How do you Write and Present Research Well?

Gregory S. Patience,[1*] Daria C. Boffito[1] and Paul A. Patience[2]

1. Department of Chemical Engineering, Polytechnique Montréal, C.P. 6079, Succ. CV Montréal, H3C 3A7, QC, Canada

2. Department of Electrical Engineering, Polytechnique Montréal, C.P. 6079, Succ. CV Montréal, H3C 3A7, QC, Canada

Research is only half the work; the other half is writing and publishing. Your research is incomplete until you publish your data.[1] Publishing is necessary but insufficient: others must cite your work.[2] Writing well and preparing a coherent story will help your paper get past the first hurdle in the publishing process – the copy editor. The second hurdle is the editor, who checks if it is suitable for the journal, and reviews the abstract, conclusions, and references.[3] The final hurdle is the reviewers, who devote more time to validate the hypotheses, results, and interpretation. Rejection rates across journals are increasing.[4] *Science* copy editors send one out of five submissions to the editors, and their overall rejection rate is 93%. The *Canadian Journal of Chemical Engineering* rejects close to 3 out of 4 papers researchers submit. Write better so journals accept your papers and researchers cite them.

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INTRODUCTION

Books and articles explain how to write papers clearly and concisely but researchers don't read them. Many engineers consider anything other than the passive impersonal voice to be unprofessional. The Institution of Chemical Engineering sent their members six versions of an excerpt from a technical report,[5] each with a different style that varied from the active voice to the passive voice. Although the article stated that the survey "should destroy forever the myth that most engineers prefer a heavy impersonal style," only 46% of the readers preferred the direct, active voice. Authors that publish in top journals like *Nature* and *Science* rely on the personal pronoun *we* to highlight and describe their work.[6] *Nature* guidelines for writing a paper explicitly state that they "prefer authors to write in the active voice (*we performed the experiment…*)."[7] The active voice communicates ideas more clearly with fewer words and is therefore easier to understand, but it's more difficult to write.

How well do you write papers and present your work at conferences? The following questions test your knowledge of writing and of Chemical Engineering bibliometrics.[8] The questions reflect the minutiae of disseminating information – forming sentences, formatting graphs, expressing error bars, following SI conventions, and understanding the impact of your work through bibliometrics. Approach writing articles and delivering presentations like research: be meticulous and express the concepts clearly.

If you correctly answer 14 of the following questions, you can communicate effectively and understand Chemical Engineering bibliometrics. The *Can. J. Chem. Eng.* will publish the answers in upcoming issues.

QUESTIONS

1. Many researchers avoid expressing sentences with personal pronouns such as *I, you, we*. Rather, they resort to the passive tense and add clutter with words and expressions like *It should be noted that* or *It is suggested that*. The former expression appears more than 2 100 000 times in Google Scholar[9] while the latter appears over 710 000 times. In the 500 most-cited articles and letters from *Science* in 2013 and the top 500 from *Nature*, how many times does *we* or *our* appear?
   (a) more than 2000
   (b) between 1000 and 2000
   (c) between 500 and 1000
   (d) between 250 and 500
   (e) less than 250
2. Passive voice, active voice, agent and patient, subject and object: the agent acts on the patient in the active voice, which makes it clearer. Select the best active sentence.
   (a) We measured the pressure periodically.
   (b) The pressure was measured periodically.
   (c) It was shown that the pressure varied periodically.
   (d) Pressure varied periodically.
3. Identify unnecessary verbs in the following sentences to measure poly(methacrylic acid) (PMMA) elasticity with an Atomic Force Microscope (AFM).
   (a) An AFM was used to measure the entropic elasticity due to the uncoiling of individual polymer chains of PMMA.
   (b) We performed AFM measurements to evaluate the entropic elasticity due to the uncoiling of individual polymer chains PMMA.
   (c) The measurement of the entropic elasticity due to the uncoiling of individual polymer chains of PMMA was done with an AFM.

*Author to whom correspondence may be addressed.
E-mail address: gregory-s.patience@polymtl.ca
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(d) The entropic elasticity due to the uncoiling of individual polymer chains of PMMA were made with an AFM.
(e) We tried an AFM to measure the entropic elasticity due to the uncoiling of individual polymer chains.

4. In the classic writing style, writers recognize that readers are competent and will recognize the truth as you lead them through your work. Soggy prose seeks "to argue for the truth."[10] Your text should read like a conversation rather than a lecture. Match each sentence with one of the cardinal sins of writing to the left. (Multiple choices possible)

1 Hedging	a) These results are extremely significant statistically and compare favorably with validation studies.[11]
2 Signposting	b) In general these results show that a system with zero-cost identities does not require centralized allocation of identities to encourage cooperation.[12]
3 Redundant	c) Here we report our new results on the samarium-arsenide.[13]
4 Self-conscious	d) More recently researchers have attempted to quantify the effects of anxiety on foreign language learning.[14]
5 Narcissism	e) Whether established pests are suitable for attempted eradication is extremely controversial.[15]
6 Boosting	f) In this section we shall evaluate the rate of recombination for nonequilibrium conditions.[16]

5. Fewer words can be more powerful than many words. Identify boosting, signposting, redundancy, hedging, feeble sentences, and convoluted expressions in the following sentence.

"It should be noted that while we have already mentioned the interaction of the implants with the tissue and will discuss later in this manuscript the effect of the regenerative therapies on the tissues, the possibility exists that the materials delivered to the interface may interact with the implant itself. We will briefly discuss this possibility now before moving forward with the rest of our discussion."[17]

What is the minimum number of words to express the same information?
(a) less than 10
(b) from 10 to 19
(c) from 20 to 29
(d) 30 or more

6. Titles should be concise but informative. Words in titles are a primary source for text-matching for internet search engines. How many characters should your title have?
(a) 50 ± 25 (σ)
(b) 75 ± 25 (σ)
(c) 100 ± 25 (σ)
(d) 125 ± 25 (σ)

7. We cite other researchers to recognize their contribution, educate, and establish the foundation of the research. References should balance recent breakthroughs with past contributions. Between 2011 and 2014, *Nature* published over 3200 articles and letters that referenced 113 000 papers. What is the average age of the references in these papers (the difference between the year *Nature* published the paper and the year the cited article was published)?
(a) 4
(b) 6
(c) 8
(d) 10
(e) 12

8. What are the minimum requirements for co-authorship?
i) conceive and design the study (or parts of it)
ii) collect and analyze data
iii) interpret data
iv) draft the article
v) revise parts of it
vi) approve the final version
vii) agree to be accountable for the results
(a) collect and analyze data (ii), draft the article (iv), approve the final verstion (vi), agree to be accountable for the results (vii)
(b) conceive and design the study (i), collect and analyze the data (ii), draft the article (iv)
(c) interpret the data (iii), revise part of the article (v)
(d) approve the final version (vi), agree to be accountable for the results (vii)

9. What do error bars in graphs or uncertainty in variables ($x \pm \Delta_x$) represent? (Multiple answers)
(a) Standard deviation, σ
(b) Standard error of the mean, $\frac{\sigma}{n}$
(c) Confidence interval, $t(\alpha, n-1)\frac{\sigma}{n}$
(d) Instrument resolution
(e) Maximum and minimum of a range of measurements

10. Significant figures pollute literature data. Don't carry more than your experiments warrant. Order the list below from most certain to most uncertain (in K).
(a) 310°C
(b) 583.15 K
(c) 310°C $\Delta_T = \pm 1\%$
(d) 583.15 K $\Delta_T = \pm 1\%$

11. The International Bureau of Weights and Measures (BIPM – Bureau International des Poids et Mesures) maintains and updates SI writing conventions. All physical quantities can be expressed with SI but the BIPM does accept non-standard expressions (bar for pressure, for example). In contrast, the *Canadian Journal of Chemical Engineering* only accepts standard SI units. Identify all acceptable SI expressions.
(a) The mass fraction of silica was 3%.
(b) The mass fraction of silica was 0.03.
(c) The silica content was 3 wt %.
(d) 450°C
(e) 3234 *ppm*
(f) $\bar{x} = \dfrac{x_{max} + x_{min}}{2}$
(g) 45 ml
(h) 45mL

12. Understanding typography – e.g. font types, typefaces, character height, line weight – can help create an aesthetic graph. Identify all correct approximations for a 0.35 mm thick line. (Multiple answers)
(a) 0.014″
(b) 1 pt
(c) 1.3 px
(d) 0.08 em
(e) 0.35 pt

13. Ideally, character heights in graphs are between 2.5% and 5% of the y-axis. In presentations and graphical abstracts,

5% of the y-axis is better. Select an ideal Arial font size for a graph that spans one column width of the *Canadian Journal of Chemical Engineering*.

(a) 4 pt
(b) 5 pt
(c) 6 pt
(d) 7 pt
(e) 8 pt

14. Line weights in presentations are heavier than in journal articles. They also depend on frame dimensions – lines should be thicker for wider graphs. What line weight should frame a 70 mm graph for a paper (or poster)? For a presentation or graphical abstract? (Multiple choices possible)

	Papers & Posters	Presentations & GAs
a	hairline	2 × hairline
b	3 pt	6 pt
c	0.75 pt	1.5 pt
d	0.25 mm	0.25 mm
e	0.01″	0.02″

15. If you speak too quickly, audience members may lose interest because they cannot follow what you are saying. If you speak too slowly, their minds can wander and you might see them heading for the exit or reaching for their electronic devices. What is the optimal speed in words per minute of a presentation?

(a) less than 90
(b) between 90 and 130
(c) between 120 and 160
(d) more than 160

16. Web of Science™ Core Collection[18] (WoS), Google Scholar[9] (GS), and Scopus are citation databases that index all sorts of publications. At the end of 2014, WoS indexed 39 million documents including scientific articles (23 million), papers in proceedings (6 million), meeting abstracts (4 million), book reviews (2 million), and editorials, letters, reviews, and news (4 million). What percentage of the scientific articles (in WoS) have been cited at least once?

(a) more than 90 %
(b) between 80 % and 90 %
(c) between 50 % and 80 %
(d) less than 50 %

17. More people have cited Axel Becke's article on Density Functional Thermochemistry[19] than any other article between 1989 and 2014 – over 45 000. How many citations has WoS indexed for the most cited Chemical Engineering paper?

(a) less than 1000
(b) between 1000 and 5000
(c) between 5000 and 10 000
(d) more than 10 000

18. WoS categorizes Arts and Sciences into 250 disciplines. What is the rank of Chemical Engineering in comparing the number of scientific papers the discipline has published over the last 25 years?

(a) top 10 %
(b) between 10 % and 20 %
(c) from 20 % to 30 %
(d) from 30 % to 50 %
(e) bottom 50 %

19. Identify WoS's top 5 Chemical Engineering journals based on the number of citations over the last 25 years.

(a) Process Biochemistry
(b) Chemical Engineering Science
(c) Energy & Environmental Science
(d) Progress in Energy and Combustion Science
(e) AIChE Journal
(f) Industrial & Engineering Chemistry Research
(g) Applied Catalysis B: Environmental
(h) Journal of Membrane Science
(i) Catalysis Today
(j) Journal of Catalysis
(k) Canadian Journal of Chemical Engineering

20. Citefactor.org reports historical impact factors for 8400 journals. How many Chemical Engineering Journals break into the top 10 %?

(a) 0
(b) 1
(c) 4
(d) 6
(e) 10
(f) 14

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