

Scientific Writing

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Agenda

1. The research paper
2. Sections of a research paper
3. Final research theses
4. Academic writing

1. The Research Paper

Research Papers

A **research paper** is

- A scientific article published after passing peer review

Scientific **peer review** is

- The review (assessment) of some artifact by scientific peers

The research paper is the gold standard of scientific publication

Other Types of Research Publications

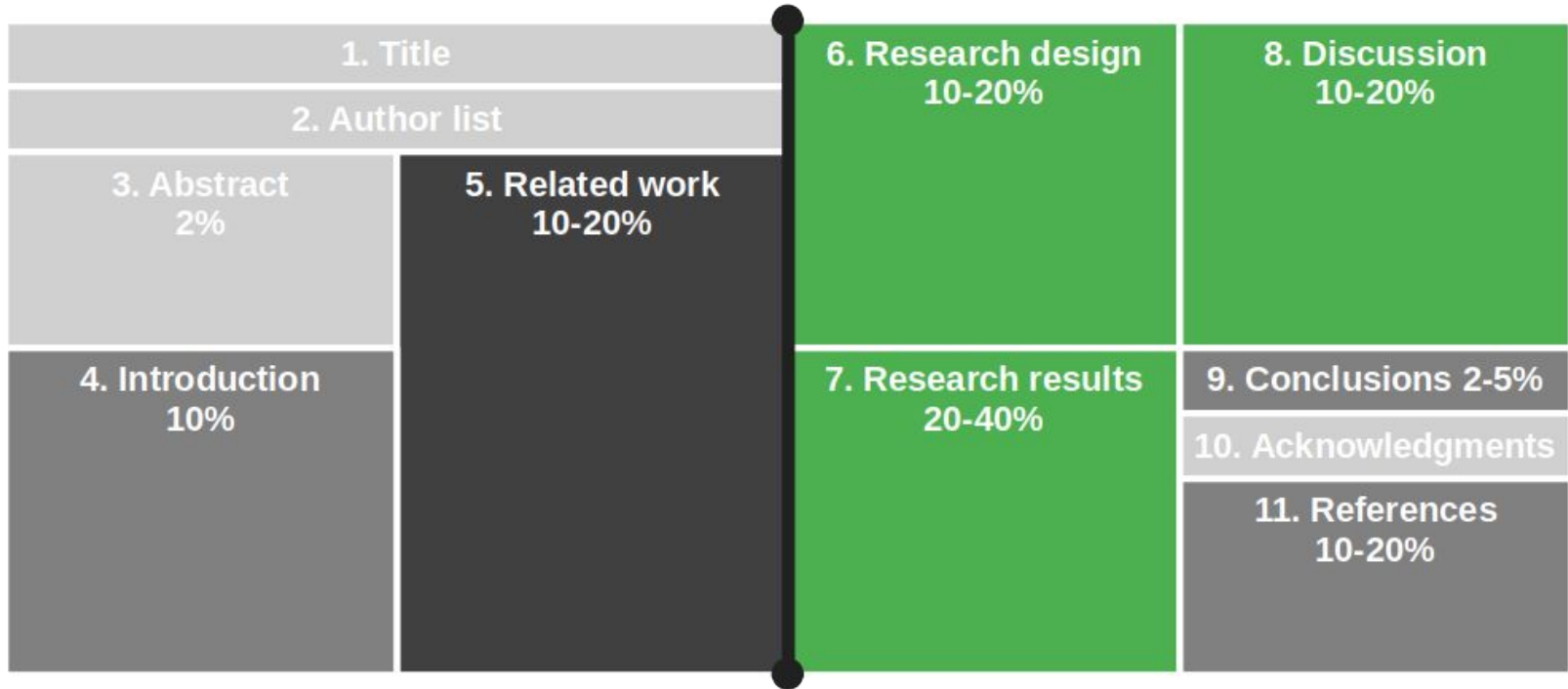
Other types of research publications of varying quality

1. Public reviews
2. Monographies (books)
3. Presentation slides (lecturing)
4. Opinion pieces e.g. letters to the editor

The goal is public documented scientific exchange

2. Sections of a Research Paper

Structure of a Typical Research Paper



1. Title

The purpose of a paper's title is to

- Attract readers
- Indicate content

Good paper titles are

- Context dependent (where will this be published)
- Properly feed academic search engines

Examples of Paper Titles

Great title

- “A rational design process: How and why to fake it”

Good title

- “Nailing your thesis” (you be the judge)

Poor title

- “A comparative evaluation of common theories in computer science”

Best Practices for Paper Titles

Do

- Raise reader interest
- Be short and memorable
- Carry a message
- Indicate story

Don't

- Be long and academic
- Be incomprehensible
- Be overly cute

2. Author List

The purpose of the author list is to

- Name and identify authors
- Rank-order their contributions

Authors always need to agree to be on an author list and at which position

Who Can be Listed as an Author?

An author to a research paper must have made

- A non-trivial intellectual contribution to the presented scientific work
- Authors of other contributions go into the acknowledgement section

How to Rank Order Authors on Author Lists

There is a logic to the author ordering

1. Minimum contribution gets you on
2. Ranking of contribution moves you up
3. Alphabetical ordering after that

Common patterns

- Ph.D. student followed by supervising professor
- First author followed by alphabetical list of other contributors
- Principal investigator followed by alphabetical list of all project members

Rank Ordering Intellectual Contributions

Use a contribution model like CRedit [1] to document and rank-order contributions

CRedit defines 14 different types of contributions

Conceptualization	Methodology	Validation
Data curation	Project administration	Visualization
Formal analysis	Resources	Writing (original draft)
Funding acquisition	Software	Writing (review and editing)
Investigation	Supervision	

[1] See <https://credit.niso.org/>

3. Abstract

The purpose of an abstract is to

- Draw readers in
- Summarize the paper

Most readers are lost in the abstract

Generic Best Practice Pattern

One sentence each describing the

- Context / domain
- Research problem
- Approach taken
- Research results
- Consequences of work

(1) Open-source software is available for free and many companies use it in their products.

(2) However, many managers worry that open source is only a temporary phenomenon and will go away, leaving them with abandoned software components that nobody is maintaining.

(3) This article empirically analyses the growth of open-source software using the top 1000 projects from GitHub.

(4) We show that open source is alive and keeps growing.

(5) Thus, open source is a sustainable phenomenon and managers can use open-source software in their products.

Beck's Four-Sentence Abstract [1]

One sentence each describing the

1. The problem
2. Why the problem is a problem
3. One “startling sentence”
4. Implications of findings

(1) Users of open-source software worry that the open source phenomenon is not sustainable.

(2) They hesitate to adopt open-source software and miss out on its economic benefits.

(3) This paper shows that open source is a sustainable phenomenon.

(4) Thus, users should not worry but adopt and gain the benefits of open-source software.

4. Introduction

The purpose of the introduction section is to

- Keep drawing in the reader
- Set expectations straight
- Get going with the paper

Most readers' belief is lost in the introduction

Structure of the Introduction Section

The introduction section

- Extends the abstract
- Contrasts most-relevant work
- Explicitly lists contributions of work
- Summarizes the structure of the paper

The Claim to Contributions

You should claim your contributions,

- explicitly, and
- as precisely as you can

The contributions of this paper are:

1. An operational definition of how to measure open source project growth;
2. The assessment of past open source growth using a large sample representative of open source;
3. The now plausible prediction that open-source software as a whole will keep growing in the future.

5. Related Work

A related work section surveys

1. Prior art you are building on
2. Related work (to yours)

Related work is identified through a literature survey

- Typically done ad-hoc

Prior Art

Prior art (work) is work you build on

- You needed it to perform your work
- Readers need it to understand your work

Prior work does not compete with yours

Related Work

Related work is work that may have

- Attempted the same as your work
- Have gone alternative ways

You need to **compare-and-contrast** this work

- You **compare** to show how the works relate to each other
 - If the work is not related, it is irrelevant to your paper
- You **contrast** to show how your work is different
 - If not different from yours, your work is not novel

Presentation Structure

You typically structure related work by

- Domains first
 - Application domain, technical domain, etc.
- Then specialize within domain
 - From the more general to the more specialized work

6. Research Design

The research design section

- Presents your research design, methods employed, etc.
- Serves to convince readers of rigor of work

The section is also known as

- Approach or
- Methods

The specifics depend on your research design

Presentation of Research Design Section

The research design section

- Presents the logical structure of the research
- Presents a one-shot rationalized process
- Discusses iterative process in own subsection

Example of a Research Design Section

Example structure (systematic review)

1. Research approach
 - a. Research design
 - i. Research questions
 - ii. Research protocol
 - b. Research execution
 - i. Study search
 - ii. Study selection
 - iii. Study quality filter
 - iv. Data extraction
 - v. Data synthesis

7. Research Results

The research results section

- Presents setup, data collection, and data analysis
- Provides basis of relevance of your work

The specifics also depend on your research design

- The results typically mirror the design section structure

8. Discussion

The discussions section

- Discusses your research results
- Establishes (beyond the results section) their quality

The specifics depend on the type of research

Discussion in Qualitative Research Papers

In qualitative research, usually called **limitations**

- Two separate (sub)sections, one each on
 - Interpreting research results
 - Limitations (using qualitative research quality criteria)

Discussion in Quantitative Research Papers

In quantitative research, usually called **threats to validity**

- Two separate (sub)sections, one each on
 - Interpreting research results
 - Threats to validity (using quantitative research quality criteria)

Structure of Limitations / Threats to Validity

Break down by relevant quality criterion

- Feel free to choose relevant criteria beyond the core four

You should always put weaknesses / challenges into context

- Explain their consequences

9. Conclusions

The conclusions section

- Reiterates the main contributions and their significance

Some readers jump from abstract to conclusions directly

Skip any outlook on future work

10. Acknowledgments

List all people and thank them

- Who made a contribution that was relevant but
- Not enough to make them an author

Increasingly, make contributions explicit

- Who made which contribution that made them an author
- Expressed using a contribution model (see author list)

11. References

The references section is

- A list of literature references used by the paper

A literature reference is

- An identifying description of the paper's sources

The references typically list articles referenced in the paper

- They are usually sorted alphabetically

Working with References

The main body of a paper uses shorthand references, for example:

- “We use Braun & Clarke (2012) as our qualitative data analysis method.”

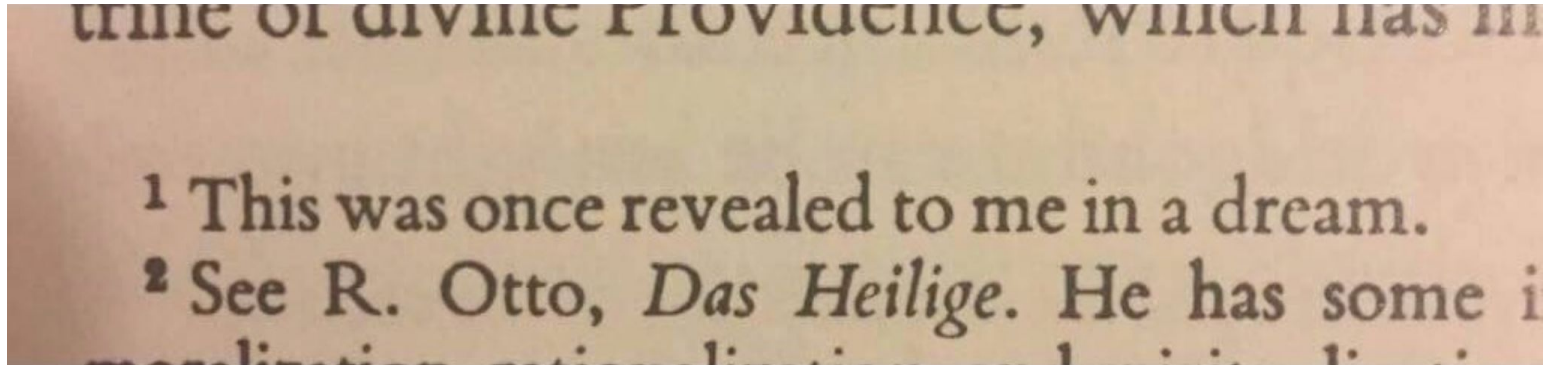
The short-hand reference serves as index into the references:

- Braun, V., & Clarke, V. (2012). Thematic analysis. APA.

Short-hand Reference (Indexing) Formats

Reference (key)	Referenced entry (value)
[27]	[27] Spector, A. Z. (1989). Achieving application requirements. In Distributed Systems, S. Mullender, Ed. ACM Press. ACM, New York, NY, 19-33.
[Spe89]	[Spe89] Spector, A. Z. (1989). Achieving application requirements. In Distributed Systems, S. Mullender, Ed. ACM Press. ACM, New York, NY, 19-33.
Spector (1989)	Spector, A. Z. (1989). Achieving application requirements. In Distributed Systems, S. Mullender, Ed. ACM Press. ACM, New York, NY, 19-33.

Not an Appropriate Literature Reference



3. Final Research Theses

Final Research Theses

We offer three options for final research theses

1. Pure research thesis
2. Design science thesis
3. Engineering thesis

Pure Research Thesis

A pure research thesis follows the format of a research paper

- It either blows up the format to the full length of a thesis, or
- It presents the results as a research paper, followed by an elaboration

Design Science Thesis

A design science thesis is a research thesis using a design science structure

1. Problem identification
2. Objective definition
3. Solution design
4. Demonstration
5. Evaluation

Engineering Thesis

An engineering thesis serves to demonstrate the student's engineering skills

The thesis structure follows the project results, for example:

1. Requirements
2. Design
3. Implementation
4. Evaluation of results

Process vs. Results

Science rewards results, not effort (skip process, focus on results)

Do not present work in the sequence you performed it, present only the results

- Research questions (research thesis) can be results
- Requirements (engineering thesis) can be results

Demonstrated ability to separate process from results is a plus

- If you absolutely must describe process, do it in a separate section

4. Academic Writing

First Rule of Writing

First and foremost rule

- Know your audience

All good writing is specific

- Use active voice
 - “An active voice walks into a bar”
 - “The bar was walked into by a passive voice”

Second Rule of Writing

Be brief and concise, or

- “Omit needless words” [1]

Variations

- Use short sentences
- Use subject-verb-object sentences
- Avoid common phrases
- Avoid imprecise adjectives (“very”)

More Best Practices

1. Avoid weak wording
2. Avoid imprecise wording
3. Use data rather than qualifications

Be Brief

Before

- “It is suggested to remove any dependency on prerequisite 3 in this experiment to not unduly restrict any possible outcome.”

After

- “It is suggested to remove any dependency on prerequisite 3 ~~in this experiment~~ to not unduly restrict the outcome.”

Be Concise

Before

- “It is suggested to remove any dependency on prerequisite 3 to not unduly restrict the outcome.”

After

- “It is suggested to remove requirement 3.”

Use Active Voice

Before

- “It is suggested to remove requirement 3.”

After

- “Drop requirement 3.”

Avoid Weak Wording

Examples of weak wording

- “We tried to...” (So what?)
- “We believe...” (OK, why?)

“Try not. Do or do not. There is no try.”

Avoid Imprecise Wording

Examples of imprecise wording

- “Very efficient...” (How efficient?)
- “Many occurrences...” (How many?)

Don't leave your reader guessing

All Rules Break Down, Eventually

“A veterinarian prescribed antibiotics Monday for a camel that lives behind an Iberville Parish truck stop after a Florida woman told law officers she bit the 600 pound animal’s genitalia after it sat on her when she and her husband entered its enclosure to retrieve their deaf dog.” [1]

[1] See <https://www.newyorker.com/magazine/2021/12/27/florida-woman-bites-camel>

Summary

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Thank you! Any questions?

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