

Writing Well²

Building Traction and Triumph into co-Authorship

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We report on a workshop designed to reveal some new ideas on how to write productively, effectively, and with the goal of a healthy, sustainable lifestyle. Accomplishing this requires that we teach graduate students to write well and independently. The results of the workshop are summarized below.

Workshop Objectives

The objective is to find ways to write productively, effectively, and with the goal of a healthy, sustainable lifestyle. Accomplishing this requires that we teach graduate students to write well and independently. Four invited speakers addressed different facets of this, and some time was reserved for everyone to contribute their own best ideas and practices. Recommended background reading ^{1,2}.

1. Review current research on how students learn to write: *Roger Graves - Director, Writing across the curriculum*, who has assisted with the design and teaching of several writing courses for graduate students in other faculties on campus, and is available as a resource to all instructors for undergraduate teaching.
2. Teaching exercises for research groups and graduate students: Several exercises are proposed for group meetings where students learn how to take apart a journal paper and put it back together to uncover the argument structure and logic which lie beneath the surface.
3. Constructing a compelling story in the form of a journal paper.
4. Publishing in a large and productive research group: the human element of collaboration.

Writing Studies Research

First, writing studies research reveals that students learn to write in a social context ^{3,4}. Their social groups include relationships with advisors, research groups, peer writing groups, and departmental activities ^{5,6}. Putting students in writing groups, where they give each other feedback, can substantially reduce the strain on both the student and the advisor. Second, a research paper is a specific genre of writing, so if we think students don't know how to write in this style when they start, we are right, because they have never been taught to write in this new genre ⁷.

Teaching Exercises: Deconstruction-Reconstruction - Exercises in Communication

A novice reading a research paper tends to knowledge acquisition; the novice searches for facts and figures whilst assuming that there is correct informational content to be acquired. An expert reader tends to analyze the merits of the arguments in a research paper and judge the

validity of the work. The inherent difference is how experts read; experts are in fact reading the paper to assess how strong an argument has been made for a particular position regarding an idea. In order to help graduate students achieve critical thinking and writing we have to change the way they read and write papers, and even how they speak in public. Research is largely about clear communication of data, ideas, and hypotheses.

Because novice students have not been formally trained in the writing genre of research articles a series of communication exercises (some of which are contained in the Appendix) have been developed to teach graduate students how to take apart a journal paper and put it back together. The exercises help students uncover the argument structure and logic which lie beneath the surface of the facts and figures. The communication exercises range from ghost writing the title, abstract, and conclusions to an unknown paper to choosing the right journal for publication, knowing the competition, and analyzing argument structure.

Besides attaining a higher quality of communication another major underlying goal of the exercises is to help students establish a connection between their research and the rest of the community. The exercises help to answer four critical questions required for effective communication:

- 1. Do you *really* know what you want to say?**
i.e., What is your idea or hypothesis?
- 2. Do you know how to say it?**
i.e., What is your argument?
- 3. Do you know how to present your material in a way that compliments what you want to say?**
i.e., Which data, graphs, tables, schematics, photos will you include?
- 4. Do you know how to make your work memorable?**

Students can refer to these underlying questions to help them when they are writing, and reading. The last question about making one's work memorable takes on another form of training, which is not the main focus of the included exercises, but is also very relevant.

To enable people to remember your research and ideas it helps to understand some basic human psychology. Portraying ideas in a certain manner can make your message "sticky" or easily remembered. Heath and Heath⁶ advise a rather formulaic approach for attaining stickiness: keep the message Simplistic, Unexpected, Concrete, Credible, Emotional, and tell Stories (SUCCEsS). Of course, applying said formula takes practice and creativity! Many of the exercises contained in the Appendix also have a level to them for attaining stickiness (e.g., Exercise 5: Visual Abstract). However, it should be noted that we have found that stickiness training is best done after the basic research paper writing skills have been acquired (required sections in a manuscript and their purpose), but not too long following basic skills acquisition lest the students be required to switch their way of thinking. For example, knowing about stickiness will help students when constructing their arguments, but not so much in knowing the purpose of an introduction. However, for example, how the introduction is written and what goes in to the introduction can benefit from a little stickiness.

Students find the exercises very beneficial. Comments surrounding all the exercises will not be provided, but interestingly, a vast majority of students find "Exercise 5: Visual Abstract" very difficult the first time they reflect on their research. However, most students comment that the visual abstract exercise is crucial to them realizing what it is they are doing in their research. A

general written outline exercise has been used in the past for students to reflect on their research, but it is not as powerful as the visual abstract, likely because the students tend to make visual connections and image cues in their minds when thinking about their research, which cannot be as easily captured for them with words on a page.

By performing the described exercises graduate students feel that they have become better communicators, and such feelings are supported by evidence. Improved quality after training has been observed: first drafts of manuscripts (measured by the number of levels of required editing), research group presentations (measured by polling the audience), and conference presentations (oral and poster presentations) have improved once students have understood that they need to practice as much about “knowing things” as explaining what they know, how they think, and how their communication of their ideas impacts the community.

Once the students have developed some knowledge in the area of technical writing the transition is to one of writing a memorable story that is also compelling – telling a story to evoke an emotional response in the reader and thus making the ideas much “stickier”⁶.

Writing a Compelling Paper

There is a tight checklist of things which we expect to see included in a technical paper. Most departments have an undergraduate lab manual which can be used as a starting point for technical writing. If this is not available, a writing recipe may be developed to cut through much of the initial formatting requirements. Several checklists (for figures), flowsheets (for the writing process), and writing templates (what goes where in a paper) were submitted to the workshop by different supervisors. An overview of the results shows some distinct cultural differences between fields in the details of what is reported where in a paper, expectations of the content of figures, and the key words and references which must be cited. Several workshop presenters emphasized to their students that they should read the final version *not* as an author, but as a *reviewer*.

Once the formulas are set aside, our two prolific authors both clearly stated that, “Writing a scientific article can be a traumatic experience. One must lure and entice someone to read your work.” The art of turning scientific results into a clear and compelling story for the reader is partially deconstructed in Heath and Heath⁶. Several guiding principles for technical articles were identified in the workshop. A well written article explains the motivation for carrying out the project. It should be written in a style that is clear, leaving no doubt as to what you mean. Do not bother trying to sound scientific: focus on being clear and concise. Before you start writing, read the relevant literature, understand what you read, and be critical of what you read. Decide on the message you want to convey. Package your findings in a way that will make your results stand out as being very relevant. Remember that you are writing a story.

Realizing one’s story telling ability in technical writing is a great triumph! Maintaining sustainability in the writing process also takes considerable skill and effort (perhaps as much as collecting all the data, and accompanying evidence for the papers in the first place!). Moreover, a considerable challenge can arise when multiple authors are involved in the writing process. The participants emphasized that the traditional outline format is not helpful for many engineering authors, but that a number of other more visual tools can be used to structure parts of the writing process (storyboard of figures, beetle diagram, concept map, the Nike principle (Just write it!), tree diagram, first sentences in paragraphs tell the story, very rough draft for discussion). Using these tools effectively, early in the process, is a key characteristic of efficient collaborative

writing groups. An informal survey indicates that most engineering authors use several of these tools in trying to structure a paper.

Gumption traps in collaborative publishing

The human element of technical writing requires that we maintain momentum and excitement. One of the key points here is to stick to one level of edit at a time: fast turnaround and manageable amounts of improvement keep up the momentum and maintain excitement around the process.

The term “gumption trap” describes some of the pitfalls that either delay or completely derail a collaborative paper⁸. The term “gumption trap” refers to getting into a mindset that drains away enthusiasm for the work at hand. Pirsig⁸ refers to two types of gumption traps: setbacks, which arise from external factors, and hang-ups which are internal.

The nature of setbacks can vary considerably. For example, large setbacks may arise from overlooking some critical element in a project, which can in turn result in long breaks and a loss of interest in the project. Pirsig suggests preventing these kinds of gumption traps by being slow and meticulous during data collection, taking notes that might help later, and laying out everything required in a logical manner. Students can avoid later problems by writing up their work before they believe that it is complete. At this point in a project, gaps and omissions in the work can be filled by going back to the lab and collecting more data. This approach is much more difficult if the work was “completed” months earlier.

In contrast, hang-ups stem from internal factors that can get in the way of starting or completing a project. Pirsig’s examples include ego, anxiety, boredom, impatience, and an inability to re-evaluate facts that might seem unimportant. Dealing with hang-ups can be as simple as taking a break from the problem for a while.

How can you avoid losing your gumption about publishing a paper, in a collaborative environment like a large research group? Here are some points to watch out for.

1. Agree on authorship – Who will be an author?
 - a) Agree on roles in writing, and define who will prepare materials such as figures and tables, and who will write the different text sections. Be clear on the roles of each author in the paper, and ensure that the ethical expectation that each author must make a substantial contribution
 - b) Order of authorship – Typically the leader of the overall project will be senior author or last author, the student or researcher who did the most work and writing as the first author; other authors in supporting roles as 2nd, 3rd, 4th author
2. Scope of work. Agree on the scope and the “story” in advance; stay away from least publishable units.
3. Maintaining momentum is essential to completion without losing gumption.
 - a. Reasonable turnaround on revisions – I try for returning comments within a week; one collaborator always acknowledges and sets a target date for her response – we all have ups and downs in our workloads, but it really helps your co-authors if they know when they can expect to receive your comments

- b. How to manage a slow responder? The strategy tends to depend on whether the co-author is a graduate student, a colleague, or a faculty member at another university. There are no hard and fast rules here, except that the worst way to deal with this problem is to hope that it goes away until you are really angry with the person. Reminders are essential.

Conclusions

One idea that emerged from the workshop was to create a course that could convey information about writing to students. For a variety of reasons, creating a new course is unworkable. In some ways a course may not be the ideal solution because it is often removed from the context of writing in a working research group. One ideal solution would be a problem-based learning group that is facilitated by instructors in Engineering or writing, and embedded in the department's activities (e.g., researching, presenting, and publishing). Departments can establish these learning groups, and writing centres (writing across the curriculum programs) on the campuses of large universities are often eager to support these groups.

Ultimately we came away from the workshop with these thoughts:

1. Technical writing skills must be learned continually throughout a career as new writing genres and challenges present themselves.
2. Problem-based learning groups would be a good match for Engineering disciplines because of the inherent focus on problem-solving.
3. Guided peer response can shoulder some of the burden of responding to graduate student writing, especially if more senior students can be recruited to join the groups.

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APPENDIX: Sample Communication Exercises

Learning how to write technical documents and give technical presentations takes practice. There are many skills to master when writing and presenting; many skills do not revolve around writing! The exercises herein are designed to help you practice thinking *and* writing in an effort to enhance your communication skills. Some of the exercises are designed at mechanics. Some of the exercises are meant to develop your thought processes with the goal of understanding your own work, and then writing about or presenting it all.

In the context of manuscript preparation most journals (and even theses) have certain requirements for format, headings, layout style, bibliographic style, graphical specifications, and the like, yet none will tell you how to write a “good” article. Similarly, conference organizers may supply a PowerPoint template, but that is where the guidance stops. Reviewers will certainly tell you how “bad” your paper is and some may offer advice on how to correct it, but basic advice to make you a better communicator is often not found in such critique. Generally, no one tells you face to face how bad your talk was; anonymity in the blind reviewer process tends to be more honest and frank.

These exercises are given one at a time, usually in the order they appear. Once you have completed the tasks (within a week or two) the student meets with the advisor to go over the student work and then either compare results with a particular paper, or have a discussion.

Communication Exercise #1: “The beginning and ending”

Outcomes:

1. Be able to list the key structural elements for a title, abstract, and conclusions section of a research paper.
2. Be able to formulate a title, abstract, and conclusions section after having read an edited article for which such sections and citation information have been removed.
3. Be able to compare and contrast differences between your own work and that of the original paper.

Writing down all the information to tell your story is important, but the beginning and ending to your story are even more important; in general people read the title, glance at the pictures, laugh at all the big words, and read the conclusions. If there is something interesting in the paper they may read the *entire* paper – but the latter is unlikely.

This exercise will help you hone your skills at writing the beginning and ending of a story – someone else’s story.

I will select a paper for you from the literature that I think you may not have read, but one that pertains to your research. I will then remove the author names, affiliations, the title, the abstract, any conclusion section, and the journal name and reference information.

You will then read the paper and:

1. Determine a title for the paper.
2. Write the conclusions that you think the authors could make.
3. Write the abstract for the paper.

Communication Exercise #2: “Where to publish?”

Outcomes:

1. Be able to identify the field of research in which your work would be suited.
2. Be able to identify up to three potential journals that would provide a good match for your work, and select the “best” choice.
3. Be able to determine reasons for your choice of “best” journal in which your work should appear.

Matching your work with an appropriate journal can be a difficult but critical step of the publishing experience. Knowing the topical areas in which journals predominantly focus is helpful in finding a suitable match that will be read by the community in which you want to contribute.

The outcome of this exercise will be to find a journal for a manuscript (the one from the previous exercise) and explain your choice.

For the same paper that your first exercise was based you should:

1. Identify and list the major fields in which the paper is based.
2. Propose a list of three journals to which you would have submitted the paper.
3. Rank your first choice as the most appropriate work for the particular journal.
4. Give reasons for your choice of journal.

Communication Exercise #3: “Know the work of others”

Outcomes:

1. Be able to perform a citation search.
2. Be able to identify the major research groups in certain fields citing particular articles.
3. Be able to track and determine the major research questions being addressed by groups citing a particular work, and determine if they have been successful in achieving their goals.
4. Be able to identify unanswered questions in the literature surrounding the topic of the cited paper.
5. Be able to determine where your work fits in with the research community.

At the end of Exercises 1 and 2 you will know the author and the citation information. It is important that you know what other people in the field are doing, and what questions they are trying to answer.

Now, for the same paper for Exercises 1 and 2 determine the following:

1. Citation count over the past 5-10 years
2. Who is citing the paper? (up to 5 research groups)
3. What are the people citing this paper trying to accomplish? (have they done it?)
4. What major topic areas have been citing the work? (are they related or unrelated?)
5. What is still unresolved in the general topic of interest that the original paper was investigating? i.e., what can you work on that will add a contribution to the field?

Communication Exercise #4: “The art of the argument: reading and writing like a pro”

Outcomes:

1. Be able to read a paper and “see” the argument structure rather than the facts and figures.
2. Be able to analyze an article to determine if the problem statement is clearly defined, portrayed, and backed up with appropriate, sufficient, and reproducible evidence.
3. Be able to determine if the work is making significant contributions to the research community.

A novice reading a research paper tends to knowledge acquisition; the novice searches for facts and figures whilst assuming that there is correct informational content to be acquired. An expert reader tends to analyze the merits of the arguments in a research paper and judge the validity of the work. The inherent difference is how experts read. Experts are in fact reading the paper to assess how strong an argument has been made for a particular position regarding an idea. How did the expert shift their way of reading? How will you? The answer is easy to say, but takes practice: change the way you read.

Select a favourite research paper in your field that you know well (you can also select a poor paper as well for comparison). Try to select a paper from which you have learned facts and figures in an area where there are disparate views of the subject. Your task is to re-read the paper paying attention to the argument structure and by answering the following questions:

1. Did the author(s) explain the problem being addressed in the present work?
 - a. Can **you** clearly identify the problem - are you convinced?
 - b. At what point in the paper did you really understand the problem?
 - c. Is the motivation for solving the problem clear?
2. Have others tried to address the same problem?
 - a. What did others find?
 - b. Are the other positions explained clearly enough to make comparison to the current work?
 - c. Is the difference between the different research groups substantial, or miniscule?
 - d. Did the author(s) offer how they intend to solve the problem and how that will fit into the big picture?
3. Is there a clear indication as to why the problem needs to be solved?
4. What is the main argument for the work?
5. What evidence is given to support the author’s argument?
 - a. Is the evidence appropriate for the problem?
 - b. Is the amount of evidence sufficient?
 - c. Was the evidence collected in a suitable and rigorous manner?
 - d. Is the evidence of high quality and reproducible?
 - e. Is the evidence convincing?
 - f. Can you think of any missing evidence that would make the argument stronger or weaker?
6. What has the author done to manipulate your thinking of the subject?

Communication Exercise #5: “Visual abstract”

Outcomes:

1. Practice visual thinking.
2. Be able to prepare a simple and effective visual abstract for your research as judged by your supervisor and research group peers.

Visual communication is a critical tool in many businesses, especially research. A great resource for learning about visual communication is Bo Bergström’s book entitled “Essentials of Visual Communication”⁹.

Some journals require a visual or graphical abstract for manuscript submission. This exercise will help you develop such a visual abstract for your own research. Such visuals make for wonderfully simple slides in presentations and help you organize your work in a compact form when someone asks you “what do you do?” in the elevator.

Many science and engineering types are visual learners and thinkers. The visual thinking process involves looking, seeing, imagining, and showing¹⁰. Until now most of these exercises have been about mechanics and argument structure. This exercise focuses on your ability to distill your work into a single graphic that communicates your “story”. Basically, you need to construct a schematic that “shows” others what it is you are doing in your research project. I would encourage you do some more reading on the subject by reading Dan Roam’s book entitled “Back of the Napkin”¹⁰.

For this exercise you should have a particular project in mind. Perhaps a manuscript about a particular idea in your research, or your research in general. You will be given a napkin during group meeting, and by the next group meeting you should:

1. Prepare a list of important concepts in, or contributions of your work.
2. Determine the relationships between variables or concepts.
3. Identify key graphics, or graphics that represent the concepts of importance.
4. Construct a visual abstract on your napkin, and present it to the group for discussion.