Writing Science - Joshua Schimel, 2012

Purpose -- capture key ideas and translate them into useful and constant tools to improve my writing. My thoughts are also intertwined and not directly taken from the text. Direct quotes are not properly cited.

Ch. 1 - Writing Science

- Success <> publishing, it's being cited.
- Clear thinking --> clear writing is an oversimplification, it's iterative -- a struggle.
- This is a book about re-writing.

"Shitty First Drafts. All good writers write them. That is how they end up with good second drafts and terrific third drafts."

Ch. 2 - Science Writing as Storytelling

- Stories include more than result & methods -- they need introductions and discussions.
  - Data without interpretation & perspective is not a story.
- Why is there a problem
  - Tight structure -- different than most stories
  - We struggle for clarity
  - Scientist inherently don't see it as story telling.
- Perspectives
  - See the focus of your work (molecules, concepts, etc.) as characters
  - As we analyze "let them speak to us & develop the story" -- don't impose it on them
    - listen to them!!
  - Data will never be the story. Readers seek insights --> understanding.

![Figure 2.2. The flow of science, from data to understanding.](image)

- DEEPER you take the reader towards UNDERSTANDING the deeper your IMPACT.
  - Interpreting your data
    - Over-interpreting -- taking them to an extreme
    - Occam's razor -- reduce, simplify, slash toward simplicity
  - Meaning can come from the OUTLIERS not the average...
- Final advice
  - Publish when there is a story to tell
  - Avoid mediocre stories
  - Follow the path of: THINKING - WRITING - THINKING - WRITING over and over until it
Ch. 3 - Making a Story Sticky

- Basic evaluation question: "How long after you read this will the reader remember it?"
- Chip and Dan Health's perspective

**S: Simple**
- Simple = core idea expressed in clear / compact manner.
  - At the same time be mindful of "simplistic" as an enemy.
  - As Albert Einstein would say: "Simple as possible but not simpler".
  - The art, science, and struggle for SIMPLIFICATION cannot be overstated.
    - It distinguishes good from great.
- Process of simplification...
  - Words & equations ....
  - Cartoons -- YES. [ I agree 100% ]
- Be aware of schemas -- pre-existing ideas we bring to new ideas
  - Leverage them.
  - Know what schemas your audience holds

**U: Unexpected**
- Unexpected = new and unexpected make stories memorable.
  - Origin = questions posed and interpretations shared.
  - Your job -- find what is novel, highlight it, and frame new questions.
    - id the unknown INSIDE the mass of pre-existing data.
    - "id ignorance in the midst of knowledge"
    - Facts first, outcomes first - no. Set the stage with good questions.

**C: Concrete**
- Concrete = tangible, real.
  - Strunk and White -- in the end seek to be specific, definite, and concrete
    - Specific - narrow the field
    - Definite - don't equivocate, say what is good or clear & what is not so good and clear.
    - Concrete - enable the reader to visualize, feel, smell, taste, your work.
  - Abstract to concrete -- a continuum, the danger is in the middle (small scale abstractions & vague details).
  - The middle cannot be avoided -- you need to make connections thought to Grand Abstractions & clear details.

**E: Emotional**
- Credible = direct assume the reader is skeptical

In the end there are three components

1. content -- does it engage us?
2. structure -- how do you put together for ease of use?
3. language -- how can the story be built to maximize impact?

- Origin = questions posed and interpretations shared.
- Process of simplification...
  - Words & equations ....
  - Cartoons -- YES. [ I agree 100% ]
- Be aware of schemas -- pre-existing ideas we bring to new ideas
  - Leverage them.
  - Know what schemas your audience holds
• Ideas are grounded by previous work
• Data is grounded with our methods, presentation clarity, and well-accepted statistics
• Emotional = curiosity is well accepted emotion, show it.
  • Adding information reflects our inner nerd, the join of accumulating information.
  • Change the mindset of "what information can I share" to "what insights or new knowledge can I share"
    • Move from answers/answers/answers focus to a question/question/answer.
• The 2nd well-accepted emotion - excitement, find ways to build that excitement in your readers.
• Stories = modules of tales
  • good paper = single large story built from threads of smaller stories. Integration of the threads is key.
  • seek UNITS - subsections of your work that can parcelled out as coherent modules
    • MAKE the READERS JOB EASIER -- these modules will improve assimilation.
• Final thoughts
  • find the simple story.
  • build it around key questions that engage U and E & this will guide your choices to ensure its C and C.

**Ch. 4 Story Structure**

• Basic Science Elements = OCAR, Opening - Challenge - Action - Resolution
Opening (O): Whom is the story about? Who are the characters? Where does it take place? What do you need to understand about the situation to follow the story? What is the larger problem you are addressing?

Challenge (C): What do your characters need to accomplish? What specific question do you propose to answer?

Action (A): What happens to address the challenge? In a paper, this describes the work you did; in a proposal, it describes the work you hope to do.

Resolution (R): How have the characters and their world changed as a result of the action? This is your conclusion—what did you learn from your work?

• OCAR structure -- all the elements in sequence, assumes significant reader patience.
• ABDCE structure -- fiction and proposal writers, when reader is less patient.
  • this structure is less efficient after A -- because we have to backfill for the characters.
Critical aspect -- our understanding of the world must CHANGE, the beginning point has moved:

**Action (A):** Start with a dramatic action to immediately engage readers and entice them to keep reading.

**Fill the readers in on the Background characters and setting so they can understand the story as it develops.**

**Development** Follow the action as the story develops to the climax.

**Bring all the threads of the Climax (C):** story together and address them.

**Ending (E):** What happened to the characters after the climax? (This is the same as the resolution.)

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**Figure 4.1.** How an OCAR story makes a spiral: the story comes back to its starting point, but that point has moved.

- LD structure: lead --> development, news stories, collapse O, C, and R into one short
section.

- least patient readers.
- LDR structure: lead --> development --> resolution
- Overall -- seek to make sure the O, C, and R can be retrieved readily without too much effort.
- Connection to science writing
  - O - larger problems, central characters, framing
  - C - interesting question(s)
  - A - research plan, results
  - R - important conclusions about how our understanding has changed
- Specialist journals have more patient readers, Science or Nature -- not so much!
- Mapping OCAR to IMRaD
  - The elements of OCAR drive IMRaD. OCAR is principle, IMRaD is rule.
  - Intro = OC ; Meth and Results = A, and Disc. = R.

**Introduction:** This has three subsections, although they are rarely broken out as such:

**Opening:** This is typically the first paragraph that introduces the larger problem the paper is targeting. What is the context, and what are the characters we are studying?

**Background:** What information does the reader need to understand the specific work the authors did, why it is important, and what it will contribute to the larger issue? I consider this an extension of the
* Hour Glass Shape for Science Writing -- notice how the story is "circular" as well... coming back to initial question/challenge.

**Ch. 5 The Opening - a position of power, use it wisely.**

- Elements
  - id the problem
  - introduce the characters
target an audience
foreshadowing the challenge and conclusions are welcome as well.
  ▪ Ask -- whom do you want to read your work & what do you want them think & use it for.

• Pitfalls
  • misdirection --> leading the reader down the wrong path.
    ▪ connecting sentences and paragraphs into one central story is the challenge.
  • no direction --> not leading the reader, rambling.
    ▪ avoid using schemas that are likely obvious to the readers.
    ▪ lacking specifics / focus is the main cause.

• Targeting your audience
  • Adjust the opening to suit the audience, their background, knowledge, skills etc.
  • Starting general and then narrowing the focus can work well.
    ▪ especially useful for diverse readership.
    ▪ key idea -- be quick and efficient, not sacrificing clarity.

• Adapt your style
  • Remember the SUCCES elements.
  • Ultimate goal of your writing is impact, measured in part by citings.
  • Frame the resolution in the same context as the opening & challenge.

Ch. 6 - The Funnel: Connecting O to C.

• Opening (O) -- defines a large problem.
• Challenge (C) -- defines SPECIFIC question(s).
• The introduction connects these two.
  ▪ Your challenge: to make progress on the larger problem you need to answer these questions
• Clearly point out knowledge gaps.
• Bad introductions
  ▪ Unclear in defining the problem / challenge
    ▪ equal poor in defining the value of solution.
  ▪ Don’t say "little is known" -- that's is very rare.
    ▪ Solution be more specific .... "x,y, and z, have not been studied to examine ...."
      ▪ Use tight language.
      ▪ Concede what is known...
  ▪ Remember to put the problem first & the solution second.
    ▪ Recall the door by door salesman.
• Intro vs Lit. Rev.
• Intros -- problem, importance, what's not known, and why a solution matters.
• Lit. rev. -- show the knowledge.
• Intros -- focus on the holes inside the knowledge
  ▪ focus on literature at the edges / boundaries -- not core knowledge.
• Intros focus on what was found in research not who did the research.
  ▪ Leading with the Authors "Smith found .... " usually indicates further
    thinking/synthesis of ideas is needed"
• Backgrounds (element of intros ) are NOT data dumps!

Ch. 7 - The Challenge

• Challenge describes the knowledge you hope to gain!
• It begins with questions. Your work describes the effort to find answers

Direct Quote:
In the challenge, you describe the specific knowledge you hope to gain.
This starts with the question that drove you to do the research. You did the work to discover
the answer. From the question, we sometimes formulate a hypothesis and we usually state
specific objectives, which describe the information we will present. Some authors only pose the
question, whereas others do all three, offering a question, framing it into a hypothesis, and then
describing specific research goals. Each approach has its place, but the question is the core of it
all.
If you don't have a question, you are not doing good science. If readers can't tell what it is, you are
not writing good science.

• Hypotheses are secondary to questions. They can help organize thoughts, structure
  research
• Questions, defining the knowledge gap, is key / vital / essentail.
• Critical idea -- questions come BEFORE objectives.
• After the question
  ▪ layout the challenge briefly
    ▪ specific objectives
    ▪ approach
• Front loading the introduction (providing conclusions) is fine - particularly in biomedical
  literature
  ▪ particularly useful for impatient readers
• Good challenges
  ▪ condenses down to --- "to learn X we did Y". Critical part = "to learn X"
• Possible layout / approach
  ▪ Significance of overall problem
  ▪ What other people have done -- highlighting
    ▪ unique findings
    ▪ gaps / wholes
    ▪ opportunities
  ▪ State the question
    ▪ reinforce the value of the question - how it relates to prior work
  ▪ Briefly explain the objectives approach
  ▪ Briefly summarize what has been found -- condensed conclusions.
• Pitfalls
  ▪ Focus on information alone; "we did Y, Y1, Y2, ...." omitting "to learn"
• In summary -- good challenges
defines data you show/collect & the knowledge you hope to gain.

Ch. 8: Action

- Contents = everything between challenge and resolution or
  - Materials and Methods
  - Results
  - Most of the Discussion
- Your challenge: embed the action into the larger story. If not -->
  - aimless
  - incoherent
  - dull
- Two parts (maybe three - 1st say what you are specifically seeking)
  - What you did -- materials and methods
  - What came of it -- results and most of discussion
- Methods
  - Used to assess credibility of data & conclusions, not so much to repeat the work
  - Use the LD (lead --> development) structure in cases
    - big picture
    - details for those who want them
  - Tap into well-established schemas or techniques when possible.
  - Summing it up:

"Through such approaches, using LD structure and tapping into established schemas, you can make your methods easier for both novices and experts, allowing them to get the information they need at whichever level they choose."

- Results and Discussion - core principles
  - Make the reader's job easy -- present results & interpretations in a way that helps develop the story.
  - Enable the reader to discover what you found from what you think !?
  - Material in a paper:
    - data - raw or condensed (Schimel says results but Zeiger says data <>results)
    - inference - clear and robust interpretations of data, some times obvious
    - interpretations -- your thoughts, hypotheses, and speculation of what the results may mean
  - Integration -- it depends, shorter papers tend to integrate more.
    - There isn't a simple guide -- make the decisions based on Reader Effort.
    - Results and Discussion ARE distinct but they do NOT have to be presented in diff. locations
- Choosing Data to present
  - The must contribute to the overall story in a significant manner.
- How to present
  - Go beyond raw towards synthesize data (reduced in clear parcels) that easily understood.
  - Use the LD (lead/development) structure starting with major points and following up with details.
  - Don't let the statistics steal the show - be clear and concise, and focus your wording on the data.
• the focus should not be the p-value but rather the finding or difference.
• Saying there is not significat effect because p>0.05 is problematic, especially when there is a clear difference.
  ▪ you should still saying the important effect, noting, "however the p = 0.07".

• Discussion
  • thoughts and interpretations, answering the challenge questions - showing contribution to the larger problem framed in the beginning.
  • Critical Act of Creativity
  • Pick a structure -- OCAR or LDR (more common) or ... and stick with it. Some options include
    ▪ reiteration of the challenge
    ▪ re-energize the readers curiosity
    ▪ state the critical result in the framework of the challenge
  • should be story within itself.

Ch. 9 Resolution = it resolves the challenge posed! (or at least takes us closer...)

• Target = your final take-home message, with strongest, most memorable words
• Shows how our understanding of nature has improved
• New insights into the problem posed
• Wraps up the story

"A good resolution achieves this by stepping backward through OCAR: it reiterates the action, answers the questions raised in the challenge, and demonstrates how those answers contribute to the larger problem."

• "In conclusion" is a helpful flag to consider...
  ▪ Alternatively -- make a strong statement backed by results and explain value/significance.
• Consider ending with a question if
  ▪ it can be stated in a clear and concrete manner
  ▪ it arose from your work
    ▪ The key question -- does it engage the reader's curiosity in a powerful way?
  ▪ it follows a natural progression of investigation. ( your next paper )

• Weaknesses
  • Claiming importance, but not backing it up with evidence
    ▪ overreaching and underdelivering.
  • Not answering the specific question posed.
  • A lack of synthesis -- lots of data but know clear explanation of how understanding has been improved.
  • Repeating well understood facts that are textbook material or at least better suited for the intro.
  • Introducing new ideas never previously discussed -- no! this is not a mystery novel.
  • Focusing on what you haven't done
    ▪ "more research is needed to clarify our findings".....
    ▪ resolution is not the place for an abundance of humility
    ▪ re-arranging words or sentence structure can place emphasis where it should be ... your work.
Avoid generalities regarding the need for future research, more exploration, etc.

- At its core
  1. synopsize results
  2. synthesize those results - showing us how they answer your question.
  3. show what it contributes to the larger problem
     - clearly
     - concretely --> maximizes the "punch line"
- Proposal Resolutions:

"Make space for a resolution paragraph that encapsulates the proposal, reiterates the big issue and explains how the components work together to address it— make the final pitch for why the proposal should be funded."

**Ch. 10 Internal Structure**  - Story Arc

These direct quotes are soooo good -- let me cite them directly:

"OCAR defines the overall structure of a story. The **opening** grabs your attention with characters and a setting that you care about.

The **challenge** creates uncertainty and curiosity: what is going to happen to those characters?"
Novelists describe that as creating "tension"— the emotional drive to keep reading. The action feeds you information and develops the story.

Finally, the resolution rewards your efforts and relieves the tension— our hero and heroine finally get together, our questions are answered! We may not feel the emotional intensity in a science paper that we do in a good novel, but the tension that keeps us reading is fundamentally the same— it's grounded in curiosity. We don't bother reading a paper if we already know the story.

This flow of opening, development, and resolution— building and then rewarding curiosity— creates a story's "arc" (figure above). The vision of story as arc also emerges from the idea that a story has a spiral structure, moving forward but coming back, at the end, to where it began.

**Scientific writing is successful when it creates that flow and that arc.** But papers and proposals are made up of sections, each of which tells its own story and has its own arc. The Introduction tells us why you did the work— it opens, narrows, and resolves with the paper's overall challenge. The Materials and Methods starts with the study system, then the measurements, and wraps up with how you analyzed the data. The Discussion, too, should form a story of its own, as I argued in chapter 9. It opens by restating the issue, discusses the evidence, and resolves with the paper's conclusion.

- Guidance
  - Headings help.
  - Paragraph simplicity helps
  - Words that flag transitions/comparisons/highlights work -- "however, consequently,
- When "arcs" are not clear and present
  - Arcless writing drifts. While the facts are likely credible the connection between them are weak.
- Questions to ask:

"Does each unit make a single, clear point?

When several paragraphs together form a section, are the linkages among them clear?

Has every extraneous thought that breaks the serial arc structure been removed?

When you introduce a topic, do you resolve that discussion before introducing a new topic?

Is every major unit of the work defined by either a subhead or clear opening text?"
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Ch. 11 Paragraphs

• Strunk and White -- Mke

Ch. 12 Sentences

Ch. 13 Flow

Ch. 14 Energizing