VIRGINIA JUNIOR ACADEMY OF SCIENCE STYLE MANUAL
How to Produce an Effective Scientific Paper

The purpose of the VJAS Style Manual is to compliment the VJAS Handbook and specifically guide students on how to write the scientific research paper and complete their oral presentation.

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I. WRITING THE PAPER

A. General Style

1. In most scientific disciplines, papers have traditionally been written in third person, but more recently, first person has also been used. Results of the study should be written in past tense while accepted facts may be written in present tense. In contrast, papers in the areas of mathematics, statistics, and computer science are written in first person present tense.
2. Italicize scientific names (genus and species), such as *Escherichia coli*. and abbreviate in subsequent usage, such as *E. coli*.
3. Be aware that the word data is plural while datum is singular. This affects the choice of a correct verb. The word "species" is used both as a singular and as a plural.
4. Numbers should be written as numerals when they are greater than ten or associated with measurement. This means that “6 mm” and “2 g” are correct, but not “2 explanations” or “6 factors.” When one list includes numbers over and under ten, all numbers in the list may be expressed as numerals (for example: 17 sunfish, 13 bass, and 2 trout). Never start a sentence with numerals; spell all numbers at the beginning of sentences. Never start a number with a decimal point; put a zero in front. The correct format is 0.002.
5. Structure paragraphs with starting or ending sentences and be consistent in the use of tense throughout a paragraph. Avoid the use of slang and the overuse of contractions. Be sure to make the antecedent of a pronoun clear. For example, in the statement "Sometimes cecropia caterpillars are in cherry trees, but they are hard to find," does "they" refer to caterpillars or trees?

6. After writing a report, read it over, watching especially for lack of precision and ambiguity. Never use words such as may, might, could, perhaps, etc. Each sentence should present a clear message. The following examples illustrate lack of precision:
    a. There may have been an error in our temperature measurements.
    b. The sample was incubated in mixture A minus B plus C. Does the mixture lack both B and C or lack B and contain C?
    c. The title "Protection against Carcinogenesis by Antioxidants" leaves the reader wondering whether antioxidants protect from or cause cancer.

Symbols, Acronyms, Spelling and Measurement.

7. Define all symbols and spell out all acronyms the first time they are used.
8. All weights and measurements must be in the metric system, SI units.

B. Text Components

A scientific report usually consists of the following, in order:

Experimental Process	Section of the Paper
What did I call my project?	Title
What did I do in a nutshell?	Abstract
What is the problem?	Introduction
How did I solve the problem?	Methods and Materials
What did I find out?	Results
What does it mean?	Discussion and Conclusion
Whose work did I refer to?	Literature Cited
Extra Information	Appendices (optional)

The next sections will outline expectations for each of the above components.

Title

The title should be concise, reflect the factual content of the paper, and use key words in the field. The title is used only on the "Student Entry Form" and the Reader's and Judge's Evaluation Forms. There is no separate title page.

Abstract

A good abstract is a concise summary of the purpose of the report, the data presented, and the author's major results and conclusions. It is written after completing the rest of the report. VJAS abstracts must be one page only.

Introduction

The introduction defines the subject of the report. It must outline the scientific purpose(s) or objective(s) for the research performed and give the reader sufficient background to understand the rest of the report and what has been done previously. It should summarize the methods and results as well as a take-home message.

Methods and Materials

This section serves as a set of instructions for anyone desiring to replicate the study in the future. It should be thoroughly written, but without unnecessary detail that breaks the flow of the writing. The materials and equipment utilized during the experiment should be mentioned throughout the procedure as they are used. It should be written in past tense. Use diagrams and photographs to describe your procedure. Finally, include the safety guidelines followed.

Results

1. The results section should **summarize the data** from the experiments without discussing their implications. The data should be organized into tables, figures, graphs, photographs, and so on. Data included in a table should not be duplicated in a figure or graph.
2. This section of your report should also **analyze the data**, enabling the reader to develop an appreciation of the general trends in your data and the degree of variability in the results. Concentrate on general trends and differences rather than trivial details. Many authors organize and write the results section before the rest of the report.
3. Data analysis and presentation:

    a. **Types of Data.** Raw data are the individual pieces of qualitative and quantitative data that are actually collected and recorded. Quantitative data include measurements and counts. Qualitative data are categorical (discrete) data represented by a word or "number" label of measurement made with a non-standard scale. For qualitative data, it is important to determine if the data have no inherent

order (nominal data) or can be placed in rank order (ordinal data). Typically raw data are included in appendices, if necessary.

b. **Descriptive Statistics.** Results are more valid when repeated trials (replications) of a procedure are conducted and careful records of qualitative and quantitative data are kept. When the trials are completed, the raw data are summarized using appropriate measures of central tendency and variability. These summary data should be presented in the results section of the paper as part of data table(s) and/or graphs.

   i. **Measures of Central Tendency** include the mean, median and mode. The type of data determines which measure is appropriate: a) qualitative nominal data – mode only, b) qualitative ordinal data – mode or median and c) quantitative data – mode, median or mean. Typically, the median is used with ordinal data and the mean with quantitative data.

   ii. **Measures of Dispersion/Variability.**

      1. For quantitative data, the range communicates dispersion and is appropriate for all students. More advanced statistics are mean absolute deviation, standard deviation and variance. Some students may use other tools such as stem-and-leaf plots, histograms and box-and-whisker plots.

      2. For qualitative data, a frequency distribution (number of items falling into each category) communicates dispersion and is appropriate for all students.

c. **Graphical Displays.**

   If the independent variable involves discrete categories (cold, medium, hot) or continuous data (0^o, 10^o, 20^o, 30^o, 40^o C); if discrete, a bar graph is the only option. On graphs, each axis should be clearly labeled with the independent and dependent variables and the units for the variable measures included in parentheses.

d. **Verbal Summary.** After presenting the summary data and an analysis of these data, there should be a clear summary of the findings in paragraph form. The summary data presented should be evaluated for general trends and the degree of variability should be discussed. This should include clear references to the applicable charts, graphs and/or figures.

4. Selecting appropriate methods of analysis

A. **Middle School students** are expected to calculate and understand appropriate measures of central tendency (mean, median, mode) and dispersion/variability (range and frequency distribution).

B. **High School students** are expected to calculate and interpret dispersion in data using statistics such as mean absolute deviation, standard deviation, variance, and other tools such as box-and-whisker plots, scatterplots and curve fitting of linear and non-linear data. Many high school students will have the skills to write null and research hypotheses, establish levels of significance and degrees of freedom, and calculate and interpret statistical tests such as z-scores, various t-tests, Chi-Square and measures of correlation. With assistance from mentors, students may be able to understand and use analysis of variance/ANOVA

Discussion & Conclusions

In the discussion and conclusion section, the data collected are interpreted in relation to the hypotheses or purposes proposed in the introduction. This section should stress interpretation of the data, relating it to existing theory and knowledge. Suggestions for the improvement of techniques or experimental design may also be included here. In writing this section, you should explain the logic that allows you to accept or reject your original hypothesis. You should also be able to suggest future experiments that might clarify areas of doubt in your results.

Literature Cited.

1. All **references** must be properly cited in the paper. When information belongs to others, they must be given proper credit. Failure to do so is plagiarism.
2. The **Literature Cited** is a list of all books, publications, and communications from which significant materials were cited in the paper.
    a. The listing is alphabetical by the last name of the first author of a citation.
    b. All works cited in the text must be listed alphabetically in Literature Cited; works not cited must not be listed. Provide the full names of all journals.
    c. Single space within the citation and double space between citations.

3. In-text citations are within the text instead of footnotes to refer to references.

a. In-text citations must take the form: (Author, date). For example:

- Fox, in 1978, investigated the effects of hormones on the nest-building behavior of catbirds.
- Hormones are known to influence the nest-building behavior of catbirds (Fox, 1978).

b. Multiple citations should be listed by year of publication, the earliest first: (Author, date; Author, date).

c. Use the first author's name and "et al." for in-text citation of works with more than two authors or editors (Author et al., date);

d. Middle school papers (grades 7-8) will be accepted in both MLA and APA citation formats.

However, we will only accept APA citation format for high school papers (grades 9-12).

LITERATURE CITATIONS

A. **Peer-reviewed.** Peer-reviewed and scholarly references may be cited using guidelines for APA (middle school and high school) or MLA (middle school only). Citation formatting suggestions can be found on sites such as Purdue OWL and EasyBib.

B. **Non-peer-reviewed.** Most magazine articles are only judged/reviewed by the editor of the magazine, who may not have any knowledge of the article's subject matter and are considered non-peer-reviewed references. Be careful that the non-peer-reviewed references you use are credible and professional sources. You might want to research the editor's background or the magazine's specialty before choosing to cite an article.

Paper Component	***Suggested Slide(s)***	***Contents of Slide***
Title	**Project Title**	▪ The Title of your project. ▪ Your name and school.
Introduction	**Introduction**	▪ Explain the background concepts, demonstrating your understanding of them. ▪ State why you chose the project, its purpose and the research question.
	Experiment (Project) Design	▪ State and describe your variables (levels of IV, DV, control, etc.), constants and trials. ▪ You may do this with an "experimental design" chart. ▪ State your hypothesis.

Methods & Materials	**Methods & Materials**	▪ Describe the equipment used. ▪ Outline the procedure followed. ▪ Describe the safety guidelines followed. ▪ Use pictures and diagrams.
Results	**Data Presentation**	▪ Present summary data in numerical or visual form: tables, graphs, photographs, etc. ▪ Describe your results, referring to the summary data.
	Data Analysis	▪ Evaluate the data presented for general trends and variability using appropriate methods of analysis. ▪ Demonstrate your understanding of the analysis that you used.
Discussion & Conclusion	**Discussion**	▪ Interpret your results
	Conclusion	▪ State your conclusions and whether your hypothesis is accepted or rejected. ▪ Suggest improvements and future experimentation.
Literature Cited	**Literature Cited**	▪ This can be done in a summary slide, or in a footer on each slide, as appropriate.
Acknowledgments	**Acknowledgments**	▪ Although this was not allowed in your paper, it is encouraged in your oral presentation.

Appendix. The appendix is for supplementary information and is included in the page limit of the paper.

II. ORAL PRESENTATION OF THE PAPER. The oral presentation should cover all of the sections of the paper: Introduction, Methods and Materials, Results: Data Presentation and Data Analysis, Discussion and Conclusion, and Literature Citations. Acknowledgments, while not allowed in the paper, should be included in the oral presentation. There is a sample PowerPoint on the website at www.vjas.org.

A. **Tips for a good PowerPoint presentation.**

1. PowerPoint Format
    a. Use color, but ensure contrast between the print and the background.
    b. Do not use gimmicky animations or sounds. They detract from what you are saying.
2. Slide Construction
    a. Keep to a maximum of 4-5 key points per slide.

   b. Use pictures and other visuals.
   c. Ensure that graphs and data tables are large enough to be read from a distance.
3. Summarize your results with key points
   a. Put main takeaways from your presentation onto your slides.
4. Do not read your slides. The slides will just have bulleted information. The presentation should be more in depth and explain the bullets.
5. Practice
   a. Make sure that it will fit in the time allowed.
   b. Make sure you are comfortable and confident giving it.

Sample Presentation.

Project Title

Researcher's Name
School
City, State

Introduction

- Explain the background concepts that your audience needs to understand your research.
- Describe why you chose your project and it's purpose.
- State the question and concise objectives.

Experimental or Project Design

- State the independent (manipulated) variable,
  - Levels of the independent variable,
  - Control group.
- State the dependent (responding) variable.
- Note the constants and repeated trials.

State your hypothesis

Methods and Materials

- Outline the steps you used and the materials you needed to collect your data.
  (Is this precise enough to be replicated?)
- Use pictures to describe your procedure when possible and then describe the pictures to your audience.
- Include the safety guidelines followed.

Results: Data Presentation

- Summary data *(not raw data)* are presented and should consist of:
  - Numerical Data – titled and labeled.
    - Tables (charts) and graphs, or
    - Pictures and photographs
  - Verbal Summary
    - This is a verbal summary of your findings with reference to the applicable tables, graphs or pictures.

Results: Data Analysis

- Evaluate the data presented for general trends and variability, using an appropriate method of analysis, such as:
  - Measure of central tendency,
  - Measure of variation,
  - Statistical analysis.
- Demonstrate an understanding of the analysis you used, by describing:
  - How it was done.
  - What it means.

Discussion

- This is where you interpret your results.
  - State your major findings.
  - Compare them to other research.
- Your statistical analysis should support the conclusions that you are drawing from your data and the explanations that you propose.
- What are the major reasons, with citations, that explain the major trends found in your data?

Conclusions

- State your conclusions clearly and concisely.
- State whether the hypothesis is accepted or rejected.
- Suggest any improvements that could be made.
- What are the 'next steps' in your research?

Literature Cited

- The sources you used should be cited.
  - This can be done in a slide(s) here, or
  - The sources used for each slide can be listed in the footer of the slide.

Acknowledgements

- This is reserved for those individuals you want to thank.

Note. Although this was not part of your paper, it is suggested that you include a list of acknowledgements here.