

Methods Training

Scholarship, Posters and Thesis

(English)

Dr. Karl N. Kirschner

Spring 2018

| Day | Date | Session | Topic |
|------------|------------|---------------------------|---------------------------------------------|
| 1 | 13-02-2019 | Morning (9:00 – 12:00) | Introduction |
| 1 | 13-02-2019 | Morning | Scholarship and research |
| 1 | 13-02-2019 | Morning | Taking notes |
| 1 | 13-02-2019 | Afternoon (13:00 – 15:30) | Posters |
| 1 | 13-02-2019 | Afternoon | Intro to Linux, desktop, command line |
| 1 | 13-02-2019 | Afternoon (15:30 – 18:00) | Personal working time (poster) |
| 2 | 14-02-2019 | Morning | Citations |
| 2 | 14-02-2019 | Morning | Literature searching and bibtex files |
| 2 | 14-02-2019 | Morning | Reference management (Citavi and Jabref) |
| 2 | 14-02-2019 | Afternoon | Inkscape & (Python3 ?) |
| 2 | 14-02-2019 | Afternoon | Personal working time (poster) |
| 3 | 15-02-2019 | Morning | Research questions and hypotheses |
| 3 | 15-02-2019 | Morning | Writing your thesis and personal time line |
| 3 | 15-02-2019 | Morning | FAQ thesis, LATEX |
| 3 | 15-02-2019 | Afternoon | Personal working time (poster) |
| 17-02-2019 | | Night (21:00) | Final PDF uploaded to LEA |
| 4 | 18-02-2019 | Morning 9:00 | Poster PDF must be delivered to printshop |
| 4 | 18-02-2019 | Morning (1 hr) | Git |
| 4 | 18-02-2019 | Morning 10:00 | Library seminar |
| 4 | 18-02-2019 | Afternoon | Significant figures and rounding |
| 4 | 18-02-2019 | Afternoon | Personal working time |
| 5 | 19-02-2019 | Morning | Ethics |
| 5 | 19-02-2019 | Morning | Course evaluations |
| 5 | 19-02-2019 | Afternoon | Poster presentation |
| ??-??-2019 | | 08:00-11:00 | Poster Session at the Niehl training center |

Questions or comments from last lecture(s)?

German and English Thesis Examples and Template:

https://gitlab.com/k.n.kirschner/H-BRS_Thesis_Template.git

FAQ About Thesis:

LEA → EMT-Studieninfos → Prüfungen → FAQ →
Häufige Fragen zu Prüfungsangelegenheiten →
Prüfungsinformationen für alle EMT-Studiengänge: →
Fragen zur Abschulssarbeit und zum Kolloquium

Bib-Cloud – <https://www.h-brs.de/en/bib/cloud-storage-keep-your-files-safe-bibcloud>



Photo by Cristina Gottardi on Unsplash

A Credible Statement or Not?

- "Hard thinking makes people think about different things besides driving, which is dangerous."
-

A Credible Statement or Not?

- "Hard thinking makes people think about different things besides driving, which is dangerous."
- "Mental workload [1] and mind-wandering [2] shifts focus away from driving, and this causes accidents."
 1. www.cartalk.com
 2. [www.wikipedia.org](https://en.wikipedia.org)

A Credible Statement or Not?

- "Hard thinking makes people think about different things besides driving, which is dangerous."
-
- "Mental workload [1] and mind-wandering [2] shifts focus away from driving, and this causes accidents."
 1. www.cartalk.com
 2. [www.wikipedia.org](https://en.wikipedia.org)
-
- "Mental workload and mind-wandering shifts focus away from driving, and is positively correlated to preventable accidents [1,2]."
 1. Zhang, Y. & Kumada, T. *Relationship between workload and mind-wandering in simulated driving*. PLoS One, **2017**, 12, 1-12.
 2. Paxion, J.; Galy, E. & Berthelon, C. *Mental workload and driving*. Frontiers in Psychology, **2014**, 5, 1344.

Citations - provide credibility and avoid plagiarism

Why spend time doing proper citations?

- Provides credit for hard work done
- Enables reproducibility
- Enables fact-checking
- Demonstrates and builds your credibility as a scholar (avoid plagiarism)
- Establishes the writing to be authoritative – being scholarly – strengthens your arguments/finding

When do I need cite?

When you obtain knowledge/information from

- journals and books
- websites, magazines and newspapers
- private communications (e.g. interviews, emails, conversations)
- tv, youtube, documentaries, movies programs

This includes when you use

- direct and indirect quotes
- use figures, plots, illustrations, etc.



6d

"Either write something
worth reading or do
something worth writing."
—Benjamin Franklin

Photo by Mona Eendra on Unsplash

Two categorically different topics to discuss:

- 1 Citation styles** within the body of the text
- 2 Reference/Citation formats** in the reference section

In text citation styles

Two different styles

1 Harvard: places “author-date” within text

- blah blah (Smith 2018), blah
- blah blah (Smith 2018, p. 8), blah
- blah blah (Smith 2018, chap. 2), blah
- blah blah (Smith *et al.* 2018), blah – when there are ≥ 3 authors
- blah blah (Smith, n.d.), blah – when no year is given

2 Vancouver: place “number” within text

- blah blah [1], blah
- blah blah (1), blah
- blah blah¹, blah

Format of citations

You want to provide enough information for others to find the source. However, there are lots of variations to this.

Articles

- Authors, Article Title, Journal Title, Volume(Issue), Year, Pages.

Books

- Authors, Chapter Title, Book Title, Editors, Publisher, City, Year.

Websites

- Authors, Title, date published (date visited), URL address.

NOTE: Proving only a DOI (Digital Object Identifier), or in place of a Journal name, volume, year, pages is not acceptable, because it does not allow the reader to easily judge the reference quality.

Formats

There are lots of formats that one can choose from.

- Every journal/publisher has its own format
- Some very common formats that are well known
 - Every journal/publisher has its own format
 - APA (see <http://pitt.libguides.com/c.php?g=12108&p=64730> for examples)
 - Chicago (see <http://pitt.libguides.com/c.php?g=12108&p=64732> for examples)
 - IEEE (see <http://pitt.libguides.com/citationhelp/ieee> for examples)
 - most common for engineers

APA (American Psychological Association) format

Journal article Author, A., & Author, B. (year). Title of article. Journal Title, Volume, page range. DOI

Zhang, W. (2014). Ten simple rules for writing research papers. PLOS Computational Biology, 10(1), 1-3.
<https://dx.doi.org/10.1371/journal.pcbi.1003453>

Whole book Author, A., & Author, B. (year). Title of book. Publisher location: Publisher Name. DOI

Beveridge, W. (1957). The art of scientific investigation. New York: W.W. Norton & Company.

Edited book chapter Author, A., & Author, B. (year). Title of chapter. In E. Editor & A. Editor (Eds.), Title of book (pp. xx-xx). Publisher location: Publisher Name. DOI

Easterbrook, S., Singer, J., Storey, M.-A., & Damian, D. (2008). Selecting empirical methods for software engineering research. In F. Shull, J. Singer, & D. I. K. Sjøberg (Eds.), Guide to advanced empirical software engineering (pp. 285–311). London: Springer London.
https://dx.doi.org/10.1007/978-1-84800-044-5_11

Website Group Author. (year). Title of page. Retrieved from
<http://xxxxxx>

Goel, S. (2012). Research Method for Engineering Research Students – Part II: A Checklist for Reflective Self-assessment of the Research Work. Retrieved from
<https://goelsan.wordpress.com/2012/04/15/research-method-for-engineering-research-students-part-ii-a-checklist-for-reflective-self-assessment-of-the-research-work>. (Accessed: 2016-11-20)

Examples

Show examples (located in citation_example)

- Harvard and sorted
- Numbers and unsorted
- IEEE

Possible (and often) Pitfalls

- Not citing the original source
- Propagating errors created by other's carelessness

Classwork/Homework: Identify Mistakes and Errors

Now that you know the general rules for citation and formating references...

- 1 Find at least 15 citation and reference format mistakes in the following handout.



Photo by Annie Spratt on Unsplash

Literature Search

Why do literature searches?

- To learn something new (ie. fill a knowledge gap).
- To identify the important players within a field (cognitive authority).
- To identify key papers.
 - State-of-the-art
 - Writing a thesis/manuscripts (introduction, methodology, discussion)

Usually a combination of these.

Second-hand knowledge^a

Much of what we know comes as “Second-Hand Knowledge” – comes from other people.

Need to identify the cognitive authority level of the sources (i.e. from high to low).

Credibility (of you and your writing, and of those that you read):

- Competence - Does the person present information in an organized and understandable way?
- Trustworthiness - Does the author indicate the information sources?

A credible source is sometimes enough (eg. journalist, text book) - doesn't have to be the absolute authority, but it reduces level of “belief/truth”.

a. Patrick Wilson

T. Swanson. [Teaching students about information: Information literacy and cognitive authority.](#) *Research Strategies*, 20(4):322 – 333, 2005

Credibility levels

- 1 Universities
 - 2 Democratic national government
 - 3 Individual professionals
 - 4 Commercial services assessing something other than themselves
 - 5 Graduate students
 - 6 Undergraduate students
 - 7 Businesses talking about themselves
 - 8 Non-democratic national governments
 - 9 Adult with no visible credentials
 - 10 Young people
-
- 1 Scholarly books and articles
 - 2 Serious trade books and articles
 - 3 Popular magazines and books
 - 4 Newspapers and news organizations
 - 5 Sponsored Web sites
 - 6 Individual Web and Internet contacts
 - 7 Listserves and usenet newsgroups

References within T. Swanson. *Teaching students about information: Information literacy and cognitive authority.*
Research Strategies, 20(4):322 – 333, 2005

Identify important papers

- How many times has it been cited versus its age?

- What did those citing papers say about the original?
(Avoid those highly cited papers that are used as a bad example -
“This is an example of how not to...”)

- Who are the authors and from what institution – what are their credibility?

Search engines

Primary

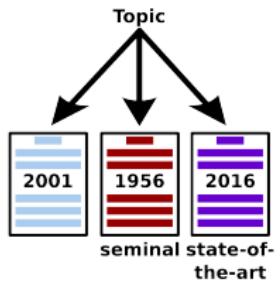
- Web of Science (<https://apps.webofknowledge.com>) - all disciplines
- Google Scholar (<https://scholar.google.com>) - all disciplines
- ScienceDirect (<http://www.sciencedirect.com>) - all
- Pubmed (<https://www.ncbi.nlm.nih.gov/pubmed>) - life sciences

Others

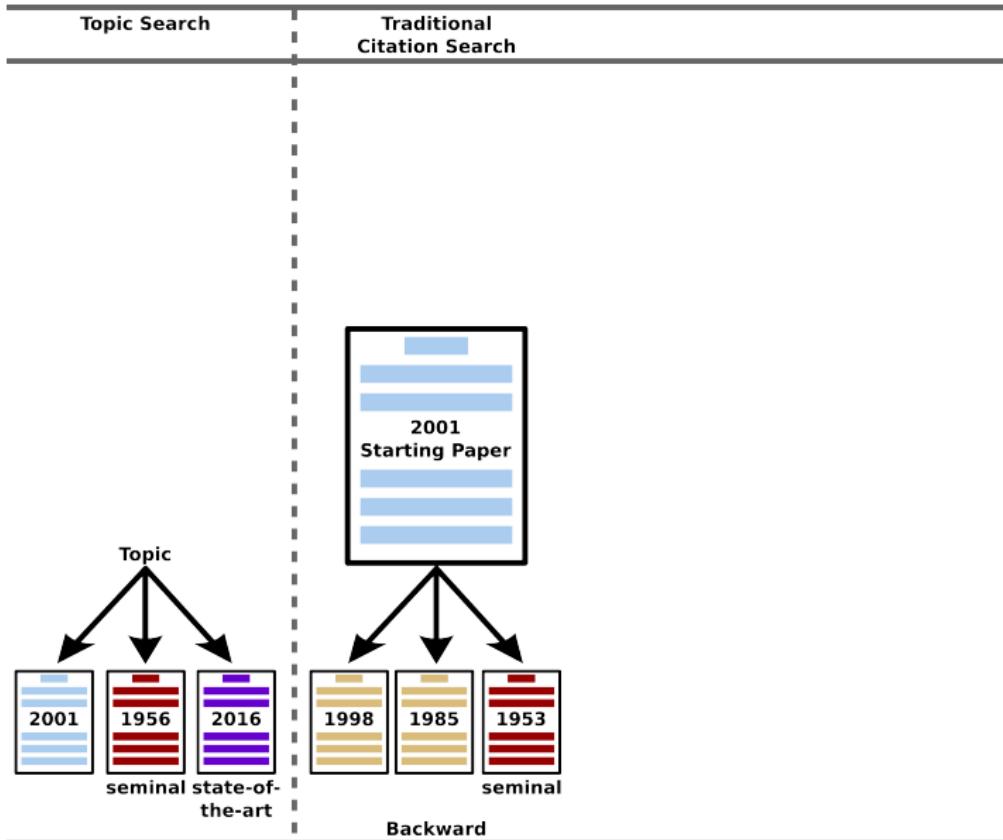
- IEEE Xplore (<http://ieeexplore.ieee.org/Xplore/guesthome.jsp>) - Electronics, Electrical engineering, Computer science

3.01: Searching for papers

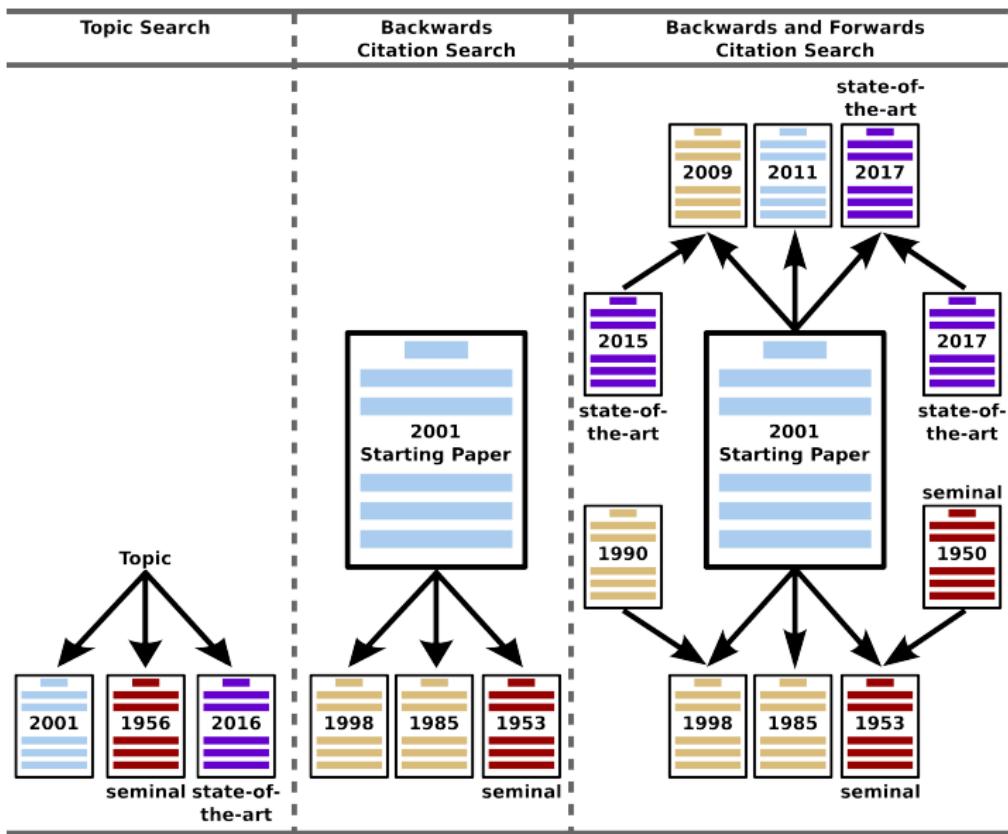
Topic Search



Searching for papers



Searching for papers



Free access to papers

- Via Google Scholar (PDF links on right-hand-side) - all
- ResearchGate - all
- arXiv - Physics, Mathematics, Computer science, Quantitative biology, Quantitative finance and statistics
- CiteSeerX - Computer science
- PLOS - Sciences
- High Wire Press - Natural sciences
- NASA Scientific and Technical Information (STI) - Aerospace
- SOA/NASA Astrophysics Data System - Astronomy, physics

Full List:

https://en.wikipedia.org/wiki/List_of_academic_databases_and_search_engines



Photo by jesse orrico on Unsplash

Reference Management

Format/Software for Reference Management

- Bib format (aka BibTex) - readable by all other software
- Jabref (www.jabref.org) - local; platform independent, opensource
- Citavi (www.citavi.com) - local; Windows
www.h-brs.de/en/bib/citavi-collecting-and-managing-references
- Mendeley (www.mendeley.com) - online; social network
- Zotero (www.zotero.org) - local; mac, windows & linux

Bibtex files

Example:

```
@Article{GrotthussPR2003,
  Title      = {{Ligand-Info}}, searching for similar ...},
  Author     = {von Grotthuss, Marcin and Pas, Jakub ...},
  Journal    = {Bioinformatics},
  Year       = {2003},
  Number     = {8},
  Pages      = {1041-1042},
  Volume     = {19},
  Abstract   = {Motivation: The Ligand-Info system is ...},
  Doi        = {10.1093/bioinformatics/btg117},
  Eprint     = {http://bioinformatics.oxfordjournals...},
  Url        = {http://bioinformatics.oxfordjournals...}
}
```

Some common bibtex entry types

- article – journal or magazine
- book – book with explicit publisher
- incollection – a part of a book that has its own special title
(e.g. a book with chapters by different authors)
- manual
- mastersthesis & phdthesis
- misc – use for programs, websites and personal communications

```
@Misc{PriemTGN2010,  
    Title      = {Altmetrics: a manifesto},  
    Author     = {J. Priem and D. Taraborelli and ...},  
    HowPublished = {\url{http://altmetrics.org/manifesto}},  
    Year       = {2010},  
    Note        = {Accessed 2017-03-28}  
}
```

Demonstration

Retrieve a bibtex file for a journal article

- Direct from publisher
- From Google Scholar

Bibtex special formatting

- Compound last names – e.g. Charles De Gaulle, Vincent van Gogh
 - Author = {De Gaulle, Charles and van Gogh, Vincent}
 - Author = {Charles {De Gaulle} and Vincent {van Gogh}}
- Names with Jr. or Numbers
 - Author = {FirstName {LastName, Jr.} and ... }
 - Author = {LastName, Jr., FirstName and ... }
 - Author = {LastName {III}, FirstName and ... }
- Character accents
(https://en.wikibooks.org/wiki/LaTeX/Special_Characters)
 - \'{o} : ó
 - \"{o} : ö
 - \c{c} : ç

Jabref

.bashrc: alias jabref='java -jar /bin/JabRef-2.10.jar'

- Imports: RIS, Medline/Pubmed (xml), Refer/Endnote, INSPEC, BibTeXML, CSA, ISI Web of Science, SilverPlatter, Scifinder, OVID, Biblioscape, Sixpack, JStor, and RIS
- Exports to other software (haven't personally tested)
- Searchable
- Group entries via keywords
- Link to local database of PDF files
- LaTeX (kile), LibreOffice compatible

Jabref 4.3.1 integration with LibreOffice

<http://help.jabref.org/en/OpenOfficeIntegration>

LibreOffice:

- 1 Insert page break into document to make room for the bibliography
- 2 Insert → Table of Contents and Index → Table of Contents, Index or Bibliography → Type: Bibliography → Okay
- 3 Place you cursor where you want to insert a citation within the body of the text

LibreOffice and Jabref

Jabref:

- 1 Tools → OpenOffice/LibreOffice connection (Alt 0)
- 2 Click on the "Connect" icon to see if it can determine the LibreOffice setting (e.g. soffice). If not then you will have to manually set it by clicking on the "Manual connect" icon
- 3 Select on the reference that you want to push to LibreOffice
- 4 Click on the "Cite" icon.
- 5 Once you have done this for a few reference, click the "Update" icon to update the LibreOffice document

Once you close a LibreOffice document and reopen it, you will need to do step 2 above to reconnect Jabref. Then you can continue working.

Warning I have not extensively tested this - I don't know if there is a breaking limit.

Demonstrate Jabref



Photo by Jonah Petrich on Unsplash

PDF naming convention

Smith, L. J.; Daura, X. & van Gunsteren, W. F. Assessing equilibration and convergence in biomolecular simulations Proteins: Structure, Function, and Bioinformatics, 2002, 48, 487-496

- 1 Name is based on the article's content

e.g. Equil_Convg_Bio_Sim.pdf

- 2 Name is based on Authorship and Year

e.g. SmithDG2002.pdf (and SmithDG2002b.pdf)

- 3 Some combination of the above

e.g. Equil_Convg_Bio_Sim_Smith_2002.pdf
and easy to implement in Jabref

Jabref and unique PDF file names that match its bibkey

Within preferences add to the following to BibTex key generator, and select "Ensure unique keys using letters (b,c,...):"

```
[auth] [auth1_2] [auth1_3] [auth1_4] [auth1_5] [auth1_6]
[auth1_7] [auth1_8] [auth1_9] [auth1_10] [auth1_11] [auth1_12]
[auth1_13] [auth1_14] [auth1_15] [auth1_16] [auth1_17]
[auth1_18] [auth1_19] [auth1_20] [auth1_21] [auth1_22]
[auth1_23] [auth1_24] [auth1_25] [auth1_26] [auth1_27]
[auth1_28] [auth1_30] [auth1_31] [auth1_32] [auth1_33]
[auth1_34] [auth1_35] [auth1_36] [auth1_37] [auth1_38]
[auth1_39] [auth1_40] [auth1_41] [year]
```

Type "control g" to automatically apply the format while in Jabref.

Folder structure for storing PDF

Have a PDF folder that only stores downloaded articles – nothing else.

- /home/UserName/01_Project/00_PDF_Database
 - All papers related to a project in a one location
- /home/UserName/Writing/Master_Thesis/00_PDF_Database
- /home/UserName/Writing/Manuscript_1/00_PDF_Database
 - All papers related to single piece of writing in one location
- /home/UserName/00_PDF_Database
 - Easy to keep track of
 - Not redundant

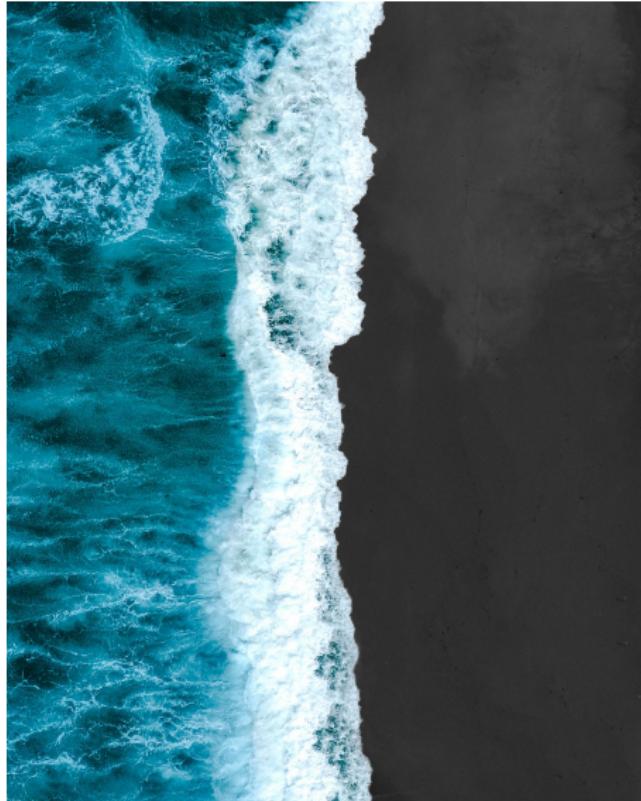


Photo by Sacha Styles on [Unsplash.com](https://unsplash.com)

What are some ideas for finding a problem to work on?

Finding a Problem to Work On (also for a career)

- Hop onto an existing trend
 - Identify them via conferences (current trends) & funding agency's "calls for proposals" (future trends)
- Become an expert in something – develop a secret technology/workflow and look for a target to apply it
 - Apply it to a different field - be a border crosser
- Revisit old problems, but with new knowledge - assumptions and (new) abilities may have changed
- Look for "pain points" and develop solutions (e.g. via scripts, workflows, technology)
- Dream big and create a wish list (e.g. solve cancer, create a personalized flying car)

Got the problem, now ...

Once you find a problem, what is next?

One must know about the basic steps in the research / problem solving process.

Basic Steps for Research: Science and Engineering

| Science | Engineering |
|---------------------------------------------------------------------------------|------------------------------|
| State your interest | Define a need |
| Do background literature research | |
| Formulate hypothesis (identify variables), or formulate a research question | Establish design criteria |
| Design experiment, establish procedure | Prepare preliminary designs |
| Test hypothesis by doing an experiment, or gather data concerning your question | Build and test a prototype |
| Analyze results & draw conclusions | Test & redesign as necessary |
| | Present results |

http://www.sciencebuddies.org/science-fair-projects/project_engineering.shtml

What is a Research Questions

and how does that differ from

a Research Hypothesis?

Research Questions vs. Hypothesis

A Research Question ...

- is used when little work (knowledge) exists or
- is used when there is contradiction within the literature
- does not state how variables will be related
- is **inquisitive** in nature

Example: "What effect does being able to read English well have on a student's grade?"

Research Questions vs. Hypothesis

A Hypothesis (a Statement) ...

- is used when a large body of work already exists
- usually makes a **prediction** of the relationship between two variables
- are considered to be more precise than a research question

Example: "Time spent studying outside of class is positively correlated with a student's grade."

- Research Questions: allow for a wide variety of outcomes.
- Research Hypothesis: usually allows for a narrow set of outcomes

Research Questions

- First you must be familiar with a subject before you can ask a question. (In fact, it might have been already answered.)
- Within the field, where is knowledge lacking? Where are the uncertainties?
 - Scholarship – conduct a thorough search of published literature within the area (and read it)
 - Relationships/conversations with experts
 - Meetings (talks, posters)
- Can't be too narrow or too broad.

Research questions

■ Ultimately, the research question must

- initiate a process of hypothesizing
- initial predictions
- learning of existing knowledge
- exploration
- generate new knowledge
- generate new questions
- generate new solutions

C. Chin and J. Osborne. *Students' questions: a potential resource for teaching and learning science.*

Studies in Science Education, 44(1):1–39, 2008

A different perspective for "Types of research questions"

- **Factual** - look for causal relationships and describe them
(e.g. Which fuel additive results in the most horsepower?)
- **Comparative** - these identify at least two alternatives to a situation and compare them with what actual happens
(e.g. Does bioethanol produce less greenhouse gas than diesel fuel?)
- **Predictive** - constructing “scenarios” of how something might occur
(e.g. Will molecule X be a strong protein binder?)
- **Problem solving** -Propose solutions to existing problems
(e.g. Does the use of a cover reduce evaporation from swimming pools?)
- **Paradoxical** - explore an apparently contradictory situation to make a suggestion for resolving the contradiction
(e.g. How can we fertilize crops without creating algal blooms?)

Adapted from http://www.scmb.uq.edu.au/cpd1/d2s1_researchable-questions_and_right-answers_activity.pdf

Soooooooo....

What makes for a good research question?

Characteristics of a good research question

Box 1. FINER criteria for a good research question

| | | |
|---|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F | Feasible | <ul style="list-style-type: none">• Adequate number of subjects• Adequate technical expertise• Affordable in time and money• Manageable in scope |
| I | Interesting | <ul style="list-style-type: none">• Getting the answer intrigues investigator, peers and community |
| N | Novel | <ul style="list-style-type: none">• Confirms, refutes or extends previous findings |
| E | Ethical | <ul style="list-style-type: none">• Amenable to a study that institutional review board will approve |
| R | Relevant | <ul style="list-style-type: none">• To scientific knowledge• To clinical and health policy• To future research |

Adapted with permission from Wolters Kluwer Health.²

S. B. Hulley, S. R. Cummings, W. S. Browner, D. G. Grady, and T. B. Newman.

Designing clinical research.

Lippincott Williams & Wilkins, 2013

Plus, good research questions ...

- Have no easy answers
- Focuses on 2-3 variables
- Defined with respect to current knowledge
- Makes you think of other questions
- Often starts with “how, which, why...”

While bad research questions ...

- Have simple and easy answers
- Can be answered in a few words or sentences
- Have no answer or are opinion
- Often starts with “where, who, how many, when...”

Examples and how to improve

- Too narrow: What is the childhood obesity rate in NRW, Germany? (Simple quantitative answer.)
 - Less narrow: How does the education level of the parents impact childhood obesity rates in NRW, Germany? (Data allows you to draw a conclusion.)
-
- Too objective: How much time do young children spend doing physical activity per day? (What is the data going to say?)
 - More subjective: What is the relationship between physical activity levels and childhood obesity? (Correlation)

adapted from <https://cirt.gcu.edu/research/developmentresources/tutorials/question>

Developing a hypothesis from a research question

Research questions are often more natural for new researchers to form. Here we demonstrate how one can reform a question into a hypothesis.

A good research question should lead almost directly to at a single hypothesis.

A hypothesis predicts the nature and direction of the relationship between two or more variables.

Example

Research question : Will a lower pH of seawater increase the rate of ice melting?

Hypothesis: An increase in the number of ions in solution will increase the rate that water molecules move from a solid into a liquid state.

http://www.scmb.uq.edu.au/cpd1/d2s1_researchable-questions_and_right-answers_activity.pdf

A little more about a hypothesis

- A proposed explanation for a phenomenon.
- It is considered more “scientific” (i.e. it must be testable)
- Must be a statement
- Provides a bridge between *theory*, *observables* and *practice*
 - How variables (theory) affect (i.e. influences) an observable
 - Perform experiments that test the theory (practice)

Hypothesis examples

Not too good Device X will perform better than all other devices.

Not too good Device X will help to discover some underlying aspect of something.

Better Device X in the process of Y will help engineers perform Z more rapidly, with higher success rates than M.

Good A robotic terminal device (hand) can be designed and fabricated that will mimic the natural hand with sufficient fidelity [accurately] to permit exploration of strategies to orchestrate its use.

E. K. Antonsson. *Development and testing of hypotheses in engineering design research*.

Journal of Mechanisms, Transmissions, and Automation in Design, 109(2):153–154, 1987

Hypothesis example - improving it

Poor "Water levels affect the amount of lice suffered by rainbow trout."

- No guidance towards how to design the research

Better "Rainbow trout suffer more lice when water levels are low."

- Some direction, but not really testable

Best "Rainbow trout suffer more lice in low water conditions because there is less oxygen in the water."

- Established variables that are testable

<https://explorable.com/how-to-write-a-hypothesis>

Further Information

- Constructing research questions from existing literature:
 - M. Alvesson and J. Sandberg. [Generating research questions through problematization](#).
Academy of Management Review, 36(2):247–271, 2011
- Identify trends and patterns in scientific literature (CiteSpace, VOSViewer, Science of Science Tool)
 - R. Vasudevan, M. Ziatdinov, C. Chen, and S. Kalinin. [Analysis of citation networks as a new tool for scientific research](#).
MRS Bulletin, 41(12):1009–1016, 2016
 - N. J. van Eck and L. Waltman. [Software survey: VOSviewer, a computer program for bibliometric mapping](#).
Scientometrics, 84(2):523–538, July 2009
 - R. Haunschild, L. Bornmann, and W. Marx. [Climate change research in view of bibliometrics](#).
PLOS ONE, 11(7):1–19, 07 2016

"Design as problem solving is a natural and the most ubiquitous of human activities. Design begins with the **acknowledgment of needs** and **dissatisfaction with the current state of affairs**, and **realization that some action must take place in order to solve the problem**. In this way, scientists have been designing and acting as designers..."

"Our thesis is that **design as an evolutionary problem solving activity** conforms to the **structure of problem solving of scientific communities**."

D. Braha and O. Maimon. [The design process: properties, paradigms, and structure.](#) *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 27(2):146–166, Mar 1997

- [1] M. Alvesson and J. Sandberg. Generating research questions through problematization. *Academy of Management Review*, 36(2):247–271, 2011.
- [2] E. K. Antonsson. Development and testing of hypotheses in engineering design research. *Journal of Mechanisms, Transmissions, and Automation in Design*, 109(2):153–154, 1987.
- [3] D. Braha and O. Maimon. The design process: properties, paradigms, and structure. *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans*, 27(2):146–166, Mar 1997.
- [4] C. Chin and J. Osborne. Students' questions: a potential resource for teaching and learning science. *Studies in Science Education*, 44(1):1–39, 2008.
- [5] R. Haunschild, L. Bornmann, and W. Marx. Climate change research in view of bibliometrics. *PLOS ONE*, 11(7):1–19, 07 2016.
- [6] S. B. Hulley, S. R. Cummings, W. S. Browner, D. G. Grady, and T. B. Newman. *Designing clinical research*. Lippincott Williams & Wilkins, 2013.

- [7] T. Swanson. Teaching students about information: Information literacy and cognitive authority. *Research Strategies*, 20(4):322 – 333, 2005.
- [8] N. J. van Eck and L. Waltman. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2):523–538, July 2009.
- [9] R. Vasudevan, M. Ziatdinov, C. Chen, and S. Kalinin. Analysis of citation networks as a new tool for scientific research. *MRS Bulletin*, 41(12):1009–1016, 2016.