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CIMER Center for the Improvement of Mentored Experiences in Research

Entering Research: Research Mentee Training to Support Undergraduate and Graduate Trainees

The activities you have chosen for your customized curriculum are drawn from *Entering Research* (2nd edition; Branchaw, Butz, & Smith, 2019; Macmillan). The *Entering Research* materials were developed, reviewed, and tested by many partners across the country. Activity developers are acknowledged in the footer of each page. A full listing of partners and funders can be found at CIMERProject.org and in the *Entering Research* book.

Navigating Research and Mentoring

macmillan learning

THE POWER OF SOCIAL PERSUASION

Learning Objectives

Trainees will:

- Assess the influence that mentors have on confidence in abilities.
- Devise strategies to cope with and respond to feedback that negatively influences trainee confidence.

Self-efficacy refers to the confidence that you have in your ability to perform a given task. Individuals evaluate their self-efficacy based on their past accomplishments and experiences, the successes and failures of others, their emotional and physiological state, and the messages that they receive from others (i.e., social persuasions). In this activity, we are going to focus on the messages that you receive from your mentor. Feedback and criticism are an inevitable part of the mentoring relationship, especially when it comes to writing and presenting research. In this activity, consider the influence that feedback from mentors may have on your self-efficacy, and devise strategies to maintain confidence in the face of criticism.

Directions: You have written the first draft of a manuscript for which your mentor is a coauthor. You spent a lot of time working on the manuscript and are really pleased with the progress that you have made on this paper. You send the manuscript to your mentor for feedback. Imagine that you have received an email from your mentor with this feedback:

> *I have included some edits for grammar and clarity in the document. The manuscript needs substantial work before I see it again. You have cited a lot of prior research in the introduction and literature review, but it is disorganized and difficult to follow. The methods and results are okay, but the manuscript will not be ready to submit to the editor until the discussion is further developed. Once you have made these changes, let me know and I will take another look. I do not want to waste any more of my time reviewing this until the manuscript has been drastically improved.*

Questions for Discussion

- How do you feel right now? Write down some of the emotions and/or physical responses you are feeling.
- What are the assumptions that you find yourself making about the person giving you this feedback?
- How would this feedback influence your confidence in your ability to continue to prepare this manuscript for publication?
- How would it influence your confidence in your ability to write successful manuscripts in the future?
- How might you go about looking to other sources (i.e., individuals, messages, or experiences) that could increase your self-efficacy to revise this manuscript?

Contributed by A. R. Butz. (2015). *The Power of Social Persuasion.*

Consider the same feedback framed in a different way:

> *This is a good first draft of the manuscript. I have included some edits for grammar and clarity in the document. I can tell that you have put in a lot of time and effort into reviewing the literature. The methods and results are clearly articulated and are explained in a way that should be accessible to a broad audience, which should please the journal editor when we submit it. The discussion section needs some work, particularly where you are trying to make the case for how our study extends what is currently known. I think you could also spend a little more time in the introduction setting up the study and doing a little foreshadowing for the reader. I would like to review the manuscript again once you have addressed these comments, but I have every confidence that you can get this manuscript to where it needs to be.*

- How do you feel after receiving this feedback?
- What are the assumptions that you find yourself making about the person giving you this feedback?

Contributed by A. R. Butz. (2015). *The Power of Social Persuasion.*

MESSAGES SENT AND RECEIVED

Learning Objectives

Trainees will:

- Identify the intent behind statements and questions.
- Practice effective ways to communicate with their research mentor.

Instructions: Fill in the blank columns for two or three statements below.

Statement or Question	What is the likely intention of this statement?	How might the statement be heard?	How could you respond to this statement in a constructive manner?
"Be on time to our group meetings from now on."			
"How much longer do you think it will take you to finish that project?"			
"You will never get anywhere in this field if you don't dig in and stick with problems until you solve them."			
"If you think you are busy now, wait until you're a faculty member."			

Contributed by C. Pfund and A. R. Butz with information from Handelsman, J., Pfund, C., Miller Lauffer, S., and Pribbenow, C. M. 2005. *Entering Mentoring: A Seminar to Train a New Generation of Scientists.* Madison, WI: University of Wisconsin Press.

Statement or Question	What is the likely intention of this statement?	How might the statement be heard?	How could you respond to this statement in a constructive manner?
"Clean up your work area."			
"I haven't seen you around the lab much. Are you taking time off?"			
"I'm not sure you have your priorities in order."			
"What's it like to be a minority in this program, anyway?"			
"It seems you might be better suited for an 'alternative' career."			

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RESEARCH CAREERS: THE INFORMATIONAL INTERVIEW

Learning Objectives

Trainees will:

- Explore possible research careers and consider how the skills learned by doing research may be transferable to other types of careers.

The skills learned doing research are important when preparing for a research career, but also for many other types of careers. Below is a list of careers for which research training is important.

Select a career on the list (or one that is not on the list), identify an individual with this career, and do an informational interview via email or in person with that person.

Possible Careers

- Museum professional
- Consultant
- "Big data" analyst
- Entrepreneur
- Editor
- Science writer
- Patent lawyer
- Government scientist
- Science policy advisor
- Private industry scientist
- Research university professor
- Research university professional staff (researcher, instructor)
- Teaching university/college professor
- Outreach coordinator (private or academic)
- Clinical researcher (e.g., clinical chemist, hospital clinic manager)
- Academic or private administrator/leader
- Others _____

Use the email template on the next page to contact the interviewee. **Send the email at least 2 weeks before this assignment is due and email the name of the interviewee to your facilitator.** It may be useful to contact more than one individual to ensure that you receive a response.

Once a response is received, write a summary and **reflection essay** about what you learned using the question prompts on the next page.

Contributed by K. Spencer, J. Branchaw, and J. Gleason with information from Branchaw, J. L., Pfund, C., and Rediske, R. (2010) *Entering Research: A Facilitator's Manual.* New York: W.H. Freeman & Co.

INFORMATIONAL INTERVIEW EMAIL TEMPLATE

Dear Dr./Mr./Ms._____,

I am a student at _____ and am writing to request an email interview. We are studying different careers that research training can prepare us for, and I am interested in your career as a _____. If you are willing to answer the few questions listed below, I would really appreciate it. If you do not have the time, perhaps you could forward this to a colleague who might?

Sincerely, _____

Interview Questions

1. What do you do in your job?
2. What kind of education or training is needed for your career? Is research training needed? Why or why not?
3. What is a typical starting salary in your career?
4. How much time do you have for personal, noncareer interests?
5. What advice do you have for young people interested in pursuing your career?

Summary and Reflection Essay Prompt

After you receive a response to your interview questions, write a brief summary of the responses. Then reflect on and answer the following questions:

- Why did you explore your chosen career?
- What, if any, preconceived ideas about the career have changed based on what you learned?
- What specific research thinking and technical skills are required for the career you explored?
- Based on the informational interview, are you interested in pursuing this career? Why or why not?

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RESEARCH DOCUMENTATION PROCESS

Learning Objectives

Trainees will:

- Explain why it is important to accurately document research.
- Identify key elements in research documentation.
- Identify commonalities and differences in documentation associated with different research fields.
- Understand the ethical implications of documenting research.

Meet with your mentor to go over the protocol you must follow when documenting your research. Aspects of research that need to be documented may include a description of the methods followed, the raw data results, the analysis used, and the results of analyses. Discuss the level of detail expected in the documentation for your research group and ask your mentor to identify a research team member who keeps an exemplary notebook, or to show you another excellent example. The specifics of what and how to document research will vary depending on the nature of the research (e.g., field or lab based, computational, library).

Write an outline of the documentation protocol that you are to follow when doing research and identify the parts of the process that are common to your entire research group and the parts that are specific to your project. In addition, address the following questions:

- What kinds of notes are kept? Are they hard-copy documents or electronic files?
- Where are the notes kept?
- What parts of the research are documented? What level of detail is needed in documenting experiments?
- How are data to be recorded?

Contributed by J. Gleason with information from Branchaw, J. L., Pfund, C., and Rediske, R. (2010). *Entering Research: A Facilitator's Manual.* New York: W.H. Freeman & Co.

RESEARCH DOCUMENTATION PROCESS

Learning Objectives

Trainees will:

- Explain why it is important to accurately document research.
- Identify key elements in research documentation.
- Identify commonalities and differences in documentation associated with different research fields.
- Understand the ethical implications of documenting research.

Trainee Level:

undergraduate or graduate trainees novice trainees

Activity Components and Estimated Time for Completion

- Trainee Pre-Assignment Time: 1 hour
- In Session Time: 1 hour

Total time: 2 hours

When to Use This Activity

This activity should be used very early in the novice trainee's research career, preferably as soon as they start working with a research group to establish good research documentation practices. It can be implemented before or after a trainee selects a mentor.

Inclusion Considerations

Consider learning styles, differences, and disabilities when discussing best practices in research documentation. Ask whether trainees have concerns about traditional best practices to empower them to talk about any of these barriers or concerns with their mentor or another advisor.

Areas of Trainee Development

- Practical Research Skills
  - Develop ability to conduct a research project.
- Research Ethics
  - Develop responsible and ethical research practices.
- Research Comprehension and Communication Skills
  - Develop disciplinary knowledge.
  - Develop research communication skills.

Contributed by J. Gleason with information from Branchaw, J. L., Pfund, C., and Rediske, R. (2010). *Entering Research: A Facilitator's Manual.* New York: W.H. Freeman & Co.

Implementation Guide

Trainee Pre-Assignment (1 hour)

- Have trainees complete the "Research Documentation Process" assignment, which requires them to discuss with their mentor how research is documented in their group. Trainees should bring their outlines to the session.
- Before the discussion, you may also distribute *Guidelines for SCIENTIFIC RECORD KEEPING in the Intramural Research Program at the NIH*, which is available as a PDF and is a good resource on scientific notebook keeping. (https://oir.nih.gov/sites/default/files/uploads/sourcebook/documents/ethical_conduct/guidelines-scientific_recordkeeping.pdf)

Workshop Session (1 hour)

- Research activities are diverse; thus the documentation of those activities can vary, including both written and electronic forms. What is outlined below may include documentation of activities that none of the trainees in the cohort are doing. Other trainees may have documentation needs that are not addressed. However, **the underlying principle of documenting all work done so that it can be repeated should come through in the discussion.**
- If this activity is used with graduate students in a program that has rotations, include a discussion about watching for similarities and differences as they rotate among groups. Graduate students may also discuss comparisons to groups in which they worked as undergraduates.

- **Activity: What to document?**
  - Ask each trainee to name one thing that should be included in each research notebook entry. Generate a comprehensive list for the subsequent discussion. (5 minutes)

    This list might include:
    - Date
    - Hypothesis
    - Explanation of goals/rationale for the experiment
    - Detailed procedures identifying experimental and control treatments
    - Reagents
    - Key for labeling and identifying tubes, animals, etc.
    - Data, both successful and unsuccessful results
    - Analyses of data
    - Interpretation and thoughts about what to do next
    - Computer scripts for data mining and data analysis
    - Locations of transects and other field notes
    - References to locations of specimens and electronic data
    - Citations for methods, reagents, analyses, etc.
  - Using the list of items generated above, discuss the commonalities and differences across trainees' research groups. (20 minutes)

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- **Discussion Questions**
  - Why is it important to keep a research notebook?

    - to be able to repeat the experiment
    - to be able to write up the results for publication
    - to document for patents
    - to defend against accusations of fraud

  - What format is required?

    - Does the lab use paper copies or electronic copies?
    - If paper copies, what happens to any photo, video, or other computer output?
    - If electronic copies, how is the electronic copy maintained? How are the data backed up?

  - Who owns the data? Where is the notebook to be kept?

    - All data belongs to the research group and university or company.

  - How will the notebook be used in the future? How does planning for the future influence how notes are kept?

    - The notebook needs to be detailed for you or other lab members to do follow-up experiments.
    - Discuss obligations for sharing data post publication (both the scientific ethics of sharing and publication requirements).

  - What elements of research need to be documented? This could lead to a discussion of:

    - procedures, including descriptions of experiments, observations, and computer scripts
    - raw data
    - data analysis, including the procedures used to analyze the data
    - processed data

  - Are there elements that are used in other research groups that you may find helpful to your own research?
  - How do your group's research documentation protocols reflect the culture in your research group? How do they reflect the communication style in your research group?

► **Wrap-up** (5 minutes)

- Summarize key points of the discussion with trainees. Encourage trainees to clarify with their mentor any parts of the documentation process that are unclear to them.

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ACTIVITY 4. EXPLAIN/ELABORATE—"Mentor Interview About Making Research Posters"
Tool from *Entering Research (2019) contributed by K. Eskine (2018)*

- Research poster-making is a common growth area for undergraduates and new grad students.
- Do you think the following tool would help you foster a growth mindset and align expectations with one of your mentees?

MENTOR INTERVIEW ABOUT MAKING RESEARCH POSTERS

Learning Objectives

Trainees will:

- ► Learn how to create a research poster.
- ► Learn disciplinary norms for graph or image construction.
- ► Set deadline(s) for poster completion.

Before you begin creating your research poster, interview your mentor to learn about the policy and formatting standards that you should use as a member of the research group.

1. How independent would you like me to be in making this poster (do you want to see the intro, then the methods, etc., or are you happy to see a completed poster for edits)?
2. Is there a template our research group uses that I should use? Is there an example that I can refer to?
3. What software program does the research group use to make posters? Are there particular parameters that I need to set, like height and width?
4. What software program does the research group use to make graphs? Do you have any tips or are there any formatting conventions that I should use to make the graphs?
5. What software program does the research group use to manipulate images? Do you have any tips or are there any formatting conventions that I should use to create images?
6. I will present the poster on [insert date]. By what date would you like to see the poster so that you have enough time to review it and provide feedback for revision?
7. What research funding sources should I cite on the poster? Are there any specific funding agencies or grant numbers that I should include?

Notes:

Deadlines:

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ARTICLE ORGANIZATION, COMPREHENSION, AND RECALL

Learning Objectives

Trainees will:

- Learn about electronic tools for organizing papers, citing papers, and taking notes on papers.
- Learn to use a framing funnel as a strategy to actively read papers.
- Learn to use guided questions to understand and evaluate scholarly papers.

Trainee Level

undergraduate or graduate trainees
intermediate or advanced trainees

Activity Components and Estimated Time for Completion

- Trainee Pre-Assignment Time: 20 minutes
- In Session Time: 1 hour

Total time: 1 hour, 20 minutes

When to Use This Activity

This activity is recommended for intermediate and advanced trainees who have foundational research experience. It can be implemented on its own or paired with:

- Research Writing 4: Research Literature Review and Publishing Process

Inclusion Considerations

Learning and reading styles will vary among trainees. Invite them to share with you any learning accommodations they need or preferences they have and be flexible when setting reading and writing assignment deadlines. Encourage them to share with the group alternative ideas about how to approach reading scientific papers, organizing information, and constructing reviews.

Areas of Trainee Development

- Research Comprehension and Communication Skills
  - Develop disciplinary knowledge.
- Professional and Career Development Skills
  - Explore and pursue a research career.

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Implementation Guide

Trainee Pre-Assignment (20 minutes)

► Ask trainees to complete the "Tools for Handling Your Papers" worksheet by interviewing their primary mentor, at least one member of their research team, or a senior member of their research team. The worksheet may be distributed in the previous session or electronically.

Workshop Session (1 hour)

► **Introduction** (2–3 minutes)
- The goal of this activity is for trainees to learn how to organize, cite, and take notes on papers. Using the framing funnel and guided questions, trainees will learn to better evaluate and understand scientific papers.

► **Large-Group Discussion** (10 minutes)
- Use the following questions to lead the discussion in the large group.
  - What are the tools and combinations of tools that people use to organize their papers?
  - What tools are people using that did not appear on the worksheet?
  - Why do people like the specific tools that they are using?
  - What limitations do these tools have? Benefits?
  - Which tools are the most attractive to you and why?

► **Activity 1: *The Framing Funnel*** (20 minutes)
- In the large group, ask trainees the following questions about reading papers. Either assign a paper for this activity or instruct students to read and bring a paper from their research group. Alternatively, the facilitator can provide an article where all elements of the *Framing Funnel* are apparent and ask the students to read it before class. Record responses and/or strategies on a whiteboard or chart.
  - What are the easiest and most challenging parts of reading research articles?
  - How might you use the sections of a research article to break down complex ideas and results?
  - How might reading a textbook help you understand a research article?
  - Can you link ideas and concepts learned in courses to research articles?
- Distribute the *Framing Funnel* document. Explain that the framing funnel is a tool that can be used by readers to outline research articles. It represents the language that scientists use to think about and present their research and what they expect from other scientists. Every research paper has an underlying framing funnel. Using the framing funnel to map scientific articles can increase understanding and retention of the information that is presented and develop logical thinking skills.
- Review each element of the framing funnel with the group.

► **Activity 2: Critical Evaluation of Papers** (20 minutes)
- Brainstorm: Ask trainees to describe the function of each part of a research paper. For example:
  - What should the *Title* of a research article do?
  - What information should be in the *Abstract*?
  - In the *Introduction*?
  - In the *Methods*?
  - In the *Results*?
  - In the *Discussion*?

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- Distribute the *Paper Parts and Evaluation* document and compare the trainees' ideas to the descriptions on the handout.
- Ask the group how confident they feel critically evaluating a paper. Individually, have them take a few minutes to look over the questions behind the descriptions of paper sections in the *Critical Evaluation of Papers* handout provided in the trainee materials. Ask them to consider which questions they think they can answer, and which would require them to read the paper more closely. For example:
  - Do the authors' methods critically or directly test their hypothesis?
  - Did the authors use a creative method to evaluate their hypothesis?
  - Do you agree with the authors' interpretation of the data or are there other interpretations?

Optional Assignment: Facilitators may assign trainees to use the *Critical Evaluation of Papers* activity to identify and review a scientific paper that is relevant to their research project. These review assignments can be assessed by peers or the facilitator using the following rubric.

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CRITICAL EVALUATION OF PAPERS

Assessment Rubric

	0 Absent	1 Does not meet expectations	2 Meets expectations	3 Exceeds expectations
Title, Abstract, Introduction				
Articulated the title and purpose of the article.				
Provided a brief overview of the article, including hypotheses and key results.				
Methods				
Determined whether the proposed methods critically test their hypotheses.				
Identified limitations of the method.				
Examined creativity of the author's methodology.				
Examined methodological process.				
Identified methodological innovation.				
Results				
Determined whether data supports argument.				
Interpreted the data.				
Formulated own opinion based on the data.				
Examined format in which data was presented in the paper.				
Evaluated all figures and supporting documents.				
Discussion				
Determined whether the conclusion is supported by the data.				
Identified alternative interpretations of the data.				
Identified novel insights gained from the results.				
Determined if the results may be applied more generally.				
Identified author's future directions.				

Notes:

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ARTICLE ORGANIZATION, COMPREHENSION, AND RECALL

Learning Objectives

Trainees will:

- Learn about electronic tools for organizing papers, citing papers, and taking notes on papers.
- Learn to use a framing funnel as a strategy to actively read papers.
- Learn to use guided questions to understand and evaluate scholarly papers.

Pre-Assignment: Tools for Handling Your Papers

Generate a list of electronic (and other) tools for organizing your papers, citing papers, and taking notes on your papers by interviewing your current mentor or a senior person on your research team to ask what tools and methods they use to organize, cite, and take notes on the papers. If you interview multiple people, you may find that everyone has their own system!

Based on your interview, circle the tools used below. If your interviewee suggests new tools, record them. Also ask why your interviewee likes or dislikes the tools they use.

Finding papers:

- Google Scholar
- PubMed
- Bing
- Papers (Mekentosj)
- Readcube

Organizing and note-taking for PDFs:

- Adobe Acrobat
- Papers (Mekentosj)
- OneNote
- Word
- Google Docs
- Notes Plus
- Good Note
- Evernote
- Readcube

Citing papers:

- EndNote
- Papers (Mekentosj)
- Mendeley
- Readcube

Tools at journal websites for digging deeper:

- Social media (Facebook, Twitter)
- eAlerts
- Journal-specific Apps
- Video Portals
- Podcasts
- Webinars
- Blogs
- Twitter

Mindful note-taking (plagiarism scanning software):

- TurnItIn
- iThenticate
- Doc Cop
- Grammarly

Contributed by A. Sokac with information from Branchaw, J. L., Pfund, C., and Rediske, R. (2010). *Entering Research: A Facilitator's Manual.* New York: W.H. Freeman & Co.

Consider these questions about the pre-meeting activity:

- Who did you interview to complete this worksheet?
- What are the tools and combinations of tools that people use to handle their papers?
- What tools are people using that did not appear on the worksheet?
- Why do people like the specific tools that they are using?
- What limitations do these tools have? Benefits?

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ARTICLE ORGANIZATION, COMPREHENSION, AND RECALL

Activity 1: The Framing Funnel

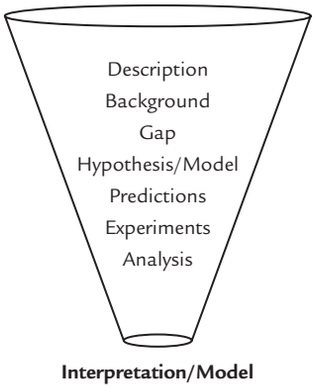
Use these questions to explore strategies to improve your understanding and retention of the research presented in scholarly articles:

- What are the easiest and most challenging parts of reading research articles?
- How might you use the sections of a research article to break down complex ideas and results?
- How might reading a textbook help you understand a research article?
- Can you link ideas and concepts learned in courses to research articles?

The framing funnel is a tool that can be used by readers to outline research articles. It represents the language that researchers use to think and present their research and what they expect from other researchers. Every research paper has an underlying framing funnel. Using the framing funnel to map research articles can increase understanding and retention of the information that is presented and develop logical thinking skills.

Select a research article to read and use the framing funnel below to outline the content.

The framing funnel



Description: In very few words, what is this paper about? What is the synopsis?

Background: What is already known?

Gap: What knowledge is still missing? What are the open questions?

Hypothesis*/Model/Research Question: What is the working hypothesis, model, or research question that these authors are testing or investigating? What is the rationale for doing this specific set of experiments or collecting the data?

Predictions: If the authors' hypothesis/model is correct, what results are expected? What if the hypothesis/model is incorrect?

Experiments/Data Collection: What are the experiments or data collection methods? What is the flow of the experiments or the collection of data? What are the strengths and weaknesses of the methods used? Are there alternative methods? What are the results?

**A hypothesis is a possible explanation that is proposed on the basis of a small amount of preliminary data. A hypothesis serves to launch and focus future research.*

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Data Analysis: How are the data analyzed? Are the analysis techniques appropriate to address the hypothesis or research questions?

Interpretation/Model: Based on the results, what new things were learned? What do the results mean? Was the initial hypothesis/model correct or incorrect? How does the hypothesis/model need to be revised? *What are the next directions? What new **gap** opened up?*

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ARTICLE ORGANIZATION, COMPREHENSION, AND RECALL

Activity 2: Critical Evaluation of Papers

The goal of this activity is to provide a set of questions and criterion that will help you critically evaluate research papers that you read. Research articles are typically organized in sections as outlined below. Knowing what types of information are present in each section allows you to more efficiently and effectively find information.

In your own words, describe each part of a research paper.

- What should the *Title* of a research article do?
- What information should be in the *Abstract*?
- In the *Introduction*?
- In the *Methods*?
- In the *Results*?
- In the *Discussion*?

How confident do you feel in critically evaluating a paper?

Take a few minutes to look over the questions following the descriptions of paper sections below. Among these, identify good questions to ask when you are critically evaluating a paper. For example:

- Do the authors' methods critically or directly test their hypothesis?
- Did the authors use a creative method to evaluate their hypothesis?
- Do you agree with the authors' interpretation of the data or are there other interpretations?

Title

Paper titles are usually brief, stand-alone overviews of a paper's contents. Authors make an effort to include keywords that abstracting services could use in indexing the article. Therefore, if you are new to a field and/or subject, it is useful to take note of the words used in the title as they may provide you with useful keywords to use in future literature searches.

Abstract

The purpose of the abstract is to provide the reader with a brief summary of the article. Thus, the abstract should provide information about the specific research problem being investigated, the methods used, the results obtained, and what the results of the study mean in the larger context of the research study and in some cases the field of study. This means that the abstract is a good place to look first if you are trying to decide whether or not the paper is relevant to your work.

Introduction

The introduction section provides a general overview of the research question being studied—why it is a worthy question, what work has already been done by others to address it, and what the authors may have already done in this area. Introductions are a good place to go if you are new to the subject.

- What is the main question they are interested in pursuing?
- What background research, pattern, theoretical prediction, or theoretical framework motivates this question?
- Why is this question interesting in light of the background they discuss?
- Do they offer one hypothesis or more than one?
- What assumptions are made when proposing the hypotheses?

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Methods

The methods section will provide detailed information about experiments performed or data that was collected. Such information typically includes sources for all materials used, names of all data collection instruments, detailed descriptions of experimental or data gathering techniques, and detailed descriptions of data analysis techniques, including computer programs used.

- Do the proposed methods test the hypotheses or address the research question?
- Are any of the methods confounded?
- Did the authors use a creative method to evaluate their hypothesis or interpret their data?
- Are the methods simple and elegant or complicated and convoluted?
- Was a new technique or research approach presented that will better evaluate a problem that others have struggled with?

Results

Some articles will distinguish between "Results" and "Discussion" while others will combine this information into one section "Results and Discussion." In papers that contain two distinct sections ("Results" and "Discussion"), the data obtained from the study are introduced in the "Results" section and their interpretation is delayed until the "Discussion" section. In papers that contain one section ("Results and Discussion"), results are introduced and interpreted experiment-by-experiment.

- What does the data say about the hypotheses or research questions?
- Is there only one interpretation of the data?
- Are there any big surprises/unexpected results?

Discussion

In papers that contain a distinct "Discussion" section, the interpretations of the results are included here. The "Discussion" should also place the results in the context of the existing literature in the field of interest. Authors may also address limitations to the study or suggest future directions in this section.

Keep the following in mind:

- Does the author say that they support or reject the hypothesis?
- Do you agree with the author's interpretation of the data?
- What novel insights are gained from the results?
- What do the results imply more generally for the field of interest? For other fields?
- What will the authors do next?

Sophisticated Understanding

With experience, reading the literature in a given field will come more easily. This includes the ability to better evaluate what is being presented, and the ability to ask more sophisticated questions.

- Be critical when reading papers but also pay attention to exciting findings, novel insights, and creative ideas. It's easy to criticize, but hard to praise!
- What critical experiment would you do to evaluate the proposed hypothesis?
- What data would you collect to address the research questions?

Contributed by A. Sokac with information from Branchaw, J. L., Pfund, C., and Rediske, R. (2010). *Entering Research: A Facilitator's Manual.* New York: W.H. Freeman & Co.

- Form an opinion after looking at the data, before reading the author's interpretation and conclusions.
- Do you agree with the author's interpretation or are there others?
- If more than one hypothesis is offered, does each hypothesis propose a distinctly alternative explanation that is incompatible with the others, or could some of the hypotheses operate simultaneously?
- Are there compelling alternatives given the data?
- What assumptions are made about the effectiveness of the experiments or the accuracy of the data?

Consider these questions:

- Is a research paper comprised of "facts" or "arguments"?
- What is the difference between a result and an interpretation?

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