yourselves:

QUESTION 1. What was the source of the research topic?

HINT - Begin by orienting a reader to the overall problem by placing it in the proper historical perspective.

QUESTION 2. What other research has been done in this area and how is it relevant to your research?

HINT - References to the related research of other scientists to your topic should be brief, citing only the research that specifically relates to your project.

QUESTION 3. In general terms, why was your research done?

HINT - State clearly and concisely why the research was done. Give the implications of the study and state what theory is being tested.

QUESTION 4. What is the precise purpose of the research?

HINT - Define the dependent and independent variables. Should begin - "The purpose of this project was to _____ ."

The objective of the introduction is to make the paper self-contained for a reader knowledgeable about the field of interest, but not the specific problem. A good introduction will show a considerable understanding of what research has been done leading directly to the problem undertaken.

Readers should convince the reader the your research was of sufficient interest to have done it.

IV — METHOD

The METHOD section should be broken down into three subsections. Examples of these for a project studying the effects of light on the respiration of seeds might be:

1. TEST SUBJECT IDENTIFICATION -"Butterfruit" sweet corn seeds. Obtained from Parks Brothers seeds. Taken from 1985 harvest.

2. APPARATUS - The following apparatus was used to control and/or measure the variables indicated.
DEPENDENT - Respiration rate - A Bobbitt Laboratories volumeter and a Zollinhofer manometer.

METHOD (continued)

INDEPENDENT - Wavelength of light - Filters - CBS Blue 450 and CBS Red 650.
CONTROLLED - Temperature - Thermometer; Moisture - all seeds soaked for same length of time.

3. PROCEDURE - A summary of each step followed in completing the experimental phase of the project. It should tell what was done and how!!

V — RESULTS

This section is strictly a presentation of the data gathered during the experimentation. The data should be in table form. Units for all numbers should be included, and graphs may be used when appropriate. These should be completely and clearly labeled and scaled with units noted.

Statistical analysis data should include the value of the test, the probability level and the degrees of freedom. The mean and standard deviation should be given. Doubts about the suitability of a test should be justified.

VI — CONCLUSIONS

This section explains how the above results are interpreted. What do they mean? What conclusions can be drawn as a result of the research? Reference should be made to the original purpose stated in the introduction.

Similarities and differences between the findings of this research and the work of others should be noted, (if applicable).

The following questions should be answered: (1) Has this research resolved the original "Cause - Effect" question? (2) What implications can be deduced from this research?

VIII — BIBLIOGRAPHY

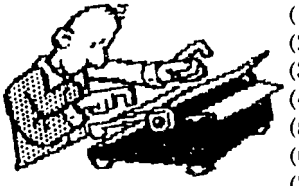
The bibliography is a list of specifically pertinent resource materials. On the following page of "HELPFUL HINTS FOR WRITING AWARD-WINNING SCIENCE RESEARCH PAPERS" is an example of a bibliography format.

VIII — ACKNOWLEDGEMENTS

This section gives the names of all the folks who helped in the completion of the paper. Include teachers, parents, other students, and friends.

HELPFUL HINTS FOR WRITING AWARD-WINNING SCIENCE RESEARCH PAPERS

1. ORGANIZE THE PAPER



Put pages in this order:
(1) Title Page
(2) Abstract
(3) Introduction
(4) Method
(5) Data
(6) Conclusions
(7) Bibliography
(8) Acknowledgement

2. USE A TYPING GUIDE

MARGINS - Left: one inches
Right: one inch
Top: one inch; bottom one inch

NUMBERING - The Introduction is page one. All subsequent pages are numbered consecutively.

SPACING - (1) TITLE PAGE - See example on page 1.
(2) ABSTRACT - Single spaced, following example on page 1.
(3) INTRODUCTION - The word INTRODUCTION is to be centered and typed in all caps on the twelfth line. After triple spacing, begin typing the introductory comments. (Double spaced)

***NOTE - The above mentioned rules are only "rule of thumb". Follow the style guide suggested by your teacher.

3. "COMPUTERIZE"

If you have access to a computer, learn to use a word processor. Makes editing, rewrites, rough drafts, etc. a "Cool-Breeze".

4. BE OBJECTIVE & CALM

(1) Always convey an objective, calm tone in your report. There should be an absence of emotion.

(2) The scientific point of view is impersonal. Omit elements which are personal. The active voice and first person (I, me, mine: "I mixed the solution" is not allowed. It should be: "The solution was mixed..." (passive voice).

5. FOLLOW CORRECT FORM

EXAMPLES OF BIBLIOGRAPHY FORMAT:

BOOKS -
DeJong, Marvin L. Apple II Applications Indiana: Howard W. Samr & Co., Inc.; 1873.

ARTICLES -
Magazine Article:
Rowson, David J. Competing. The Science Teacher, 22 (December 1985):32.

Newspaper Article:
Edson, Lee. Enzyme Explosion. New York Times. Nov. 7, 1979.

Encyclopedia
Epistrophe. Webster's New International Dictionary. 2nd ed., 1982.

The following is an excellent style guide for correctly writing research papers and bibliographies.

Publication Manual of the American Psychological Association: Washington, D.C.; American Psychological Association, 1200 - 17th Street; 1983.

WARNING

The directions given on pages 1-3 of this guide may be hazardous to the success of your project in a particular competition. It is *your* responsibility to obtain the specific guidelines for preparing your paper for a particular science fair, paper symposium, or publication. Check with your teacher, and/or write to the director of a particular competition for specific details.

HINT: A CHECKLIST LIKE THIS INSURES A WELL-ORGANIZED PAPER

WRITING A SCIENCE PROJECT RESEARCH PAPER

WORKSHEET

Name _____ Class _____

Project Title _____ Date _____

A rough draft of your report is due on _____ . You should use the guidelines on pages 1 thru 3 of this booklet in preparing this draft. As you proceed, use the checklist below. Attach a copy of this sheet (provided by your instructor) to your rough draft.

I - TITLE PAGE

[ ] Title contains dependent and independent variables.
[ ] Identification information is given.

II - ABSTRACT

[ ] Begins with a statement of purpose.
[ ] Written in third person, past tense.
[ ] Length less than 250 words.
[ ] Includes brief statement on the results.
[ ] Contains brief, general statement on how research was done.

III - INTRODUCTION

[ ] Describes source of research idea.
[ ] Describes other relevant research on your topic.
[ ] Answers question - "Why was research done?"
[ ] Gives precise purpose of research.

IV - METHOD

[ ] Identifies test subjects.
[ ] Describes apparatus used to control variables.
[ ] Gives concise description of experimental method.

V - RESULTS

[ ] Data are given in table or graphic form.
[ ] If a calculation was required, it is described.

VI - CONCLUSIONS

[ ] Includes interpretation of results.
[ ] Refers to original purpose.
[ ] States the relationship between the dependent and independent variables.
[ ] Gives implications of results.

VII - BIBLOGRAPHY

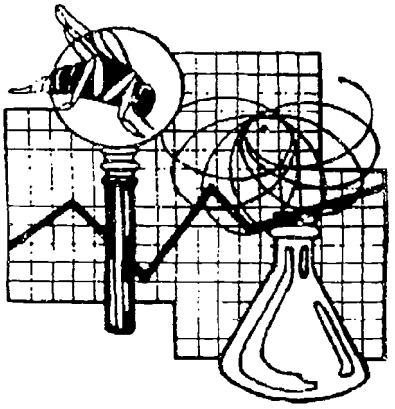
[ ] List specifically pertinent resources.

VIII - ACKNOWLEDGEMENTS

PUBLISHING PAPERS

Journal of High School Science Research

focusing on the research of precollege students



The first issue of the Journal of High School Science Research was published in February of 1990. The main purposes of the Journal are to:

- recognize the significant research conducted by pre-college age students
- encourage high school students to do science research projects
- provide guidance for young people who want to do research
- provide teachers with a resource to help young researchers
- encourage young people to share their ideas with their peers
- encourage teachers to share their ideas for helping students

Toward these goals, the *Journal of High School Science Research* publishes, in addition to student research papers, reviews of books, software and hardware helpful to young researchers; a database of resources (per issue), helpful research hints (ideas for research); and other resource information.

Preparing Papers for Submission

In general, the Journal of High School Science Research follows the guidelines and principles suggested in the ACS Style Guide [Dodd, Janet., Ed. American Chemical Society: Washington, DC, 1986] and the suggestion in this guide.

The requirements below are adapted from the guidelines recommended by the editors of *The Journal of Chemical Education*.

Papers on research conducted by high school students in the fields of Aerospace Science, Behavioral Science, Botany, Biochemistry, Chemistry, Computers, The Environment, Earth Science, Mathematics, Microbiology, Physics, and Zoology will be considered for publication.

GENERAL GUIDELINES

Before submitting a paper for possible publication, make sure that the paper —

_____ 1. Has not been published elsewhere.

_____ 2. Is submitted in triplicate typewritten copies. (Original and two copies. May also be submitted on diskette as an Appleworks, Microsoft Works, DIF, or ASCII file.)

_____ 3. Is double-spaced with one inch margins on 8.5 x 11" white paper.

_____ 4. Title is followed by the name and high school address of author.

_____ 5. Is organized into sections with headings and subheadings. These sections are referred to in the paper by name or by "above" and "below".

Also Make Sure That

_____ 6. If the paper has been presented at a Junior Academy meeting, science fair, or other competition, a footnote giving name of competition, date, and any award received is included.

_____ 7. Equations, formulas, chemical reactions, etc., are numbered sequentially in parentheses at the right margin. All references to these inclusions are by these numbers.

_____ 8. Acknowledgements are placed at the end of the text, but before the literature cited.

_____ 9. The manuscript is limited to 15 typewritten pages.

_____ 10. Literature references are designated with a number enclosed in parentheses [e.g., "This subject has been studied by Jones...(6)". References are arranged numerically in order of first appearance in the text, and placed at the end of the paper under the heading - Literature Cited. (See a recent copy of *The Journal of Chemical Education* for examples of the style to use.)

_____ 11. All illustrations, tables and graphs should be clearly labeled with self-explanatory titles. Photographs must be high resolution black and white prints.

Papers will be returned immediately if it contains any of the following:

_____ 1. Three or more misspelled words

_____ 2. Unacceptable grammar, punctuation, etc.

_____ 3. Written in first person

_____ 4. No bibliography and/or citations given

_____ 5. No Abstract

_____ 6. Failed to submit three copies or diskette

_____ 7. No Data

_____ 8. No conclusions drawn

_____ 9. Data does not support conclusion(s)

_____ 10. Topic too advanced or too simple for most JHSSR readers.

SUBMITTING PAPERS

Papers intended for publication in the Journal should be submitted to Mr. M.H. Farmer, Editor, Applied Educational Technology, P.O. Box 193, Tigerville, SC 29688. Copies of back issues are available for $10.00 each, postpaid.

To subscribe to the journal, send a check, MO, or PO to the above address.

Back issues of the *Journal of High School Science Research* are available. Each issue contains outstanding examples of high school students' scientific papers. Listed below are articles from back issues currently available. (Available for $10.00 each, postpaid, from Applied Educational Technology.)

CONTENTS - FEBRUARY, 1990 VOLUME I, Number 1

Wagner, Gretchen	UV - Induced Photodynamic Action in Slentor Coeruleous
Kaplan, Evan R.	A Comparison of a Numerical Scheme with One Developed by Conventional Methods
Shenoy, Nirmal	A Simple and Practical Approach for Measuring Diffusion Rates Using a Colorimeter

CONTENTS - SEPTEMBER, 1990 VOLUME I, Number 2

Swartz, Cliff	How to Win the Science Project Contest
Wilkerson, Ashley	The Marble and the Fly
Speiser, Lenny	Preservation of Poultry by Radurization, Vacuumization, and Thermal Processing
Bernold, Justin	Impedance Modeling of the Mark 15 UBA Using Forces Oscillations
McCue, Randy	The Proteolytic Activity in Embryonic Extracts of *Rana Pipiens* Exposed to Simulated Nitric and Sulfuric Acid Precipitation

CONTENTS - FEBRUARY, 1991 VOLUME II, Number 1

Hinshaw, Matthew	Stroboscopic Study of High Speed Projectiles in Water
LaPointe, Miriam	Determining the Efficiency of Kaolinite Clay in Heavy Metal Ion Exchange
Page, Rachel	Electromagnetic Fields in Occurrence of Leukemia in Children

Two additional publications that feature scientific papers by high school students include:

Journal of Student Research
20110 Canyon Road
Sheridan, OR 97378

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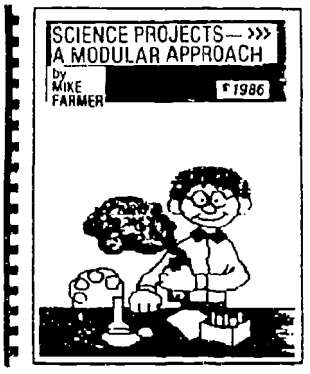

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■ A MODULAR APPROACH ■

BY MIKE FARMER

This step-by-step manual for developing successful science projects guides both teacher and students throughout the research process, from selecting an original topic to displaying final results. It lists 100 science project ideas, outlines procedures for experimentation, explains data analysis, describes exhibition techniques, discusses the use of computers, and provides checklists and worksheets for the teacher to help students in conducting well planned research and in effectively presenting results and conclusions. Now in its fifth printing, this N.S.T.A.-endorsed publication is being used by an increasing number of teachers and students to insure successful results. Fifty-two page, spiral-bound manual, $7.50 each; lots of 20, $5.00 each.

Need books, information, procedures, topic ideas, equipment, addresses, or kits related to science projects? Use this 1989 NSTA award winning resource.

NEW!

SCIENCE PROJECT DATA BASES

Written for Students
by Michael H. Farmer, Teacher
Riverside High School

SCIENCE PROJECT DATA BASES is a comprehensive listing of eleven areas of resources, including ideas, addresses, articles, procedures, books, topics, kits, information sources, materials and lab equipment that students may use. Available both as printed list and computer data bases, the printed version costs only $7.00 per entire set; the computer version (Appleworks data base on either a 3.5" or 5.25" diskette) is $20.00 per set.

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□ FROM START TO FINISH □

FOR THE TEACHER

The Science Fair Book: A Guide for Pre-High Schools: Discusses the many details of planning and holding a successful science fair. Offers helpful suggestions, handouts, help in organizing, and a detailed time line. Correlates with the student version.

FOR THE STUDENT:

Doing a Science Project: A Guide for Pre-High Students: Guides students through each step of doing a project — from choosing the topic to doing a backboard. Seven worksheets keep the student on track.

Both by Rebecca Brune.
$8.50 each, lots of 20 $5.00 each.

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3. Analyze the data statistically.
4. Determine the correlation between two sets of data.
5. Draw conclusions about the research goal.

SR:SAM

Scientific Research: Statistical Analysis Module

Includes 5.25 inch diskette, 88 page tutorial guide, 26 pages of sample problems and two flow charts. **Be sure to specify IBM or Apple version. Cost - $53.00**

SCIENTIFIC RESEARCH A STUDENT GUIDE

By Myra Halpin

A compilation of ideas, strategies and explanations that have been field tested by the author during five years of conducting a successful student research program. Appropriate for middle school through high school. The basics of scientific research are explained for the novice. **Student Version** - $9.95; **Teacher's Version** - $10.95.

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