The purpose of the VJAS Style Manual is to compliment the VJAS Handbook.

The basic requirements for submitting research papers to the VJAS Research Symposium are found in the Handbook. The Style Manual provides explanations and goes into greater depth than the Handbook and should be particularly helpful for students that do not have a lot of experience writing research papers.

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I. WRITING THE PAPER

A. See the Handbook for the basic requirements for the paper.

   • Length
   • Format
   • Literature Citations
   • Mechanics of the Paper Quantity

B. General Style

   1. Even though some journals accept first person writing, we prefer that you do not. Avoid using the first person, I or we, in writing. Keep your writing impersonal, in the
third person. Instead of saying, "we weighed the frogs and put them in a glass jar," write, "the frogs were weighed and put in a glass jar."

2. All scientific names (genus and species) must be italicized, such as *Escherichia coli*. The second time the name is used, the genus may be abbreviated using a capitalized first letter, such as, *E. coli*.

3. Use the **metric system** of measurements.

4. 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.

5. **Numbers** should be written as numerals when they are greater than ten or when they are associated with measurements; for example, 6 mm or 2 g, but two explanations or six 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 beginning sentences. Never start a number with a decimal point. The correct format is 0.002.

6. Be sure to divide paragraphs correctly and to use starting or ending sentences that indicate the purpose of the paragraph. A report or a section of a report should not be one long paragraph.

7. Every sentence must have a subject and a verb.

8. Avoid the use of slang and the overuse of contractions.

9. Be consistent in the use of tense throughout a paragraph--do not switch between past and present.

10. Be sure that pronouns refer to antecedents. 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?

11. 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.

12. The only way to prevent such errors is to read and think about what you write. Learn to reread and edit your work.

**C. Symbols, Acronyms, Spelling and Measurement.**

1. Define all symbols and spell out all acronyms the first time they are used.

2. All weights and measures must be in the metric system, SI units. Abbreviations may be used for units of weight or measurements that describe data.
3. For suggestions of the conventions and examples of table style, abbreviations, symbols, etc., consult *The CBE Manual for Authors, Editors, and Publishers*. Chicago (IL): Council of Biology Editors (1994 or more recent). For spelling consult *The American Heritage Dictionary of the English Language* (Soukhanov 1992 or more recent).

**II. 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 made with a standard scale with equal intervals such as the Metric system of measurements or the Arabic system of numbers. 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 rather than the results section of the paper. If raw data are placed in the results section, there should not be a separate table for each trial or replication. Instead, all of the trials should be combined into one table with a column for each trial/replication. It is appropriate to include descriptive statistics in such a table.

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.

1. **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.

Prior to seventh grade, students calculate and interpret these measures for data sets in their mathematics classes; however as seventh graders, they may still need sponsor’s guidance when applying these to their experimental data.

2. **Measures of Dispersion/Variability.**

   a. For quantitative data, the range (difference between maximum and minimum values) 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.

   b. For qualitative data, a frequency distribution (number of items falling into each category) communicates dispersion and is appropriate for all students.
C. **Graphical Displays.** Although students have constructed both bar and line graphs prior to the seventh grade, they often have difficulty selecting the appropriate graph.

1. Assist by having the student determine if the independent variable involves discrete categories (cold, medium, hot) or continuous data (0\(^\circ\), 10\(^\circ\), 20\(^\circ\), 30\(^\circ\), 40\(^\circ\) C); if discrete, a bar graph is the only option. Next, the student can select the appropriate summary statistic to be graphed (median, mean).

2. All students should select and construct appropriate bar and/or line graphs for their data. 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. **Summary Data** should be presented in the results section of the paper as data tables (charts), graphs and other figures (diagrams, pictures, photographs, etc.). **These should:**

   1. Be able to stand alone, i.e., have descriptive titles and should include a legend explaining any symbols, abbreviations, or special methods used.

   2. Be numbered separately and should be referred to in the text by number. The numbers should be in order as they appear in the text. For example, do not refer to table 2 before you refer to table 1.

   3. Have labels that meet the font format requirements and be situated in the text to meet the margin format requirements.

   4. In drawings and graphs, please capitalize only the first letter of the first word of each label; please use a typeface without bold or italics (unless genus, species, or gene names).

   5. If necessary, lower case letters should be used to indicate table footnotes.

E. **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.

III. **SELECTING APPROPRIATE METHODS OF ANALYSIS.**

Students should use statistics that are appropriate for their experience and grade level (7-8 or 9-12). A key in making this decision is the student’s understanding of how the statistic is calculated and the student’s ability to interpret the results. It is better to choose a “simpler” method and demonstrate good understanding than to use a more complex method and not be able to explain how it is calculated or what it means.

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

   1. Many middle school students will be able to construct and interpret stem-and-leaf plots, histograms, box-and-whisker plots and scatterplots.
2. Some middle school students will also understand mean absolute deviation, standard deviation and variance. With guidance, a few students may use more advanced tests provided they fully understand them.

B. **High School students should** be 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.

1. 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.

2. It should be noted, however, that the expectations for a 9th grader may be very different that for a 12th grader, and actually closer to that of an 8th grader.

3. As noted above, the key is truly understanding the method used (i.e. when questioned by judges) regardless of the student’s grade level.

IV. **TEXT COMPONENTS**

A. General.

Written reports exist for a long time and yield long-term benefits for the author and others. Learning to write effectively can only be learned by writing. For this reason, most papers submitted by new scientists receive many comments and usually require rewriting. Papers submitted by senior scientists usually require few revisions.

Scientific research is a group activity. Individual scientists perform experiments to test hypotheses about physical phenomena. After their experiments are completed and duplicated, these researchers attempt to persuade others to accept or reject their hypotheses. The scientific paper is the vehicle of persuasion and an archival record for future generations. When it is published, it is available to other scientists for review. If the results stand up to criticism, they become part of the accepted body of scientific knowledge unless later disproved.

A scientific report usually consists of the following:

1. Title
2. Abstract
3. Introduction
4. Materials and Methods
5. Results
6. Discussion & Conclusion
7. Literature Cited
8. **Acknowledgements: not allowed in VJAS papers, should be in oral presentations.**
9. Appendix
There is general agreement among scientists that each section of the report should contain specific types of information.

B. Title
   1. The title should be less than ten words and should reflect the factual content of the paper. Scientific titles are not designed to catch the reader's fancy. A good title is straightforward and uses key words in the field.
   2. Remember that the title is only used on the “Student Entry Form” and the Reader’s and Judge’s Evaluation Forms. There is no separate title page.

C. Abstract
   1. The purpose of an abstract is to allow the reader to judge whether it would serve his or her purposes to read the entire report.
   2. A good abstract is a concise summary of the purpose of the report, the data presented, and the author's major results and conclusions.
   3. Write the abstract after completing the rest of the report, even though the abstract comes at the beginning of the paper.
   4. The abstract should never contain images or reference citations.

D. Introduction
   1. 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. Care should be taken to limit the background to whatever is pertinent to the experiment. It should demonstrate the author’s understanding of the subject.
   2. A good introduction will answer several questions, including the following:
      a. Why was this study performed? Answers to this question may be derived from observations of nature or from the literature.
      b. What knowledge already exists about this subject? The answer to this question must review the literature, showing the historical development of an idea and including the confirmations, conflicts, and gaps in existing knowledge.
      c. What is the specific purpose of the study?
      d. The specific hypotheses and experimental design pertinent to investigating the topic should be described.

E. Materials and Methods
   1. As the name implies, the materials and methods used in the experiments should be reported in this section. The difficulty in writing this section is to provide enough detail for the reader to understand the experiment without overwhelming him or her. When procedures from a lab book or another report are followed exactly, simply cite the work, noting that details can be found in that particular source. However, it is
still necessary to describe special pieces of equipment and the general theory of the assays used. This can usually be done in a short paragraph, possibly along with a drawing of the experimental apparatus. Generally, this section attempts to answer the following questions:

a. What materials were used?

b. How were they used?

c. Where and when was the work done? (This question is most important in field studies.)

2. Use diagrams and photographs to describe your procedure and then describe the pictures.

3. Include the safety guidelines followed.

F. **Results** *(Also see Data Presentation and Data Analysis, above.)*

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. But 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 and not on trivial details. Many authors organize and write the results section before the rest of the report.

G. **Discussion & Conclusion**

1. In the discussion and conclusion section, the data collected are interpreted in relation to the hypotheses or purposes proposed in the introduction.

2. This section should not just be a restatement of the results, but should stress interpretation of the data, relating it to existing theory and knowledge. Speculation is appropriate if it is so identified. 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.

3. Your findings should be related to existing knowledge on the topic. You should also be able to suggest future experiments that might clarify areas of doubt in your results.

H. **Literature Cited.** 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.

1. 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.

d. See the Section V for examples.

2. 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, 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); list every author or editor in the "Literature Cited" list unless there are more than 10 authors.

3. You must have a minimum of three peer-reviewed or scholarly references. (See the Handbook for definitions and examples in the next section.)

I. Acknowledgments. In this section the writer gives credit for special assistance received from scientists or other sources, stating specifically what assistance was provided (e.g. someone who ran statistical analysis, someone who injected animals, etc.).

   1. This section is no longer allowed in the VJAS Paper. It is VJAS policy not to identify the student researcher(s) or sponsors until the papers are presented at the Research Symposium. We have had to eliminate this section to accomplish this.

   2. This section should be included in the oral presentation at the Research Symposium.

J. Appendix. The appendix is for supplementary information. As much information as possible should be placed in the 12 limit of the paper. Information critical to the understanding of the paper, that can’t be placed in the 12 page limit of the paper should be included in the appendix.

V. LITERATURE CITATIONS: EXAMPLES

A. The following are examples of peer-reviewed and scholarly references and the correct format/style for citing them.

   1. Journal article:


2. **Book:**


3. **Chapter in a Book:**


4. **Dictionary:**


5. **Encyclopedia:**

*If subject is authored-*


*If not authored, use the subject in place of the author-*


6. **Online Article:**


7. **Personal communications, unpublished data, and manuscripts in preparation** should be cited in the text. Letters should be available from authors of personal communications giving permission to cite the unpublished data. The citation should include the source's name and affiliation in the following form:

Henry J. Smurd, university or other affiliation, city, state, personal communication.

8. **Technical Report:**


9. **Scholarly magazines**, such as *Scientific American*, while not peer-reviewed, are written for scholarly audiences and therefore considered scholarly publications.

10. **Trade publications** are not peer reviewed or written for scholars in a particular field, but they are written for an educated audience that has some knowledge of the issues presented. They are more in-depth than popular magazines and may be useful for certain types of research.

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. Therefore popular magazines whose articles are geared to a general audience should be considered as non-peer-reviewed references.

VI. **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 make sure it looks good when projected on a screen. There should be good contrast between the print and the background.
      b. Don’t use a lot of gimmicky animation or sounds. They detract from what you are saying.
   2. **Slide Construction**
      a. Keep to a maximum of 4-5 key points per slide. No one will read slides with lots of text in them.
      b. Do use pictures and other visuals.
      c. Make sure that graphs and data tables are large enough to be read from a distance.
   3. **Summarize your results with key points.**
      a. What do you want the audience to take away from your presentation?
      b. This is what goes on your slides.
   4. **Don’t read your slides.**
      a. The slides are just to illustrate the key points of your presentation.
      b. If all you are doing is reading your slides there is no reason for you being there.
   5. **Practice giving your presentation – several times.**
      a. Make sure that it will fit in the time allowed.
      b. Make sure you are comfortable and confident giving it.
B. **Outline.** The following outline can be used in structuring the PowerPoint Presentation; it is based on the required sections of the paper and what the readers and judges look for.

<table>
<thead>
<tr>
<th>Paper Component</th>
<th>Suggested Slide(s)</th>
<th>Contents of Slide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td><strong>Project Title</strong></td>
<td>• The Title of your project.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Your name and school.</td>
</tr>
<tr>
<td>Introduction</td>
<td><strong>Introduction</strong></td>
<td>• Explain the background concepts, demonstrating your understanding of them.</td>
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<td></td>
<td></td>
<td>• State why you chose the project, its purpose and the question you’re trying to answer.</td>
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<tr>
<td>Experiment (Project) Design</td>
<td></td>
<td>• State and describe your variables (levels of IV, control, etc.), constants and trials.</td>
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<td>• You may do this with an “experimental design” chart.</td>
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<td></td>
<td></td>
<td>• State your hypothesis.</td>
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<tr>
<td>Methods &amp; Materials</td>
<td><strong>Methods &amp; Materials</strong></td>
<td>• Describe the equipment that you used.</td>
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<td></td>
<td></td>
<td>• Outline the procedure that you followed.</td>
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<td>• Describe the safety guidelines followed.</td>
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<td></td>
<td></td>
<td>• Use pictures and diagrams.</td>
</tr>
<tr>
<td>Results</td>
<td><strong>Data Presentation</strong></td>
<td>• Present summary data in numerical form: tables, graphs, photographs, etc.</td>
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<tr>
<td></td>
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<td>• Describe your results verbally, referring to the summary data.</td>
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<td></td>
<td><strong>Data Analysis</strong></td>
<td>• Evaluate the data presented for general trends and variability using appropriate methods of analysis.</td>
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<td>• Demonstrate your understanding of the analysis that you used.</td>
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<tr>
<td>Discussion &amp; Conclusion</td>
<td><strong>Discussion</strong></td>
<td>• Interpret your results</td>
</tr>
<tr>
<td>Conclusion</td>
<td><strong>Conclusion</strong></td>
<td>• State your conclusions and if your hypothesis is accepted or rejected.</td>
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<td></td>
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<td>• Suggest improvements and future experimentation</td>
</tr>
<tr>
<td>Paper Component</td>
<td>Suggested Slide(s)</td>
<td>Contents of Slide</td>
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<tr>
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<tr>
<td>Literature Cited</td>
<td>Literature Cited</td>
<td>• This can be done in a summary slide, or</td>
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<td>• It can be done in a footer on each slide, as appropriate.</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td></td>
<td>• Although this was not allowed in your paper, it is encouraged in your oral presentation.</td>
</tr>
</tbody>
</table>

C. **Sample Presentation.** The following sample PowerPoint can be downloaded from the VJAS website.

![Project Title Image]

**Project Title**

Researcher's Name  
School  
City, State

![Introduction Image]

**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 Image]

**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 Image]

**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.