

**Effectively Performing Experiments
and
Writing A Research Paper**

Li An

Acknowledgement

Prof Duxin Sun at University of Michigan for
sharing his slides

Experiments

- Lab work
 - Data collection (Satellite imagery, digital elevation model, census data)
 - Data coding, compiling, and analysis
 - Statistical analysis
 - All types of modeling...
- Fieldwork
 - Ground reference data collection
 - Social surveys
 - Vegetation data collection (e.g., plot sampling)...

Many people prefer doing experiments to writing a paper



Before you perform experiments



- Read about your topic
 - Your paper is built upon previous body of literature (and hopefully adding something), so you need to have a good knowledge of the literature: *What done? Not done? Gaps? Why important?*
 - Reading tremendously improves writing skills
- Read! Read!! Read!!!
 - But you can not afford reading all information
 - Only read related information
 - Read, digest, and grasp the main points (focus on ideas)

Where to find relevant literature

- Web of Science
 - Keywords, titles, author names
 - Publication years, affiliated organizations
- Libraries (e.g., SDSU Library)
- Many disciplinary databases
- Google (Google Scholar), Yahoo, Bing

Identify The Problem

Could out-migration cause
environmental degradation
In migration origins?
I want to collect data to test it!



- Identify at least one problem from reading or from your previous experiments
 - A question has not been answered, but worthwhile and feasible
 - One problem is often enough for you to perform experiments and write a paper
 - A best problem usually comes from your previous experiments and literature reading

Form A Hypothesis or Question

- Form a hypothesis (raise a question) to answer the identified problem (question)
 - That is all you need to answer in one paper
 - You might have sub-hypotheses or sub-questions revolving around the central hypothesis or question

Design Your Experiments



- Design your experiments around your hypothesis
 - Stay focused
- What figures and tables that you need for the paper
 - Fig 1 gives the conceptual framework (optional)
 - Fig 2 gives a site map (if any; optional)
 - Fig 3 gives an exemplar of your results
 - Fig 4 gives other parts of your results...
 - The plan may change depending on your finding of each experiment (then you need to re-plan the figures)
- Estimate your timeline for these experiments
- What is enough
 - Just to answer the central hypothesis (one problem in your paper)
 - Not too much (do not add unrelated data)
 - Not too little (provide different experiments to confirm the data)

Writing Your Paper



- Prepare your figures and start writing your paper while you are doing experiments
 - Know what you needs
 - Know how to organize and perform the analyses
 - Identify inconsistency in real time
- Lay out all your figures
- Decide what is the main point (idea) that you want to tell
- Decide the sequence of the figures
- Write an outline in your own English- don't bother with polishing it
 - do some story telling - don't simply dump all your data together

A scientific paper is not a mystery novel

- Tell the story directly
- Avoid suspense

The image is a collage on a light green background. At the top center, the word **AVOID** is written in large, bold, black letters. Below it, the word **MANUSCRIPTS** is written in large, bold, black letters. Six images are arranged around the central text, each with a label below it:

- Long**: A painting of a woman's face with a blue and yellow striped headscarf.
- Obscure**: A painting of a bull's head with a colorful, abstract pattern.
- Jargonized**: A painting of a woman in a black and white outfit, appearing to be in motion or dancing.
- Ambiguous**: A painting of a woman in a green dress sitting at a table, with a shadowy figure behind her.
- Redundant**: A painting of a woman in a red dress riding a white horse in a circus setting.

Your Paper Need to Answer These Questions:

- Why do I do this ?
 - Introduction (literature review)
 - Problem statement
 - Hypothesis
- How did I do it?
 - Procedures and Methods
- What did I find?
 - Results
- What does it mean?
 - Discussion and Conclusion

Structure of Most Research Papers (Geography)

- Title
- Authors and affiliations
- Abstract (250 words or so)
- Introduction
- Procedures and Methods
- Results
- Discussion
- Conclusion
- Acknowledgement
- Reference

Introduction

- What is known --- First
 - Begin with key terms and concepts in the field
 - Brief and balanced review of status of the research before your study
 - Do not forget to give people their credit
 - Not too much details, you will discuss the details in discussion

Introduction

- What is unknown --- Second
 - Define a problem statement (1 problem is enough for a paper)
 - Why it is unique or controversial
 - What significant changes will come out by solving the problem
 - No one has done it and that's why we are doing it
 - Why did you work so hard to get all these data?
 - Why should I read your paper and not another one?

Introduction

- Hypothesis (Question) --- Third
 - State your goal and objectives
 - Could decompose to a few (not too many) sub-hypotheses
- Briefly state the approach and rationale to study the problem --- Fourth
 - Why are these experiments designed this way?
 - What are the scientific merits of *your* work?
 - What advantages may arise in answering the question you are asking?
- Briefly state what you found and what it means/implies --- Fifth
 - Briefly describe the major finding
 - State the principle conclusion
 - How will this study advance our knowledge?
 - Empirical findings
 - Methodology (Innovative? Transformative?)
 - How will this study benefit the research community and/or the society?

Procedures and Methods

- Easy to write
- Equipments, Software, or Materials
 - GPS units (model, brand, accuracy...)
 - ArcGIS xx, IDRISI xx ...
- Experimental method is detailed enough for other people to follow and repeat
 - Use reference if previously published
 - Not overly detailed
 - Not a step-by-step protocol
 - Some details could be posted online
- How data are summarized and analyzed
- Use subheadings

Results

- Decide the sequence of presentation of each figure/table
- State why I did each step or procedure
- Present results without too much interpretation
- Use figures or tables whenever possible
- **Do not** reiterate each value from a Figure or Table - only the key result.
- **Do not** report raw data values when they can be summarized
- Report *negative* results - they are important!
 - Counter intuitive
 - Marginally significant
 - Opposite to your hypotheses

Discussion

- Discuss what is new in your work, and why it matters (refer to your introduction especially literature review)
- Show how your data may relate to previous knowledge
 - Your findings agrees with other's finding
 - Your data help interpret other's finding
 - Other's data help interpret your finding
 - Combine your data and other's to make a new model
 - Your findings do not agree with other's finding?
 - Do they suggest an alternative theory?
 - Be tactful about apparent disagreement
 - A data collection/design flaw, limitations, difference in your experiment (or theirs) ?
 - Next step to resolve any conflict
- State your conclusion as clearly as possible
- Summarize evidence for each conclusion
- Elaborate what the implications and significance of your findings are
 - Clearly distinguish between facts and speculations
 - do not be shy, but do not go too far
- What would be the next step in your study?

Note for Discussion

- Difficult to write
- Interpret (but not reiterate) your findings (and data sometimes)
 - Interpret the results in a large context of the problem
 - Explain new understanding of the problem
- Always link to the introduction and your hypothesis in the introduction
 - Not simply repeat
 - But move forward from the place you left in the introduction
 - Do your results provide answers to the hypotheses?
 - If so, how do you interpret your findings?
- Discuss the results in a sequence as presented in result section
 - Not to restate all the results
 - But bridge the results with interpretation
- Do not introduce new results in discussion

Conclusion

- What do your results mean?
 - Do not just repeat the results
 - What is your new understanding of the problem you outlined in the Introduction?
- Provide insight, significance, and implications
 - Issues for the future research
 - Elaborate but not too far

- Acknowledgement
 - People who offered assistance (even small helps)
 - Funding agencies
- Reference
 - Do not forget to give people their credit, otherwise they will be offended
 - An important ethical issue (“Do not push whatever you do not like to other people”; “So in everything, do to others what you would have them do to you”)!)

Abstract

- State the current status (one sentence) --- what (my not need)
- State the purpose and scope (one sentence or two)--- why
- Describe the methods and design briefly --- how
- Summarize the major finding --- what did I find
 - Key quantitative results
- State the conclusions --- what does it mean
 - Implication of your results

Authorship

- Single author or multi-authors?
 - Do other people contribute directly and significantly to your paper in funding, problem identification (idea), data, experiments, and analyses?
 - People providing logistic help: as co-author (if substantial) or put in the acknowledgement list
- Who should be the 1st (lead) author?
 - Who carried out the majority of the research (literature review, problem identification, experiment design & execution, data collection & analyses)?
 - Who wrote the majority of the paper?
- How many coauthors?
 - Put some people into your acknowledgement list
 - There is no absolute upper limit

Notes for Abstract

- Abstract is usually written last
- Abstract is an abbreviation of the paper and should stand on its own
- Abstract should cover all major aspects of the paper
- No lengthy background information
- Usually not more than 200 - 250 words
- These things should **NOT** occur in your abstract:
 - References to other literature
 - Incomplete sentences
 - Abbreviations or terms that may be confusing
 - Illustrations, figures, or tables

Title

- You can finalize the title last, but you need a provisional title when starting the writing
- Adequately describe the finding of the paper
 - If you could not summarize your research finding and conclusion in one sentence that catches people's attention, it would not be a paper in Science, Nature, or Annals of AAG
 - Can be a fragment (do not have to be a sentence)
 - Succinct and specific
 - Avoid "A study of...." or "A project on..."
- Not too long
- Avoid uncommon abbreviation (Okay for GIS)
- Most people will only read the title
 - So give some information that will add to their knowledge

Editing

- Writing is re-writing
 - Writing helps clarify your thoughts and redefine problems/new ideas
 - Writing is both a mental and physical exercise
- Better plan the writing
 - Put it into your schedule for several days
 - Have a good sleep
 - Put it aside and read it again (If possible)
- Does it make sense?
 - Flows well
 - One paragraph tells only one point (often the case)
 - Good sentence structure (simple sentence, active voice)

Use simple sentence in scientific paper

- Avoid cumbersome/complicated sentences
 - J. Liu's rule of thumb: When one sentence is over four lines, consider condensing it or breaking it into two
 - Avoid too many clauses in one sentence (e.g.: ...that...that..., which...)
- Simplify the sentence
 - Use less wordy phrase and verbs
 - If you can delete it without changing the meaning, then delete it!!
 - Delete a paragraph
 - Delete a sentence
 - Delete a word

Active vs. Passive Voice

- Use the active voice when possible
 - Especially in abstract, introduction, result, and discussion
 - You may have to use passive voice in some sections (e.g., methods)
- Say “who did what”
 - “It was not expected that outmigration would cause environmental degradation” → “We did not expect that outmigration would cause environmental degradation”
 - “The population size was increased by 8-fold when the reforestation policy was implemented” → The reforestation policy induced population increase by 8-fold
- About “who”
 - (Debatably): Avoid using “I” (in some fields Okay); use “we”
 - Use “this project”, “this study”, “our analyses”, etc., as the subject

Numbers

- Spell out one-digit number (e.g. Eight)
- Use numbers for two or more digits (e.g., 104)
- Do not start a sentence with Arabic numbers
 - “8 people were added to the survey list” → “Eight people were added to the survey list” or “A total of 8 people were added to the survey list”

Tense

- Introduction
 - Present tense for background information and previous knowledge
 - Sometimes present perfect tense: “Their data have resulted in a significant finding...”
 - Sometimes emphatic present tense: “Their findings do point out a new direction for ...”
- Methods
 - Past tense (that is what YOU did in times prior to your paper writing)
 - There are exceptions: All present tense for Methods (depending on disciplines)
- Results
 - Past tense and present tense
 - “We hypothesized that outmigration should be medicated by livelihood factors”
 - “Fig. 4 shows that remittances from out-migrants increased the amount of fuelwood collection”
- Discussion
 - Literature and previous knowledge: present tense
 - (Specifically for your research) Our data suggested that ...
- Conclusion
 - Present tense
 - “Our data suggest that ...” or “The methods used in this paper have broader implications on...”

Jargon

- Avoid confused, unintelligible, and strange language
- Avoid unnecessary obscure and long words (or sentences)
- A jargon story: The plumber wrote to the Bureau of Standard saying he found hydrochloride good for cleaning out the clogged drains
 - The Bureau: “The efficacy of the hydrochloric acid is indisputable, but the chlorine residue is incompatible with metallic performance”
 - The plumber replied that he was glad the Bureau agreed

 - The Bureau: “We can not assume responsibility for the production for the toxic and nontoxic residues with hydrochloric acid, and suggest that you use an alternate procedure.”
 - The plumber again said that he was glad the Bureau agreed with him

 - The Bureau: “Don’t use hydrochloric acid; it eats hell out of the pipes”

Small mistakes that deserve attention

- Spelling
 - Modeling or modelling? Labor or labour?
 - Data analysis or data analyses?
 - We used three tens (tons) of water...
 - People's names: Wandersee (not Wondersee), An (not Ann), Wang or Wong
- Grammar
 - A large number of migrants was (or were) moving into... vs. This cohort of students was (were) put in another experiment setting...
 - The data was (or were) collected...
- Format
 - Subheading with or without numbers?
 - Style of citations in text and in the list (check the journal requirements)?
 - Acres or hectares (mostly metric measures are accepted)

Do Not Copy

- Do not copy sentences from the paper of others and use it directly in your paper
 - Citing it in quotation marks is acceptable
 - Perfect sentences from various sources pile together do not make any point
 - Copyright concern

Developing solid writing skill

- Remember: clarity is key - not a mystery novel
- **STRUCTURE:** break your paper into subsections, each one with a specific topic
 - Write with a logical flow of thoughts
- (Quite often) Use the first sentence to introduce the paragraph to the reader

Writing with passion

- To reflect and elaborate on something you believe
- To express something you enjoy telling other people
- To write something with your passion (not a boring job)



Does your paper answer these questions?

- What is about ?
- Why did I do?
- How did I do?
- What did I find?
- What does it mean?