

# **Teacher's Guide to Technical Writing for STEM: Proposals, Plans, and Reports**

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The purpose of this teacher's guide is to provide resources to assist teachers in preparing students for the technical writing required for any type of STEM proposal or report. This guide follows many of the Believe in Ohio <http://www.believeinohio.org/documents/roadmap.pdf> mileposts and lays out an easy-to-follow roadmap to helping students pursue a project from idea to completion.

## **TEACHER ADMINISTRATION**

### *Description:*

Students will develop a STEM commercialization proposal to be used in the Believe in Ohio program or a STEM research paper to be used for state science day. Each session will focus on the various components that are necessary for writing an appropriate proposal. With teacher guidance, students will be taught to find reliable sources, compare ideas from multiple articles, use appropriate citations, develop a plausible prototype, and present their ideas in a coherent manner.

### *Objectives:*

#### **Session 1 Objective:**

- Upon completion of this session, the student will be able to identify and find reliable sources for their topic.

#### **Session 2 Objectives:**

- Upon completion of this session, the student will be able to compare/contrast ideas presented in multiple sources.
- Upon completion of this session, the student will be able to make connections from their sources to their topic.

#### **Session 3 Objectives:**

- Upon completion of this session, the student will be able to use appropriate in-text citations.
- Upon completion of this session, the student will be able to write a references cited page.

**Session 4 Objective:**

- Upon completion of this session, the student will be able to design a prototype for their product.

**Session 5 Objective:**

- Upon completion of this session, the student will be able to present their information and argue for their product.

**Standards Addressed:****English/Language Arts**

- RST9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- RST9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- RST9-10.9: Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
- WHST9-10.1: Write arguments focused on *discipline-specific content*.
- WHST9-10.6: Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.
- WHST9-10.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation
- WHST9-10.8: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- WHST9-10.9: Draw evidence from informational texts to support analysis, reflection, and research.

## Science

- Physical Science/Biology Inquiry and Application Standards
  - Identify question and concepts that guide scientific investigations.
  - Design and conduct scientific investigations.
  - Use technology and mathematics to improve investigations and communications.
  - Formulate and revise explanations and models using logic and evidence.
  - Recognize and analyze explanations and models.
  - Communicate and support a scientific argument.
- *Cognitive Demand:*
  - **Designing Technological/Engineering Solutions Using Science Concepts** requires student to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.
  - **Interpreting and Communicating Scientific Concepts** requires student to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

### Depth of Knowledge Levels:

- DOK 4

## Session 1: Reliable & Credible Sources

*Expected Duration:* 2 - 3 class periods

*Materials List (Student):*

- Computers/Devices for each student/group
- Source Information Handout
- Scavenger Hunt Record Sheet
- Source Sleuth Game
- How Do I Identify Credible Sources? Handout

*Teacher Directions:*

- Introduce topic of choosing credible sources to students.
  - A credible source is fact-based. Sources that are peer-reviewed, and/or on a recognized organization or university website are generally credible.
- Make a list of potentially credible sources with the class.
- Hand out or project the “Source Information Handout” document. Discuss with students how the two different sources have pieces that sound credible, but have various reasons why they are not credible sources.
  - Explain that sometimes content seems so amazing that it makes a reader wonder if it’s true or not. Ask students which of the examples – A or B – seems too good to be true. (Answer: A) Tell them to beware of this type of writing as it can indicate unreliability and inaccuracy. They should ask themselves these questions to help determine if the writing might be largely untrue: *Does this information seem unbelievable? Does it make sense to you or others? Does what you read conflict with something you already know to be true? Does the writing seem like hyperbole where something is grossly exaggerated? Is there a way to check this information out so you know whether it is true or not?*
  - Ask students what they might do when they encounter such dubious material. By **comparing multiple sources** as a search strategy, they can get a sense of the quality of the information. If there is inconsistency among sources, this far-fetched claim may be too good to be true.
  - In Example B, it may not sound too good to be true, but it still makes the reader feel skeptical. Encourage students to use the same strategy of corroborating or verifying the information using other sources to help determine if the facts or assertions are true or not. **Optional:** Have students search the Internet for other stories

on the two topics in “Source Information Handout” to validate the accuracy.

- Go back to class-created list of potentially credible sources and revise based on information learned.
- **Bridge to previous learning.** Remind students that in the previous activity, they identified that knowing the task and finding credible sources are important when gathering information. Tell them in this and other lessons, they will have some tools to help them identify credible sources.
  - Explain that identifying the author can help determine the credibility and truthfulness of your source. Ask students what questions they would want to know about an author. Possible answers: *Who wrote this information? When did s/he write it? Is this person reliable?*
  - Tell students they will either go on a Scavenger Hunt or play a game (TEACHER: choose which activity or allow students to choose, possible differentiation) so they can delve into the kinds of questions they just generated about the author of an information source. Explain that not all of the information they seek will be available for every source. This activity is intended to show them the kinds of information they might see to get a sense of credibility.
  - Make these points to students or use them for your own edification when teaching:
    - Recognizing credibility is not cut and dry. With web sources it is hard to determine credibility, but considering the questions posed in this activity will help.
    - Information sources that are missing answers to some of the questions posed does not necessarily mean that they are entirely unreliable. Therefore, use the questions subjectively to determine credibility. **These questions are not a checklist. It is designed to be an opportunity for students to practice locating, identifying, and processing this kind of information.**
    - Other factors of credibility include when an article was written and if the source can be verified. For certain topics, how old the information is can impact its reliability and accuracy. Examples of information where date is important can include presidential elections, Olympic Games, latest scientific findings, or current events. Where the date might not be so important is when researching about a historic event like what is in King Tut’s tomb or the Trail of Tears, or information about a person from the past like Helen Keller, Albert Einstein, or Julius Caesar. The caveat is when these events or people become a current event because of a new finding. Ask

students to volunteer their own examples of when date is important or not so important when researching sources.

- **Option #1: Conduct scavenger hunt.**

- Group students homogeneously by reading level or by sets of students who are able to push each other to think more deeply. Invite groups to select a topic of interest from a list that you prepare prior to this activity. Issue a website address to each group based on their topic of interest and readability level. Instruct them to complete the “Scavenger Hunt Record Sheet” based on their assigned site.
  - **Differentiation:** When preparing the list of sites, consider interest so that you have links for various interest-based sites. Additionally, within these interest areas, select several sites that span readability levels so that if more than one group chooses the same interest topic, you can assign website links that are appropriately challenging to each group. For students at the Intermediate Level, consider leveling sites by how difficult they are to find valid information to help with assessment (e.g., a site authored by an authority who only uses a Twitter handle instead of their name). Interest ideas can include sports, animals, art, or music. Please do not pick hoax sites, as it is difficult to transfer these skills from fictional topics to information on topics students will actually encounter in life. For groups needing additional support, work with them on an individual basis to get started on this assignment.

- **Option #2: Play a game.**

- Group students in homogeneous pairs or trios by reading level. Invite groups to select a topic of interest from a list that you prepare prior to this activity. Issue a website address to each pair or trio based on their topic of interest and readability level.
- Tell students they will use the game board “Source Sleuth Game” to investigate information about the author of material on a website. To start the game, students put a game piece on the “Start” box. This can be a collection of pieces you or students provide, such as beans, pennies, buttons, macaroni, metal rings, or paperclips. In addition, provide duplicate cards with a 1, 2, and 3 point value. Place these cards face down.
- Assign students a website and ask them to open it next to their prepared game cards. Students determine who goes first. This person turns over a card and moves to the spot on the board indicated by this number. Using the source information, the student answers the question. The pair or trio must agree before it is the next student’s turn. Repeat so that students continue to move

around the game board answering and discussing questions based on the website. The game is over with the first person (or all students, as you wish) reach the “End” spot.

- **Differentiation:** When preparing the list of sites, consider interest so that you have links for various interest-based sites. Additionally, within these interest areas, select several sites that span readability levels so that if more than one pair or trio chooses the same interest topic, you can assign website links that are appropriately challenging to each grouping. For students at the Intermediate Level, consider leveling sites by how difficult they are to find valid information to help with assessment (e.g., a site authored by an authority who only uses a Twitter handle instead of their name). Interest ideas can include sports, animals, art, or music. Please do not pick hoax sites, as it is difficult to transfer these skills from fictional topics to information on topics students will actually encounter in life. For those needing additional support, work with them on an individual basis to get started on this game.
- **Debrief with classmates.**
  - Invite groups to share one or two key findings from the scavenger hunt or game that they found noteworthy. Avoid having students read off of their “Scavenger Hunt Record Sheets” (if they performed this activity). Their findings can include what they find or don’t find from their sites. Use these questions as a springboard for discussion: *“Is it important to be able to answer every question? Why or why not? What do we do when we find sources where there are a lot of unanswered questions? What do you think about the credibility of your site after investigating answers to these questions?”*
  - To close this lesson, have students complete a sentence starter. You might say: *“We have started to learn about what makes a credible source. Using what you learned in this lesson, complete this sentence starter with your partner (trio or group) and be ready to share with the class. Here is the sentence starter: **When we research, it is important to....”***
  - Listen as students share their sentences. Guide them to respond with something close to this: *“When we research, it is important to find and use credible sources. To help determine credible sources, researchers need to know about the author, when the article was written, and how this source can be verified.*
- **Distribute list of credibility factors.**
  - Make a class set of copies of the handout “How do I identify credible sources?” Before distributing it, show and read the top paragraph only on a document camera or overhead. Explain that

this handout will be a resource for them as they consider credible sources to use for their tasks. Once again, **it is not a checklist, but rather a set of ideas to get them started. No website will meet all these criteria, and some websites that do may have other factors that make students suspect them.** Then uncover the whole sheet and show them that they have already focused on the top four rows.

*Formative Assessment Suggestions:*

- Revision of the credible sources list
- When we research, it is important to... activity

*Key Points and/or Misconceptions:*

- Students need to realize that not everything that is written and posted online or printed in a magazine is credible.
- Students need to realize that newspaper article may or may not be reliable sources; this is dependent on whether they truly are fact-based.

*Extensions:*

- Based on students' scavenger hunt work, use of other websites and further discussion of credible sources may be needed.
- Another instructional activity would be to distribute a newspaper article and have students circle the words that appear bias (those words that seem to push the reader in a particular direction). Then, students "re-write" the article in a more neutral manner while still expressing the same idea. (i.e. "Lack of sleep is *detrimental* to productivity at school." Vs. "Lack of sleep *reduces* productivity at school.")

*Enduring Understandings:*

- Students need to gain the enduring understanding that not all written materials are credible and further research may need to be conducted to verify the reliability of the research and/or documents to be used in their own professional endeavors.



### *Attachments:*

- Source Information Handout
- Scavenger Hunt Record Sheet
- Source Sleuth Game
- How Do I Identify Credible Sources? Handout

### *Research Tips:*

- Search for the article in Google. Click on advanced search, select file format PDF.
- If you can't find any articles immediately, try different combinations of keywords.
- Skim the abstract of an article first to decide whether it is relevant to your research.
- Find one really good paper and then look for more articles in the works cited page
  - These papers are more likely to be well written and well reviewed.
- Google Scholar (<http://scholar.google.com>)
  - Enter key words related to your topic. The search engine will find relevant primary literature references.
  - IMPORTANT: Google Scholar will provide you with a link to the article reference but NOT a link to the actual article, because many journals require a subscription to view and download their articles.
- INFOhio ([www.infohio.org](http://www.infohio.org)) then click on EBSCOhost Multi-Database Search
- [The University of North Carolina – Writing Center](#)

## SOURCE INFORMATION

**Example A:**

In this article, I will explain how people can get taller. There are many short people who have been told by their doctors that they have completed their growth spurt years and that they no longer will continue to achieve additional height. These doctors certainly have misinformed their patients, and as a result have discouraged them. Instead, they should tell them that if patients were to hang upside down for 10 minutes every 4 hours, they will stretch their spinal columns. If these short people follow this routine for one full month, they can increase their height two full inches and stand shoulder to shoulder with peers their age. The medical research about spinal stretching spans many decades and have been attributed to the success of many basketball players who sought to increase their height beginning in their middle school years.

**Example B:**

All football players are angry, vicious people who use the football field to express their anxiety. It has been reported that this sport draws males who are inherently distressed individuals who seek this activity as a means to blow off steam. The following was reported in the magazine *Sports and Mental Health*, "Everyone who plays this sport, even from a young age, has issues relating to anger management. This has been a pervasive problem that management of national teams must address head on." Unless football coaches and officials take this issue seriously and recruit players who are more emotionally stable, our society might incur problems. For example, some players visit bars and begin fights with patrons. Others engage in violent activities like dog fighting and breeding pit bulls.

## SCAVENGER HUNT RECORD SHEET

**Search Topic:** \_\_\_\_\_ **Site Address:** \_\_\_\_\_

**Group Members:** \_\_\_\_\_ **Class Period:** \_\_\_\_\_

**Directions:** Review a site and answer these questions and prompts. You may divide this task with group members.

<b>Who wrote this information?</b>	
<i>Can you identify an author? A real name or an alias?</i>	
<i>What is the author's education, training, or experience as it relates to this content?</i>	
<i>Does s/he have a professional title or is s/he recognized as an authority? Identify the title.</i>	
<i>Is the author connected with an organization? If so, can you determine if it is a respected organization? Name the organization.</i>	
<i>Can you contact the author or company? How?</i>	
<i>If the author is unnamed, can you take extra steps to find information about this author? What steps did you take?</i>	
<b>When was the article written?</b>	
<i>Does the author include a date for the information written? What is it?</i>	
<i>Is it important that the information be current or are you researching a topic from long ago?</i>	
<i>Do the links on the site work, or are they outdated?</i>	
<b>Can the information be verified for accuracy?</b>	
<i>What sources does the author of this information use? Name one.</i>	
<i>Are these sources listed in the article? Linked?</i>	
<i>Does the author include a works cited or other links to provide additional resources or original source information? Identify one.</i>	
<i>Are there identified sources for any data or statistics in the content? Write one statistic and its source.</i>	
<i>Can you find other sources that share the same information, or is this the only source? Name which other source you accessed.</i>	

### SOURCE SLEUTH GAME

**Directions:** Sit with a partner and access your assigned information page on the web. Take turns playing this game. When you land on a square, answer the prompt based on the source information on your site. Discuss each of your answers so there is agreement before taking the next turn.

<b>END</b>			Do you feel this source is credible? Why or why not?	Can you find other sources that share the same information?	Are there identified sources for any data or statistics in the content? Show one statistic and its source.
	Is the author connected with an organization? Which one?	Does s/he have a professional title? What is it?	Is the author unnamed? How can you find the name?	Is it important that the date is current? Why or why not?	Does the author include a works cited or other links? Identify one.
	What is the author's education, training or experience?		What sources does the author of this information use?		Are the sources the author uses listed in the article? Where?
	Can you contact the author or company? How?	Does the author include a date for the information? What is it?			
	Do the links on the site work?				
<b>START</b>					

## How do I identify credible sources?

When collecting evidence for a research project, information report, argument paper, or similar task, it is important to use factual information. For an argument paper, it is true you want to sway your reader and will have a clear position and perspective. However, basing your evidence on facts will be more convincing to your readers. For a research project or report, you will want to include accurate and reliable facts and information. Consider the following when you collect evidence so you can use credible sources.

### Does the writing seem too good to be true?

Sometimes content seems so amazing that it makes a reader wonder if it's true or not. Beware of this as it can indicate unreliability and inaccuracy. Ask these questions to help you determine if the writing might be largely untrue: *Does this information seem unbelievable? Does it make sense to you or others? Does what you read conflict with something you already know to be true? Does the writing seem like hyperbole where something is grossly exaggerated? Is there a way to check this information out so you know whether it is true or not?*

### Who wrote this information?

Identifying the author can help you determine the credibility and truthfulness of your source. Consider these questions: *What is the author's education, training, or experience as it relates to this content? Does he or she have a professional title or is he or she recognized as an authority? Is the author connected with an organization? If so, can you determine if it is a respected organization? Can you contact the author or the company? If the author is unnamed, can you take extra steps to find information about this author?*

### When was the article written?

For certain topics, how old the information is can impact the reliability and accuracy. *Does the author include a date for the information written? Is it important that the information be current or are you researching a topic from long ago? Do the links on the site work, or are they outdated?*

### Can the information be verified?

To check the accuracies of information, we might consider these questions: *What sources does the author of this information use? Are these sources listed in the article? Does the author include a works cited or other links to provide additional resources or original source information? Are there identified sources for any data or statistics in the content? Can you find other sources that share the same information, or is this the only source?*

### How might the tone or style of the writing reflect its credibility?

The actual design of the website will not necessarily mean it is unreliable. What is most important is the actual writing. The way in which an article is written can reveal clues about its credibility. Consider the following: *Does the article have several grammar, spelling, punctuation, or capitalization errors? Is the writing emotional and include language that has a bitter, critical, or demanding tone? Is the writing so informal that it seems hard to trust? Does it seem unfair or extremely slanted to a point of view and biased? If it is biased, are there facts to back it up or other sites to verify what it states? Does it seem like it would anger or manipulate people?*

### Why does the author write this information?

Sometimes people write articles for reasons that contribute to unreliability, bias, and untruths. This doesn't mean that a company writing an article about something it is passionate about will be unreliable. Or that a person who writes a persuasive piece is completely biased. Argument papers are by nature meant to persuade a reader, so take this into account while reading. As you read sources, use your judgment and the clues about credibility to make sure you access the information you need to satisfy your task.

## **Session 2: Incorporating Ideas from Multiple Sources**

*Expected Duration:* 2-3 class periods

*Materials List (Teacher):*

- Comparing and Synthesizing Sources chapter

*Materials List (Student):*

- Computers/devices for each student
- Comparison Table graphic organizer
- "Watson and Crick Session 2" article
- "'Lost' Letters Reveal Twists in Discovery of Double Helix" article

*Teacher Directions:*

- The focus of these lessons is to help students synthesize information from two or more resources.
- This process is important for students because as they begin searching for information on their specific topics, they will find many articles referring to their area of study. Some of these articles may have conflicting or slightly different information (For example, an article regarding Watson and Crick's DNA structure written in the 1950s would be different than an article written on DNA structure today, in light of advancements in technology and genetic research). Students will need to be able to determine which information and research is the most current and reliable, and most closely related to their research topic. They may also need to combine thoughts presented in multiple articles into a cohesive idea of their own.
- Present students with two articles (see provided or choose your own).
- Have students read the articles and find a point where the two have similar and/or conflicting information. Have them mark/annotate the information in each article and/or use the "Comparison Table" graphic organizer.
- After students have read and annotated their articles with the information asked for, conduct a class discussion where you look at one student's annotated information and paraphrase that into a sentence or two that accurately depicts the information gleaned from both articles.
- Following the whole class discussion, have students follow the same procedure in a small group with another set of ideas (from the same articles).

- After students have successfully practiced synthesizing and paraphrasing information, explain to students that they will need to use this skill when they are writing their background information for their research papers.
- At this point, if students have not yet chosen their topic for research, they need to choose their topic.
- If students are struggling to choose a topic, the resources available at the following website may be helpful:  
<https://www.umflint.edu/library/how-select-research-topic>
- As a reminder, teachers can choose to create a list of potential topics for students from their specific content of study
- Have students find two articles related to their research topic and go through the process completed above on their own. Students should find one point where the articles have similar (both articles agree but information is presented in two different manners) or conflicting (the two articles have differing points of view on the topic) information and determine which information will be used in their own papers and how to paraphrase that information for inclusion in their writing.

*Formative Assessment Suggestions:*

- Observe students' small group discussions for their understanding of synthesizing and paraphrasing information.
- Students' practice on their own research topic (last bullet point above)

*Key Points and/or Misconceptions:*

- Students' research will not necessarily agree with information presented in all articles on the topic; students need to understand how to synthesize and use the appropriate information to support their own viewpoint of their topic.

*Sample Responses:*

- Points students may find from DNA articles:
  - Both articles credit Rosalind Franklin for her work in discovering the structural component of DNA.
  - A point where the articles differ:
    - Watson & Crick article credits Chargaff for the complementary-base pairing
    - "Lost letters..." has no mention of Chargaff; focusing more on Franklin and her assistant (Wilkins).
  - Both articles discuss the importance of x-ray crystallography in identifying the structure of DNA.

*Enduring Understandings:*

- For the Believe in Ohio project, this helps students move from milepost 1 into milepost 2 and gives them foundational skills for further research in mileposts 3-8.
- This session prepares students to write their background portion of the state science day competition paper.

*Attachments:*

- "Watson and Crick Session 2" article
- "'Lost' Letters Reveal Twists in Discovery of Double Helix" article
- Comparison Table graphic organizer
- Comparing and Synthesizing Sources chapter

*Web Links:*

- [Ohio Academy of Science](#) (state science day)
- [Believe in Ohio](#)



# COMPARISON TABLE

② OVERALL CONCEPT

① CONCEPT

① CONCEPT

③ CHARACTERISTICS	③ CHARACTERISTICS
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④ LIKE CHARACTERISTICS	⑤ LIKE CATEGORIES
⑥ UNLIKE CHARACTERISTICS	⑦ UNLIKE CATEGORIES

⑧ EXTENSIONS

⑧ SUMMARY

- Step 1: Communicate targeted concepts
- Step 2: Obtain Overall Concept
- Step 3: Make lists of known characteristics
- Step 4: Pin down Like Characteristics
- Step 5: Assemble Like Categories
- Step 6: Record Unlike Characteristics
- Step 7: Identify Unlike Categories
- Step 8: Nail down a summary
- Step 9: Go beyond the basics

## James Watson & Francis Crick

It took an ex-physicist and a former ornithology student — along with some unwitting help from a competitor — to crack the secret of life

By ROBERT WRIGHT

On Feb. 28, 1953, Francis Crick walked into the Eagle pub in Cambridge, England, and, as James Watson later recalled, announced that "we had found the secret of life." Actually, they had. That morning, Watson and Crick had figured out the structure of deoxyribonucleic acid, DNA. And that structure — a "double helix" that can "unzip" to make copies of itself — confirmed suspicions that DNA carries life's hereditary information.



CORBIS

James Watson and Francis Crick, crackers of the DNA code, in 1959

Not until decades later, in the age of genetic engineering, would the Promethean power unleashed that day become vivid. But from the beginning, the Watson and Crick story had traces of hubris. As told in Watson's classic memoir, "The Double Helix," it was a tale of boundless ambition, impatience with authority and disdain, if not contempt, for received opinion. ("A goodly number of scientists," Watson explained, "are not only narrow-minded and dull but also just stupid.") Yet the Watson and Crick story is also one of sublime harmony, an example, as a colleague put it, of "that marvelous resonance between two minds — that high state in which 1 plus 1 does not equal 2 but more like 10."

The men were in some ways an odd pair. The British Crick, at 35, still had no Ph.D. The American Watson, 12 years Crick's junior, had graduated from the University of Chicago at 19 and nabbed his doctorate at 22. But they shared a certain wanderlust, an indifference to boundaries. Crick had migrated from physics into chemistry and biology, fascinated by the line "between the living and the nonliving." Watson had studied ornithology, then forsook birds for viruses, and then, doing postdoctoral work in Europe, took another sharp career turn.

At a conference in Naples, Watson saw a vague, ghostly image of a DNA molecule rendered by X-ray crystallography. DNA, he had heard, might be the stuff genes are made of. "A potential key to the secret of life was impossible to push out of my mind," he later wrote. "It was certainly better to imagine myself becoming famous than maturing into a stifled academic who had never risked a thought."

This theme of Watson's book — the hot pursuit of glory, the race against the chemist Linus Pauling for the Nobel Prize that DNA would surely bring—got bad reviews from the (relatively) genteel Crick. He didn't recall anyone mentioning a Nobel Prize. "My impression was that we were just, you know, mad keen to solve the problem," he later said. But whatever their aims, Watson and Crick shared an attraction to DNA, and when they wound up in the same University of Cambridge lab, they bonded.

Fatefully, such amity did not prevail at a laboratory over at King's College, London, where a woman named Rosalind Franklin was creating the world's best X-ray diffraction pictures of DNA. Maurice Wilkins, a colleague who was also working on DNA, disliked the precociously feminist Franklin, and the feeling was mutual. By Watson's account, this estrangement led Wilkins to show Watson one of Franklin's best pictures yet, which hadn't been published. "The instant I saw the picture my mouth fell open," Watson recalled. The sneak preview "gave several of the vital helical parameters."

Franklin died of cancer in 1958, at 37. In 1962 the Nobel Prize, which isn't given posthumously, went to Watson, Crick and Wilkins. In Crick's view, if Franklin had lived, "it would have been impossible to give the prize to Maurice and not to her" because "she did the key experimental work." And her role didn't end there. Her critique of an early Watson and Crick theory had sent them back to the drawing board, and her notebooks show her working toward the solution until they found it; she had narrowed the structure down to some sort of double helix. But she never employed a key tool — the big 3-D molecular models that Watson and Crick were fiddling with at Cambridge.

It was Watson who fit the final piece into place. He was in the lab, pondering cardboard replicas of the four bases that, we now know, constitute DNA's alphabet: adenine, thymine, guanine and cytosine, or *A*, *T*, *G* and *C*. He realized that "an adenine-thymine pair held together by two hydrogen bonds was identical in shape to a guanine-cytosine pair." These pairs of bases could thus serve as the rungs on the twisting ladder of DNA.

Here — in the "complementarity" between *A* and *T*, between *C* and *G* — lay the key to replication. In the double helix, a single strand of genetic alphabet — say, *CAT*—is paired, rung by rung, with its complementary strand, *GTA*. When the helix unzips, the complementary strand becomes a template; its *G*, *T* and *A* bases naturally attract bases that amount to a carbon copy of the original strand, *CAT*. A new double helix has been built.

Watson's famous "Aha!" was but the last in a long chain. It was Crick who had fastened onto a chemist friend's theoretical hunch of a natural attraction between *A* and *T*, *C* and *G*. He had then championed the complementarity scenario — sometimes against Watson's resistance — as a possible explanation of "Chargaff's rules," the fact that DNA contains like amounts of adenine and thymine and of guanine and cytosine. But it was Watson who had first learned of these rules.

As Horace Freeland Judson observed in "The Eighth Day of Creation," this sort of synergy is, above all, what Rosalind Franklin lacked. Working in a largely male field in an age when

women weren't allowed in the faculty coffee room, she had no one to bond with — no supportive critic whose knowledge matched her gaps, whose gaps her knowledge matched.

Writing up their findings for the journal *Nature*, the famously brash Watson and Crick donned a British reserve. They capped a dry account of DNA's structure with one of the most famous understatements in the history of science: "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material." They faced the question of byline: Watson and Crick, or Crick and Watson? They flipped a coin.

The double helix — both the book and the molecule — did nothing to slow this century's erosion of innocence. Watson's account, depicting researchers as competitive and spiteful — as human — helped de-deify scientists and bring cynicism to science writing. And DNA, once unveiled, left little room for the ethereal, vitalistic accounts of life that so many people had found comforting. Indeed, Crick, a confirmed agnostic, rather liked deflating vitalism — a mission he pursued with zeal, spearheading decades of work on how exactly DNA builds things before he moved on to do brain research at the Salk Institute for Biological Studies in La Jolla, Calif.

Watson drifted from pure science into administration. As director of the molecular-biology lab at Cold Spring Harbor, N.Y., he turned it into a scientific powerhouse. He also served as head of the Human Genome Project, absorbing some fallout from the high-energy ethical debates whose fuse he and Crick had lighted nearly four decades earlier.

As the practical and philosophical issues opened by the double helix continue to unfold, policy, philosophy and even religion will evolve in response. But one truth seems likely to endure, universal and immutable. It emerges with equal clarity whether you examine the DNA molecule or the way it was revealed. The secret of life is complementarity.

*Robert Wright is author of The Moral Animal: Evolutionary Psychology and Everyday Life*

Article from <http://www.time.com/time/time100/scientist/profile/watsoncrick.html>

# 'Lost' letters reveal twists in discovery of double helix

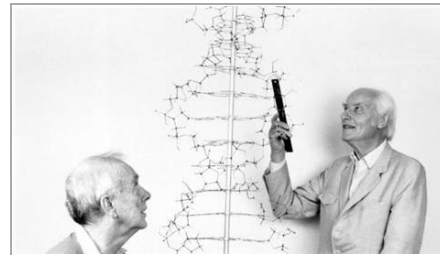
Fierce competition covered among scientists who discovered DNA's famous double helix structure and unraveled the genetic code

By **Jeremy Hsu**

Life Science  
updated 9/29/2010 3:20:59 PM ET

Rediscovered letters and postcards highlight the fierce competition among scientists who discovered DNA's famous double-helix structure and unraveled the genetic code.

Francis Crick and James D. Watson shared a 1962 Nobel Prize with Maurice Wilkins for their work on revealing the structure of the [DNA molecule](#) that encodes instructions for the development and function of living beings. But formerly lost letters kept by Crick add more color to the well-known rivalries between Wilkins and the Crick-Watson duo.



Francis Crick and James Watson recreate their demonstration of the double helix model for DNA in 1990.

"The [letters] give us much more flavor and examples illuminating the characters and the relations between them," said study researcher Alexander Gann, editorial director at Cold Spring Harbor Laboratory Press in New York. "They're consistent with what we already believed, but they add important details."

A fourth researcher credited with initial DNA work, Rosalind Franklin, died of cancer in 1958 and was never nominated for a Nobel Prize. She and her male colleagues did not get along despite their professional collaboration, as seen in some rather blunt messages contained within the new material.

Rediscovered letters and postcards highlight the fierce competition among scientists who discovered DNA's famous double-helix structure and unraveled the genetic code.

"I hope the [smoke of witchcraft](#) will soon be getting out of our eyes," Wilkins wrote to Crick and Watson in 1953, as Franklin prepared to leave Wilkins' lab for Birbeck College in London.

Nine boxes of Crick's material turned up mixed in with the correspondence of a colleague, Sydney Brenner, who had donated his personal documents to Cold Spring Harbor Laboratory Library in New York.

Researchers knew that much of Crick's earlier correspondence had been lost, but no one suspected it would emerge in Brenner's files.

## Rival labs

The rediscovered material contains several nuggets about the race between rival labs to develop a DNA model in the early 1950s. Wilkins and Franklin worked at King's College London, while Crick and Watson did their research at the Cavendish Lab of Cambridge University.

Watson and Crick built an incorrect triple-helix model of DNA in 1951, after Watson saw a lecture by Franklin where she showed crystallographic X-ray images she had taken of DNA. The overconfident Watson had failed to take notes, and so he underestimated the amount of water in the DNA structure.

That led to a temporary agreement that Watson and Crick should not pursue a [model of DNA](#) for the time being, because the duo had merely used data from the rival King's College lab. Wilkins and Crick exchanged newly uncovered letters that show Wilkins alternating between a formal, typed letter about the agreement and a handwritten note expressing more personal anguish over the situation.

Yet Crick and Watson still managed to come off as confident in a rediscovered letter to Wilkins, and even include a verbal jab.

Rather than end the letter by praising Wilkins for now having a clear chance to solve the DNA structure, they crossed it out and wrote: "...So cheer up and take it from us that even if we kicked you in the pants it was between friends. We hope our burglary will at least produce a united front in your group!"

The exchange emphasizes the different attitudes among the scientists, Gann explained.

"Watson and Crick are jovial and cavalier, even though they've just been humiliated," Gann told

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Livescience. "But Wilkins was always anxious and tortured about different things."

#### 'Rosy' the scientist

The rediscovered Crick material, which includes correspondence, photographs, postcards, preprints, reprints, meeting programs, notes and newspaper cuttings, also gives new details on the relationship between Rosalind Franklin and her male colleagues.

Well-known tensions reigned early on. An early misunderstanding poisoned the relationship between Wilkins and Franklin, and Watson's rather chauvinist attitude toward Franklin at the time included complaints that she failed to wear lipstick or pretty herself up like other women.

Most popular

Franklin's male peers also persisted in calling her "Rosy" or "Rosie," a nickname she disliked immensely.

Still, her work with X-ray crystallography created a certain "[Photograph 51](#)," which allowed Crick and Watson to realize that DNA has a double-helix structure. Without Franklin knowing, Wilkins showed her photograph to Crick and Watson in 1953.

Wilkins later complained to Crick and Watson in a rediscovered letter: "To think that Rosie had all the 3D data for 9 months & wouldn't fit a helix to it and there was I taking her word for it that the data was anti-helical. Christ."

The rival labs eventually agreed to publish several papers together on the DNA structure in the journal *Nature*.

#### A twist of discovery

Many have argued that Franklin deserved Nobel recognition, because her experimental work revealed the double-helix structure that helped Crick and Watson build their DNA model. Even Watson suggested much later that Franklin and Wilkins should have shared a Nobel Prize in chemistry for their contributions.

Franklin, who had all the photographic evidence of DNA's double-helix structure in front of her, had dismissed the idea of a helix. That's because she focused her attention on the clearer data from the A form of DNA, which looks less obviously like a helix than the B form of DNA.

The crucial photograph shown to Crick and Watson had contained the B form of DNA, and so the pair immediately seized upon its helical shape. But a newly rediscovered letter shows that even they might have hesitated for a moment upon seeing the A form of DNA.

"This is the first time I have had an opportunity for a detailed study of the picture of Structure A, and I must say I am glad I didn't see it earlier, as it would have worried me considerably," Crick told Wilkins in the summer of 1953.

Gann suspects today that Crick and Watson would have gone ahead with their double-helix model and ignored the more ambiguous evidence from the A form of DNA.

"It wasn't anti-helical; it just wasn't obviously helical," Gann said in a phone interview.

#### Publishing what-ifs

Other rediscovered letters include one in 1963 from C.P. Snow, the British physicist who bemoaned the communication gap between science and the humanities in a lecture titled "The Two Cultures." Snow wanted Crick to write something for general audiences about the DNA discovery story.

But Crick declined by noting he would have to consult Watson, Wilkins and everyone else involved. Five years later, Watson published his famous first-person account on his own, titled "The Double Helix."

Similarly, Crick spent six years putting off writing a textbook on molecular biology, despite pleas from a publisher. Watson eventually published a textbook called "Molecular Biology of the Gene," which defined the field of molecular biology and is now in its sixth edition.

Had Crick gone ahead and written his textbook, he might have ended up [defining molecular biology](#) in the same way, but in a different style, Gann said.

"Watson's first response when we showed him [the correspondence] was 'Wow, if he had written that I would have never written mine,'" Gann recalled.

Gann and Jan Witkowski, executive director of the Banbury Center in Cold Spring Harbor Laboratory,

commented on the new Crick material in the Sept. 30 issue of the journal Nature.

[Top 10 Mysterious Diseases](#)

[Genetic Science Oozes Out of Amateurs' Garages](#)

[10 Worst Hereditary Conditions](#)

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## 9

# COMPARING AND SYNTHESIZING SOURCES

Once you start comparing the statements of different authors, you may discover many problems in fitting sources together. Books may cover the same subject but have different focuses and different purposes. Authors may disagree over ideas, facts, and basic viewpoints. Large gaps of knowledge may exist, not covered by the available sources. In this chapter, we will study ways of fitting parts together and evaluating differences between authors. Two types of essay, *the synthesis of sources* and *the evaluative comparison of sources*, will help you develop the skills of bringing sources together.



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## Knowledge Is Messy

A library presents an imposing vision: books neatly arranged according to reference numbers on endless rows of shelves. Initially, the wall-to-wall books make you feel that any fact you want to know must be in one of them and that the ideas in these books should fit together as neatly as the books fit together on the shelves. You have a comforting feeling that all knowledge in books interlocks to provide a smooth carpet of learning—everywhere even and firm under foot, no matter where you tread.

When you actually start to look for specific information or try to find agreement between the books on a particular topic, you are more likely to feel that you have stepped into the Bad Lands of the Dakotas or the swamps of Florida. You cannot always find what you are looking for; what you do find may be contradictory or confusing. On the positive side, you may uncover some wonderful surprises—ideas and information that you had no idea existed.

If you stop to consider why and how books are written, the unevenness of ground may not be so surprising. Each writer makes a particular statement, based on personal thinking and perceptions, to address a specific problem. Although authors may share common knowledge and familiarity with statements made by others, each individual uses these background materials and ideas in a unique way. As we saw in Chapter 6, a writer constructs the conversation he or she is participating in from his or her own individual vantage point. Moreover, each writer shapes a text around specific purposes, as we have examined in Chapter 7. Every author does build on what has been previously written but each builds in an individual way to achieve specific effects with different readers. Knowledge in disciplines and professions has been organized to some degree so that writers in these fields may agree on many matters about the prior conversation. Through intense conversation, a discipline may achieve consensus on certain facts, principles, and procedures of investigation, as we see in Part 3. Yet even in highly codified fields, different approaches, significant disagreements, and varying points of view provide enough room for each author to speak as an individual, arguing a novel position.

If you read only one book, follow only one author's perspective in a complex conversation, the issues may seem simple, for that single author has constructed a personal sense of all that has been said. As we examined in Chapter 6, a writer's controlling voice creates overall harmony out of the many voices that have spoken on any given subject. However, once you read a second and third book and move beyond the controlling wisdom of one author, you will have to make sense of the diverse statements you find. To write your own informed statement on a subject that other writers have addressed, you will have to sort out agreement from disagreement, fact from opinion, reliable information from unreliable. You will need to see how all the parts of the written conversation fit together into a picture you are satisfied with. You will become an author whose controlling voice brings the other voices together into a coherent written statement. You thus become an authority yourself, for you are an author too.

In this chapter we examine how to find the points of connection between diverse statements and how to create one overall structure that reveals those connections. This bringing together is the task of *synthesis*. All professions that use data or knowledge constantly require synthesis; that is, putting information from a number of sources into one usable, coherent form, whether to give a picture of a company's financial stability or to write a newspaper story.

In this chapter we also examine how to identify when texts truly disagree, how to locate their exact points of disagreement, and how to evaluate their disagreements to judge which side states a better case. This is the task of *evaluative comparison*. Whatever career you enter, whenever you are engaged in any serious problem and find important disagreements between sources, you will

need to do this kind of detailed comparative work. Business executives field conflicting reports and proposals, police officers and social workers receive conflicting accounts of events, and academics encounter conflicting opinions about scholarly knowledge. All must weigh the alternatives.

### **Agreements, Disagreements, and Disjunctions**

A group of people united by a common situation and a choice between two alternatives are likely to be divided. That is, some will make one choice and others will choose its alternative. On election day, people vote for candidates running against each other for one office. In court, attorneys for the prosecution and for the defense are likely to make directly opposing claims. Members of a jury come to a verdict of guilty or not guilty. In such well-defined situations, choices are clearly identified; opposing sides are clearly drawn. In debates, in legislative deliberations, and in scientific controversies, issues become joined, as lawyers say. Once issues are joined, people migrate to one side or the other, opponents formulate their positions, points of disagreement are identified, and arguments become focused. The joining of the issue in itself organizes the discussion.

However, when issues are not formally joined within a specific group of people gathered together over a common problem, focused agreement or disagreement is far less probable. Although general topics, ideas, and information may be similar, every person is likely to address the subject slightly differently. Each individual is usually trying to convince others that he or she is right rather than that anyone else is wrong. The fact that one person is right may not necessarily mean that the other is not. All the parties may be right. They all may be wrong. Even when people appear to be in disagreement, scrutiny of their arguments may reveal differences only in focus and purpose rather than any real contradictions between their substantive positions. In library research you need to find a way to make various materials fit together with one focus. There are likely to be gaps or disjunctions between what each source addresses. For example, while researching changes in family structure in America over the past twenty years, you may come across a psychological study of the effects of divorce on children in the Midwest during the 1970s, a news magazine's editorial decrying society's loss of family values, a news report on unmarried couples living together in California, and a personal account of related stepfamilies in Boston resulting from the marriage of divorcees with children. The four sources do address family structure in America over twenty years, but they appear to have little information in common. Even though some of the writers seem to accept change, and others resist it, it might be very hard for you to say that any writer disagrees with any other on a specific point. How can a researcher possibly make one coherent statement using such diverse sources, each of which takes such a different approach? But if you step back and think about these four articles for a moment, you may discover common threads among them. For example, all four texts indicate that there have been significant changes in American family arrangements and that individuals have reacted in a variety of ways to them. All the texts show that changing family patterns have been a matter of public concern. They also reveal how major regions across the country have been subject to these changes. Other similarities may emerge with more thought.

Further research would probably turn up more tightly related sources, but your basic problem will remain the same: to fit other writers' statements together so as to develop your own statement and ideas about your subject. Out of all the voices in your research you must construct a coherent conversation that you control in your own text. Simply linking quotations and summaries from the different sources end to end will not do. By thinking through what you

learn from your reading and seeing how each source helps you to understand part of an issue, you will see how to appropriate these voices to your own purposes as a writer.

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## Writing a Synthesis of Sources

The purpose of the *essay of synthesis* is to combine what a number of sources have to say into a coherent overview of the subject. In preparing the synthesis, you have to compare and analyze a number of sources in order to choose between conflicting statements, but the paper presents your final understanding of the subject—not your gropings. If, for example, you wanted to synthesize all that was known about the astronomy of the Aztecs of ancient Mexico, you would have to draw on facts, ideas, and interpretations from a number of different sources about the Aztecs, premodern astronomy, architecture of sun temples, and mythology. Your main focus, however, would be what you discovered about Aztec astronomy—and not the differences among your sources.

In the past, writing the essay of synthesis might have struck you as an easy task, much like the library report you may have done in junior high school. But by now you are much more aware of the problems of fitting multiple sources together in a coherent, consistent way. Not only do sources conflict, but also they often omit just the information you are seeking. You become very significant at this point. Only you can make the connections between the information provided in different sources. Only you can search out additional sources to fill in the gaps. Only you can assemble the pieces into an intelligent whole. The sources remain, quite separate until you bring them together.

In particular, the essay of synthesis will present you with five separate tasks: (1) framing a subject, (2) gathering material from varied sources, (3) fitting the parts together, (4) achieving a synthesis, and (5) unifying the style of presentation.

### Framing a Subject

To frame a subject on which there is enough—but not too much—source material, you must find a question, issue, or subject on which a number of people have written, presenting facts and interpretations. But the number of sources should not be so great as to create a confusion of material. In other words, you have to find a limited topic that forms the center for a cluster of writing.

One place to look for such topics is within the structure of different academic disciplines. Each academic discipline is defined by a series of research questions that focus the attention of researchers in that field. For example, in anthropology much investigation centers on determining social roles within different societies. By selecting one type of society and one social role—such as the role of the shaman in American Indian tribes—you can define a cluster of research materials with which to work.

Sometimes a dispute over a controversial theory may excite interest and lead to a flurry of new publications in support of one theory or the other. For example, much geological writing in the late 1960s argued for or against the controversial idea of continental drift. At other times a discovery or an invention may affect the work of many scholars and scientists, exciting them to write on the meaning of the discovery or the consequences of the invention. A major new discovery may have widespread consequences for an entire discipline. Such, for example, was the enormous effect of the discovery of the structure of DNA on all biological studies. Thus, within

academic subjects, you can look for clusters of sources around topics defined by the structure of the field, around controversial theories, or around discoveries and inventions.

In more popular writing, such as newspapers, general-circulation magazines, and general nonfiction books, you can often find clusters of interest around social problems (juvenile delinquency in the 1950s or inflation in the 1970s), major historical figures and events (Abraham Lincoln or Pearl Harbor), social institutions (changes in the nuclear family), trends and fads (toga parties), or matters of political and public debate (the merits of national health insurance). In such areas of public interest and excitement, the different pieces of writing may not fit together in such clear-cut ways as they do in more organized academic disciplines. By sorting out the ways in which these different sources do relate to one another, you will find out much about the different attitudes behind the public interest.

### Gathering Material from Varied Sources

Since you are trying to gather a composite view of the subject, you need to go beyond the most obvious sources for your topic and draw on the information and insights of a number of different viewpoints. If, for example, you are interested in what TV programming was like in the mid-1960s, you will get only a very limited view if you rely totally on the program descriptions in *TV Guide*. However, in an article in an old issue of *TV Guide* you may find mention of criticism of TV programming quality. If you follow that lead up by finding out who these critics were and what their complaints were, you might discover the large public debate set off by Newton Minnow's remark that TV programming was a "vast wasteland." And you might also find out about the movement that resulted in the Public Broadcast System. *One source will lend you to another* until you get many different ways of looking at a single topic.

### Fitting the Parts Together

If you find conflicting statements among sources, you need to judge which is the most reliable, according to the methods and criteria presented later in this chapter. A more frequent problem results when sources do not have any easily compared points—either of agreement or of disagreement. So it will be up to you to discover their correspondences. You may have to point out the relationship between the broad theoretical statement of one writer and the details of a case study by another. Or you may have to make explicit an indirect connection between two separate sources. Or you may have to identify a pattern that shows the similarity between the viewpoints of two articles.

The connection between facts and interpretations is discussed throughout this chapter. In the final writing of your synthesis, you must explain these connections to your readers. To make the connection clear to someone who may not have recognized it before, use transitions between sections. A transitional phrase or sentence, describing the connection between one idea and the next, can tie together seemingly diverse material, fill in gaps, and put the facts and ideas in sensible relationship. A careful writer will help the reader follow all the steps of his or her presentation.

### Achieving a Synthesis

At this stage, you must add up all the information to discover significant patterns and to come to conclusions. These patterns and conclusions will be the shaping forces behind your organization of the final synthesis. You cannot simply rely on the patterns and the conclusions of your sources, for the limited purpose of each source determines the organization and ideas of

that piece of writing. You are combining material from several sources—and you may well be broadening the scope of the subject—so your own conclusions and organization will necessarily take on a new shape.

Informal and formal outlines are, as always, useful as attempts to make coherent sense of all your journal notes and annotations. By trying different outlines, you can see in which way the information fits together best. As you approach a satisfactory outline integrating the ideas and information from the sources, you will be able to formulate an overview of the subject. A direct statement describing this overview—tying together the various parts of your synthesis—can serve as a thesis statement for your paper.

For example, if you were reviewing for an economics course several analyses of how the end of the Cold War would affect the economy of the United States, simply summarizing the articles one after another would do little to show how they fit together or what they add up to. At the very least, organizing the articles according to those saying the economy would be helped and those saying it would be hurt could lead you to see the various reasons proposed by each side. It would be even better to note which articles focus on the contraction of the defense industry, which focus on the impact of unemployment of the military, which focus on readjustment of research and industry, which focus on the effect of improved world relations and international economic competition, and so on. Thus you will be able to observe how different analyses reveal different aspects of the economy. Or you may find interesting patterns of organization based on the political attitudes of the authors and what role each of them sees for government involvement in the readjustment. Or there could be patterns based on when each of the projections was made in relation to the changing state of the economy and international relations. Each way of attempting a synthesis of the articles will reveal new patterns and offer more ideas.

### Unifying the Style

Unifying the writing style while remaining true to the sources will be your final task. Because the sources you use have their own separate purposes, the material in each may be presented in very different ways—from numerical statistics to anecdotes to highly detailed analyses. When you bring together such varying material, you must present all materials in a way that is consistent with the overall design of your paper, the *synthesis*. For example, if you are collecting information on the effects of the Supreme Court's Bakke decision, you may be drawing on a wide variety of materials: statistical charts of college enrollments by ethnic background, direct comments on the decision by college admissions officers, general policy statements by college boards of trustees, straight news reports, and analyses by journalists. You must bring together all these different kinds of writing into a single readable whole. Instead of copying an entire statistical table—with much unnecessary material—you must pull out the most relevant statistics and explain their bearing on your topic. You cannot simply string together the statements of college officials; you must rather bring out the official positions and hidden attitudes behind them. In other words, you must translate the separate kinds of language used in the various sources into a uniform style appropriate to your synthesis.

Even though you will often need to rephrase and rearrange the material from the original sources, you must be careful not to distort the original meanings. When you pull out only selected statistics and explain their meaning, you must be careful not to leave out other important statistics that might give rise to conflicting interpretations. In summarizing the argument of a newspaper column, you should not leave out so much of the context that the article appears to say something it could not possibly have meant. Chapter 11 gives more specific advice on how to present the ideas of other writers as part of your own coherent

argument—without distorting the original meanings. That chapter also covers the various methods for documenting the sources of your information. In a synthesis you must document your sources fully and carefully so that the reader can judge the credibility of your material.

### A STUDENT EXAMPLE FOR DISCUSSION

Each time you have to synthesize material from a number of sources—whether as a separate essay of synthesis or as part of a larger project—the tasks just described will appear in varying forms. Each time you will have to find different ways to handle them, so the advice we have given should, serve as only the most general of guidelines. The following sample paper, entitled "Walt Disney Company and the Selling of American Popular Culture," shows the way one student solved these problems in one particular case.

Katherine Ellis's assignment was to follow one object, artifact, or figure of American popular culture in articles published in newspapers and magazines during three recent months and then to synthesize all the material to create the picture that an educated reader would have at the end of that time period. Because everyone in the class was working on different subjects, the students' papers combined to form a general picture of recent popular culture. After gaining a good sense of the role of popular culture in contemporary American life during this period, through doing their individual research and reading one another's papers, for their major research papers the students were to focus on a specific issue raised by their popular culture object, artifact, or figure (see Chapter 10).

Because Katherine was interested in Disney films she began by looking into the Walt Disney Company, which produces and distributes them. Since November 1992 marked the release of a new Disney animated film, *Aladdin*, she decided to research that month, the preceding month, and the following month. As she looked into news stories about the Walt Disney Company during this period, she found that Disney's contribution to American popular culture was more vast than she had anticipated. The release of *Aladdin* quickly led to questions about the way Walt Disney promotes its many entertainment products and about how these products are received by the general public. The articles Katherine found showed that Disney's success was due not only to the appeal of the products and images it offered, due also to the corporate policies behind them.

The issues raised by this subject so interested Katherine that she went on to explore them more fully in her main research paper, entitled "Exporting American Culture: Disneyland in Japan and France," which analyzed the factors contributing to Disney's initial success in exporting its products and images to Japan and Europe. In the smaller synthesis paper, however, she covered a broader topic and pieced together the basic facts as they first appeared in the newspapers and magazines. Her thinking and analysis showed how the different aspects of the Disney entertainment empire appearing in different articles fit together coherently. In this smaller paper she did not try to analyze or evaluate the factors contributing to Disney's success. Instead, by carefully synthesizing the articles, she explored her subject deeply and gained a strong sense of how Walt Disney Company makes a business of selling American popular-culture to the American public.

This synthesis paper showed the other students in Katherine's class that particular American popular-culture objects, artifacts, and figures raise questions about related issues of interest to consumers of popular culture. Katherine's first subject, Disney films, naturally evolved into a synthesis paper on the connections between popular culture and big business. Other students' topics, however, led them to different issues. For example, a student who explored the return of disco music discovered a connection between popular culture and the way Americans view the

past—in this instance, the 1970s. Another student, who researched the Statue of Liberty, found that the news articles surrounding this artifact often discussed immigration policy in the United States. Still another student, writing about the Grand Canyon as an element of American popular culture, found this subject linked to discussions about the environment and the conservation of natural resources.

The parenthetical references and the list of works cited in Katherine's paper followed the recommendations of the Modern Language Association (see Chapter 11, pages 212-216).

### Sample Essay of Synthesis

#### Walt Disney Company and the Selling of American Popular Culture: More than a Mickey Mouse Business

Most Americans associate Disney with Mickey Mouse and Donald Duck, but Disney's influence on American popular culture can be seen in a broad range of products, images, and enterprises it produces and sells, from movies and television shows to full scale theme parks and resorts. Disney is big business: a line on the stock exchange listing and a multi-faceted corporate structure. Its influence on American popular culture is due in part to how well it does its business. In 1992, Walt Disney Company was expanding its markets and increasing its profit more than ever before. Disney, which is known for its animated feature-length films and its theme parks, continued to build on this proven base to expand its entertainment empire.

In late 1992, Disney films continued to provide a strong base for the company's success. In early November, Walt Disney Company prepared the public for the release of its new animated feature film, Aladdin, with a media advertising blitz. Building on the unprecedented success of its last feature-length animated film, Beauty and the Beast, Aladdin promised to be another huge hit (Sharkey H1). Reviews offered high praise for its artistic and technical merits as well as for its entertainment value (Salamon A12; Ansen 76-77; Corliss 74-76).

Box office receipts showed that the general public agreed with the critics. Over the Thanksgiving holiday, Disney's Aladdin combined with Fox's Home Alone 2 to break the previous box-office sales record for that period by over twenty percent. In its five day national opening, Aladdin took in over twenty-five million dollars, a higher gross than any of Disney's previous animated films and a remarkable sum of money given the number of half-price tickets sold to children (King B4). The film's popularity quickly led to the marketing of its characters—for example, in late December, Disney licensed the use of Princess Jasmine in Spanish language ads (Gellane D1)—which brought in additional revenues and further promoted the film.

Aladdin was not the only successful Disney film during this period. Walt Disney Company's Sister Act and Beauty and the Beast, released earlier in the United States, were among the most popular and profitable American films showing in Europe (Groves 47-48). In the video market, Disney led the shift from rentals to sales in videocassettes (Turner A1). In late October, Disney announced plans to re-release its classic animated feature film Pinocchio on home video ("Walt Disney to ... " B8) and in early December, Beauty and the Beast was at the top of the list in video sales ("Disney's 'Beauty' ... " C3).

In late 1992 Walt Disney also continued to broaden and expand its theme parks, in spite of setbacks abroad. Euro Disneyland, which opened in April 1992, continued to be a disappointment both in terms of popularity and profits. The park's operating company, Euro Disney S.C.A, reported a thirty-five million dollar loss for its first fiscal year (Gumbel B4). Euro Disney announced plans to reduce prices in order to boost sagging attendance ("Disney Defers ... 54). In mid-November, stock in Euro Disney was considered "overvalued" and European financial analysts were urging "all but the most risk tolerant" to sell (Eichenwald D1).

Despite losses from its European operations, Walt Disney Company nevertheless continued to make profits, posting a twenty-eight percent increase in net income (816.7

million dollars) and a twenty-three percent increase in revenues (7.5 billion dollars) during the fiscal year ending September 30, 1992 (Gumbel B4; Bates D1; "Disney Reports ... " 8). In fact, the company's huge profits prompted its two top executive officers, Michael Eisner and Frank Wells, to sell over five million shares on the New York Stock Exchange. This stock (valued at 185 million dollars) represented about one percent of Disney's outstanding stock, an amount large enough to drag Disney stock prices down almost two dollars per share and trigger an eleven point decline in the Dow Jones industrial average (Farm C1).

Disney's success prompted expansion plans. Walt Disney Company announced plans to build "Disney Sea," an ocean theme amusement park and marine life park, adjacent to Tokyo Disneyland (Gumbel B4). It also announced plans to build a three billion dollar expansion of its original park in Anaheim ("Good News ..." B6). Disney also took steps to further expand its film, video, and television empire. In early November Walt Disney Company completed a deal with Joe Roth, who released the blockbuster Home Alone during his three years as Chairman of Twentieth Century Fox, to start his own production company at Walt Disney Studios (Citron A1). It also signed a contract to produce movies for ABC ("Disney to Roll ..." 27) and signed box-office draw Julia Roberts to a contract (Goldman B7).

Walt Disney Company also negotiated agreements with three other major corporations during this three month period. Disney and McDonald's Corporation Signed an agreement to team up for a "Happy Meals" promotion tied to Dinosaurs, an ABC comedy series produced by Walt Disney Television, and made plans for another promotion in the summer of 1993 to tie in with the theatrical re-release of Snow White ("Disney, McD's ..." 8). In another attempt to combine expansion with promotion of preexisting products, Walt Disney Company signed a licensing agreement with Penguin Books to create a line of moderately priced children's books based on Disney stories ("Pearson's Penguin Agrees ..." B8). Finally, in conjunction with Blockbuster Entertainment Corporation, at a cost of fifty million dollars, Walt Disney Company gained conditional approval from the National Hockey League to bring a new expansion franchise to Anaheim, California ("A Shot on Goal ..." B7)—a strange new twist of "Disney on Ice"?

Walt Disney Company's success as a business is unquestionably linked to the appeal of its products, images, and enterprises. The reverse is also true: the appeal of its products, images, and enterprises is unquestionably linked to its success as a business. The combination of the two account for Disney's ability to successfully sell new products—be it a MacDonald's Happy Meal with a "baby Mickey" toy inside or an ice hockey franchise in the middle of Sun City—and at the same time to continue to successfully sell the old. If Disney offers it, it must be good. It must be as "American as apple pie and baseball." In fact, when Bill Clinton won the Presidential election, I almost expected someone to greet him with the Disney question: "Well, Bill. You've just been elected to the Presidency of the United States of America. What are you going to do now?" I think we're hooked.

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### WRITING ASSIGNMENTS

1. Choose a word that is currently used as slang. Look it up in three different dictionaries including a dictionary of slang, if one is available. Then write a 150-to-200-word synthesis incorporating all information that seems relevant to the current usage of the word.
2. Write an *essay of synthesis* of about 800 words characterizing the social trends or one major story mentioned in print during one week out of the last fifty years. Use material from newspapers, news magazines, and at least one other kind of periodical. All members of the class should choose weeks or events within the same year so that they will be informed readers of one another's papers.
3. Choose a minor historical event or a short period in the life of a famous person. Find what four reputable sources say on the subject and write a narrative combining the information. Imagine your reader to be a high school student with a strong interest in history.
4. Choose a news story that is currently breaking. Taking your information from several newspapers and magazines, write a narrative of the events as they might appear in a year-end summary of major news events. Direct your paper to a college-educated audience.
5. Imagine you are working for your city's mayor. The mayor, who is away for a week's vacation on a tropical island far from any news of your community, expects to find a report waiting on local issues the first day back at work. Using accounts in local newspapers, write a SOO-word synthesis of events concerning one problem that has affected the community in your mayor's absence.

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## Disagreements: Joining the Issue

Having seen how much work you must do to establish a significant connection among different sources, it should not surprise you that to identify and define a genuine disagreement requires even more work. Occasionally one article will directly confront another, a letter to an editor may directly challenge an author's statement, or a pair of writers will debate a specific claim in print. However, more often, you must identify actual points of difference between two authors who are each pursuing separate lines of argument without paying any particular

attention to the claims of the other. You must join the issue between the two and construct precisely what the difference between them consists of. You must sharply define what the exact point at issue is, and what each author has to say on it. Only then can you begin to evaluate the logic and validity of each author's claim.

If you treat disagreement in a sweeping, general manner, it may seem that authors are more opposed to each other than they turn out to be, after the specific arguments are examined. If we reduce all issues to general questions—Is abortion right? Should the United States have engaged in the Vietnam War? Was Franklin Delano Roosevelt a good president?—most people will take one side or the other and categorize others as either sharing or opposing their view. Posing broad yes-or-no questions will dichotomize people into those for an issue and those against it. Having committed themselves to one side, people are likely to reject arguments that generally support the opposite view. But if you review the detailed reasoning that led someone to adopt a position and listen to the actual arguments used to support the decision, you may find that opponents do not disagree on much, if on anything at all, beyond a yes—or-no general preference.

It is commonly known that dire opponents who sit down together and thrash out their arguments often find that they share many points of agreement. Both supporters and opponents of legalized abortion, for example, when not locked into superficial confrontation, may well agree on the great harm caused by illegal abortions and the social costs and suffering caused by unwanted children. They may each also recognize the emotional and moral consequences of legalized abortion as well as the temptations it creates for thoughtlessness and abuse. No doubt, if the two parties search long enough, they will find serious differences between them, perhaps over the exercise of individual rights, the use of religious teachings, or the best way to care for children and families in our society. When viewed in a considered and careful way, issues usually become more discussable. The clear thinking that results offers some hope of resolution, workable compromise, or, at least, mutual understanding.

### Identifying Disagreements

While reading several sources about one subject or while researching a topic, you may be tempted either to overlook disagreements that don't announce themselves with flags and cannons or to emphasize differences between texts once you notice any diverging tendencies. In order to make intelligent judgments about disagreements you must identify points of disagreement accurately and define exactly what a disagreement consists of.

To identify differences between sources precisely, you first need to determine whether texts are addressing the same subject. This means determining not just that they have the same general topic but that they cover the same part of the topic; only then can they answer one question from similar perspectives.

For example, there are many books about capital punishment. Some discuss the death penalty in different countries during different periods in history. Others present U.S. statistical studies based on current death-row sentences. Others offer biographical accounts of individual prisoners on death row. Many more explore the legal, social, moral, and political consequences of capital punishment. Some of these books favor the penalty of death. Others oppose it. Still others do not take a stand on the issue. Only a few books will directly join a specific issue using comparable data to allow a careful evaluation of alternative answers to a question such as whether the death penalty has served as a deterrent to crime in the United States during the past decade. Even statistical studies may not prove helpful, because each study focuses on different states, different periods of time, and different prison populations, each with a number of complicating factors. No sharply defined contrast has emerged from such statistical studies to

point to a clear resolution of the issue. Once you determine that two texts address the same issue and answer the same question, you are able to decide whether their answers are compatible or mutually exclusive. Different answers often exist side by side. The statement "Gun control reduces the total number of guns available to criminals" is not incompatible with "Gun control also reduces the number of guns available to honest citizens to defend themselves." On the other hand, the second statement directly contradicts the statement "Gun control will not affect the number of guns available to criminals." Statements that make absolute or strong claims, using words like *a/I*, *never*, *a/ways*, and *only*, are likely to conflict with other claims on the subject. Weaker claims that make concessions with words like *in part*, *along with*, *one of several*, and *sometimes* are more likely to be compatible with other statements.

### Levels of Disagreement

After you have found two disagreeing sources, you need to identify at what level their disagreement occurs. Is the disagreement over what the facts are? Is it over the meaning of the facts? Or is it over the value, consequence, or implications of the facts? Each level of disagreement can be understood and evaluated in a different way.

### Factual Differences

Facts are accounts people give of events. Different people may give different accounts. The accounts may vary for a number of reasons: imperfect memories or observations, differences in focus of attention, different styles of expression, different mental attitudes and perceptual frameworks, interests, or even lying. One eyewitness to an alleged robbery says the suspect was carrying a gun. Another reports only a suspicious-looking hand in the suspect's pocket. The victim says a gun was pointed directly at him. The suspect says he carried no weapon and made no threat, but that he did reach into his pocket to get change in order to make a purchase. Everyone reports the same incident by telling a different story. Unfortunately, there is no way to know for sure what actually happened, because to each person the event was experienced—it happened—differently. Even videotapes of the incident will be biased for the same reasons. The camera operator will have a particular angle of observation and focus. The camera will record only certain actions. The operator might experiment with clever camerawork, perhaps editing the footage to support a special story. If the robbery itself occurs right in front of police officers trained to be accurate observers, the officers will still only provide their personal accounts of the event.

### Criteria for Evaluating Sources or Witness

- Generally, the closer the witness was in time and place to the original events, the better. If the writer was not there, he or she may cite reliable sources who were.
- The more the writer or primary witness knows about the subject or events he or she is describing, the better he or she will know what to look for, what to report, and what to conclude.
- The fewer biases and prejudices writers or witnesses have about the matters they are reporting on, the more likely they are to give an undistorted account.

In judging accounts, we can only judge which data and witnesses seem more solid or more reliable. As in a court of law, we *must* judge witnesses' accounts on the basis of the evidence they offer and on the characters of the witnesses. Some reports seem more reliable because they are supported by detailed observations that might correspond with documentary records. Such records, however, are only another account written and prepared by someone closer to the events when they occurred. The relevance and meaning of physical evidence such as a gun or threads found on a gun must still be established through interpretive accounts. Thus these accounts seem fuller and more consistent combined with other accounts. And more reliable witnesses are those who are in a better position to observe and understand the events than others or who have a greater reputation for trustworthiness or have less reason to distort their accounts. As a researcher, judge the teller and the tale.

### Criteria for Evaluating Evidence

- The more specific and complete the evidence is, the more likely it is to present a clear and precise picture.
- The more internally consistent the evidence is, the more likely the report is to be accurate. Internal consistency means that one part of the evidence does not contradict another part and that all parts support the single interpretation. Be cautious: in some cases, evidence that is too consistent may mean oversimplification or fudging of observations.
- The more evidence was recorded at the time of the events reported, the fewer problems with distorted memory will occur.
- The more the evidence is tied to matters of public record—such as contemporary newspaper accounts, government documents, or widely acknowledged facts—the more credible the evidence is.
- The less indication of bias, fraudulent, or false statements there is, the more reliable the evidence.

Criteria for determining the reliability of witnesses and the validity of data vary from situation to situation and discipline to discipline, as discussed in Part 3. Courts of law have extensive rules of evidence that define what kinds of testimony are appropriate, what kind of supporting evidence is admissible, and how a witness's credibility may properly be established or broken. Judges constantly must evaluate the admissibility of testimony and physical evidence according to these rules of evidence. In academic disciplines as well, editors, referees (who evaluate manuscripts for publication), and readers constantly make judgments about the quality of authors' statements and their supporting evidence according to the criteria of their disciplines. What counts as valid testimony and evidence for a psychologist will not likely count for a physicist, a philosopher, or a literary scholar. The guidelines that follow provide a starting point for your evaluation of conflicting evidence.

At times you may not be able to make a clear-cut choice between two conflicting reports of fact: the witnesses and the evidence may be equally good—or equally poor—on both sides, or you may lack enough background information to judge. In such cases, all you can do is acknowledge the conflict and suggest what the *implications* of either report being true' might be. Tracing the logical implications of each report may give you an indirect indication of which side is more likely to be true. At least you will learn the consequences of favoring one report over the other.

## Meaning Differences

Every writer presents a framework of meaning or ideas, which is used to interpret the consequences or relationships of facts as well as to develop conclusions. These frameworks of meaning may be built on all the information presented or may come from another source of interest or beliefs. For example, consider the earlier example of a robbery. One witness sees a man with his hand pushed deep in a jacket pocket approach another person on the street. He hears the comment, "Hand it over!" and sees money change hands. The witness frames these events in the context of a robbery, thereby assigning specific meaning to each observation. The hand in the pocket becomes a weapon; the words spoken are the criminal act itself; and the money is now "loot." If the same witness noticed a television camera crew filming the scene, the witness would assign these observations a different meaning. On the other hand, if, based on no new personal observations, the witness believed that every person on the street was involved with drug deals or loan sharking or elaborately staged practical jokes, he would assign different meanings to the same set of observations.

When two authors give contradictory meanings or develop opposing ideas about one topic or set of events, you can understand and evaluate their differences only by identifying where the differences in meaning come from. Do they come from the authors' accepting contradictory facts or paying attention to different categories of facts? Do the differences come from applying different reasoning to facts they generally agree on? Do the authors approach the subject with such fundamentally different prior beliefs that they see all the events in an entirely different way?

If the differences are based on contradictions about what the facts were, by determining the facts you may resolve the conflict in meaning. If beyond a reasonable doubt solid evidence and unshakable witnesses establish that the suspect did indeed have a gun in his pocket, you can rule out all other interpretations and meanings that present the incident of robbery as a legal business transaction or cinematic event.

If differences in meaning result from the writers' paying attention to different sets of facts, consider which writer examines the more appropriate and comprehensive set of facts. Since there are usually more facts available than anyone person can make coherent, concise use of writers and witnesses must select the facts they consider most relevant. Even when two authors agree on specifics, they will likely make different selections from the data available and put an individual emphasis on them. Given the issues and context of the discussion, as a researcher you can make reasonable judgments about which source pays attention to the more appropriate facts. In the robbery scene, the witness who describes the physical manner and appearance of the suspect and omits mentioning a camera crew obviously has missed an important clue to the pattern of events. On the other hand, if the witness is a film critic attending the shooting of a robbery scene, the presence of the camera crew may be assumed in the witness's report of the incident, so it would be perfectly appropriate for the observer to emphasize the suspect's appearance in any account of the event.

If writers' disagreement on interpretations or understanding of the subject is based on different choices of the facts, you may never agree totally with either source. That is, you may put together the partial view each source presents with a more comprehensive synthesis that takes into account data chosen by both authors. The suspect in the robbery is not a criminal but is a terrible actor. Or the members of the camera crew are accomplices in a daring public mugging.

## Differences in Point of View and in Fundamental Beliefs

Differences of interpretation may arise not out of differences in facts but differences in ways of looking at or thinking about the facts. A psychologist, using a clinical perspective, may

interpret the robbery suspect's behavior as random 'psychotic hostility not directed at anyone in particular; the victim happened to be in the wrong place at the wrong time. A prosecuting attorney interprets actions through a framework of legal responsibility. An urban anthropologist may see robbery-as part of a culture of violence to which the suspect and victim belong.

Differences of interpretive framework are much harder to resolve than differences in fact or meaning. Ultimately, you must judge the validity of the source's entire framework to see whether one author's point of view is more valid for your purposes than another's. Sometimes you can judge which interpretive framework is more appropriate to the subject and question under discussion. In court the lawyer's and judge's framework of legal responsibility is most significant, but in a rehabilitation program a psychologist's frame of reference carries more weight. When a psychologist offers testimony as expert witness during a trial, it is to answer specific questions defined by the legal framework. In a clinical setting, a lawyer's judicial expertise offers little aid.

Differences of interpretation or patterns of meaning may come from fundamental differences in belief, which influence how people evaluate events and how they think about the world. A Marxist will interpret political situations differently than an Adam Smith capitalist; a Zen Buddhist will weigh moral issues differently than a Baptist. Differences about such basics as religion, morality, national loyalties, life goals, and personal commitments are notoriously difficult to evaluate and to resolve. At least as a researcher you can attempt to understand what these differences consist of in your sources. You may then be able to see whose assumptions and beliefs are closer to the ones you hold. Even more important, you will come to see how people with different beliefs may perceive the same events or data differently.

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## Writing an Essay of Evaluative Comparison

In examining two sources that cover the same subject, you need to do two separate tasks: first, identify the specific agreements and disagreements between the sources; second, analyze the patterns of agreement and disagreement. The first task will let you know how much difference exists, and the second will help you resolve these differences. In preparing an *essay of evaluative comparison*, the first step has to be completed before the second step is begun, because you must know the differences precisely and explicitly in order to analyze them. In your final version of the paper, the results of the two tasks may be intermixed as part of an overall evaluation of both sources.

### Selecting Two Passages

Unless two passages are handed to you by your instructor, you must select the pieces of writing that you will compare and analyze. Finding them is no easy task. The passages should be short enough to allow detailed discussion. Often well-matched passages of only a few paragraphs provide enough material for a five-to ten-page comparison. The passages should have more than a vague similarity: they should cover exactly the same issues within exactly the same limits and make directly comparable statements.

Sometimes you can find short, self-contained selections in two versions of a news story published in newspapers or in weekly news magazines. Or you might excerpt matched selections from longer works. On the other hand, magazines and anthologies sometimes present statements already matched to present opposing or multiple views on a single issue. The sample essay of evaluative comparison that follows on pages 155-157 considers two such matched opinions on the subject of active euthanasia. These two views, for and against legalization of medical

assistance in the death of the terminally ill, were originally published on facing pages of a monthly law journal and are reprinted on page 74 of this book.

When you are working with excerpts, your decisions on where to begin and end each selection are crucial. Try to match the subjects, the limits, and the authors' claims in the two passages. Even when you are working with pieces already matched as opposing, do not assume that they will argue clearly and directly with each other. Close examination may indicate that the authors see the issue in such different ways that their arguments do not confront each other directly. This is to some degree true of the pair of arguments compared in the sample essay by student Kevin Nichols, and part of the work of the essay is to identify that difference of basic assumptions and perceptions. It is often useful to select for comparison passages that you come across during research for a paper or another project for one of your courses. Then the conflict will be real to you—one whose resolution will clarify issues of interest.

### **Making Apt Comparisons**

Having chosen two selections, you should try to understand each as fully as possible in its own terms. To do this, you may use any or all of the techniques presented earlier—reading journal, paraphrase, and so on. If you are working with selections from longer works, it usually helps to become familiar with the surrounding contexts as well.

Then identify the specific areas of correspondence between the two passages. For each claim or statement made in the first selection, take note of any corresponding claims in the second. You may keep track of these correspondences "by numbering comparable claims of both writers with the same number or by annotating ("see line 24 of other"). Or you may want to compile a comparative chart of correspondences.

As you collect these correspondences, you will already be noticing patterns of agreement and disagreement. Once you have all of them collected, you can organize the various agreements and disagreements according to the categories of difference presented earlier in this chapter: fact, meaning, point of view, and fundamental beliefs.

As you sort out the agreements and disagreements, you may see patterns start to emerge. For example, the two authors may agree that specific events took place but may disagree on the dates and order of the events. Or you may find absolute agreement on facts and total disagreement on conclusions. Or you may notice crucial issues on which the two writers turn to entirely different types of evidence. As patterns emerge, you will also gain more insight into the major differences between the writers regarding their purposes and their conclusions. The patterns you discover—of similarities and differences between the sources—will become the core of your essay.

If the pattern is one of basic similarity, you might consider whether shared assumptions, common sources of information, or common purposes lie behind the similarity. If there is a mixed pattern of agreement and disagreement, you might try to determine whether the similarities or dissimilarities dominate—or whether the dissimilarities seem random and minor.

If many major disagreements leave you confused about where the truth lies, you should try to determine which writer presents the more credible or persuasive case. In each instance, you will have to decide what the appropriate criteria are for judging the kind of dispute before you; these criteria were discussed earlier.

In the special case of two writers consciously arguing with each other (that is, each knows and discusses the other's views), you may also consider how effectively they argue against each other. Does each one answer the other's objections adequately? Does each successfully confront the other's main points? Or do they each write past the other, avoiding direct confrontations or missing the other's main objections? You should explore these issues in journal entries, notes,

outlines, or through other informal means until you come to some firm conclusions. At that point you are ready to begin writing the rough draft of the final paper.

### The Final Essay

The final paper should begin by clearly identifying title, author, and publication information for the two passages being compared. If you are using excerpts of longer pieces, identify precisely where your excerpts begin and end. If the readers of your paper are not likely to be familiar with the material you are discussing, you would do well to include copies of both selections in their entirety as an appendix to the essay. The *introduction* to the paper should present, in general terms, the overall pattern that will emerge in your comparison and possibly what you intend to prove about the relative value of the two selections. In other words, indicate to the reader at the outset where the comparison leads and what kind of analysis you will pursue.

**The Body** The body of the paper should present the substance of the agreements and disagreements. Expose the patterns and analyze the examples you have found. You need not discuss all the details from both selections, but you must use enough specific examples to support your general characterizations. You may refer to details in the two originals by quotation, paraphrase, summary, or line number if you have included copies of the originals. Whatever method you use, accuracy and fairness in representing the originals are particularly important because you will be setting details from two separate sources against each other. If too much gets changed between the originals and the discussion, you may wind up comparing products of your own imagination rather than actual sources. Notice that, in the sample essay that follows, the information from the sources is integrated into the comparative discussion. Chapter 11 contains a complete discussion of appropriate and accurate reference.

**Organization** The development and organization of the evaluative comparison will, of course, depend on what you need to say and the kind of sources you are comparing. You may want to present the whole pattern of agreement and disagreement initially, halting only to fill in representative details, then follow with a detailed analysis of underlying causes of the pattern. That is, before going through a point-by-point comparison, you can present an overall view of how the two articles fundamentally differ. Or you may want to analyze and evaluate each disagreement as you come to it, slowly building an awareness of points of contrast into an overall picture of two distinct approaches.

If your two sources describe a series of events, you may want to discuss the points of comparison chronologically, showing how two different stories unfold. Or you may find that you can produce a clearer comparison by separating differences of evidence from differences of interpretation. If the sources describe opposing positions on a hotly debated issue, you may want to organize your comparison around specific points that both texts consider. For example, in his evaluative comparison of Smith's and Kamisar's articles, Kevin Nichols organizes his body paragraphs around differences in the ways the two texts present the consequences of legalization for physicians, patients, and society as a whole. Because there are many ways to organize an essay of evaluative comparison, you should derive your organization from the patterns you have come to identify in the particular sources you use.

**Comparative Focus** Take care to stay focused on the *comparison between the two sources*. Don't fall into the error of simply summarizing each of the two separate pieces or of just recounting facts covered in the two sources (as you might do in a synthesis). Remember that in



this kind of analysis your main purpose is to analyze the relationship between the two pieces of writing. Two techniques of sentence style can remind you—and your readers—of this purpose.

First, whenever you refer to details from one source, refer to the author or the title of that source, and do not continue the example for more than a few lines without repeating the reference. For example, by repeating Yale Kamisar's name as author through the second paragraph of his essay, Kevin emphasizes that these are only Kamisar's ways of presenting the issue at hand—only Kamisar's claims about negative effects on physicians of legalizing active euthanasia. Kevin is distinguishing Kamisar's ideas from Smith's (which appear in the following paragraph) or from his own.

The second technique is to include many sentences—especially paragraph topic sentences—that directly compare the two sources being discussed. Placing statements side by side within the same sentence helps maintain the comparison throughout the essay. For example, in the sample essay, Kevin begins his fourth paragraph with the following sentence directly comparing Smith's and Kamisar's views on the effects of legalization on physicians: "While Kamisar suggests that the participation of physicians in active euthanasia violates the code of medical ethics, Smith interprets this code as allowing physicians to aid-in-dying without violating their ethical obligations to their patients."

The conclusion of the essay should develop the issues you have raised in the body paragraphs and sum up the results of your analysis. If it seems appropriate, you might sum up the points of comparison, thereby making an overall evaluation of the relative trustworthiness of each source or (as in the sample essay) the relative strength of the arguments the sources present. Alternatively, you might observe how two writers approaching one subject from such different standpoints come to the same conclusions.

### ASTUDENT EXAMPLE FOR DISCUSSION

In the following essay, Kevin Nichols introduces a large topic for comparison—the arguments for and against the legalization of active euthanasia—but he quickly focuses on a more specific aspect of this topic, limiting the actual comparison to two short articles that offer opposing opinions. He narrows his topic even further by focusing on three specific issues addressed in both sources. In examining and evaluating specific differences between the two articles, he notes who seems to have examined more of each issue, and how differences in position derive from different values and assumptions of the two authors. Kevin winds up by observing that the two authors' difference in perspective points to a fundamental disagreement about society and the way to freedom and autonomy.

#### Sample Essay of evaluative Comparison

##### Whose Life Is It, Anyway?

In the United States the debate over the legalization of active euthanasia has been going on for many years. Recently the activities of Dr. Jack Kevorkian, nicknamed "Dr. Death" by the press, have brought this debate to the front pages of newspapers and cover stories of weekly news magazines nationwide. The Hemlock Society has recently sponsored attempts to legalize active euthanasia in California and New Hampshire. Thus far, these attempts have been unsuccessful. In Michigan, in a direct response to Kevorkian's open practice of providing aid-in-dying to patients who request it, the state legislature issued a temporary ban on active euthanasia.

In two short articles printed on facing pages in the April 1993 issue of the American Bar Association Journal, Cheryl K. Smith, staff attorney for the Hemlock Society U.S.A., and Yale

Kamisar, law professor at the University of Michigan, present opposing opinions about the legalization of active euthanasia. Both see the effects on physicians, patients, and society as a whole as critical issues. However, while Smith predicts that the effects of legalizing active euthanasia will be positive, Kamisar fears that these effects will be overwhelmingly negative. While some of their arguments directly conflict and challenge each other, an underlying disagreement of values and assumptions leaves the conflict difficult to resolve.

In the first place, Kamisar and Smith have opposite opinions of the effect of legalization on physicians. Kamisar argues that it will have a negative impact on "the dynamics of the sick room" and erode the trust upon which the physician-patient relationship is based. He is appalled that, should it become legal, it would be viewed as "an acceptable alternative to treatment and would be discussed in polite conversation," and he is especially disturbed by the fact that the physician might be "the first person to broach the subject." Here Kamisar implies that such a discussion would undercut the physician's purpose, in the sick room—to heal and provide "treatment."

While Kamisar suggests that the participation of physicians in active euthanasia violates the code of medical ethics, Smith interprets this code as allowing physicians to aid-in-dying without violating their ethical obligations to their patients. In fact, she argues that "Relief of suffering, always a major goal of medicine, provides the best rationale for legal aid-in-dying for the terminally ill." Smith also acknowledges a point which Kamisar ignores—that physicians are not always able to relieve pain and suffering and that the Hippocratic Oath, which "requires physicians to relieve pain, as well as give no deadly medicine," contains within it an internal inconsistency in these cases. Smith believes that, given the advances in medical technology since the time of Hippocrates, the oath "should be relied upon as a guide" only. In further contrast to Kamisar, she claims that legalizing active euthanasia may strengthen rather than erode the physician-patient relationship because "Patients who are able to discuss sensitive issues such as this are more likely to trust their physicians."

While we can see that Smith seems to have a more complex sense of medical ethics than Kamisar, we see that complexity based on an interactive trust between doctor and patient, in which communication is foremost. Anything that can increase that communication will lead to a more sensitive and appropriate response by the doctor. Kamisar, on the other hand, sees patient trust based on the doctor's authority as a benign care-giver. Increased communication from the doctor about options may seem coercive, an authoritarian suggestion to hasten death.

Second, Kamisar and Smith draw opposite conclusions about the effects of legalizing active euthanasia on patients. Again, Kamisar feels that it would have detrimental effects. He fears that legalization would put undue stress on severely ill patients and perhaps even violate their autonomy: for example, some might feel pressured or obliged to opt for euthanasia "to relieve their relatives of financial pressures or emotional strain" or "feel that to reject euthanasia, once it is a viable alternative and others are 'doing it,' would be selfish or cowardly." Kamisar also believes that legalization will harm some patients by "denying them the possibility of staying alive by default." In other words, he believes that the legalization of active euthanasia implies that a person must have a reasonable "excuse" for living.

Smith, however, feels that legalizing active euthanasia will "benefit patients by preventing abuses and by providing an alternative to uncontrollable pain and unbearable suffering. She believes that legalization will help to guarantee the autonomy of patients by making it easier to regulate the practice, which "is currently occurring outside the law and without any reporting requirements." She also claims that patients will benefit from the open dialogue between physicians and patients made possible by legalization which will "enhance detection of treatable depression, which may decrease emotional suicides, and resolution of other problems such as pain."

Although both Kamisar and Smith seem to put patient autonomy first, they have very different ideas about what process maximizes autonomy. Smith believes open communication and consideration of all alternatives increases autonomy and decreases the psychological pressures on the patient. Kamisar believes that the more the patient must confront and the more options presented, the more the patient will feel pressured. The patient is put in the uncomfortable position of actively having to decide and assert that continuing life is good for himself and for others. Smith, on the other hand, sees that

assertion as liberating, and believes the dialogue leading to that assertion may help relieve depression and other emotional stress that could hasten death.

Finally and most significantly, Kamisar and Smith differ in their views of the effects of legalizing euthanasia on society as a whole. Kamisar sees these effects as resulting in nothing less than the breakdown of the "web of rules"—one of which prohibits killing—which together make up our society's moral code. He fears that legalization will result in "lost distinctions of former significance" concerning the ethics of death and dying and thus argues that "traditional restraints" must be preserved. Kamisar also believes that the breakdown of one rule will lead to the breakdown of others, and as a result. "If we legalize active euthanasia for only the 'terminally ill,' it will not remain limited for very long."

While Kamisar is concerned with the breakdown of our society's moral fiber, Smith is concerned with breakdown of our society's respect for individual autonomy and challenges our society to respond to a problem which "demands a compassionate response." In fact, she believes that "respect for a person's autonomy requires that his or her considered value judgment must be taken seriously even if that judgment is believed to be mistaken." Although she does not directly address the effect of legalization on society, her comments suggest that to refuse patients their right to choose active euthanasia is a denial of individual freedom as well as an act of cruelty. She rejects the notion that legalizing active voluntary euthanasia will inevitably lead to the acceptance of active involuntary euthanasia because her argument for legalization is based squarely on her appeal to individual autonomy: "Of course, the person desiring aid-in-dying must be both competent and fully informed. This implies voluntariness and disclosure of the risks, benefits, reasonable alternatives and probable results."

Once again we see Kamisar believing the best way to preserve freedom and life is through maintaining traditional beliefs and not questioning their authority. If traditional arrangements are questioned too far, they will break apart and we will be left without protections. Smith, on the other hand, sees our protection *only* in our constant discussion of our situation, assertion of our needs and desires, and decisions based on our understanding of each case. The following of strict rules about which we have no choice is for her not a protection, but a loss of freedom.

Although Kamisar and Smith consider the same issues, they draw different conclusions about the effect of legalizing active euthanasia, because of their different beliefs about how freedom and rights are best upheld in society. While Kamisar appeals to "traditional restraints" against killing, Smith appeals to the principle of personal autonomy. Kamisar emphasizes the negative effects of opening up discussion of these difficult matters because people may not feel free to choose, may feel pressured, or may make poor choices. Smith emphasizes the benefits of legalization for the patient because she believes in the power of openness and communication to increase our freedom. One feels society is fragile and will deteriorate if pressed too far. The other feels society is robust and healthy only insofar as we constantly creatively remake it to fit our needs and perceptions. For both the issue of active euthanasia is more than even a matter of individual life or death—it is the life or death of society itself. But that issue is barely begun to be argued here.

#### Sources

Kamisar, Yale. "No: Preserve 'Traditional Restraints.'" *American Bar Association Journal* (Apr. 1993): 43.

Smith, Cheryl. "Yes: A Matter of Choice." *American Bar Association Journal* (Apr. 1993), 42.

## WRITING ASSIGNMENTS

1. Write an essay of evaluative comparison of about 500 words, comparing the positions in anyone of the following sets of articles.
  - a. Yale Kamisar's and Cheryl Smith's discussions of active euthanasia on page 74.

- b. The editorial by McPherson and Shapiro on page 80 and one of the letters to the editor on page 79, on national service.
  - c. The closing statements of two of the three presidential candidates in the second 1992 presidential debate, on pages 107-108.
  - d. The two reviews of the book *Equality Transformed*, on page 131.
2. Survey ten people in your class to find out their opinions about a current event or a controversial issue, asking them five specific, uniform questions. Then, in 500 to 750 words, compare and evaluate the responses you received, organizing and classifying responses around either the characteristics of the respondents or the nature of the responses.
3. Drawing on a research project you are currently working on for this or another course, select two passages from different sources covering the same topic. Write an evaluative comparison of about 500 words—or as long as necessary to cover all the pertinent issues. Your audience is classmates doing research in the same area, who will be concerned with the extent of agreement and disagreement between the sources.
4. Find two newspaper or magazine articles or editorials that disagree about a currently controversial issue. Write an evaluative comparison of the articles or of any short passages taken from them.
5. Write an evaluative comparison of the viewpoints expressed in the following two articles concerning a controversial alternative penalty for convicted rapists.

[COPYRIGHTED MATERIAL REMOVED]

### Session 3: Citations & References

*Expected Duration:* 1-2 class periods

*Materials List (Teacher):*

- Access to Purdue OWL website (see web links below)

*Materials List (Student):*

- APA Classroom Poster
- Student Guide to Science Fair
- Articles/sources used in session 2

*Teacher Directions:*

- Teachers need to have a brief discussion about the importance of citing the sources used in any writing.
- Citing needs to be used in the text of the paper and in a “references” sheet at the end.
- APA formatting for citations needs to be used.
- Distribute copy of APA classroom poster to each student as a quick-reference guide.
- In-Text Citations
  - In-Text citations must be used when students are quoting an author’s work in their own paper and when they are paraphrasing another author’s idea.
  - When using in-text citations, with a direct quote, students need to include author’s last name, publication date, and page number.
  - When using in-text citations, when paraphrasing, only the author’s last name and publication date need to be included.
  - See examples on Purdue’s OWL website:  
<https://owl.english.purdue.edu/owl/resource/560/02/>
  - Using articles from session 2, have students practice writing a quoted citation and paraphrased citation. Have students peer-check their work, make corrections, and then share with you.
- References Page
  - Students must cite ALL references used during the research process.
  - Reference should be included, even if students don’t directly quote from that particular source.
  - Again, refer to Purdue’s OWL website for guidance on what to include on the references page.  
<https://owl.english.purdue.edu/owl/resource/560/10/>

- Have students practice creating a reference entry for the articles used in session 2.

#### *Formative Assessment Suggestions:*

- Practice in-text citations.
- Practice reference sheet from session 2 articles.

#### *Key Points and/or Misconceptions:*

- Any reference used during the research process **MUST** be included on the references sheet.
- Students do not have to memorize the appropriate format for citations; allow them to use reference websites or other tools (APA Classroom Poster).

#### *Sample Responses:*

- References Citation for Session 2 Articles:

Hsu, J. (2010). Lost letters reveal twists in discovery of double helix. *NBCnews.com*. Retrieved from [http://www.nbcnews.com/id/39423795/ns/teachnology\\_and\\_science](http://www.nbcnews.com/id/39423795/ns/teachnology_and_science)

Wright, R. (1999). Molecular biologists Watson & Crick. *Time*. Retrieved from <http://www.time.com/time/time100/scientist/profile/watsoncrick.html>

- In-Text Citation Examples:

Paraphrase: According to Hsu (2010), Watson and Crick had incorrect information on the structure of DNA until they discovered Franklin's research.

Direct Quote: "The men were an odd pair" (Wright, 1999, para. 3).

#### *Enduring Understandings:*

- Students need to gain the understanding that when they use someone else's work to guide their own work or increase their understanding of a topic, they need to give that person/entity credit for the work.
- If students do not use in-text citations, they are plagiarizing someone else's work. If students do not learn to cite others' work, plagiarizing could lead to code of ethics violations in the future.

*Attachments:*

- APA Classroom Poster
- Student Guide to Science Fair

*Web Links:*

- Purdue OWL website:  
<https://owl.english.purdue.edu/owl/resource/560/01/>
- STEM Commercialization Plan Template from Believe in Ohio:  
<http://www.believeinohio.org/bio/competition.html>

**Introduction**

This poster provides basic rules for using APA style. To supplement this material, consult the *Publication Manual of the American Psychological Association* (6th edition). The APA manual is available in most writing centers, libraries, and bookstores. You may also reference the Purdue University Online Writing Lab (OWL) for information on APA: <http://owl.english.purdue.edu/>.

Poster by Kate Rowen and Allen Brown. © 2009 The Writing Lab & OWL at Purdue University.

**Formatting**

Type APA papers on white 8.5 x 11 inch paper. Margins should be 1 inch on all sides. Text should be double-spaced with two spaces after punctuation in between sentences. Use a legible font in 10 to 12 pt. size. Include a page header at the top of every page. To create a page header, type "THE TITLE OF YOUR PAPER" flush with the left margin. Abbreviate your title to 50 or fewer characters. Then insert page numbers flush right.

**Title Page**

Title pages should include the "Running header: TITLE OF YOUR PAPER" in the header. In the upper half of the title page, type your name, the byline, and affiliation centered on separate lines.

**Abstract**

On a new page, center and type the word "Abstract." Beginning with the next line, type a double-spaced paragraph of 120 or fewer words containing your topic, research questions, participants, methods, results, data analysis, and conclusions.

**Main Body**

The top area of the body pages should contain the header and the page numbers. Page margins should be 1 inch. Indent first lines of paragraphs one half-inch from left margins.

**Headings**

APA uses a five heading system to separate papers: Level 1: Centered, boldface and lowercase heading; Level 2: Left-aligned, boldface, uppercase and lowercase heading; Level 3: Indented, boldface, lowercase heading with period; Level 4: Indented, boldface, italicized, lowercase heading with period; Level 5: Indented, italicized, lowercase heading with period.



**In-Text Citation**

**Basics**

Use the past tense or present perfect tense when using signal phrases to describe earlier research, e.g., "Jones (1998) found" or "Jones (1998) has found." Follow the author-date method of in-text citation: (Jones, 1998).

Place direct quotations longer than 40 words in a free-standing block of typewritten lines and omit quotation marks. Start the quotation on a new line, indented five spaces from the left margin. Type the entire block quotation on the new margin and indent the first line of any subsequent paragraph within the quotation five spaces from the new margin. Place the parenthetical citation after the closing punctuation mark.

**A Work with One or Two Authors**

Name the author(s) in the signal phrase or in the parentheses. Spell out "and" in signal phrases but use the ampersand in parentheses.

(Megan and Petty (1994) found that... (Megan & Petty, 1994).

**A Work by Three to Five Authors**

List all the authors in the signal phrase or in parentheses the first time you cite the source.

(Mernis, Cornell, Sun, Berry, & Harlow, 1993)

In subsequent citations, only use the first author's last name and "et al"

**A Work by Six or More Authors**

Use the first author's name then "et al" in signal phrases or in parentheses.

Harris et al. (2001) argued... (Harris et al., 2001)

**Unknown Author**

If the work does not have an author, cite the source by its title in the signal phrase or use the first word or two in the parentheses. Italicize titles of books and reports; titles of articles and chapters go in quotation marks.

A similar study was conducted with students learning to format research papers ("Using APA," 2001).

**Organization as Author**

For organization or government agency authors, mention organizations in the signal phrase or the parenthetical citation the first time you cite it.

According to the American Psychological Association (2000),...

**Two or More Works in the Same Parentheses**

When your parenthetical citation includes two or more works, order them the same way they appear in the reference list, separated by a semi-colon.

(Bernat, 2002; Harlow, 1993)

**Internet Sources**

If possible, cite an electronic document the same as any other document.

In his online journal article, Kenneth (2000) explained...

**References**

**Basics**

References lists appear at the end of papers on a separate page. Center and type the word "References" at the top of your list. All lines after the first line of each entry in the list should be indented one-half inch from the left margin. Author's names are inverted; give last names and initials for all authors of a work unless the work has more than six authors.

**Single Author**

Smith, T. J. (2002). Friendship and social development.

*Current Directions in Psychological Science*, 11, 7-10.

**Two Authors**

List by author last names and initials. Use the ampersand, not "and."

Harrod, D. T., & Petty, R. E. (1994). Mood management.

*Journal of Personality & Social Psychology*, 66, 1034-1048.

**Three to Six Authors**

Jones, M., Yang, E., Ellis, G., Miller, D., Casper, R., & Sax,

F. (2001). Writing labs. *WPA Journal*, 4(3), 213-245.

**More than Seven Authors**

Hiller, F. H., Choi, M. J., Angeli, I. L., Harland, A. A.,

Stamoe, J. A., Thomas, S. T., . . . Rubin, L. H. (2009). Web

site usability. *Technical Communication*, 57, 323-335.

**Organization as Author**

American Psychological Association. (2003). *New directions...*

**Unknown Author**

Merriam-Webster's collegiate dictionary (10th ed.). (1993).

Springfield, MA: Merriam-Webster.

**Articles in Periodicals**

Author, A. A., & Author, B. B. (Year). Title of article. Title

of Periodical, volume number(issue number), pages.

**Internet Sources with and without DOI**

APA now recommends using a Digital Object Identifier (DOI) if available.

Brown, D. Toward effective presentations. *Journal of Marketing*,

41(11/12), 1245-1283. doi:10.1108/03090560710821161

Kenneth, I. A. (2000). A Buddhist response to human rights.

*Journal of Buddhist Ethics*, 8. Retrieved from

<http://www.cac.psu.edu/jbe/twocont.html>





# The Ohio Academy of Science

## STUDENT PARTICIPANT GUIDELINES

### Scientific Inquiry and Technological or Engineering Design Projects

#### Before Beginning a Research Project

1. [Become familiar with Policies, Rules and Procedures](#)
2. [Locate a teacher or other professional that will supervise the work](#)
3. [Review the Judging Criteria](#)

#### Beginning a Research Project

4. [Generate ideas involving various Scientific Inquiry and Technological or Engineering design projects](#)
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6. [State a Problem or Question or a Design Statement to solve](#)
7. [Read background information regarding proposed topic](#)
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12. [Collect and Organize Data](#)
13. [Analyze Data and Prepare Graphs](#)

#### After experimentation and data analysis

14. [Prepare Final Research Report](#)
15. [Outline the Oral Presentation](#)
16. [Expectations of the Physical Display](#)
17. [Review the Nine Appendices](#)



# STUDENT PARTICIPANT GUIDELINES

## Before Beginning a Research Project

Before you begin a research project for Local or District Science Day participation, the information in the following sections should be thoroughly reviewed. If you have any questions, please discuss the issue with your parent, teacher, or contact The Ohio Academy of Science **before** you begin your research project.

### 1. Become familiar with the Ohio Academy of Science and the Science Day Standards, Rules and Judging Procedures for Scientific Inquiry & Technological or Engineering Design Projects.

For additional information or questions:

A. Contact: phone: 614.488.2228 email: [info@ohiosci.org](mailto:info@ohiosci.org)

a. Website: <http://www.ohiosci.org>

#### B. Required Components of ALL Science Research Projects

- a. An Identified Problem or Design Statement
- b. Research Plan and Project Data Book/Notebook
- c. Detailed Research Report including an Abstract
- d. Physical Display
- e. Oral Presentation

### 2. Locate a teacher or other professional that will supervise the work

Guidance by an adult professional is important in assuring that rules and special protocols are followed, and that safety in the use of equipment is maintained. Many scientific organizations, industries, as well as local schools and businesses will gladly give valuable aid if properly asked. If a teacher or another professional is not available, contact The Ohio Academy of Science to assist in locating an advisor. Email [info@ohiosci.org](mailto:info@ohiosci.org)

### 3. Review the Judging Criteria

#### A. Criteria for Individual and Team projects

*Student may earn a maximum of 10 in each criteria*



# STUDENT PARTICIPANT GUIDELINES

- Knowledge Achieved
- Effective Use of Scientific Method or Technological and Engineering Design
- Clarity of Expression
- Originality and Creativity
- Teamwork is an added criteria for Team projects

## ***Knowledge Achieved***

- Correct use and understanding of terms and principles
- Evidence that student acquired in-depth knowledge
- Literature search: extent of scientific, engineering or medical journals/sources or just popular literature citations
- Supplements answers/responses with additional relevant information

## ***Effective Use of Scientific Method or Technological and Engineering Design***

- Well-documented Project Data Book/notebook/ lab journal
- Experimental Design: Specific problem or question; a clearly stated hypothesis or technological design statement
- Experimental Design: Designed based testing rather than a summary of knowledge
- Experimental Design: Identified problem---how and why did the student develop the prototype
- Experimental Design: Clear method(s) with correctly defined and measured variables and controls; appropriate testing of prototype
- Experimental Design: sufficient understanding of methods from related studies in the literature
- Data handling: data tables, graphs, statistics; sufficient number of trials or samples for the problem
- Valid conclusion(s) or discussion of results
- Effective Use of professional equipment, or correct construction/use of home-made apparatus, equipment, experimental materials, or models



# STUDENT PARTICIPANT GUIDELINES

## ***Clarity of Expression***

- Explanation and understanding of the project is demonstrated in Oral Presentation; questions answered clearly and correctly; clear statement of how/why the student was testing their design
- Written report: specific title, organization, results, citations, references
- Abstract with clear statement of results; need and results
- Ability to explain information included in the Abstract, the Research Report, and the Project Data Book/notebook/lab journal
- Visual Display: conveys essence of the idea or problem; the design statement or hypothesis; results and valid conclusions

## ***Originality and Creativity***

- New idea, concept, principle, hypothesis, insight or non-obvious approach or problem definition;
- Originality of the idea; did the student redesign the prototype based on their collected data
- Novel association or relationship of previous discoveries or knowledge; literature search includes scientific, engineering or medical journals/sources, patents awarded or just popular literature citations
- Inquiry or Designed based rather than a summary of knowledge
- Unique presentation; ingenious use of materials
- Evidence of initiative; rigorous analyses of extensive or robust data, or results that reveal previously unknown relations

## ***Teamwork*** (criteria only used for Team Projects with a 50-point rating scale)

- A Team includes a maximum of three 3 students, from the same school (district) and same grade brackets (grades 5-6), (grades 7-8), grades (9-12).
- Full names of all team members must appear on the Abstract and registration forms.
- A supplemental sheet of the contribution each member made towards the team project must be signed by each team member and must be included in the project display and in the Research Notebook.



# STUDENT PARTICIPANT GUIDELINES

- All Team members must be present to be judged at District and State Science Day or project is disqualified.

## **Each member of the Team is expected to:**

- Show active participation, and understanding of the entire project
- Be able to serve as the spokesperson, and participate equally in the presentation
- Be fully involved in the project
- Be able to clearly express their personal contributions to the project
- Respond correctly and clearly to all questions

## **B. Ratings for Individual and Team Projects**

### Superior Rating

Individual student earns 36 to 40 points    Team of students earn 45 to 50 points

### Excellent Rating –

Individual student earns 24 to 35 points    Team of students earn 30 to 44 points

### Good Rating

Individual student earns 12 to 23 points    Team of students earn 15 to 29 points

### Satisfactory Rating ---

Individual student earns 04 to 11 points    Team of students earn 05 to 14 points



# STUDENT PARTICIPANT GUIDELINES

## Beginning a Research Project

Now that you know what is expected and required, use the information below as you work through your research project.

### 4. Generate ideas involving various Scientific Inquiry and Technological or Engineering design projects

Inquiry projects shall have a hypothesis; technological and engineering design projects shall have a design statement with measurable criteria for success. Just as **scientific inquiry projects require** 1) the identification of a problem or question and 2) a proposed hypothesis that might offer a solution to the problem or answer the question, so too, **engineering and technological design projects require** 1) a problem or needs statement and 2) a design statement that identifies such limiting factors and criteria for success or meeting the design as cost or affordability, reliability, (mean time between failure MTBF), material limits (strength, weight, resistance to corrosion, color, surface texture, ease of manufacture or reproducibility), operating environment or conditions (temperature, humidity, barometric pressure, caustic conditions), ergonomics (human factors), health and safety, and general ease of use or operation.

In a manner similar to the development of methods used to test a hypothesis, engineering and technological design projects must test the design statement to see how close a prototype, for example, comes to meeting the design criteria. A prototype developed for an engineering and technological design project must achieve stated design objectives and satisfy specified constraints. Generally, the results of an engineering and technological design project will describe the extent to which the prototype met the design criteria. An inquiry project shall state the extent to which the results derived from experimentation validate or invalidate a hypothesis.

### 5. Determine multiple Resources to enhance research

The quantity and quality of the references are reviewed during Science Days by the Judges. Your resources help to demonstrate the scope and depth of the literature search. Consult a Research Librarian to assist in locating more scholarly and reliable reference materials. Science Journals, and other periodicals may have more current articles relating to your topic to give additional background information. It is essential to give proper documentation both in the text and in the listing of References at the end of your Research Paper, for all text information, photos, or graphs, taken from an author's work.



# STUDENT PARTICIPANT GUIDELINES

## 6. State a Problem or Question or a Design Statement to solve

Scientific Inquiry projects require the identification of a problem or question and a proposed hypothesis that might offer a solution to the problem or answer the question. Generally the results derived from experimentation validates or invalidates the stated hypothesis. Engineering and technological design projects require a problem or needs statement and a design statement that identifies limiting factors and criteria for success. Generally, the results of an Engineering and Technological Design project will describe the extent to which the prototype met the design criteria.

## 7. Read background information regarding proposed topic

- A knowledgeable background of the topic is necessary to formulate a hypothesis or design statement or to develop a prototype.
- Students considering the use of vertebrate animals should review **OAS 6**
- Note taking of relevant material is necessary for use in the required Research Report **OAS 2**
- Your literature review should include a variety of reliable and scholarly resources

## 8. The Importance of Documentation

Science Projects are required to have three forms of documentation. The Research Plan **OAS 1**, the Research Report **OAS 2**, and the Project Data Book/notebook **OAS 3**.

### **Project Data Book/Notebook REQUIRED**

Research projects require written documentation from the very beginning of the project starting with gathering ideas for the project, locating references, resources, and the design statement or hypotheses and problems to be investigated. The information the student records in the bound notebook will be used to write the Research Plan for the project. Record the date on each page each time you add any notes to the Project Data Book/ notebook. Detailed notes are essential during the process of setting up the experiment, the conditions, variables, observations, measurements, calculations, graphing results, discussion of the conclusions and implications. Also include other records such as photographs, and discussion notes from your meetings with an advisor, teacher or mentor. Science Day Judges are instructed to review the records that students have documented in their Project Data Book/Notebook.

See <http://www.sciencebuddies.org/mentoring/project-laboratory-notebook.pdf>



# STUDENT PARTICIPANT GUIDELINES

**Patents** also require documentation. Keeping a good Project Data Book/ research notebook is extremely important for students and for professional scientists especially if they ever apply for a patent. Record any original thoughts, concepts or procedures in the bound notebook, with numbered pages. Sign and date those pages and have an adult witness sign and date the page(s) to attest to the event. Use or disclosure of this written record may be required if a patent is applied for and may help assure the claim of originality.

## 9. State Hypothesis or Design Statement considering variables and testable applications

With the problem or question in mind, the student uses the knowledge gained through searching the literature, taking notes, and building a background of information to formulate a hypothesis or design statement. The hypothesis or design statement needs to state precisely what will be tested. The statement also will guide the investigation to answer the questions. Students should consider realistic implementation of the experiment or prototype design. The statistical treatment should be considered simultaneously. Answer questions, such as how will the data be analyzed and evaluated? The validity of the experiment should be addressed---did the experiment test the stated hypothesis? Or was the prototype tested appropriately? Did the prototype meet the design criteria?

Choosing the appropriate variables, the experimental groups, the controls, the limiting factors and/or criteria for success are extremely important. After you have an understanding and sufficient information to set up your investigation, be sure to consult with your teacher or advisor concerning your selection of variables and testable applications.

### Sampling and the use of Statistical Analysis

Projects must provide adequate sampling and analyze results using statistics. This may require a great deal of time and many trials. Due to the nature of projects, it is not possible to state minimum sample sizes. Sampling of subjects is of utmost importance. Students doing behavioral studies using vertebrates, should learn what the minimum number of subjects is needed for adequate sampling. In project abstracts and reports always state the number of trials or the population samples as (N=number). Consult with an advisor, mentor, science or mathematics teacher, or someone familiar with statistics for further information.





# STUDENT PARTICIPANT GUIDELINES

## 10. Complete a Research Plan OAS 1 (Required)

All students who participate in Science Days sponsored by The Ohio Academy of Science, are required to complete a Research Plan before beginning their experimentation or research trials. Modifications in the plan are permitted during the process of research. The modifications must be prepared and dated as a Research Plan. If the modifications involve new protocols that must be approved before experimentation, the Modified Research Plan must be approved before the student resumes experimentation. The initial Research Plan must be kept if any data obtained before the modification will be used in the final project.

## 11. Complete Experimentation or Design Testing

All information regarding project designs and experimentation shall be recorded in a Project Data Book/Notebook **OAS 3**. *It is important to include every model or design or experiment attempted, regardless of the outcome or use.* A discussion of the variables, experimental groups, limiting factors and conditions should also be included in the Project Data Book/notebook. Many trials and designs are often necessary to obtain the desired process. Mention all of them detailing both quantitative and qualitative observations. Problem solving is a major part of acquiring the needed outcome. Discussion of all the trials, or the different designs or models attempted in your Project Data Book will reflect well and be an asset to your project.

## 12. Collect and Organize Data

Almost all scientific research involves statistics. A scientist should not draw a conclusion based on a single measurement or observation. Scientists usually repeat the same measurement three (3) or more times and then use statistics to express its reproducibility or significance. If the term “significant” is used, then the actual statistical test of significance must be stated. Other scientists may repeat the research to see if they can replicate your results. Consult your Mathematics or Science Teacher to provide you with an appropriate statistical method.

## 13. Analyze Data and Prepare Graphs

- Record all data, graphs, drawings, designs, models, etc. in your Project Data Book/Notebook.
- Interpret the data in a written account



# STUDENT PARTICIPANT GUIDELINES

- Prepare appropriate graphing type to illustrate the data
- Analyze the data to identify patterns and verify findings
- Review various types of graphics available to represent your data

## After Experimentation and Data Analysis

Congratulations! The most difficult part might be behind you, but the following section is just as important as conducting experiments. It is critical that your work is presented clearly for judges so they can recognize the amount of work you put into your project. Make sure you approach the Research Report and Oral Presentation with the same level of detail that you gave your science!

Please note that the ISEF Ethics Statement on **OAS 7** is required to be signed by both student and parent. This statement is included on the applications for both District and State Science Day.

### 14. Prepare Final Research Report (Required)

Each project must include a Research Report, **OAS 2**, covering in detail all of the work, references consulted, and acknowledgement of assistance received. The experimental data, statistics, notes, and computations should be recorded in a Project Data Book/notebook. The report should include a description of the work, the results, and the conclusions. This report should follow an accepted form of technical reporting and be checked for correct punctuation, spelling, and grammar preferably by an English teacher. If possible, the report should contain illustrations in the form of photographs, sketches, graphs, data tables or charts that contribute to the effectiveness of the material presented. The Ohio Academy of Science recommends the following format for sections of the Research Report:

- Title Page including the date and name of student
- Table of Contents (optional for reports fewer than 10 pages)
- Abstract(250 words or fewer) explanation below & **OAS 4**
- Introduction-(background, problem and hypothesis or technical design statement
- Methods and Materials used to study the problem
- Results, including an analysis of collected data with graphs, tables, photographs, and diagrams to illustrate investigation
- Discussion including Conclusions and Implications for further research
- References or Literature Cited



# STUDENT PARTICIPANT GUIDELINES

## Abstracts (OAS 4) REQUIRED

Abstracts have a 250 word limit and must be submitted with applications for both District and State Science Days. The abstract must contain a heading that includes a project title and name(s) of the author(s). The heading does not contribute to the word count.

The purpose of the abstract is to provide a summary of the project that will inform interested individuals of the contents. The wording must be written in a manner that any scientifically minded individual, who may not be familiar with the topic, can quickly understand the project's important points.

Summarize in a few sentences:

1. Background information necessary to understand the project and its importance
2. The problem that was investigated and the hypothesis or technological design statement
3. Outline the materials and methods used in the actual experimentation
4. Summary of the results obtained from experimentation
5. The conclusions drawn from results
6. The importance or potential applications that the research offers

Do not be concerned with including all of the details in the abstract. The key point to remember when writing an abstract is to keep the wording brief and concise. Use complete sentences. Avoid personal pronouns like "I" and "my".

Abstracts should provide only information essential to understand the project's basic points and importance. Omit needless words, especially adjectives and adverbs that have no statistical reference or validity. Further information can be found in **OAS 4**.

***Any form of plagiarism is cause for disqualification***

## 15. Outline the Oral Presentation

The student is expected to give a clear and concise oral presentation of their project, to answer questions, and to define any terms used. This brief presentation should completely summarize the project. The quality and quantity of knowledge attained by the student will be evaluated by this Oral Presentation. Students should not memorize a formal speech. An outline (notecards) that lists the variables, procedures, data collection,



# STUDENT PARTICIPANT GUIDELINES

results, conclusions, references, and implications of the entire project may assist the student during the presentation. Use photographs or drawings of the equipment on the poster boards, in the Research Report, and in the Project Data Book/notebook to document and explain equipment used. Items on display should be used as visual clues to keep the student's Oral Presentation to the judges on track or to refer to when responding to a question. Students who are able to supplement their responses with additional, relevant information to the Judges' questions, provide evidence of knowledge achieved.

## 16. Expectations of Physical Display

***Displays at District and State Science Day are strictly poster format only.***

### ***A. Display Components:***

- One lightweight, usually tri-panel, bi-fold, single-sided display board with appropriate information (including graphs, data tables, drawings, sketches, diagrams, or photographs),
- Extra copies of the Abstract for Judges
- Required Documentation of the project:
  - Project Data Book/Notebook
  - Research Plan and Protocols
  - Research Report
  - Use **Appendix 5** for identifying photograph sources

### ***B. Table-Top Display***

The top of the display shall not be more than 85" (216 cm) above floor level or 55" (140 cm) above a 30" high table. Free standing floor projects are not permitted at District or State Science Days. Extension of a project beyond the stated limits will result in dismantling or severe modification of the display, and may disqualify the student's participation. Note that the physical display size at District and State Science Days is smaller than the size allowed at the International Science and Engineering Fair. **The score of the student's project may be impacted by the violation(s) if either the physical dimensions or physical items rules are not followed.**



# STUDENT PARTICIPANT GUIDELINES

## ***C. Use of Kits***

Although the use of a “kit” model is discouraged, such models may be used if they make a definite contribution to the research approach. Models made by students are preferred, since they have a much greater instructional value and demonstrate that the participant has had a proportional gain in knowledge. Models, samples from a research project, or research equipment may not be displayed at District or State Science Days. Only drawings, sketches, diagrams or photographs may be used.

## ***D. Equipment***

Use commercial equipment especially when it would be impossible to conduct the research without it. However, if such equipment is used, the participant must be prepared to describe its operation, function, and the reason(s) for its use. Research equipment may not be displayed at District or State Science Days.

## ***E. Safe Project Displays***

Project displays shall not involve materials or elements that might be dangerous to exhibitors, judges or onlookers. Explosives, toxic elements, injurious chemicals or gases, open flames, or any unprotected moving parts, etc. may be necessary in the research project, but cannot be on the display poster, on the display table, or under the tables at any Science Day. The experimenter should always exercise the greatest care and conduct these phases of the work under qualified supervision and follow all protocols required by the Rules of the Intel International Science and Engineering Fair.

## ***F. Computer Simulation***

Battery-powered computers may be used only for simulation, modeling, animation or data display integral and essential to understand, analyze or interpret the project results; may not for general Power Point™ or other visual or sound presentations. Electricity will not be provided.

## **17. Review the Nine Appendices**

Students are encouraged to read and review all Appendices included at the end of this text. These supplements have been created to help students to understand and to meet



# STUDENT PARTICIPANT GUIDELINES

the required elements of Science Day Projects sponsored by The Ohio Academy of Science. **Appendix 1 through 7** focus on the required elements needed for all student participants in District or State Science Days. Appendix 8 and 9 are Student Check Lists to assist students throughout the process. **Appendix 8** is a Time Line Guide and Check List approach to completing the entire Science Project process, and **Appendix 9** is a Check List to be used by the student at the completion of the project to assure adherence to rules and procedures.

## Student Appendices Include:

- OAS 1 Research Plan Format**
- OAS 2 Research Report**
- OAS 3 Project Data Book/Notebook**
- OAS 4 Writing an Abstract**
- OAS 5 Photographic/Graphics Source Identification**
- OAS 6 Human Informed Consent Form**
- OAS 7 ISEF Ethics Statement**
- OAS 8 Student Time Line Approach**
- OAS 9 Student Check List at Completion of Project**



# OAS Appendices

## Appendix: OAS 1

### **Required Research Plan**

All students who participate in District and State Science Days shall complete a Research Plan PRIOR to beginning their experimentation or research trials. Modifications in the plan are permitted during the process of research. The modifications must be prepared and dated as a Research Plan. If the modifications involve new protocols that must be approved before experimentation, the modified plan must be approved before the student resumes experimentation. The initial Research Plan must be kept if any data obtained before the modification will be used in the final project.

#### **A Research Plan shall include:**

1. Name and Address of each student involved in the research:
  2. Teacher and/or Research Supervisor:
  3. Project is New \_\_\_\_\_ Project is a Continuation \_\_\_\_\_
  4. Project Location: (where the work will be completed: home, school, lab or other institution)
  5. Project Title:
  6. Project Research Question or Problem:
  7. Project Hypothesis or Technical Design Statement:
  8. Experimental Methods or Procedures:
  9. List 5 major references specifically applicable to the proposed research:
  10. If the proposed research involves vertebrate animals, the research plan must also:
    - A) Provide a detailed justification for their use
    - B) Discuss non-vertebrate alternative
    - C) Give an additional animal care reference for the species being used
-



# OAS Appendices

## Appendix: OAS 2

### **Required Research Report**

The Research Report includes:

1. An Abstract

A maximum of 250 words that summarizes the investigation, the methods and results. (OAS 4)

2. A Search of the Literature

Use various forms of resources to gather background information on the topic, the possible variables, the sampling possibilities, the models, the designs, etc. This is the information that will be used in the student's Oral Presentation to provide Judges with evidence of in-depth knowledge acquired. Use articles from STEM (Science, Technology, Engineering and Mathematics) periodicals, and other reliable and scholarly references. Discuss the topic with Research Librarians at the school or local library. They will provide the name and location of current reference material that will address your topic.

3. Scientific Methodology—Technical Discussion

- the problem or question
- the hypothesis or design statement
- the methods, procedures, and materials used
- the data collected
- the analysis of data
- the significance of the results
- the conclusions or generalizations
- the questions or statements for further study





## OAS Appendices

4. A Title Page, a Table of Contents Page , and a listing of Resources and References documented in a standard format
5. Visual Graphics to assist in the explanation of the data collected such as tables, diagrams, maps, photographs, graphs, etc.

### **Other points to remember during the preparation of the Research Paper**

- Designate a note taking system---it's essential
- Use detailed titles and labels on all of the graphics
- Do not use first or second person pronouns (I, me, my or you) within the paper. If the paper has a personal/reflection section I and me are allowed
- Document everything
- Use quotation marks, and correct citations within the paper, as well as, at the end in the list of references.
- anyone should be able to replicate the experiment using the procedures, methods and materials described in the research paper
- Continually write explanations and observations in the Project Data book/Notebook during the entire project. Often these comments become significant and can be used in the Research Report when summarizing and analyzing data.
- Graphics and diagrams should be included within the paper, not just stacked at the end.
- Cite any patterns or trends in the investigation
- Mention all reasons that supported or did not support the hypothesis or design statement.
- All figures, diagrams, tables used in the Research Paper must be mentioned in sentences within the writing.
- All sources cited in parenthesis ( ) in the paper must have a corresponding entry in the Reference Listing.



## OAS Appendices

### Appendix: OAS 3

#### **Required Project Data Book**

Students will need project data book (logbook or journal) to record all aspects of their research project beginning with the background information, and the formulation of the design statement or hypotheses. The note book may be of many different types and sizes. Choose one that is appropriate for you and your project. The purpose of the notebook is to have one place to record data, procedures, thoughts, and graphics and to keep the sections of the project organized.

The Project Data Book/Notebook should include:

- Methods, Materials, and Procedures used;
- Qualitative and Quantitative Data collected;
- Independent and Dependent Variables,
- Samples, Trials, Models, Designs
- Results
- Possible Conclusions
- Other essential information
- Comments
- Explanations
- Questions for Future Study

Notes:

- An 8 ½ X 11 inch notebook will accommodate printed graphics, diagrams and computer print outs that may need to be taped or glued into the notebook.



## OAS Appendices

- A permanent marking pen is suggested so that the ink will not smear, and the data and wording remains as written initially. Pages should never be torn out, and correction fluid should not be used. If a mistake is made---it is suggested that a single line is drawn through the error, and the correct word or number is written next to it.
- Entries written in the Research Notebook are dated to record progress, and to maintain the order in which the content of the entry occurred.
- Teachers may request specific sections to be included within the Project Data Book: for example: Methods, Procedures, Materials, Qualitative data, Quantitative data, Correspondence, Results, and/or Conclusions. Follow the instructor's, or mentor's guidelines regarding the notebook sections.
- Hand Drawings, sketches, graphs, and photographs may also be included in the notebook. Be sure to label each entry clearly with the date and a detailed description. Specific labels, as well as the units used on data tables and other graphics should be clearly written. Photographs of human test subjects must have informed consent forms (OAS 6). Credit must be given to the source of all photographs and graphics used.



# OAS Appendices

## Appendix: OAS 4

### **Required Abstract**—250 word limit

Abstracts are often the first part of your research that is seen, and will often determine whether someone continues to read your report or examines your work further. Because of this, it is critical that your abstract is concise and clear. Abstracts should: 1) describe what was previously known and what your study added (Background), 2. How you carried out your research (Methods), and 3) what your studies found using statistical results when possible (Results).

Modified from Andrade, 2011

All abstracts should contain:

**Background:** What is already known about the subject, related to the paper in question? What is not known about the subject and hence what the study intended to examine (or what the paper seeks to present)?

Example: Based on sales numbers from car dealers, red cars have been the most popular car color for the past two decades. However, it remains unknown whether this is due to the consumers' preference or whether the dealers simply provide more models in the red color, essentially forcing the consumer to buy a red car. We hypothesized that when given the option of any color, red would not be the most popular option.

**Methods:** It should contain enough detail to allow the reader to understand how the work was done.

Example: This study surveyed 200 prospective car buyers (age 22-45) and asked, "If all colors were available, which color of car would you buy?"

**Results:** What did you find? When possible express your results in terms of statistical testing and significance.

Example: Interestingly, the most popular choice was silver (35%) with red being second (20%). This difference was statistically significant as tested using Analysis of Variance ( $p < 0.03$ ). These results suggest that car dealers are restricting the consumers' choice, and furthermore, that the dealers could possibly sell more cars if they had more models in silver.



## OAS Appendices

### Appendix: OAS 5

#### **Required Photographic/Graphics Source Identification**

Students shall complete and *post* the following 14pt type on the front of their display.

- “outside sources” below means the student did not create the graphics himself or herself. The graphics came from or were modified from computer clip art, the internet, books, journal articles or other printed or digital sources.

Photographs taken by: \_\_\_\_\_

Graphics from outside sources are from: \_\_\_\_\_

Photographic permissions were obtained and are located:

\_\_\_\_\_



# OAS Appendices

## Appendix: OAS 6

### Human Informed Consent Form

Student Researcher(s): \_\_\_\_\_

Title of Project: \_\_\_\_\_

I am asking for your voluntary participation in my science fair project. Please read the following information about the project. If you would like to participate, please sign on the appropriate line below.

Purpose of the project:

Time required for participation:

Potential Risks of the Study:

Benefits of the Study:

How confidentiality will be maintained:

If you have any questions about this study, feel free to contact:

Adult Sponsor/QS/DS: \_\_\_\_\_ Phone/email: \_\_\_\_\_

*Participation in this study is completely voluntary. If you decide not to participate there will not be any negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.*

*By signing this form I am attesting that I have read and understand the information above and I freely give my consent/assent to participate or permission for my child to participate.*

Adult Informed Consent or Minor Assent    Date Reviewed & Signed: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Printed Name of Research Participant:

Signature:

Parental/Guardian Permission (if applicable)

Date Reviewed and Signed: \_\_\_\_\_

\_\_\_\_\_  
Parent/Guardian Printed Name:

\_\_\_\_\_  
Signature:



## OAS Appendices

### Appendix: OAS 7

#### **Required ISEF ETHICS STATEMENT – ISEF Approval Form 1B**

The following statement is to be signed by both the student participant and parent/guardian of the participant. The signatures acknowledge that the student disclosed and cited where appropriate the specific source(s) of the idea for the project, all written reports, and Project Data Book/log book/journal, the Display and all aspects of the Project.

**Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs or the Intel ISEF.**

_____	_____	_____
Printed Name of Student	Signature	Date

_____	_____	_____
Printed Name of Parent/Guardian	Signature	Date



# OAS Appendices

## Appendix: OAS 8

### Student Time Line Guide and Check List

#### Completion of a Scientific Research Project

- \_\_\_\_\_ Preview Sample Projects and check several resources for project ideas
- \_\_\_\_\_ Read Ohio Academy of Science Standards
- \_\_\_\_\_ Read OAS Student Participation Guide
- \_\_\_\_\_ Consider completion date of project    DUE \_\_\_\_\_
- \_\_\_\_\_ Choose Individual or Team Project
- \_\_\_\_\_ Note the assessment criteria to be used for the project
- \_\_\_\_\_ Note all required elements and forms needed
- \_\_\_\_\_ Begin the Required Project Notebook--# pages and add dates
- \_\_\_\_\_ Write all notes, ideas, problems, procedures, etc. in the Project Data Book
- \_\_\_\_\_ Choose a Scientific Inquiry or a Technical Engineering Design Project
- \_\_\_\_\_ Identify Problems or Questions to be researched and studied
- \_\_\_\_\_ Literature Review (Note taking) using a variety of resources--- minimum 5
- \_\_\_\_\_ Identify a documentation style that will be used throughout the project
- \_\_\_\_\_ Develop a Hypothesis or Design Statement
- \_\_\_\_\_ Secure all equipment and materials needed for implementation
- \_\_\_\_\_ Designate the methods and procedures to be followed
- \_\_\_\_\_ Formulate the Required Research Plan before experimentation begins
- \_\_\_\_\_ Read all the OAS and ISEF rules and procedures before any work begins
- \_\_\_\_\_ Implement Experiment or Test Prototype
- \_\_\_\_\_ Collect, Organize and Interpret Data
- \_\_\_\_\_ Prepare appropriate Graphics of the collected Data
- \_\_\_\_\_ Reread Judging Criteria and Standards





## OAS Appendices

- \_\_\_\_\_ Complete First Draft of Research Report
- \_\_\_\_\_ Construct visuals for the Report and/or Poster Display
- \_\_\_\_\_ Arrange Photographs for Report and/or Poster Display
- \_\_\_\_\_ Write the Required Abstract
- \_\_\_\_\_ Complete Final Draft of Required Research Report
- \_\_\_\_\_ Reread Display Rules for participation in the chosen competition
- \_\_\_\_\_ Plan Final Poster Display that meets all requirements
- \_\_\_\_\_ Create Oral Presentation that emphasizes Judging criteria
- \_\_\_\_\_ Complete all registration forms for entry in District and State Science Days

**Be Proud of Your Accomplishments!**



# OAS Appendices

## Appendix: OAS 9

### Student Check List at Completion of Research Project

- \_\_\_\_\_ I have completed the Required Research Plan.
- \_\_\_\_\_ I have completed the Required Research Report.
- \_\_\_\_\_ I have completed the Required Project Data Book/Notebook.
- \_\_\_\_\_ I have Checked all OAS Standards and ISEF Rules to ensure I followed all procedures and protocols.
- \_\_\_\_\_ I designed an experiment to test variables or a prototype to respond to a design statement.
- \_\_\_\_\_ I had adequate sampling and/or testing.
- \_\_\_\_\_ I listed all materials and equipment used.
- \_\_\_\_\_ I collected and organized my data.
- \_\_\_\_\_ I created graphics using the data I collected.
- \_\_\_\_\_ I wrote daily/frequently in my Project Data Book/Notebook.
- \_\_\_\_\_ I included dates, page numbers, thoughts, plans, and diagrams in my Project Data Book/Notebook.
- \_\_\_\_\_ I took photographs, or developed a flow chart, or drew diagrams of the experimentation or making of the prototype.
- \_\_\_\_\_ I reviewed the OAS Judging Criteria to make sure my project showed evidence of all criteria.
- \_\_\_\_\_ I took notes from each resource making sure that I identified the resource used for each page or card of notes.
- \_\_\_\_\_ I used a documentation style such as MLA or APA throughout my research paper.
- \_\_\_\_\_ I am able to pronounce and explain all terminology used in my reports, on my poster display and in my presentation.
- \_\_\_\_\_ I have included all important information regarding my experiment, design, model or prototype.



## OAS Appendices

\_\_\_\_\_ I have edited all of my written research reports (EXCEPT my Project Data Book/Notebook) checking for sentence structure, spelling, punctuation, and grammar.

\_\_\_\_\_ I have listed **all** of my resources both in the text and at the end of the paper.

\_\_\_\_\_ I have created all of my graphs, tables, charts, diagrams and poster display, OR if I used another source, I listed the source to give proper credit.

\_\_\_\_\_ I have developed my oral presentation with the evidence needed so that the judges will know that I am knowledgeable about my entire project.

\_\_\_\_\_ I have prepared my poster display with graphs, tables, charts and diagrams that will help me explain my project with detail.

\_\_\_\_\_ I have written the required Abstract that describes my project detailing all of the suggested sections. Copies of the Abstract will be exhibited with my project.

\_\_\_\_\_ I have used the required format of the Research Plan to be included with my applications to District and/or State Science Day.

\_\_\_\_\_ I have SIGNED both the Human Consent form and the ISEF Ethics Statement and sent them to the designated address for District and/or State Science Day.

\_\_\_\_\_ I have studied the Display Rules and measured my poster display and checked all of the items listed as Not Allowed at Science Day.

\_\_\_\_\_ I have attached onto my poster the three statement form that designates where my photos and graphics originated.

\_\_\_\_\_ I will contact the Ohio Academy of Science if I have any questions or concerns.

OAS phone number: 614-488-2228      email: [info@ohiosci.org](mailto:info@ohiosci.org)

## Session 4: Prototype or Experimental Design

*Expected Duration:* 3-4 class periods, plus data collection

*Materials List (Teacher):*

- *Access to the websites listed below*

*Materials List (Student):*

- *Materials for their project and data collection*

*Teacher Directions:*

- Based on students' chosen topics, they need to determine the "problem" to be solved through their data collection.
- Using research that students have gathered on their proposed topics, students should brainstorm testable ideas that would "fill a marketplace need or solve a societal problem" (Ohio Academy of Science).
- During brainstorming, students should discuss with their peers as they are narrowing their topics. Additional research time may be necessary.
- Once students have determined what their "testable idea" (problem statement) will be, they need to develop a hypothesis or proposed solution, which could offer solutions to the problem.
- Use the following information to help students write their hypotheses.
  - What is a hypothesis?
    - A possible explanation to an observed phenomenon or event
    - A tentative statement of a relationship between two or more variables.
  - A "good" scientific hypothesis is one that is *testable*. *Testable* means that you can perform a test (e.g., experiment) to show how the variables might be related. The results of the test will determine whether you "reject" or "accept" your hypothesis. If you cannot test your hypothesis, then you cannot verify whether or not it is correct.
  - How to write a formalized hypothesis
    - Identify the independent and dependent variables that you are testing. The independent variable is the variable that you, the "scientist" control and the dependent variable is the one that you observe and/or measure. The dependent variable will change in response to changes in the independent variable. For example, if you are interested in

the effect of energy consumption on economic growth, then energy consumption is the independent variable and economic growth is the dependent variable

- Hypothesize how the two variables are related. For example, you might hypothesize that as energy consumption increases, economic growth will increase. This is a positive direct relationship. You could alternatively hypothesize that as energy consumption decreases, economic growth will decrease. This is a negative direct relationship. You might even hypothesize that as energy consumption increases, economic growth will decrease. This is an inverse relationship.
- Write your hypothesis using an IF/THEN statement.
  - Caution! An IF/THEN statement is only a testable hypothesis if you describe the relation between the variables
  - IF *<insert dependent variable>* IS *<describe relation>* RELATED TO *<insert independent variable>* THEN *<insert the hypothesized relation between the variables>*
  - Using the example of the positive relation between energy consumption and economic growth, you would hypothesize the following: IF economic growth IS positively RELATED TO energy consumption, THEN as energy consumption increases, economic growth will increase
- The next step is for students to determine materials needed and the methodology to test their hypothesis.
- In this section, you want to describe in detail how you will test the hypothesis you developed using appropriate materials and also to clarify the rationale for your procedure. In science, it's not sufficient merely to design and carry out an experiment. Ultimately, others must be able to verify your findings, so your experiment must be reproducible, to the extent that other researchers can follow the same procedure and obtain the same (or similar) results.
- Have students participate in an activity to help them understand the importance of providing accurate and complete step-by-step procedural directions. Have students give directions to a partner, to complete a simple task, such as tying your shoes or putting on a coat.
- After this activity, discuss how well students were able to follow the directions given and complete the desired task. Reiterate the importance of writing specific procedures in order to get the desired results.

- Using knowledge gained from the giving directions activity, remind students that as they begin to write up their methodology, they need to be specific about what tests they conducted and explain the step-by-step procedures that they went through for these tests. Students should not merely summarize the testing they would complete.
- See “How to Write a Paper in Scientific Journal Style and Format” website.
- As students begin working on their materials list (as part of the materials and methodology section), they again need to be reminded to BE SPECIFIC.
- An activity to help students think clearly about specific materials list is to have them think about brushing their teeth, or getting ready for school. Have students list all materials that would be needed to do the activity that they have chosen and then discuss the list with a partner. Did they include everything needed? Was their list specific? Could someone else replicate their process without them in the room giving additional directions or information?
- The next step in this process is for students to actually put their methodology into practice - run the actual tests and gather data.
- As students begin to run their tests, they need to remember to think about their independent and dependent variables.
  - Ideally scientists control all extraneous variables other than the one independent variable. However, this does not always happen. Sometimes this is by choice (delimitations) and some things are just inherently random and uncontrollable (limitations). Have students identify these if possible before conducting the experiment.
- Use the resources in the web links from “Mrs. Averett’s Classroom: The Nature of Science” to help students practice identifying variables.
- Once students are comfortable, they need to run their tests. Remind them to keep track of data in data tables or written logs to be used in the next section.

*Formative Assessment Suggestions:*

- Brainstorming “problems”
- Peer discussion
- Writing their hypothesis
- Writing and following directions activity
- Listing materials activity
- Variables practice

*Key Points and/or Misconceptions:*

- When the term multiple sources is used, please include print, digital, and personal communication as types of potential sources.
- It is EXTREMELY important to remind students to be specific in all of the work for this section. A vague summary doesn't help the reader understand how to replicate a process or procedure.

*Instructional Practices:*

- Any time you can model or show students examples from this section; it will be helpful to them.

*Accessibility / Universal Design:*

- At the beginning if students are struggling with a problem, you may need to introduce/give a problem to them to get them started.

*Enduring Understandings:*

- It is necessary for students to anticipate and solve problems throughout life. Although a test is not always run to solve each problem, there are steps that you follow, which are outlined in this section.

*Web Links:*

- [How to Write a Paper in Scientific Journal Style and Format](#)
- [Mrs. Averett's Classroom: The Nature of Science](#)

## Session 5: Presentation of Information

*Expected Duration:* 2-3 class periods

*Materials List (Teacher):*

- Access to websites listed below
- How to Write a Conclusion handout

*Materials List (Student):*

- Results from their experiments/tests

*Teacher Directions:*

- In this final section, students need to complete an analysis of their project and data, then draw conclusions from their work, and defend their solution/product to solve the identified problem.
- Analysis
  - Once students have completed their testing, they need to collect their data and create a chart or table to share their results.
  - After creating the results table, students need to review the results and draw a conclusion based on what the data says.
  - The “Analyzing and Graphing Data” section of The Biology Corner website has several activities to help students understand how to interpret data charts and graphs.
- Conclusion/Defense of Solution
  - After analyzing their data and results, students need to write their conclusions, which will review their stated hypothesis and then explain how their results supported or didn’t support their hypothesis and explain why or why not.
  - Students also need to discuss any additional scientific research that might be required to continue with the current project or change the idea to make it workable (defense of solution).
  - See “How to Write a Conclusion” handout.

*Key Points and/or Misconceptions:*

- Students need to realize that even if their hypothesis is proven correct, their work isn’t finished. They need to be able to give the reasons for this and to discuss additional scientific research or development that would be needed to replicate their results and/or move their results forward to gain acceptance from the scientific community or purchase from the entrepreneurial community.



### *Sample Responses:*

- The “How to Write a Conclusion” handout includes some sample sentences and wording students might use as a model.

### *Extensions:*

- You could have students give their presentations in class; this would add additional days to the expected duration.
- For Believe in Ohio, the conclusion section can be used for Part 2: Executive Summary, Part 4: Summarizing the Stem Concepts and Principals, and Part 6: Science and Technology Proof of Concept.

### *Instructional Practices:*

- This entire project is an integration of scientific thought and experiment and literacy skills. It references both science standards and Literacy for Science/Technical Subjects anchor standards.

### *Accessibility / Universal Design:*

- If students are struggling to meet the literacy standards at their grade band, you could move to the prior grade band to help students gain success in meeting those standards.

### *Enduring Understanding:*

- Students need to have the skill set of analyzing data and using evidence to back up their decisions or reasons made in the workforce. These are the foundation for developing new ideas, explaining new information to the public, asking the boss for a raise, etc.

### *Attachments:*

- How to Write a Conclusion
- Anchor standards for ELA Literacy in Science/Technical Subjects

### *Web Links:*

- [The Biology Corner](#)

# Writing conclusion paragraphs in a science lab report

A **conclusion paragraph** contains a description of the purpose of the experiment, a discussion of your major findings, an explanation of your findings, and recommendations for further study.

Address the following points in paragraph form (don't just number off and answer each question)

1. Restate the overall purpose of the experiment (include IV and DV in this sentence.)

**One format:** The purpose of the experiment was to investigate the effect of the (IV) on the (DV)

**Example:** The purpose of the experiment was to investigate the effect of stress on the growth of bean plants by comparing the growth of bean plants subjected to stress for 15 days with a control (non-stressed plants.)

2. What were the major findings? (Summarize your data and graph results)

**Example:** No significant difference existed between the height of stressed plants and non-stressed plants. As the graph shows above, the average height of all the stressed plants was 10.2 cm and the average height of all the non-stressed plants was 10.4 cm.

3. Was the hypothesis supported by the data?

**One format:** The hypothesis that (insert your hypothesis) was (supported, partially supported, or not supported.) Please do not ever use the word "prove" – we do NOT prove hypotheses true in science.

**Example:** The hypothesis that stressed plants would have a dramatically lower mean height was not supported.

4. How could this experiment be improved?

**Example:** This experiment relied on a very artificial source of stress – just digging out the plants at one time and replanting them. Perhaps this experiment could be improved by simulating real-life stressors, including drought and lack of nutrients in soil.

**NOT acceptable:** This experiment would have been better if we had done it correctly – we did sloppy work and made careless measurements.

**NOT acceptable:** This experiment would have been better if we had more time to do more trials.

5. What could be studied next after this experiment? What new experiment could continue study of this topic?

**Example:** Additional investigations using various sources of stress at more frequent intervals would be a good additional experiment. Also, other crops could be subjected to the same experiment, such as corn and squash. Perhaps scientists could find a chemical that the plants release during stress.

## Rubric for conclusion paragraphs in lab reports

Purpose restated	
Major findings stated, refers to graph or data table	
Revisits hypothesis (supported or not supported)	
Suggests improvement to lab procedure	
Suggests extension to lab	



STANDARDS FOR

**Literacy in  
History/Social Studies,  
Science, and Technical Subjects**

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6-12

## College and Career Readiness Anchor Standards for Reading

The grades 6–12 standards on the following pages define what students should understand and be able to do by the end of each grade span. They correspond to the College and Career Readiness (CCR) anchor standards below by number. The CCR and grade-specific standards are necessary complements—the former providing broad standards, the latter providing additional specificity—that together define the skills and understandings that all students must demonstrate.

### Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
3. Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

### Craft and Structure

4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
5. Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.
6. Assess how point of view or purpose shapes the content and style of a text.

### Integration of Knowledge and Ideas

7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.\*
8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

### Range of Reading and Level of Text Complexity

10. Read and comprehend complex literary and informational texts independently and proficiently.

\*Please see “Research to Build and Present Knowledge” in Writing for additional standards relevant to gathering, assessing, and applying information from print and digital sources.

### Note on range and content of student reading

*Reading is critical to building knowledge in history/social studies as well as in science and technical subjects. College and career ready reading in these fields requires an appreciation of the norms and conventions of each discipline, such as the kinds of evidence used in history and science; an understanding of domain-specific words and phrases; an attention to precise details; and the capacity to evaluate intricate arguments, synthesize complex information, and follow detailed descriptions of events and concepts. In history/social studies, for example, students need to be able to analyze, evaluate, and differentiate primary and secondary sources. When reading scientific and technical texts, students need to be able to gain knowledge from challenging texts that often make extensive use of elaborate diagrams and data to convey information and illustrate concepts. Students must be able to read complex informational texts in these fields with independence and confidence because the vast majority of reading in college and workforce training programs will be sophisticated nonfiction. It is important to note that these Reading standards are meant to complement the specific content demands of the disciplines, not replace them.*

## Reading Standards for Literacy in History/Social Studies 6–12

The standards below begin at grade 6; standards for K–5 reading in history/social studies, science, and technical subjects are integrated into the K–5 Reading standards. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
<b>Key Ideas and Details</b>		
1. Cite specific textual evidence to support analysis of primary and secondary sources.	1. Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.	1. Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.
2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.	2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.	2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.
3. Identify key steps in a text’s description of a process related to history/social studies (e.g., how a bill becomes law, how interest rates are raised or lowered).	3. Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.	3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain.
<b>Craft and Structure</b>		
4. Determine the meaning of words and phrases as they are used in a text, including vocabulary specific to domains related to history/social studies.	4. Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social studies.	4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines <i>faction</i> in <i>Federalist</i> No. 10).
5. Describe how a text presents information (e.g., sequentially, comparatively, causally).	5. Analyze how a text uses structure to emphasize key points or advance an explanation or analysis.	5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.
6. Identify aspects of a text that reveal an author’s point of view or purpose (e.g., loaded language, inclusion or avoidance of particular facts).	6. Compare the point of view of two or more authors for how they treat the same or similar topics, including which details they include and emphasize in their respective accounts.	6. Evaluate authors’ differing points of view on the same historical event or issue by assessing the authors’ claims, reasoning, and evidence.
<b>Integration of Knowledge and Ideas</b>		
7. Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.	7. Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.	7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.
8. Distinguish among fact, opinion, and reasoned judgment in a text.	8. Assess the extent to which the reasoning and evidence in a text support the author’s claims.	8. Evaluate an author’s premises, claims, and evidence by corroborating or challenging them with other information.
9. Analyze the relationship between a primary and secondary source on the same topic.	9. Compare and contrast treatments of the same topic in several primary and secondary sources.	9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.
<b>Range of Reading and Level of Text Complexity</b>		
10. By the end of grade 8, read and comprehend history/social studies texts in the grades 6–8 text complexity band independently and proficiently.	10. By the end of grade 10, read and comprehend history/social studies texts in the grades 9–10 text complexity band independently and proficiently.	10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

## Reading Standards for Literacy in Science and Technical Subjects 6–12

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
<b>Key Ideas and Details</b>		
1. Cite specific textual evidence to support analysis of science and technical texts.	1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.	2. Determine the central ideas or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.	2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.	3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
<b>Craft and Structure</b>		
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 6–8 texts and topics</i> .	4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 9–10 texts and topics</i> .	4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 11–12 texts and topics</i> .
5. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.	5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., <i>force, friction, reaction force, energy</i> ).	5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.	6. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.	6. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
<b>Integration of Knowledge and Ideas</b>		
7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.	7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
8. Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.	8. Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem.	8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.	9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
<b>Range of Reading and Level of Text Complexity</b>		
10. By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.	10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.	10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

## College and Career Readiness Anchor Standards for Writing

The grades 6–12 standards on the following pages define what students should understand and be able to do by the end of each grade span. They correspond to the College and Career Readiness (CCR) anchor standards below by number. The CCR and grade-specific standards are necessary complements—the former providing broad standards, the latter providing additional specificity—that together define the skills and understandings that all students must demonstrate.

### Text Types and Purposes\*

1. Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence.
2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details and well-structured event sequences.

### Production and Distribution of Writing

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

### Research to Build and Present Knowledge

7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

### Range of Writing

10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

### Note on range and content of student writing

*For students, writing is a key means of asserting and defending claims, showing what they know about a subject, and conveying what they have experienced, imagined, thought, and felt. To be college and career ready writers, students must take task, purpose, and audience into careful consideration, choosing words, information, structures, and formats deliberately. They need to be able to use technology strategically when creating, refining, and collaborating on writing. They have to become adept at gathering information, evaluating sources, and citing material accurately, reporting findings from their research and analysis of sources in a clear and cogent manner. They must have the flexibility, concentration, and fluency to produce high-quality first-draft text under a tight deadline and the capacity to revisit and make improvements to a piece of writing over multiple drafts when circumstances encourage or require it. To meet these goals, students must devote significant time and effort to writing, producing numerous pieces over short and long time frames throughout the year.*

\*These broad types of writing include many subgenres. See Appendix A for definitions of key writing types.

## Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6–12

The standards below begin at grade 6; standards for K–5 writing in history/social studies, science, and technical subjects are integrated into the K–5 Writing standards. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations—the former providing broad standards, the latter providing additional specificity.

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
<b>Text Types and Purposes</b>		
<ol style="list-style-type: none"> <li>1. Write arguments focused on <i>discipline-specific content</i>.               <ol style="list-style-type: none"> <li>a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.</li> <li>b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.</li> <li>c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.</li> <li>d. Establish and maintain a formal style.</li> <li>e. Provide a concluding statement or section that follows from and supports the argument presented.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Write arguments focused on <i>discipline-specific content</i>.               <ol style="list-style-type: none"> <li>a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.</li> <li>b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience’s knowledge level and concerns.</li> <li>c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.</li> <li>d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</li> <li>e. Provide a concluding statement or section that follows from or supports the argument presented.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Write arguments focused on <i>discipline-specific content</i>.               <ol style="list-style-type: none"> <li>a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.</li> <li>b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience’s knowledge level, concerns, values, and possible biases.</li> <li>c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.</li> <li>d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</li> <li>e. Provide a concluding statement or section that follows from or supports the argument presented.</li> </ol> </li> </ol>



## Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
<b>Text Types and Purposes (continued)</b>		
<p>2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <ol style="list-style-type: none"> <li>Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.</li> <li>Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.</li> <li>Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.</li> <li>Use precise language and domain-specific vocabulary to inform about or explain the topic.</li> <li>Establish and maintain a formal style and objective tone.</li> <li>Provide a concluding statement or section that follows from and supports the information or explanation presented.</li> </ol>	<p>2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <ol style="list-style-type: none"> <li>Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</li> <li>Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.</li> <li>Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.</li> <li>Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.</li> <li>Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.</li> <li>Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).</li> </ol>	<p>2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.</p> <ol style="list-style-type: none"> <li>Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.</li> <li>Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.</li> <li>Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.</li> <li>Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.</li> <li>Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</li> </ol>
<p>3. (See note; not applicable as a separate requirement)</p>	<p>3. (See note; not applicable as a separate requirement)</p>	<p>3. (See note; not applicable as a separate requirement)</p>

**Note:** Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

## Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6–12

Grades 6–8 students:	Grades 9–10 students:	Grades 11–12 students:
<b>Production and Distribution of Writing</b>		
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.	5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.	5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.	6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.	6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
<b>Research to Build and Present Knowledge</b>		
7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.	7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
8. Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.	8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
9. Draw evidence from informational texts to support analysis, reflection, and research.	9. Draw evidence from informational texts to support analysis, reflection, and research.	9. Draw evidence from informational texts to support analysis, reflection, and research.
<b>Range of Writing</b>		
10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.