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Scientific/Engineering Writing Tips

Bad grammar and writing style can make it difficult to publish a paper containing great research results

PAPER PARTS

- 1) Your paper **MUST** have a title.

I hate questions in titles. You know the result so why try to cliff hang it for the reader.

Example: Sediment transport over a sand bar: pressure gradient or bed shear stress as the driver? Yuck.

Pressure gradient and bed shear stress forcing sediment transport over a sand bar. Better, but not perfect

Sand bar sediment transport response to pressure gradients and bed shear stress. Better, but not perfect. You get the idea.

- 2) Introduction
- 3) Theory if needed
- 4) Methods if needed
- 5) Site location
- 6) Analysis
- 7) Results
- 8) Discussion (sometimes blended into results)
- 9) Conclusion

The order of 3 through 6 can vary.

STYLE

- 1) Watch for backward/passive sentences.

Example: in order to do y we did x.

Example: In order to measure swash zone velocities, we deployed an array of sensors. Also, bad because we used the word "we". I am not a fan of pronouns in papers/reports. Proposals ok.

Better: Sensors were deployed in an array to measure swash zone velocities. Or An array of sensors was deployed to measure swash zone velocities.

2) Do not write phrases like “the figure below”. All figures must be numbered.

Worst way: The figure shows

OK way: Figure xx shows the water depth as a function of time

Better way: The water depth increases rapidly as the bore inundates the sensor (Figure xx). Then, your paper is not littered with Figure (xx) shows... Yes, sometimes it is ok, but not littered. This is my preference. When I read papers where every new figure description starts with “Figure (xx) shows”, I cringe.

3) Generic text.

Student writing is often too generic. Give examples. It is not enough to say AuthorA and AuthorB did field studies related to sediment transport. You have to tell me what they found or I do not care that they did some studies.

4) Personification.

Do not personify or provide ownership to things in scientific writing. My preference.

Example: The foreshore's grain size is 0.5 mm.

Better: the grain size on the foreshore was 0.5 mm. or The foreshore is composed of 0.5 mm coarse sand.

In a proposal it is ok to say we will investigate xyz, but in a paper I just do not like it. Phrases like “our data” or “we analyzed” → poor writing in my opinion.

5) DO NOT use contractions in scientific writing. isn't, don't, can't etc → poor writing. The lack of use of contractions is different than when we talk and email each other where we use them frequently (often without the apostrophe).

6) Re-read your papers over and over again. Have other eyes look at your papers. Student papers are often littered with typos, hanging sentences and garble. Cautionary tale: I participated on a NSF panel. There was a pretty good proposal scientifically but it was littered with typos and errors. The panel summary hammered the person for it. The program manager said although the research idea was excellent, it was not likely to get funded because sloppiness there could

indicate sloppiness in research. Do not turn in rushed work, it is a reflection of you.

7) Your paper and or writings must tell a coherent story. Student papers are often all over the place. Many times after reading the short introduction, I have no idea where the paper is headed. Writing is difficult. I am constantly learning.

8) Very.

The word "very" in scientific writing, in my opinion, is useless. I have on occasion used it, but I try to steer clear of it. You will see that I, almost by default, remove it from any document I review. You should too. Is there really a difference between something that is important or very important? No. Seek and destroy.

9) You must be consistent throughout in your writing.

Example: If you are working on bed shear stress, then you should use the phrase bed shear stress throughout so it is clear. Getting forgetful or lazy and just writing shear stress or stress later on in the text can be confusing since shear stress or stress can happen in the water column too. If you just say stress are you referring to normal or tangential stresses. So, be consistent and clear. Always put yourself in the shoes/mind frame of a person that has never seen your work. Will what you write be crystal clear to them? If not, you need to modify your text.

10) Introductions that read like the following are written poorly. Puleo (2012) found swashes contain water. Puleo et al. (2013) confirmed the research of Puleo (2012) that swashes do indeed contain water. Hsu et al. (2014) and Kirby and Shi (2015) used a shallow water model to verify that swashes contain water.

Yes, that is a silly example and written poorly. Would it not be better to just state something like Swash motions occur on natural beaches and contain water (Puleo 2012, Puleo et al., 2013) etc. What I am getting at is just state the facts and then cite the paper or papers that got you to that fact rather than saying so and so found or so and so did.

11) Tense (past vs present) in papers can be tough.

Abstract is mostly past tense because you are telling us what you did.

Introduction will be mixed but should generally be present tense because what you are presenting is mostly from the published literature that is assumed to be fact.

Example: The swash zone is located at the interface between land and sea (Puleo et al., 2001). Past tense here would make no sense even though I may have said that many years ago.

One could also use present perfect tense. Numerous studies have been conducted to show that horseshoe crabs lay eggs in the swash zone (e.g. Jones, 2013; Williams et al., 2014; Zander et al. 2016).

But it might be even better to just state: Horseshoe crabs lay eggs in the swash zone (e.g. Jones, 2013; Williams et al., 2014; Zander et al. 2016) depending on the context of your paragraph.

If referring to past research it is not always present tense if you are describing something they did rather than something they determined based on the research.

Example: Sensors were deployed previously in the surf zone to estimate turbulent dissipation (e.g. Anderson et al., 2013; Jones, 2014; Thomson, 2015). The dissipation rates vary on the order of 10^{-4} to $10^{-2} \text{ m}^2 \text{ s}^{-3}$. But, I can think of better ways to write these sentences.

Warning: some scientific writing guides suggest to write prior findings in past tense. I believe they are wrong.

Methods: Past tense.

Example: A scaffold frame was erected in the swash zone for deploying sensors. Velocity data were collected at four cross-shore locations.

Results: Generally past tense since you are telling us what was found.

Example: Swash zone velocities exceeded 2 m s^{-1} .

But, if you say something like Figure xx shows then that is present tense because you are referring to the figure right in front of you. I already stated these sentences can usually be discarded and re-written.

Warning: some scientific writing guides suggest to write results in present tense. I believe they are wrong.

Discussion: Present tense if referring to significance of results or what it means in larger context.

Example: The findings suggest that all swash zones contain water.

Past tense if just summarizing results.

Example: Swash velocities did not exceed 4 m s^{-1} indicating those velocities are not possible under incident band forcing.

Actually, I used past tense to state the finding and then present to indicate the significance.

Conclusions: Present and past. Past for what happened in past and present for what means for future or future research.

12) Write concisely. Young writers are often long-winded. Good scientific writing is brief without fluff.

13) Waffly phrases: Phrases such as the model performed well. Or The model reproduced the data reasonably well. Or The model predictions were satisfactory. Or Data were collected with reasonable accuracy. Or The velocities were significant. These are all useless and I take the writer to task every time I review a paper. What is reasonable? It has no meaning in a scientific/engineering context where research/findings are supposed to be quantified.

Those sentences are weak but some form might be ok provided the writer immediately follows it up with a quantification.

Example: The model predicted the water depths well (RMSE = 0.01) but had larger errors with respect to velocity (RMSE = 0.3). Where you would have already defined the RMSE somewhere else in the paper.

14) The word significant. Significant has a statistical context for when we test, for example, one variable against another. So, the use in scientific/engineering papers outside that context is baseless. When we speak generally in person, the word is used frequently. I suggest to steer clear in scientific/engineering writing unless you are truly doing a significance test.

15) Brevity vs Detail: I said earlier to be brief in your writing but young writers tend to be long-winded where not warranted and too brief where details are needed.

Example: Data were collected with a GPS. What is wrong with this? Not enough details. Topographic data were collected with a Leica real time kinematic global position system (RTK GPS) antenna connected to a push dolly. Data were collected in Universal Transverse Mercator (UTM) projection zone 18 in the North American Datum (NAD83). Elevation data were referenced to the North American Vertical Datum (NAVD88). The dolly was pushed through the study area in alongshore transects with roughly 3 m spacing. Additional cross-shore transects with 5 m spacing were also collected. Blah blah. I think you get the idea. You have to give enough detail so that the reader knows what you did.

Example: Sediment samples were dried. Or Sediment samples were placed in a convection oven at 450 °C for eight hours to remove moisture.

16) Boldly go: People used to go nuts over split infinitives with “boldly go” being the most often cited. Proper English should probably be “go boldly”. That is, the adverb describing the verb comes after the verb. I believe most people have lightened up on enforcing removal of split infinitives.

Example: Detailed hydrodynamic measurements are needed to better understand bed shear stress and pressure gradient processes in the surf zone.

I think diehard englishists (yes, I know that is not a word) would say it should be understand better. There may still be some reviewers out there that will give you a hard time, but I think folks have eased up.

17) In order to: If you ever start a sentence with “In order to” Stop, smack yourself and then delete those three words. They are not needed and if you do head down that path you are going to write a passive sentence (See #1 in this section).

One may like to put that phrase in the middle of a sentence. Stop, smack yourself and then delete those three words.

Example: Sensors were deployed on the frame in order to estimate cross-shore velocity → bad.

Sensors were deployed on the frame to estimate cross-shore velocity. Or probably even better

Sensors to estimate cross-shore velocity were deployed on the frame

See how the “in order to” is not even needed. Seek and destroy.

18) It is clearly evident: There is almost never a reason to use this phrase or similar.

Example: It is clearly evident in Figure (4) that unicorn horn length scales with unicorn weight.

Or It is clear from Figure (4) that unicorn horn length scales with unicorn weight. Just write Unicorn horn length scaled with unicorn weight (Figure 4). Same applies to the phrase “You can see” → garbage.

19) Professional writing: Do not write like you are talking to a friend or via text speak.

20) This and these: I am not a fan of starting sentences with this or these without reiterating what this or these is/are. Why? Because the this or these is referring to something stated in a previous sentence but it can be ambiguous or unclear as to which this or these you were referring to.

21) Drafts: It is good practice to have an obvious file title especially if passing around to multiple co-authors.

Example: SwashStress_DRAFT_01.docx. Make sure to use 2 numbers for the draft number.

One could also put the date such as SwashStress_DRAFT_20180421. That is your choice. Then when I review it, I will change the title to SwashStress_DRAFT_01_puleo.docx. That identifies my changes to draft 01. The next version you save should be DRAFT_02 or higher before sending back to me. That way you are always working on a “raw” draft copy after receiving my draft in return with the _puleo added.

I want you to be good researchers and writers. That takes a lot of practice and hard work. Go back and try to re-read from the perspective of someone with a base layer of knowledge but no real expertise in your area. That should perhaps help you to tweak the paper delivery. Then go back and scrutinize every sentence. Does it belong in the paper? Does it flow well with sentences around it? Is it too long? Is it worded properly? Is there too much jargon?

Do not turn in written work that is hot off the press. It shows. If you do this down the road in your careers it will bite you in the rear end because at this and higher levels you are competing

with "1% ers". You can get away with it in high school and maybe even undergrad because of all the lesser work around you. At the engineer/scientist level, you cannot. Soon you will want to be submitting papers. There is no way I will let something sloppy out the door with my name on it. Ask your fellow students that have already submitted papers with me. I am sure there is a love/hate relationship given the numbers of times we go back and forth for review before sending and how much I bleed "digitally" on it.

PAPER LOGISTICS

1) **Numbers**: The convention is for a number less than 10 to use the word rather than the numeric character.

Example: Four sensors were deployed on the beach.

The scaffold frame was constructed using eight galvanized pipes.

I have violated this rule many times and requested forgiveness for it.

A sentence cannot start with a numeric character

Example: Thirty-seven dogs pulled the sled across the ice. Instead of 37 dogs pulled the sled across the ice

The preceding does not hold if referring to a measurement

Example: Swash zone velocities exceeded 4 m s^{-1} . One would not use the word "four" here.

2) **Comparing model to data**: One cannot and should not get away with saying that the model and data compare well or some other waffly statement. One MUST in my opinion (and will not get by me if I am a reviewer) provide a quantitative assessment of model performance. That may include correlation coefficient, coefficient of determination, RMSE, Wilmott score etc. Even if the model and data appear to lay right on top of each other. Quantify it.

Choose your statistic well. Suppose we have a model that is predicting water level for a small-scale wave flume test where the free surface variation is only 0.03 m. Does it make any sense to say something like the model errors were only 0.01 m? Heck no. That is 33% error. There should be truth in advertising when writing papers. State results correctly. I have read numerous papers where authors have tried to pass "small" errors in prediction by stating only as the actual value. An example is water depth errors of only 0.05 m when the true variation was also 0.05 m. A paper I was a coauthor on came to me with friction coefficient errors that were only different by 0.01. But, the mean friction coefficients were 0.02. That is 50% error. I took the student to task for it.

3) **Units**: It is ok and preferred to use abbreviations for common MKS units (meters, seconds, centimeters etc). One should normally use MKS (e.g. m rather than cm) unless the latter is really warranted. The abbreviation should have a space after the number

Example: The pier was 400 m long. Rather than The pier was 400m long.

Why? Because I would never write the pier is four hundredmeters long.

The percent (%) sign should be attached to the number because it does not carry units. However, there is no universally accepted rule and some people prefer to put a space between the number and the % sign

4) Spaces: Use them. A paper looks clean when one writes

Example: Bat wing size was correlated to maximum velocity ($r^2 = 0.95$ significant at the 95% level; $n = 63$). Rather than Bat wing size was correlated to maximum velocity ($r^2=0.95$ significant at the 95% level; $n=63$).

Put spaces between the numbers and equal signs. You would have defined r^2 somewhere else in the paper.

Example: scientific notation and plus/minus.

3.23×10^{-5} or 3.23×10^{-5}

The horeshore crab mass was 425 ± 79 (mean \pm standard deviation) g. or The horeshore crab mass was 425 ± 79 (mean \pm standard deviation) g.

The latter form in both cases is better and more appropriate.

Example: One needs only a single space after a period ending a sentence

5) i.e. vs e.g.: i.e. means “that is” or “in other words”. e.g. means “for example”. They both always have two periods.

Example: I only like four legged animals (e.g., dogs, cats, and water buffalo). This just gives some of many examples

Example: I enjoy fishing with my two sons (i.e., Carlos and Anthony). This provides clarification on my sons.

DO NOT italicize e.g. or i.e. There is no standard for using the comma after the last period in i.e. or e.g. I normally do not use the comma

6) Variables. They must ALWAYS be italicized. They must be identified the FIRST time they are used.

7) All equations must be numbered. Then you can refer to them with their number. Equations should either have a period or a comma after them. If followed by a comma, then the next line would read

where variable (in itals) represents blah blah to describe your variables. If you are going to

describe the variables because they have not been described before, then do not put a period after the equation and do not start “where” with capital W.

8) Referencing:

If three authors or more it is the first author and then et al. Some journals do the “et al.” after four authors but that is rare.

If stating something like Puleo et al. (2012) found, then no comma after period.

If stating, Swashes were found to be cool (Puleo et al., 2012). Then comma after period.

If stating something like Puleo et al. (2012) used a model to do x. Puleo et al. based the model on equations blah blah. YOU MUST have the year in the second sentence too.

9) Acronym: You cannot use an acronym unless you have already defined it in the text.

10) Units: Use MKS units always. The US, partially UK and perhaps some other tiny country here or there (Eritrea?) use the English system of units. All peer reviewed work is in MKS units. Always use MKS units in your scientific/engineering writing. If it is important to also have English units then put them in ().

CHOOSE WORDS CAREFULLY

9) Further/Farther: Farther refers to distance. Further refers to figurative distance
The boat is farther out to sea than I thought.
Jack tried to further his career by taking typewriter night classes.

10) Utilize/Use: Any time you insert utilize it is just as easy and perhaps better to instead use “use”. Seek and Destroy.

11) Effect/Affect: Effect is a noun. Affect is a verb
Salinity affects horseshoe crab larval survival
The salinity has an effect on horseshoe crab larval survival.
Same concept with two different ways to write it.

12) Data: The word data is plural. So, it is most correct to write “Data are” or “Data were” rather than “Data is” or “Data was”

13) Principle/Principal:
Principle is a concept, idea, theme. The key principle is that bed stress drives sediment transport.

Principal means main or basic (or also the person that runs a school). The principal investigator is responsible for report writing.

14) Among/Between: Among for comparing three or more things and between for comparing two things. But, this is not always the case.

Between is used most when relating to distinct items independent of the number of them.

Example: I am trying to decide between math, fluid mechanics or waves for my morning class.

Among is used when referring to items as part of a group without identifying the items in the group

Example: I am trying to decide among the coastal classes to take at 0900.

15) However: Can be used mid-sentence or at the beginning. I do not normally use mid-sentence. Here is proper usage

Example: The swash zone is a difficult region to collect data; however, these data are needed to validate sediment transport models.

This is a bad sentence just used to illustrate the point. When using however mid-sentence, it must be preceded by a semicolon and have a comma right after it.

The swash zone is a difficult region to collect data. However, new sensors exist to estimate the sediment transport near the bed.

Another bad sentence used to illustrate the point. When However starts a sentence, it must have a comma after it and the rest must be a complete sentence and not just a phrase.

16) That vs. Which: I have struggled mightily with this. In fact, when I was a young writer my advisor told me to go “which” hunting meaning that I should not use the word “which”. He was wrong.

If you can write the sentence and it does not need the part that is attached to which then you can use which. Otherwise use that.

Example: The sensor, which has 29 probes, was built at UD.

This sentence tells us that there is a single sensor that was built at UD and it just so happens to have 29 probes. The sentence would be just fine written as The sensor was built at UD.

If instead I wrote The sensor that has 29 probes was built at UD. This suggests more than one sensor exists but the particular one with 29 probes... that is the one that was built at UD. See the difference. You cannot remove the “that has 29 probes: without changing the meaning of the sentence.

It is indeed tricky and I fail often. Note the placement of commas in the first example and the lack of commas in the second example.

17) Higher, greater, upper: I prefer to use higher to refer to location in the vertical or when referencing the vertical coordinate or value with reference to another.

Example: Waves were higher prior to breaking compared to inside the surf zone. Even here I might prefer to say Wave heights were greater prior to breaking than inside the surf zone.

I do not like using higher with reference to cross-shore position.

Example: Data were collected from the upper swash zone. Or Data were collected from higher on the beach face.

Upper swash zone could mean higher in the water column. See the problem. Choose carefully the words to describe size/distance when relating two items or the placement of items.

18) Etc: Probably never needs to be used in scientific writing.

19) In situ: In the past, it seemed to always be in italics because it is Latin. I feel more people are dropping the need for italics. So, that is a style issue since there is no right answer. A hyphen IS NOT needed between “in” and ”situ”. I have violated that in the past.

20) Instance vs. instant: Instance means an example. Instant means short time.

Example: You’re gonna love it in an instant. A slogan from long ago for an instant coffee commercial.

Example: There was an instance where the connector on the sensor came loose causing noisy data.