GETTING STARTED ON THE MASTER'S THESIS (STEM FOCUS)

Asynchronous Workshop
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Overview of Workshop

1. Thesis types/common structures
2. Defining your research question
3. Managing a large writing project
4. Optimizing *your* writing process
5. Writing the introduction
6. Organizing the literature review
7. Writing the abstract
8. Further writing support

PART 1

Thesis types/common structures

Thesis types/common structures

Paltridge's Four Thesis Types

- Traditional Simple
- Traditional Complex
- Topic Based
- Compilation Based

Adapted from Brian Paltridge's *Thesis and dissertation writing: An examination of published advice and actual practice* (pp. 135, 138-141)

Traditional Simple

1. Introduction
2. Literature Review
3. Method
4. Results
5. Discussion
6. Conclusions

Adapted from Brian Paltridge's *Thesis and dissertation writing: An examination of published advice and actual practice* (pp. 138-141)

Topic Based

1. Introduction
2. Topic 1
3. Topic 2
4. Topic 3
5. Conclusions

Adapted from Brian Paltridge's *Thesis and dissertation writing: An examination of published advice and actual practice* (pp. 138-141)

Traditional Complex

1. Introduction
2. Literature Review
3. (Background Theory)
4. (General Method)
5. Study 1
    - Intro, Method, Results, Discussion
6. Study 2
7. Study 3
8. Discussion
9. Conclusions

Adapted from Brian Paltridge's *Thesis and dissertation writing: An examination of published advice and actual practice* (pp. 138-141)

Compilation Based

1. Introduction
2. (Background to the Study)
3. Research Article 1
   - Intro, Method, Results, Discussion, Conclusions
4. Research Article 2
   - Intro, Method, Results, Discussion, Conclusions
5. Research Article 3
   - Intro, Method, Results, Discussion, Conclusions
6. Conclusions

Adapted from Brian Paltridge's *Thesis and dissertation writing: An examination of published advice and actual practice* (pp. 138-141)

Which structure is right for your thesis?

- **Find a good model:**
  - Review examples of prior master's theses from your lab/advisor/department/field
  - If no thesis is available, find a published empirical article that follows an appropriate format
  - Analyze the structure
    - What sections do they have?
    - In what order do they appear?

- **Work on your outline:**
  - Create a preliminary outline of the sections (and sub-sections) you might include. Then, review it with your advisor.

PART 2

Defining your research question

Developing a Research Question

- Choose a general topic that you're interested in
  - E.g. The human microbiome
- Do some preliminary research on your general topic
  - What is known already?
  - What are open questions?
- Start asking questions
  - Which open questions are most interesting to you?
  - Which questions are relevant to your available resources and expertise?
- Evaluate your research question
  - How good is the question you're asking? (More on that in a moment)
- Begin your research
  - Design experiments to provide evidence that helps answer your research question

Research Question Exercise

- Defining your research question(s)
  - What do you hope to find/learn with your research that isn't already known?
  - What question do you hope your research will answer?

- Take a few minutes to jot down what you think your research question(s) is/are. Be as specific as possible.

- We'll come back to this later…

A Good Research Question Is... (1/4)

- **Clear**
  - provides enough specifics that one's audience can easily understand its purpose without needing additional explanation.
- **Focused**
  - is narrow enough that it can be answered thoroughly in the space the writing task allows
- **Complex**
  - is not answerable with a simple "yes" or "no," but rather requires synthesis and analysis of ideas and sources prior to composition of an answer

  - Research questions help writers focus their research by providing a path through the research and writing process. The specificity of a well-developed research question helps writers avoid the "all-about" paper and work toward supporting a specific, arguable thesis.

A Good Research Question Is... (2/4)

- **Clear**
  - provides enough specifics that one's audience can easily understand its purpose without needing additional explanation.

- Unclear: Does being mindful improve deficits in children?

- Clear: Does mindfulness training improve attention regulation in children with attention deficit disorder?

A Good Research Question Is... (3/4)

- **Focused**
  - is narrow enough that it can be answered thoroughly in the space the writing task allows

- Unfocused: What is the effect on the environment from global warming?

- Focused: What is the most significant effect of glacial melting on the lives of penguins in Antarctica?

A Good Research Question Is... (4/4)

- Complex
  - is not answerable with a simple “yes” or “no,” but rather requires synthesis and analysis of ideas and sources prior to composition of an answer

- **Too simple:** How are doctors addressing diabetes in the U.S.?

- **Appropriately Complex:** What main environmental, behavioral, and genetic factors predict whether Americans will develop diabetes, and how can these commonalities be used to aid the medical community in prevention of the disease?

Return to Your Research Question

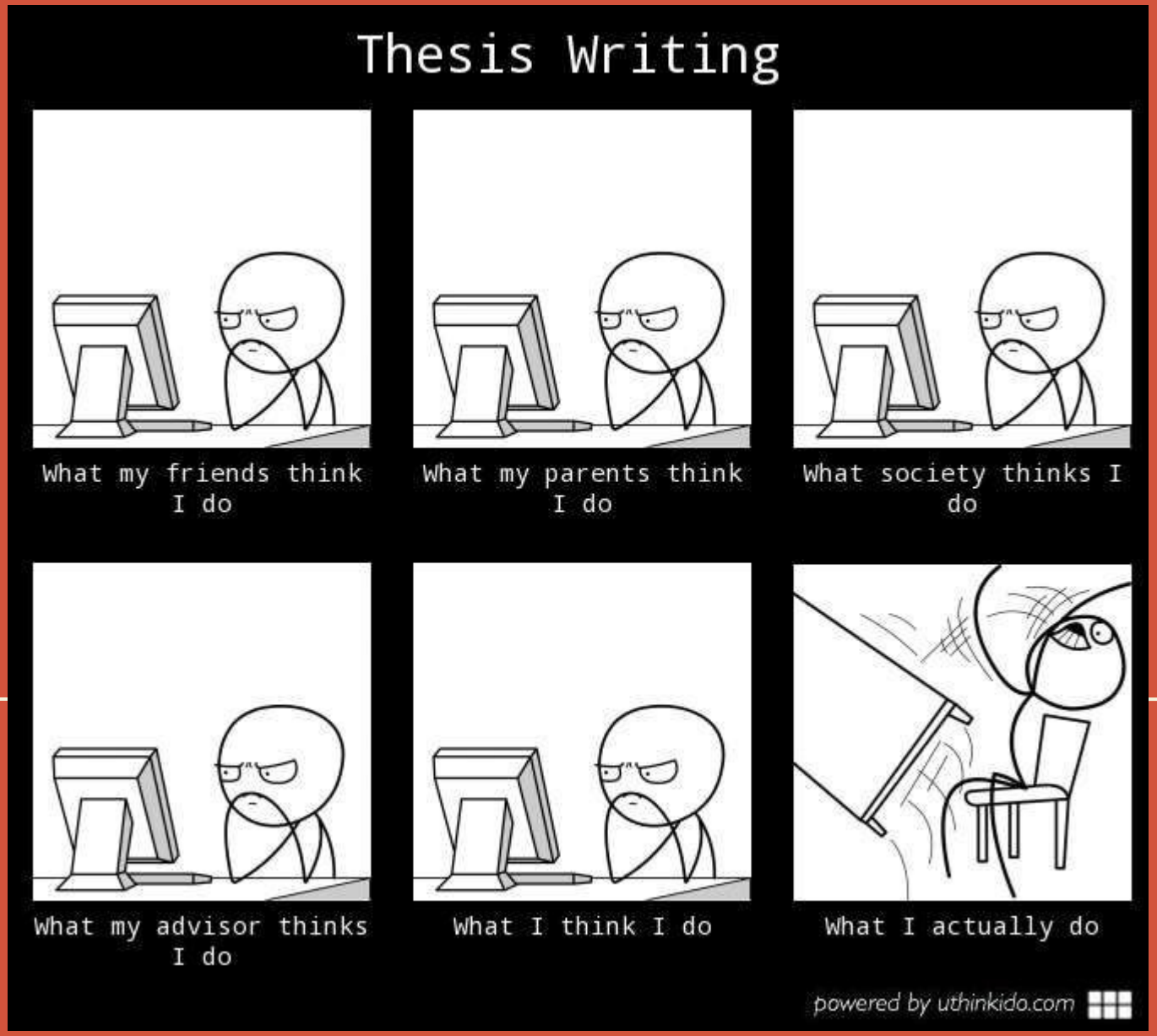
- Take a look at your research question

- Is it…
  - Clear
  - Focused
  - Complex

- Take a couple of minutes to refine your research question further

PART 3

Managing a large writing project


Thesis Writing
What my friends think I do
What my parents think I do
What society thinks I do
What my advisor thinks I do
What I think I do
What I actually do
powered by uthinkido.com

Writing as a *process*, not a *product* *(1/4)*

WRITING =

- Prewriting
- Drafting/"literal" writing
- Revising
- Editing
- Proofreading/formatting

DRAFTS:

- Zero Draft
- First Draft
- Second Draft
- Third Draft
- Fourth Draft

Adapted from Karen Gocsik's *The Process Approach to Teaching Writing* & Joan Bolker's *Writing Your Dissertation in Fifteen Minutes a Day*

Writing as a *process*, not a *product* *(2/4)*

Prewriting Techniques

- Brainstorming Freewriting/freetalking
- Outlining
- Clustering
- Note cards or research journal

The Zero Draft

= initial mess/incomplete/fragmented writing

- **Focus on:** generating ideas, locating and defining terms, identifying and explaining theories and frameworks, and connecting ideas and sources

- **Goal:** the ideas are on paper (or in the computer) in some form. Theories have been laid out (at least preliminarily). Evidence has been located and analyzed to some degree

- **Exercises:** Free-writes, thought-pieces, diagrams, brainstorming, source analyses, formal analyses, concept-mapping…

Writing as a *process*, not a *product* (3/4)

- Tips for Writing the First Draft
  - Start earlier than you think you should
  - Make an outline—at least headings & subheadings You can write parts out of order
  - Writing quickly
  - Fight the urge to “edit at the sentence level”

The First Draft

= cleaned up version of zero draft, with a discernible structure and an argument

- **Focus on:** getting all of the relevant ideas onto paper in some form, incorporating evidence or other relevant materials, fleshing out your argument and making it explicit

- **Goal:** all of the ideas and sources are on paper (or in the computer) and there is an argument that guides the work

- **Exercises:** set achievable goals (# of pages, # of hours to write, ideas/sections written), write explanations of the exercises completed in zero draft, work on linking sections/ideas together

Writing as a *process*, not a *product* *(4/4)*

- Revising
  - Analyze structure and reorganize material (revise macro to micro)
  - Work on sections, paragraphs Work on transitions
  - Strengthen argument/research narrative
  - (and development of argument/research question)
  - Focus Introduction and Conclusion
  - **See: "Backwards outlining" handout (p. 5)**

The Second Draft

= presents ideas in a logical fashion, demonstrates that you provided sufficient detail to support your ideas – organization/structure is solid

- May still not be very smooth – not necessarily polished at the sentence level
- **Focus on:** creating a coherent argument, organizing ideas in a logical fashion, creating appropriate transitions, making sure concepts flow, ensuring there's sufficient evidence
- **Goal:** draft should be structurally sound & paragraphs should connect
- **Exercises:** backward outlines, transition analysis, topic sentence analysis

Writing as a *process*, not a *product*

Editing

- Work within paragraphs
- Check for sentence-level clarity
- Sentence-to-sentence flow Word choice
- Grammar and spelling

The Third Draft

= when you clean up your language and make your writing readable

- **Focus on:** making every sentence coherent and readable, varying word choice, making each sentence connect to the next
- **Goal:** A draft that is both structurally sound and readable
- **Exercises**: read “backwards” (i.e. end of paper to beginning); review style guide; have a friend proofread

The Fourth Draft

- This draft is ready for your advisor, reviewers, committee members, etc. to read

- **Focus on:** catching spelling mistakes, subject-verb agreement, word choice, and other small details. Make sure you conform to your style guide

- **Goal:** A draft that can be handed to your advisor

- **Exercises**: read “backwards” (i.e. end of paper to beginning); review style guide; have a friend proofread

BUT… a caveat

- The writing process is *recursive* – i.e. it's not linear

- Ex. 1 - ideas you come up with during writing and revision may send you back to your data

- Ex. 2 – feedback may lead you to new sources, which leads you to reframe some of your arguments

- Etc.

Planning Your Writing Process (1/2)

- The IMRAD Structure is generally…
    - Title and Abstract
    - Intro/Literature Review
    - Methods
    - Results
    - Discussion Conclusion

Planning Your Writing Process (2/2)

- But you might want to *write* in this order
    - Methods
    - Results
    - Discussion
    - Conclusion
    - Intro/Literature Review
    - Title and Abstract

Writing Process – Example (1/2)

- IMRAD format: intro, methods, results, discussion
- General ideas:
  - Planning stages turn into components of the introduction and some parts of discussion
- Research stages turn into components of methods, results, and figures

Writing Process – Example (2/2)

Research	Planning	Writing	Revision
Experimentation and data collection	Literature preview	Methods section	Source grant proposals, other pubs from your lab for specifics
Data analysis	Identification of missing pieces in a scientific story (holes in the literature)	Results section with figures	Writing figure captions can help in improving text revisions
Summarize and organize your experimental notes	Compile an annotated bibliography with main findings and methods from all relevant papers	Introduction section	Overall summary; questions to be answered; outline of present set of experiments.; describe literature based on rationale for study
Create opportunities to organize your data for presentation (talks, posters, lab meetings), this will help in preparing for writing IMRD style papers/chapters	What is the most logical progression of experiments?	Proofread and revise: I, M, and R sections	
Stay close to your data	Develop testable hypotheses	Discussion section Proofread and revise all sections	
	What are some potential pitfalls in experimental design or with expected results	Abstract	

PART 4

Optimizing *your* writing process

Optimizing Your Writing Process

- Complete “Optimizing your writing process” handout (p.6) – 5 min. Consider…
  - What is your writing practice like now?
  - How can you improve it?

Time Management (1/2)

- Protect your writing time!
- Find out when (and where) you work best
- Investigate apps and other tools to increase productivity (e.g., Tomighty, Trello, etc.) – but don't spend too much time on this!
- Divide the project into manageable pieces
- Experiment with all kinds of writing, including freewriting and outlines – messy is good!
- *Write regularly* – even 15 minutes a day of writing will keep you actively thinking about and working on your research
- Don't get bogged down in the literature

Time Management (2/2)

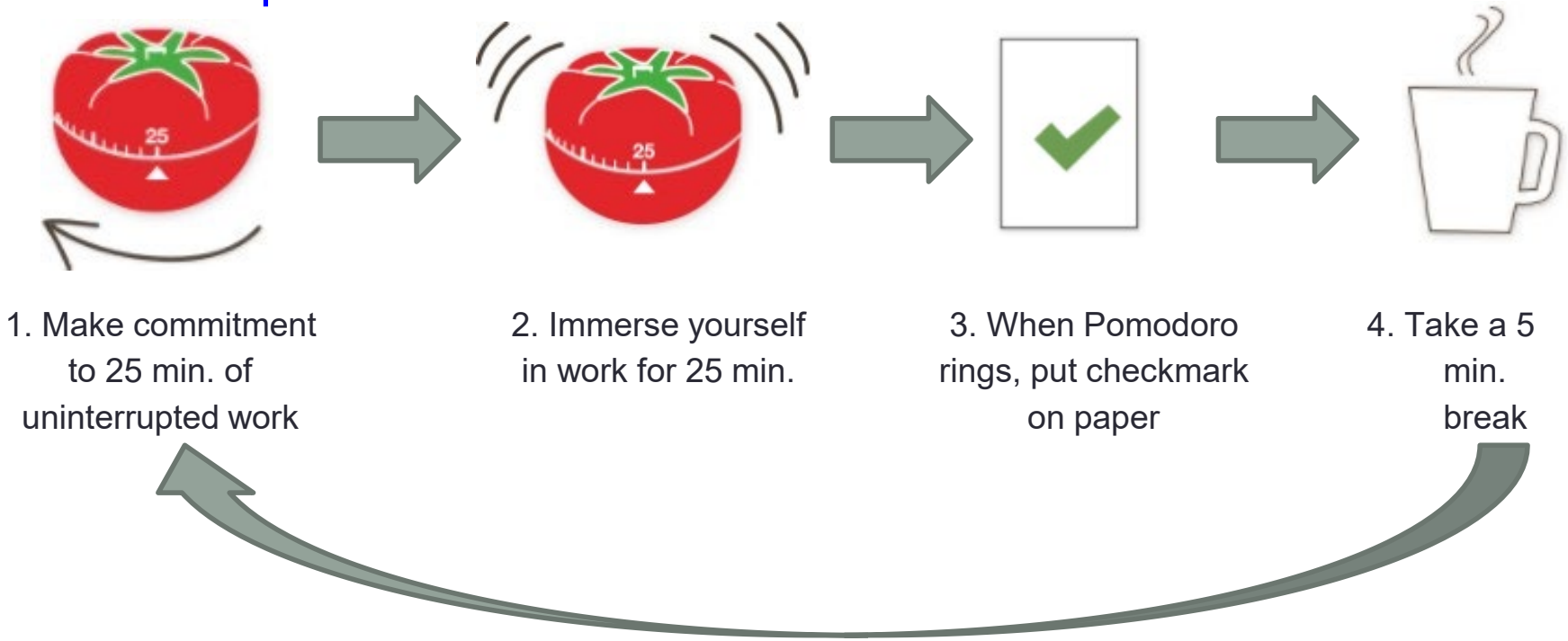
- Create a method for tracking your writing:
  - before each session, write down your writing goals
  - at the end, make notes on what you've accomplished and where you need to start tomorrow
  - refine your goal-setting

- Track your time spent on all tasks throughout the day
  - Where is your time going?
  - Does your time match with your priorities? If not, how can you restructure your time?

Internet time management

Pomodoro Technique

https://francescocirillo.com/pages/pomodoro-technique



Every four Pomodoros, take a longer break

Other Useful Apps/Programs*

- Google docs/Dropbox (saves revision history)
- To-do list makers (e.g. Todoist)
- Project management tools (e.g. Asana, Evernote, Trello)
- Time trackers (e.g. Toggl)
- For some, it can pay off (and save time) to put in the time upfront to learn a new tool.
- Others may prefer to stay “old school” and keep track of their progress in a simple notebook
- There are no rules
- *Caveat: Find what works for you,

Setting deadlines

- ***External* deadline** = tied to something out in the real world (e.g. grant proposal, conference abstract, or invited submission)

- ***Internal* deadline** = a deadline you establish for yourself with someone who can help hold you accountable (e.g. advisor, lab, fellow researcher, or writing group)

4 Approaches to Goal-Setting

- write for a defined amount of time (realistic, sustainable)
- write a certain number of words or pages (realistic, like 1 or 2 pages a day)
- write through a particular section, such as part of an outline
- write through a particular idea/concept/analysis (discovery writing/thought pieces)

Weekly Writing Goal Example

Date	Scheduled time blocks of writing	Actual time blocks of writing	Segment to work on	Goal	Log	Location	Daily Reward
Monday	All day	8:10 am; 2:30-3:00pm	Introduction	Evaluate advisor's revisions and merge into intro chapter file; revise as needed	Revised introduction and started figure 1 for chapter 5	Student office	Coffee
Tuesday	All day	11am-1pm	Chapter 5	Organize table and graph, start figure 1	Finished table, graph, and figure 1, wrote figure legend	Student office	Netflix
Wednesday	1-4om	12:30-2:30pm	Chapter 5	Figures 2-4, figure legends	Finished figures and legends; started intro	Student office	Out for dinner
Thursday	3-6pm	11-1pm, 3-5pm	Chapters 3, 5-7	Finish revisions, work on figure 5, check in with collaborator	Sent email, reviewed results and methods, finished revisions	Student office	Flowers from farmer's market
Friday	12:30pm-3:30pm	9-10am, 11-3pm	General work, intro, chapters 3 and 5	Back up files, have figures finished, send to advisor for 2nd round of comments	Updated flash drive and google, sent work to advisor	Student office	Ice cream
Saturday	10-12pm		Chapter 5	Intro and start results	Finished weekly goals by Friday	Drinks	
Sunday	Day off – final exam proctoring						
Weekly reward	Movies						

Goal setting and making your process work for you

Date	Time block(s) to write	Segment to work on & Goal	Daily Reward
Mon			
Tues			
Wed			
Thurs			
Fri			
Sat			
Sun			

Don't forget to plan a day off (and weekly reward activity)!

Block times to write in your calendar like a meeting or appointment

Reward yourself!

“Parking on the downhill slope”

- At end of your writing session. Help out your “future self” by noting:
    - What you did (so you don’t have to remember later)
    - What you need to do next

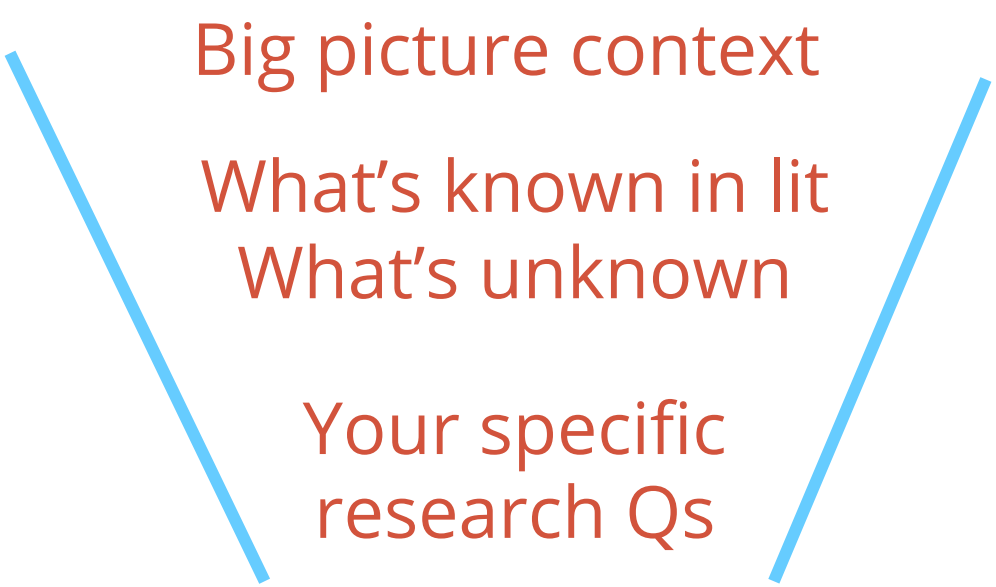
Wikimedia Commons

PART 5

Writing the Introduction

Introduction

Start broad, then narrow down



Language that Introduces Research

- Move 1: *Establishing a Research Territory*
  - Show that the general research area is important, central, interesting, problematic, or relevant in some way
  - Introduce and review items of previous research in the area
- Move 2: *Creating a Niche*
  - Indicate a gap in the previous research, or extend previous knowledge in some way
- Move 3*: Occupying the Niche*
  - Outline purposes or state the nature of the proposed research
  - List research questions or hypotheses
  - State the value of the proposed research (significance)

Adapted from John Swales' "Creating a Research Space" (CARS) approach to introductions

Move 1 Language: Establishing Research Territory

- **Indicating Centrality, Importance**
  - Recently, there has been growing interest in . . . .
  - The study of . . . has become an important aspect of…
  - …Many recent studies have addressed . . . .
- **Summarizing Previous Research**
  - Previous studies have suggested that . . . .
  - Various investigations have explored the relationship between . . . and . . . .
  - These findings were further supported by later studies that showed . . . .

Examples taken or adapted from John Swales' *Aspects of Article Introductions*

Move 2 Language: Establishing the Research Gaps

- **Negative openings/ Quasi-negative subject**
  - However:
    - Little information
    - Little attention
    - Little date
    - Little research
  - However:
    - Few studies
    - Few investigations
    - Few researchers
  - No studies/None of the prior studies have…

  - But be careful with negative statements

Examples taken or adapted from Swales and Feak's *Academic Writing for Graduate Students*

Move 2: Establishing the Research Gaps

- **Contrastive statements**
  - The research has tended to focus on . . ., rather than on . . .

    These studies have emphasized . . ., as opposed to . . .
  - Although considerable researcher has been devoted to . . ., rather less attention has been paid to . . .
- **Raise a question, hypothesis, or need**
  - However, it remains unclear whether . . .
  - It would thus be of interest to learn how . . .
  - If these results could be confirmed, they would provide strong evidence for . . .
  - The findings suggest that this approach might be less effective when . . .
  - It would seem, therefore, that further investigations are needed in order to . . .

Adapted from “Writing Thesis and Dissertation Proposals” from Penn State University’s Graduate Writing Center

Move 3 Language: Filling the Research Gap

- Indicating what the present study accomplishes
- Referring to the type of *text*— "This paper…"
  - paper, article, thesis, report, research note
- Referring to type of *investigation*—"This study…"
  - experiment, investigation, study, survey
- Referring to the text usually in present tense
- Referring to the investigation can be in either tense (past as you have already performed the study or present to make it seem new or current)

Examples taken or adapted from Swales and Feak's *Academic Writing for Graduate Students*

Language that Introduces Research: Review

- **Move 1**: *Establishing a Research Territory*
  - Show that the general research area is important, central, interesting, problematic, or relevant in some way
  - Introduce and review items of previous research in the area
- **Move 2**: *Creating a Niche*
  - Indicate a gap in the previous research, or extend previous knowledge in some way
- **Move 3**: *Occupying the Niche*
  - Outline purposes or state the nature of the proposed research
  - List research questions or hypotheses
  - State the value of the proposed research (significance)

Adapted from John Swales' "Creating a Research Space" (CARS) approach to introductions

Introducing Your Research Example

Cognitive development is a dynamic and prolonged process, extending from infancy through late adolescence and beyond. The acquisition of new cognitive capacities is a complex process, but on the most basic level includes the acquisition of visual perception abilities during infancy, sophisticated language facilities during early childhood, and reasoning and problem-solving abilities during late adolescence. These cognitive changes are thought to be related to maturational changes in brain structure that unfold based on both genetic and environmental factors. Because of the availability of noninvasive **imaging tools such as Magnetic Resonance Imaging (MRI), much progress has been made in characterizing normative structural brain development in recent years. These studies are vital** for understanding atypical brain and cognitive development among children with neurodevelopmental disorders, and also for parsing how environmental factors such as schooling and home life can influence cognitive development. In comparison, **few studies have examined relationships between brain structure and brain function**. Understanding developmental changes in function-structure relationships is of fundamental importance in the field or developmental cognitive neuroscience, as **it may help elucidate** the specific neurobiological changes underlying the maturation of a variety of cognitive processes.

Introducing your research example: Breakdown

The previous example showed how to introduce your research. The following text excerpts show when the 3 introduction moves were used.

- Move 1: *Establishing a Research Territory*
  - "…imaging tools such as Magnetic Resonance Imaging (MRI), much progress has been made in characterizing normative structural brain development in recent years. These studies are vital …"
- Move 2: *Creating a Niche*
  - "… few studies have examined relationships between brain structure and brain function."
- Move 3: *Occupying the Niche*
  - …" it may help elucidate…"

Follow-up Activities

- If you have a draft, analyze your introduction or literature review/background for these structural elements and use them to strengthen your narrative

- Look at an example introduction or lit review for a thesis in your field. Analyze the organization of the example and how the research is positioned.

- Work on a rough outline for your introduction or background/lit review while keeping these structural elements in mind.

Return to Your Research Question…Again

- After reflecting on the gap in your particular literature, consider…
  - How does *your work* fill that gap?

- Can you refine your research question(s)? Make it explicit how your research will be investigating something *novel* and *significant*

PART 6

Organizing the literature review

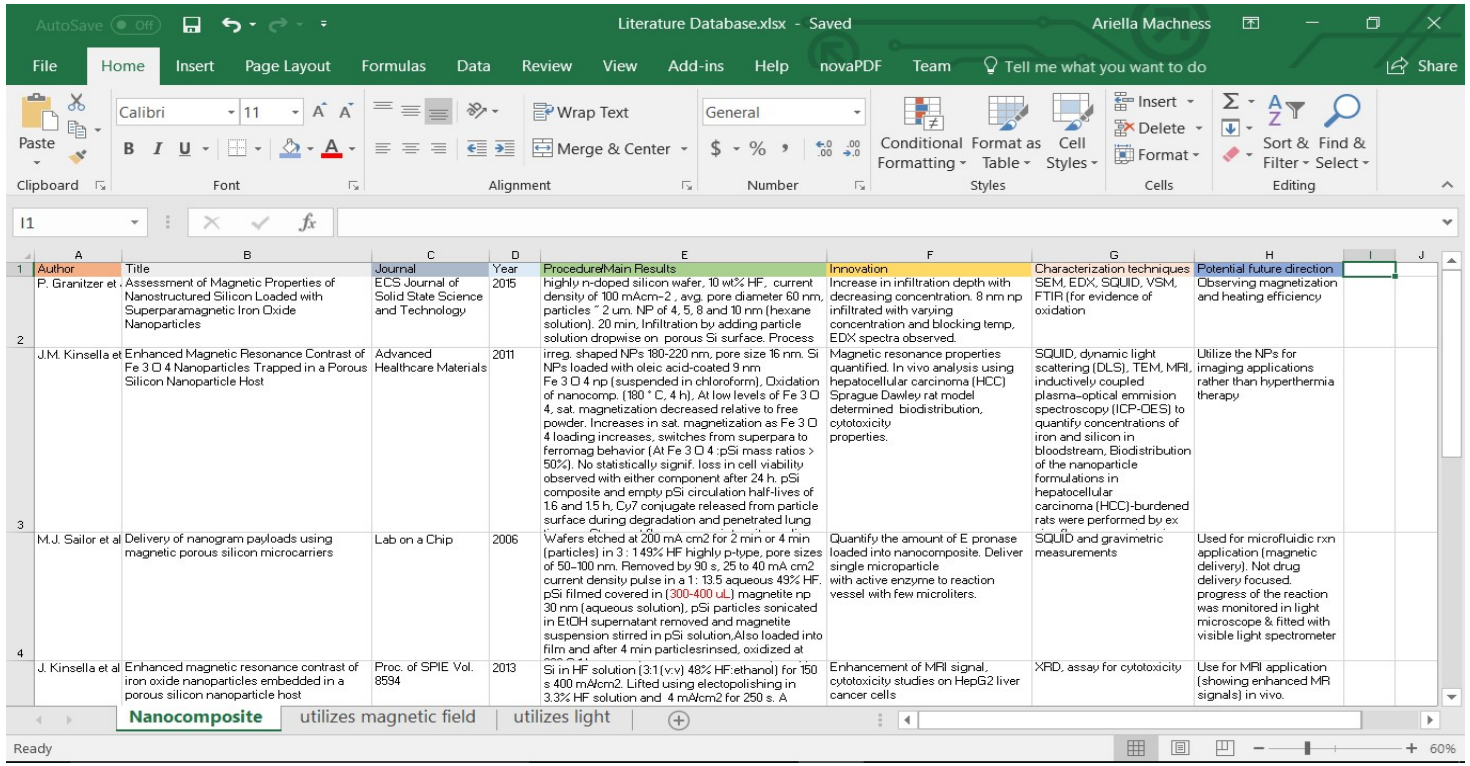
Organizing your citations (1/2)

- Make use of a citation manager

  - E.g. Mendeley, Zotero, EndNote
  - Download and save papers into folders.
  - Creates ready-made citations/bibliographies for you
  - Integrates with Internet browsers (e.g. Chrome) and word processors (e.g. Microsoft Word)
  - Allows you to take notes on and tag your papers with keywords
  - UCLA Library has great resources on how to use them

Organizing your citations (2/2)

- Track relevant literature findings through a spreadsheet



Author	Title	Journal	Year	Procedure/Main Results	Innovation	Characterization techniques	Potential future direction
P. Granitzer et al	Assessment of Magnetic Properties of Nanostructured Silicon Loaded with Superparamagnetic Iron Oxide Nanoparticles	ECS Journal of Solid State Science and Technology	2015	highly n-doped silicon wafer, 10 wt% HF, current density of 100 mAcm−2 , avg. pore diameter 60 nm, particles ~ 2 um. NP of 4, 5, 8 and 10 nm (hexane solution). 20 min, Infiltration by adding particle solution dropwise on porous Si surface. Process	Increase in infiltration depth with decreasing concentration. 8 nm np infiltrated with varying concentration and blocking temp, EDX spectra observed.	SEM, EDX, SQUID, VSM, FTIR (for evidence of oxidation	Observing magnetization and heating efficiency
J.M. Kinsella et al	Enhanced Magnetic Resonance Contrast of Fe 3 O 4 Nanoparticles Trapped in a Porous Silicon Nanoparticle Host	Advanced Healthcare Materials	2011	irreg. shaped NPs 180-220 nm, pore size 16 nm. Si NPs loaded with oleic acid-coated 9 nm Fe 3 O 4 np (suspended in chloroform). Oxidation of nanocomp. (180 ° C, 4 h), At low levels of Fe 3 O 4, sat. magnetization decreased relative to free powder. Increases in sat. magnetization as Fe 3 O 4 loading increases, switches from superpara to ferromag behavior (At Fe 3 O 4 :pSi mass ratios > 50%). No statistically signif. loss in cell viability observed with either component after 24 h. pSi composite and empty pSi circulation half-lives of 1.6 and 1.5 h, Cy7 conjugate released from particle surface during degradation and penetrated lung	Magnetic resonance properties quantified. In vivo analysis using hepatocellular carcinoma (HCC) Sprague Dawley rat model determined biodistribution, cytotoxicity properties.	SQUID, dynamic light scattering (DLS), TEM, MRI, inductively coupled plasma–optical emmision spectroscopy (ICP-OES) to quantify concentrations of iron and silicon in bloodstream, Biodistribution of the nanoparticle formulations in hepatocellular carcinoma (HCC)-burdened rats were performed by ex	Utilize the NPs for imaging applications rather than hyperthermia therapy
M.J. Sailor et al	Delivery of nanogram payloads using magnetic porous silicon microcarriers	Lab on a Chip	2006	Wafers etched at 200 mA cm2 for 2 min or 4 min (particles) in 3 : 1 49% HF highly p-type, pore sizes of 50–100 nm. Removed by 90 s, 25 to 40 mA cm2 current density pulse in a 1: 13.5 aqueous 49% HF. pSi filmed covered in (300-400 uL) magnetite np 30 nm (aqueous solution), pSi particles sonicated in EtOH supernatant removed and magnetite suspension stirred in pSi solution,Also loaded into film and after 4 min particlesrinsed, oxidized at	Quantify the amount of E pronase loaded into nanocomposite. Deliver single microparticle with active enzyme to reaction vessel with few microliters.	SQUID and gravimetric measurements	Used for microfluidic rxn application (magnetic delivery). Not drug delivery focused. progress of the reaction was monitored in light microscope & fitted with visible light spectrometer
J. Kinsella et al	Enhanced magnetic resonance contrast of iron oxide nanoparticles embedded in a porous silicon nanoparticle host	Proc. of SPIE Vol. 8594	2013	Si in HF solution (3:1 (v:v) 48% HF:ethanol) for 150 s 400 mA/cm2. Lifted using electopolishing in 3.3% HF solution and 4 mA/cm2 for 250 s. A	Enhancement of MRI signal, cytotoxicity studies on HepG2 liver cancer cells	XRD, assay for cytotoxicity	Use for MRI application (showing enhanced MR signals) in vivo.

Some Organizational Options for Lit Reviews (1/6)

Topical (most common)

- Breaks up lit review into a number of subfields, subject areas, or approaches and discusses each individually

Distant-to-Close

- A kind of topical organization that starts with studies of general relevance to topic and ends with studies most relevant to topic

Chronological

- Reviews studies chronologically from older to most recent

Debate

- Emphasizes opposing positions in field, especially long-term

Seminal Study

- Starts with focused engagement and analysis of 1-2 key studies relevant to your project

Some Organizational Options for Lit Reviews (2/6)

Topical (most common)

- Breaks up lit review into a number of subfields, subject areas, or approaches and discusses each individually

Language Patterns

- Three important areas of this fields have received attention: A, B, C
- A has been approached from two perspectives F and G
- The most important developments for B have been
- C has also been an important area of study in this field

Some Organizational Options for Lit Reviews (3/6)

Distant-to-Close

- A kind of topical organization that starts with studies of general relevance to topic and ends with studies most relevant to topic

Language Patterns

- Method/Model M (somewhat similar to current research) addresses…
- Drawing upon method/model N (more similar to current research) can help…
- This study applies the procedure used in method/model O (most similar to current research) to…

Some Organizational Options for Lit Reviews (4/6)

Chronological

- Reviews studies chronologically from older to most recent

Language Patterns

- This subject was first studied by X, who argued/found…
- In (date), Y modified/extended/contradicted X's work by…
- Today, research by Z represents the current state of the field.

Some Organizational Options for Lit Reviews (5/6)

Debate

- Emphasizes opposing positions in field, especially longstanding controversies

Language Patterns

- There have been two (three, four, etc.) distinct approaches to this problem
- The first approach posits…
- The second approach argues that the first approach is wrong for three reasons. Instead, the second approach claims…

Some Organizational Options for Lit Reviews (6/6)

Seminal Study

- Starts topic or section with extended description of an extremely important study that shaped field

Language Patterns

- The most important research on this topic was the study by X in (date)…
- Following X's study, research fell into two camps… extended X's work by building upon…

Lit Review Example

The most widely accepted theory for the origin and evolution of the Universe is the Big Bang model**. According to this model**, the Universe began approximately 10^{10} years ago from a hot dense state in thermodynamic equilibrium from which it has subsequently expanded. **The Big Bang model is supported** by several key pieces of observational evidence: the homogeneity and isotropy of the Universe on large scales, the redshift of distant galaxies, and the existence of the cosmic microwave background (CMS). **During the last decade**, cosmological data of increasing sensitivity and precisions have led to the development of more **quantitative cosmological theories that are built on the Big Bang framework. The current most widely accepted theory is the cosmological concordance model known as ACOM.**

In the ACOM model the current energy density of the Universe is divided among three main components baryonic matter, cold dark matter (COM), and dark energy. Baryonic matter consisting primarily of the constituents of normal atoms (protons, neutrons, and electrons) comprises only 5% of the total energy density while OM and dark energy comprise 23% and 72% respectively. To the precision of current measurements, the properties of dark energy are consistent with a *cosmological constant*, A, with an equation of state corresponding to a vacuum energy density, while the DM component is best modeled as a cold collisionless fluid. **In the following sections** the theoretical framework of the ACOM…

Lit Review Example: Breakdown

The previous example combined the Distant to Close organizational structure with the Chronology structure. The following text excerpts show where in the lit review these structures were used.

- Distant
  - “The most widely accepted theory…”
- Chronology
  - “During the last decade…quantitative cosmological theories that are built on the Big Bang framework. The current most widely accepted theory is the cosmological concordance model known as ACOM.”
- Close
  - “In the ACOM model…”

PART 7

Writing the Abstract

Abstract

- 150-250 words

- 1-2 sentences for each:
  - Background/Rationale
  - Method
  - Key results
  - Conclusions

- Tell your reader in as few sentences as possible, what they will find in your paper

Abstract Example

Temography of Shear Bands in Metal Foams

- Background
  - Metal foams, when compressed, deform by shear banding; the bands broaden as deformation progresses.
- Method
  - We have studied the nucleation and broadening of shear bands by laser-speckle strain-mapping. The foams were non-homogeneous, with spatial variations of density of a factor of 2…
- Key result
  - ... the shear bands nucleate in the low-density zones and broaden into the high-density regions as strain progresses.
- Conclusion
  - The results indicate that processing to minimize the density fluctuations could increase the initial compressive yield strength of the foams, when shear bands first form, by a factor of 1.5.

PART 8

Further Writing Support

Further Writing Support

- GWC STEM Thesis Writing Retreat
  - During Spring & Summer breaks!
- GWC writing appointments
  - (50 minutes, consultants available from many fields)
- Other GWC workshop recordings
  - Best Practices for Writing Scientific Articles and Article-Based Dissertations
  - Writing an Engineering Paper
  - Writing the Literature Review in the Sciences