Chapter 8: Writing the results section

Although a formal data report starts with the abstract and then introduction, most data writers begin by writing the results section, composing their report from the inside-out. You can think of the results section as the heart of your IMRD paper: it sits at the center and everything else leads to or away from this section. Even if you are not writing a formal IMRD report, you will still need a results section that communicates your main data stories.

In the results section, you need to both

Display your data visualizations (and accompanying text—captions, legends, axis labels) and
Write paragraphs that help readers understand, trust, and decide what to do with your data.

In other words, we tell our data's story in two formats: with visualizations and numbers and with traditional textual paragraphs.

These different formats serve different purposes. Visualizations help readers quickly grasp main trends and patterns and examine individual data points. (For more on creating effective visualizations, see Chapters 3 and 4). Textual paragraphs provide a way to tell your data story in more detail, supplementing it with additional material and context.

Writing your data story in paragraphs

This chapter focuses on the detailed results section of your report. For each visualization reporting main findings, you should also write paragraphs that include the following "moves":

- **Introduce** the visualization and data stories
- **Support** the data stories by calling attention to noteworthy data points or trends
- **Supplement or elaborate on** the stories with additional information. This additional information might include
    - The results of statistical tests
    - Qualitative data (such as quotations, observations, photographs, or descriptions) that help readers zoom in on the quantitative findings
    - Additional data that might not belong in the visualization but helps readers understand the story
    - Recommended guidelines or standards that help put the data in context
    - Results of prior research that shed light on the findings
- **Provide reasons** that explain unexpected or surprising findings
- **OPTIONAL: Draw conclusions** from the data

Before we delve into more details about what each of these moves involves, let's look at an example results section. First, examine just the table and draw your own conclusions about the data stor. Then read the paragraph below and note how your understanding of the data changes:

Table 8.1: Average speed and standard deviation of speed of vehicles in miles per hour under adverse weather conditions before and after a fog warning and education system was implemented on CR-155.

Implementation	*Standard deviations in vehicle speed (mph)*	*Average vehicle speed (mph)*
Before Implementation	14.3	40.5
After Implementation	7.0	42.1

Table 8.1 shows that after the county transportation agency implemented a fog warning system, standard deviations in vehicle speed on CR-155 decreased by over half. This difference is statistically significant at $p < .001$ (z=13.02). At the same time, there was a minor increase in average vehicle speed, but speeds remained below the posted speed limit of 50 mph. Since high standard deviations in vehicle speeds are a major cause of accidents (and more important than average speed when visibility is low), the fog warning system appears to have improved safety conditions on the road

For Discussion: How does the paragraph change your understanding?

What do you learn just from reading Table 8.1 and its caption? How does your understanding of the data and what it means change after reading the textual paragraph?

If you know little about traffic safety, the textual paragraph probably taught you a lot—most importantly, you learned that standard deviations are more important than average vehicle speed in causing accidents and that the fog warning system appears to have worked. However, even traffic safety experts will learn information from the textual paragraph, such as the results of the statistical tests and that the fact that the posted speed limit is 50mph. Thus, the textual paragraph helps both experts and non-experts understand the data and its context.

Figure 8.1 below illustrates the "moves" used in this paragraph:

Table 9.1 shows that after the county transportation agency implemented a fog warning system, standard deviations in vehicle speed on CR-155 decreased by over half.	**Introduce visualization & State main story**
This difference is statistically significant at $p < .001$ (z=13.02).	**Support with statistical test**
At the same time, there was a minor increase in average vehicle speed, but speeds remained below the posted speed limit of 50 mph.	**State secondary story & Supplement with additional info**
Since high standard deviations in vehicle speeds are a major cause of accidents (and more important than average speed when visibility is low), the fog warning system appears to have improved safety conditions on the road	**Provide reasons & Explain conclusions we can draw**

Figure 8.1: The moves in the fog warning system paragraph

Note how the paragraph begins with strong statements about the major trends and the statistical tests and ends with more tentative statements that draw conclusions or inferences from the data. This pattern is typical. In general, you will want to move from factual statements about trends in the data to more debatable statements about what the data means.

The conclusion that the warning system improved road safety is debatable for two reasons: (1) it is possible (though unlikely) that some other factor is responsible for the traffic changes observed and (2) it is possible that the warning system may have had unintended consequences. For instance, it is possible that even as the fog warning system reduced one danger (e.g. deviations in driver speed), it increased other dangerous driver behaviors (such as checking phones while driving). Thus, while we can confidently say that traffic patterns changed after the warning system was implemented, we need to be less confident in suggesting that the warning system *caused* these changes or that the system improved safety.

As we move from confident factual statements about our data to more debatable ones, our verb choices change from high confidence to lower confidence verbs. Figure 8.2 provides a list of common verbs found in results sections sorted by confidence.

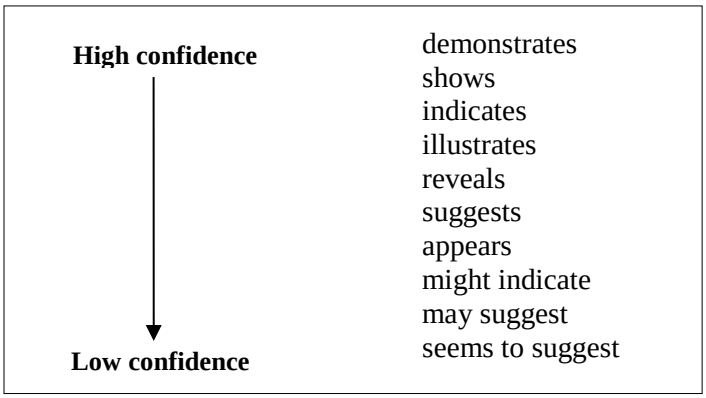


Figure 8.2: Common verbs used to refer to tables, figures, and other data

You should use high confidence verbs when you are reporting the main stories of your data—particularly when the trends you are describing are strong and can be supported. Use lower confidence verbs when you are explaining what your data means.

Some verbs and word choices should never be used because they are too confident. For instance, the verb "proves" is very strong: it implies absolute proof as in a mathematical theorem. Even research with very strong results does not provide "proof." Using this word hurts your credibility by suggesting that you are prone to exaggeration. Other words that you should avoid appear in Table 8.2:

Table 8.2: Words to avoid or use cautiously when writing about data

Avoid	*Why*	*Use instead*
Proves	This word implies absolute certainty, such as in a mathematical proof. The data we collect in real-world settings are rarely, if ever, this solid.	Shows Demonstrates
Significant	This word has a specific meaning in statistics. It indicates the writer has done a statistical test resulting in a p-value of .05 or less. Avoid this word around data unless discussing statistical tests.	Major Large Substantial
Trivial Enormous Ridiculous	These words sound like exaggerations and make the writer sound biased and unscientific.	Small, minor Large, major Unexpected

There is large variation in the extent to which Results sections draw conclusions from the data. Some writers and contexts strictly relegate all conclusions to the Discussion section. Others mix conclusions in to the Results section and repeat them in the Discussion. A good default is to include a small amount of conclusion language in the Results section and in the Discussion go into more detail about conclusions.

For the technically or mathematically minded…

The main content of this book relies on a knowledge of eighth-grade mathematics. However, the example above uses somewhat more advanced statistical concepts. If you are curious what these concepts mean…

- **Standard deviation** roughly tells us how spread out the data is. It is the range in which 2/3rds of the measured data lies. For instance, the average height of an American adult female is 5'5" with a standard deviation of 3". This means that 2/3 of American women fall between 5'1" and 5'8". Intuitively, you probably are already award of this range and tend to classify any women below 5'1" as "short" and those over 5'8" as "tall."

  In the traffic example above, a standard deviation of 7.0 with an average vehicle speed of 42.1 tells us that 2/3 of the cars on the road were between 35.1 and 48.1 mph. By contrast, before implementation of the fog warning system, 2/3rds of the cars were between 26.2 and 58.4 mph. It is easy to see how this range of speeds would cause major safety problems.

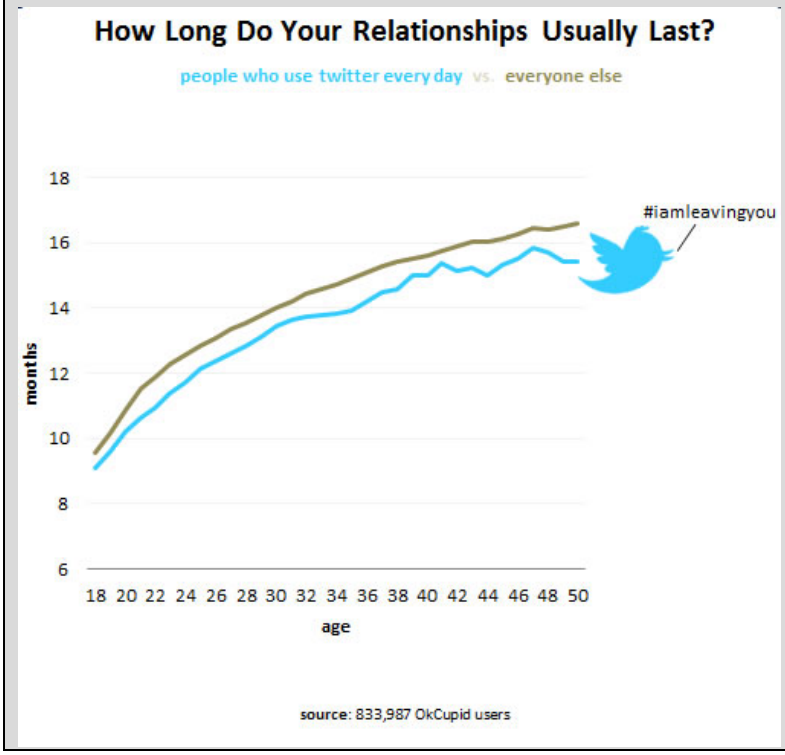
- **Statistical tests** produce what is known as a p-value. The p-value that tells the extent to which any trends we observe could be due to random chance. The equation p < .05 indicates that there is less than a 5% chance that the distribution of the data is due to random chance and *p* < .01 means there is less than a 1% chance that the distribution is due to random chance. In the traffic example above, *p* < .001 indicates a less than 0.1% likelihood that the big difference we see in standard deviations before and after the warning system was implemented is due to random chance.

  If a p-value falls below 0.5 (e.g. there is less than a 5% possibility that the distribution is random), we can say that the distribution is **statistically significant**. Because the word "significant" has this specialized meaning, you should avoid using it when talking about data unless you have calculated a statistical test.

Exercise 8.1

PART I:
It is important to distinguish between factual statements about the data and more debatable conclusions that we draw from the data. The paragraphs in your results section should usually move from factual statements to less factual (though reasonable) conclusions about the data. Your verb choices should change to reflect your confidence in the data.

Let's return to the OKCupid graph on Twitter users and relationship length from Chapter 2. Which verbs from Figure 8.2 would you use with each of these statements? Which interpretations are too far-fetched to use, even with a tentative verb?



1. Figure 8.1 _____ daily Twitter users average shorter relationships than others
2. Figure 8.1 _____ that Twitter use causes shorter relationships
3. Figure 8.1 _____ that older users tend to have longer relationships than younger users
4. Figure 8.1 _____ that relationships lengthen with age
5. Figure 8.1 _____ that older people have more stable relationships

PART II:
Using Figure 8.2 (the fog warning system) as a model, write a paragraph interpreting the OKCupid Twitter users graph above. Skip the sentence with the significance test, but be sure to (1) state the main story, (2) support it with data; (3) state the secondary story and support it with data, and (4) suggest reasons for the finding. If there is a clearly logical conclusion to draw from this data, state it in this paragraph.

PART III:
Again using Figure 8.2 as a model and skipping the signficiance test, pick **any two** of the visualizations from Chapter 4 listed below and write a paragraph interpreting the data.

- Table 4.2: Homicide rates by state
- Figure 4.3b: Friction for shoe tread widths
- Figure 4.6: Sales by employee in two different divisions
- Table 4.3: Efficiency scores for different compressors
- Figure 4.6c: Graduation rates for Polish and Slovak students
- Table 4.6b: Task speeds in different browsers

Weaving data stories together

Often when you write a Results section, you will have multiple data stories that you need to weave together to provide a coherent picture of what your analysis means. In such cases, you will have multiple visualizations and stories that you need to connect and combine. For instance, the data about OkCupid Twitter users in exercise 8.1 might be combined with other data on factors that could affect relationship length, such as the number of close friends one has or the amount of time spent watching television.

The point is, often we need to weave multiple data stories together. Good writers tell their readers exactly how these stories connect and whether they build upon one another or offer contradictions or complications. To make these connections, we use transitions and other connecting language such as….

Language showing simple continuation of same story

- Like Figure A, Table B shows…
- In agreement with Figure A, Figure B shows…..
- Similar to Table A, Figure A shows….
- Table A lends further support for the finding that….
- Figure B provides further confirmation….

Language showing more complex or specific continuation of the same story

- Table A provides a more fine-grained analysis…
- Figure B shows that when the data in Figure A are broken down by…
- Figure A rules out alternate explanations….

- To validate Figure A, Table B….

Language showing a break or contradiction in stories

- Unlike Figure A, Figure B suggests…
- Paradoxically, Figure B shows…
- Table A complicates the finding that…

Visually, our connected stories will look something like Figure 8.3.

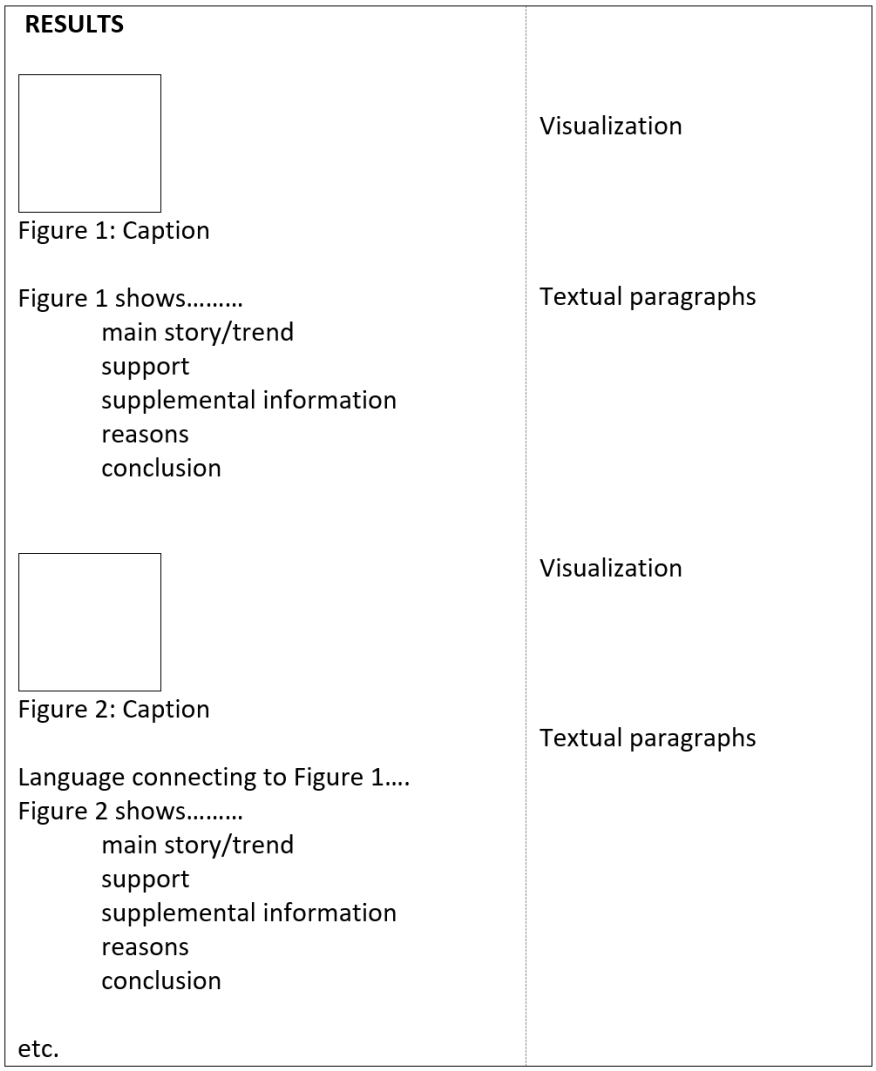


Figure 8.3: Visual representation of the results section

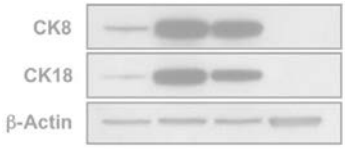
Figure 8.3 shows how each visualization contains a caption and is supported by textual paragraphs that both explain the main data stories of the visualization in words and provide additional supporting detail and interpretation. We then connect these different data stories with language that clarifies the relationships between the visualizations.

Results sections can get very long—often spanning eight or more pages. To help readers navigate this bulky information, we can use document design features such as subheadings to organize the section. These subheadings provide structure for the results section. We can choose subheadings that organize results by the type of analysis or type of data, by the hypotheses or research questions, or by the main data stories the writer wants to communicate.

Figure 8.4 illustrates four different ways subheadings can be used to organize results sections.

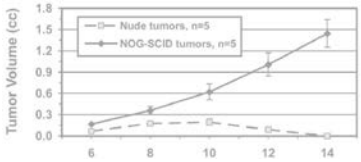
BY TYPE OF ANALYSIS

Blot Analysis:



Western blot analysis of CK8 and CK18 expression in LNCaP, PC-3, E006AA and S006AA cells. ß-Actin served as a loading control. From Loss of Androgen Receptor-Dependent Growth Suppression by Prostate Cancer Cells Can Occur Independently from Acquiring Oncogenic Addiction to Androgen Receptor Signaling. PLOS One. 2010

Quantitative Analysis



Transfer of tumor tissue derived from an established E006AA xenograft tumor from a male NOG-SCID mouse to intact male Nude and NOG-SCID mice.

BY DATA STORY

Email is the preferred mode of communication with supervisors

Table 1 shows email is an overwhelmingly preferred medium of communication for professional writers across the many different kinds of audiences they address with their written communication.

Table 1.1. Written communication preferred

	Supervisors
Email	71%
Social Media	2%
Chat/IM/Text messages	13%
Short internal docs (memos)	21%

Collaboration tools such as Slack are used to share ideas with co-workers

Communication in the Workplace: What Can NC State Students Expect? Jason Swarts, Stacey Pigg, Jamie Larsen, Julia Helo Gonzalez, Rebecca De Haas, & Elizabeth Wagner. NC State Professional writing program 2019.

BY HYPOTHESIS

Hypothesis 1
More text and images here…

Hypothesis 2
More text and images here…

Hypothesis 3
More text and images here…

BY TYPE OF DATA

Simulations
More text and images here…

Performance Tests
More text and images here…

User Feedback
More text and images here…

Figure 8.4: Four options for using subheadings to organize results sections

The goal of the subheadings is to break down a long series of stories into more manageable chunks. The subheadings provide a "skeleton view" of your findings and help readers see how the different parts fit together into a coherent whole.

Finally, when you have multiple visualizations and multiple stories to weave together, you need to think not only about how they connect, but what **order** they should be in. Common logical orders include

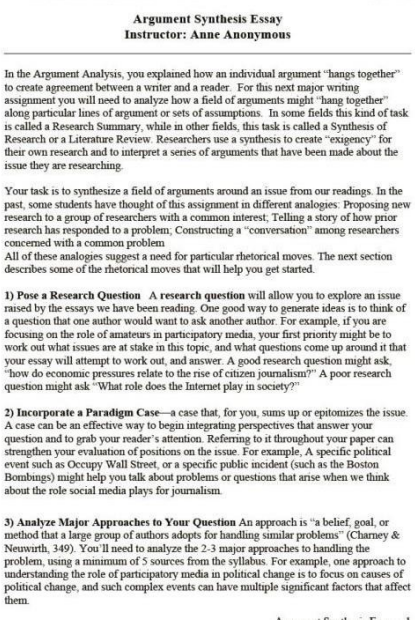
- General to specific
- Most to least interesting
- Quantitative to qualitative
- Specific to general

A sample results section: Improving instructor ethos through document design

The example below is from a small research study my colleagues and I did to analyze how document design—the use of visual elements to organize information on a page—affects students' perceptions. Our purpose was to learn if the additional time it takes instructors to visually format the classroom materials is really worth the investment. We wanted to know if this design really mattered.

To answer this simple research question, we showed over 160 incoming, first-year university students the original and redesigned versions of the assignment in Figure 8.4 below. Approximately half of the students saw the original version first and half saw the redesigned version first. All students answered survey questions asking about their perceptions of the instructor and their preferences for one version over the other.

Original assignment



Argument Synthesis Essay
Instructor: Anne Anonymous

In the Argument Analysis, you explained how an individual argument "hangs together" to create agreement between a writer and a reader. For this next major writing assignment you will need to analyze how a field of arguments might "hang together" along particular lines of argument or sets of assumptions. In some fields this kind of task is called a Research Summary, while in other fields, this task is called a Synthesis of Research or a Literature Review. Researchers use a synthesis to create "exigency" for their own research and to interpret a series of arguments that have been made about the issue they are researching.

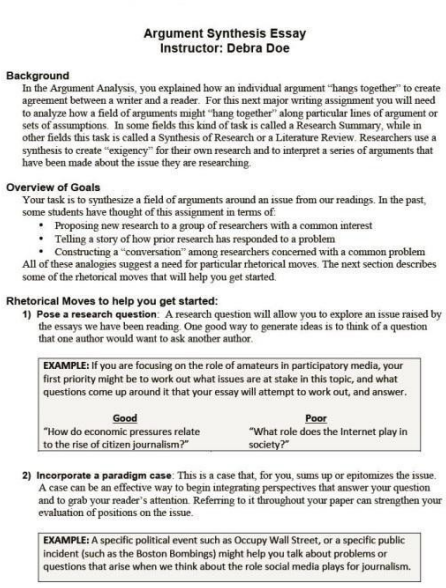
Your task is to synthesize a field of arguments around an issue from our readings. In the past, some students have thought of this assignment in different analogies: Proposing new research to a group of researchers with a common interest; Telling a story of how prior research has responded to a problem; Constructing a "conversation" among researchers concerned with a common problem
All of these analogies suggest a need for particular rhetorical moves. The next section describes some of the rhetorical moves that will help you get started.

1) Pose a Research Question A **research question** will allow you to explore an issue raised by the essays we have been reading. One good way to generate ideas is to think of a question that one author would want to ask another author. For example, if you are focusing on the role of amateurs in participatory media, your first priority might be to work out what issues are at stake in this topic, and what questions come up around it that your essay will attempt to work out, and answer. A good research question might ask, "how do economic pressures relate to the rise of citizen journalism?" A poor research question might ask "What role does the Internet play in society?"

2) Incorporate a Paradigm Case—a case that, for you, sums up or epitomizes the issue. A case can be an effective way to begin integrating perspectives that answer your question and to grab your reader's attention. Referring to it throughout your paper can strengthen your evaluation of positions on the issue. For example, A specific political event such as Occupy Wall Street, or a specific public incident (such as the Boston Bombings) might help you talk about problems or questions that arise when we think about the role social media plays for journalism.

3) Analyze Major Approaches to Your Question An approach is "a belief, goal, or method that a large group of authors adopts for handling similar problems" (Charney & Neuwirth, 349). You'll need to analyze the 2-3 major approaches to handling the problem, using a minimum of 5 sources from the syllabus. For example, one approach to understanding the role of participatory media in political change is to focus on causes of political change, and such complex events can have multiple significant factors that affect them.

Redesigned assignment



Argument Synthesis Essay
Instructor: Debra Doe

Background
In the Argument Analysis, you explained how an individual argument "hangs together" to create agreement between a writer and a reader. For this next major writing assignment you will need to analyze how a field of arguments might "hang together" along particular lines of argument or sets of assumptions. In some fields this kind of task is called a Research Summary, while in other fields this task is called a Synthesis of Research or a Literature Review. Researchers use a synthesis to create "exigency" for their own research and to interpret a series of arguments that have been made about the issue they are researching.

Overview of Goals
Your task is to synthesize a field of arguments around an issue from our readings. In the past, some students have thought of this assignment in terms of:

- Proposing new research to a group of researchers with a common interest
- Telling a story of how prior research has responded to a problem
- Constructing a "conversation" among researchers concerned with a common problem

All of these analogies suggest a need for particular rhetorical moves. The next section describes some of the rhetorical moves that will help you get started.

Rhetorical Moves to help you get started:

1) **Pose a research question**: A research question will allow you to explore an issue raised by the essays we have been reading. One good way to generate ideas is to think of a question that one author would want to ask another author.

EXAMPLE: If you are focusing on the role of amateurs in participatory media, your first priority might be to work out what issues are at stake in this topic, and what questions come up around it that your essay will attempt to work out, and answer.

Good	Poor
"How do economic pressures relate to the rise of citizen journalism?"	"What role does the Internet play in society?"

2) **Incorporate a paradigm case**: This is a case that, for you, sums up or epitomizes the issue. A case can be an effective way to begin integrating perspectives that answer your question and to grab your reader's attention. Referring to it throughout your paper can strengthen your evaluation of positions on the issue.

EXAMPLE: A specific political event such as Occupy Wall Street, or a specific public incident (such as the Boston Bombings) might help you talk about problems or questions that arise when we think about the role social media plays for journalism.

Figure 8.4: Two versions of the same assignment. The redesigned version uses more visual formatting. The purpose of my study was to see if the additional effort of producing the redesigned version was worth the time investment.

Take a look at an abbreviated version of my results section and note the types of information we included, how we organized our results, and how we mixed quantitative and qualitative data.

Excerpt from "Improving Instructor Ethos Through Document Design" by Wolfe, Roderick & Rooney

RESULTS

Students strongly preferred the redesigned prompt

Figure 1 demonstrates that incoming freshman preferred the redesigned prompt. Overall, 65% of our participants indicated that they somewhat or completely preferred the redesigned prompt, whereas only 18.7% of participants somewhat or completely preferred the original, a difference that is highly statistically significant, χ^2 (4) = 34.07, $\underline{p} < .0001$.

Students' preference for the redesigned prompt was consistent regardless of their gender, major, or self-proclaimed interest in writing. There was a slight effect for the order in which students saw the prompts: those who saw the original prompt first were even more strongly in favor of the redesigned prompt than those who saw the redesigned prompt first.

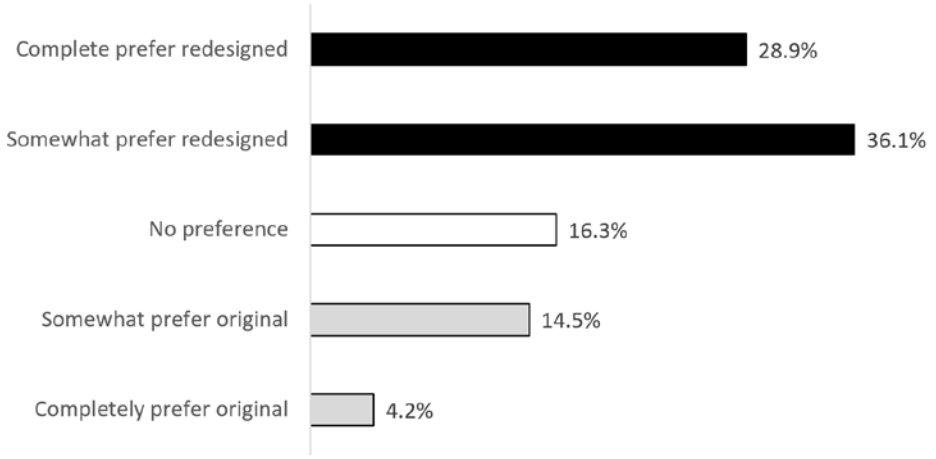


Figure 1: Student preference for the two assignment prompts

In open-ended comments, students noted that the formatting of the redesigned prompt helped them better comprehend the task. They claimed that the distinctions among different types of information helped them "mentally compartmentalize" (*Participant 31*) different aspects of the project, gave them a better idea of the task and where to start, and made for generally "less boring" (*Participants 48, 103*) reading than the original prompt. These findings all suggest that the formatting is responsible for students' preference of the redesigned prompt.

Students made inferences about instructor personality from the design

While Figure 1 shows that students preferred the redesigned prompt and found it easier to read, Table 1shows that these preferences translated into a more favorable impression of the instructor who created the prompt. Students were more likely to indicate that the instructor behind the redesigned prompt was knowledgeable, caring, enthusiastic, and experienced.

Table 1: Student impressions of instructors who wrote the prompts on a 4-point Likert scale (1=not at all; 4 = very much)

Survey questions	***Original***	***Redesigned***
How knowledgeable do you think this instructor is about academic writing?	3.58	3.70*
How experienced do you think this instructor is?	3.45	3.68**
How much do you think this instructor cares about her students?	3.16	3.39**
How enthusiastic do you think this instructor is about the course?	3.13	3.33**
How comfortable would you feel asking this instructor questions about this assignment?	3.17	3.27

* p < .05, ** p < .01

Several students elaborated on these perceptions in their comments, noting the additional effort and care the redesigned prompt required:

> [The instructor of the redesigned prompt] seems more likely to be able to answer questions and definitely more willing to, as she spent the time to try and clarify the assignment
>
> - *Participant 13*

> Her instructions are clearly and consistently formatted. This makes it seem like she really cares about her students: she seems to have put time and thought into the preparation of this assignment so that her students understand it and learn from it. It lends credibility to the instructor and makes her seem knowledgeable.
>
> - *Participant 119*

> It is more engaging and gives me a sense that [this instructor] is more willing to work for her students (Which I'm sure both would do but just given that sheet)
>
> - *Participant 55*

These comments indicate that at least some students perceived the document design as evidence that the instructor was willing to work for her students and was concerned about their understanding. They described her as "attentive" (*Participant 90),* "willing to work for her students" (*Participant 55*) and "kind"

(*Participant 103).* These students believed that the instructor of the redesigned prompt considered the assignment from her students' perspective, trying to imagine how students might use the document. Overall, these findings suggest that the redesigned document positively influenced students' attitudes towards their instructor.

Summary

The results section is the heart of most data reports. In this section, we go into detail about the stories our data tells, using both visualizations and traditional textual paragraphs to provide a complete picture of our data and what it means. The textual paragraphs and data visualizations both overlap (to ensure that readers of different levels of expertise do not miss the main message) and provide complementary information.

The textual paragraphs in the results section need to do the following

- **Introduce** the visualization and data stories
- **Support** these data stories by calling attention to noteworthy data points or providing the results of statistical tests
- **Supplement the stories** with additional information such as recommended guidelines; additional data, quotations or other evidence; or the results of prior research.
- **Provide reasons** to make sense of unexpected findings
- **Explain** what conclusions we can draw from the data

In general, we begin these paragraphs or sections with factual statements about the data that use confident verbs such as shows, demonstrates, or illustrates. We end by making inferences or interpretations of what the data mean that are more open to debate. Our verbs then shift to less confident verbs such as suggests, appears or might indicate.

In addition, as you work with multiple data stories you will need to weave them together. You can

- **Connect** your visualizations and your data stories through language such as "Figure X provides further support for…."
- **Use subheadings** to provide a skeleton view of your results section that helps readers see how the different parts fit together
- **Order** your results section so that you follow a logical organizational pattern such as general-to-specific or most-to-least interesting

Exercise 8.2

PART I:
Access the sample results excerpt, "Improving Instructor Ethos Through Document Design," and electronically annotate the sections (e.g., mark them up using computer

commenting tools) according to the following guidelines—or print out a copy and annotate it up by hand.

1. Annotate each sentence to note the type of information it contains
   - **Introducing** the visualization and data stories
   - **Supporting** data stories by noting specific data points or trends or reporting statistical tests
   - **Supplementing** the visualization with additional information
   - **Providing reasons** to explain trends unexpected results
   - **Drawing conclusions** from the data

2. Use two a solid underline to note high confidence verbs (e.g., shows, demonstrates, indicates) and *italics* or a squiggly underline to note lower confidence verbs (e.g., suggests, appears, might indicate).

PART II:

Answer the following questions

1. Do the authors organize their findings so they start off each section with more factual statements (using high confidence verbs) and end by drawing conclusions (using low confidence verbs)?

2. Are there any places where you think the authors might consider using a different verb—one with either higher or lower confidence than the one they chose?

3. What type of subheadings do the authors use to organize their results? Do you find these subheadings helpful? If you were to change these subheadings to topical subheadings describing the type of data in each section, what wording would you use? What would be gained or lost in switching from story-based to topical subheadings?

4. What specific language do the authors use to connect their main sections? In other words, what specific phrases do they use to show how their different visualizations and types of data connect to one another?

5. What is the overall entire organizational order of this excerpt? Does it move from general-to-specific; specific-to-general; most-to-least interesting; or some other order?