LANGUAGE IN SCIENTIFIC WRITING

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Abstrak

Dalam menulis karya ilmiah berbahasa Inggris aspek bahasa merupakan salah satu hambatan besar bagi penulis non-penutur asli yang belum berpengalaman. Bahasa Inggris telah digunakan untuk mengkomunikasikan penemuan-penemuan ilmiah di seluruh dunia. Dengan kata lain, bahasa Inggris telah digunakan untuk menulis karya-karya ilmiah baik untuk publikasi jurnal maupun seminar taraf internasional. Artikel ini menjelaskan aspek-aspek bahasa yang sering digunakan dalam penulisan karya ilmiah dan aspek-aspek tersebut menjadi masalah bagi penulis non-penutur asli. Aspek-aspek tersebut antara lain pemilihan kata, kejelasan, dan ketepatan, gaya bahasa, variasi kalimat, pemilihan kata.
***Kata kunci**: tulisan ilmiah, pilihan tensis, gaya bahasa, variasi kalimat*

1. Introduction

The use of proper language is an essential element in writing scientific papers. Scientists communicate their findings or knowledge through language. If they do not use proper language, they will fail to convey the message. English has been used to write scientific papers for international journals or to participate in international conference. This paper will describe some aspects of language used in scientific writing such as tense choice, clarity & conciseness, style, sentence variety, diction, etc.

The language of science or scientific papers differs from that literary works (e.g. novel, drama, poetry). It has its own rules or conventions shared by scientists. In novels or dramas it is common for writers to use metaphorical, ambiguous, or flowery language to attract the readers, but in scientific papers such language is avoided. The language of science should be formal, straightforward, concise and brief. A scientist who uses complicated, metaphorical or ambiguous sentences may mislead the readers: accordingly his message will not be properly understood by them. As Day (1979: 5) comments:

> *"In scientific writing, language need not be difficult; and the best English is that which gives the senses in the fewest short words. Literary tricks, metaphors and the like, divert attention from the message to the style. They should be used rarely, if at all, in scientific writing".*

In this respect, Trimble (1905: 5) makes a similar comment:

> An EST text is concerned only with the presentation of facts, hypotheses, and similar types of information. It is not concerned with the forms of written English that editorialize, express emotions or emotionally based argument or are fictional or poetic in nature.

It goes without saying that in order to be able to use appropiate language in scientific papers, the writer should have a thorough knowledge of certain grammatical rules. Both written and spoken language always involve a set of grammatical rules. Those who do not master such rules properly will not be able to write a good scientific paper or speak English correctly.

Young scientists, especially non-native speakers (NNS) sometimes face language problems in expressing their ideas or findings. It is not surprising as English is not rooted in their culture.

English is only learned or studied as a subject in high school and higher education. The patterns and rules of English are, to some extent, different from their first language (e.g. Indonesian). The Indonesian language does not have any tenses; "time" is identified by introducing adverbs of time. Accordingly, the main language problems faced by young Indonesian lecturers are the use of tenses, together with active or passive voice, singular-plural, concord, diction, phrases, style, etc.

2. Tense Choice

In scientific writing the types of tenses which are commonly used by the writers are simple present, simple past, and perfective aspects, (e.g. present perfect, past perfect simple). Progressive aspects are rarely used in scientific writing. Modality is also used, especially when the writers wishes to make a recommendation or give an instruction.

In non-scientific English the use of tenses is governed by the concept of time, but in scientific writing (EST) it is governed not only by time but also by non-temporal factors. By non-temporal factors it means that a piece of scientific discourse does not use time as the major factor governing his choice of verb tenses (Trimble, 1985: 123). Trimble proposes three areas where the non-temporal use of tenses occurs regularly in written EST discourse:

1) when writers describes apparatus;
2) when they make textual reference to a visual aid and;
3) when they refer to previously published research (including their own) which is related to the subject of their discourse.

Concerning the description of apparatus, he distinguishes two types of apparatus: temporary and permanent apparatus. If the apparatus is used temporarily, the writers will use the past tense; on the other hand, if the apparatus is used permanently, he will use the present tense. The following is an example of how temporary and permanent apparatus are described.

1. Temporary Apparatus

The test section was *constructed* of a pure copper cylinder 2ft long, 6 in in id. and 6.25 in in od. Both ends of the cylinder *were closed* with removable Pyrex glass end plates ¼ in thick. A fluid port *was located* at each end of the cylinder.

2. Permanent Apparatus

The measurement were made in the side wall of the one foot wind tunnel. The tunnel is a blowdown-to-atmosphere facility operating over the mach number range 0.2 to 3.5. Mach number in the tunnel is generated by fixed nozzle blocks at supersonic speeds.

In textual reference to a visual aid, he comments as follows:" If the readers are told about gathering the data and designing the visual, the writer will use the past tense. If, on the other hand, the writer discusses the visual itself and its relationship to the subject at hand, he will choose the present tense". The following is an example of textual reference to a visual aid.

The results which are shown in Table V were achieved by developing a new computer program. These **results indicate** that it is no longer necessary to budget at the 7 per cent rate for repairs.

The shift of tense in the above example shows a shift in rhetotical concept. In the first sentence the writer uses a present tense verb when referring readers to the visual, and then shifts to past tense when describing how the data were obtained. In the second sentence the writer again uses the present tense because he wants to show the readers the importance of the visual to the subject matter.

Reference to previous research is always found in scientific papers. Writers always refer to previous research done either by themselves or by others working in the same field based on his research, Trimble (1985: 126) concludes as follows:

> If the writers use the past tense in reporting research done previously by themselves or by others then that research is of secondary importance to the current work being reported on. If, on the other hand, the writer uses the present perfect or the present tense, then the research is more direct and primary importance to the writer's current work.

The following example illustrates how the three tenses are operated in scientific writing.

> Among the many statistical studies of data from the IGY (International Geophysical Year) are some analyses by Davis (1962) of the distributions and motions of auroras in Alaska during the last sunspot maximum...From these studies Davis deduced thar auroral displays was essentially a fixed pattern...In contrast to the statistical methods used by Davis are detailed studies by Akosofu and Collaborators (1961: 64) of individual auroral displays...they conclude that there is a basic stable system of auroral arcs...The smallest disturbance is represented by the formation of ryas which Akosofu has shown to be waves of folds in a thin sheet of aurora...On the other hand Elvy (1957) has observed the formation of rayed arcs.
>
> (Trimble 1985: 126)

3. Clarity and Conciseness

To write a good scientific paper, however, mastering certain grammatical rules (e.g. the use of tenses) is not enough, as a writing activity involves a number of other skills. For instance, when a scientist starts writing, he has to think of how his ideas are organised into sections and paragraphs. At the same time he has to choose appropiate words, phrases and grammatical structures. Using a series of long and complicated sentences throughout the whole paper will baffle the reader; on the other hand, using a stretch of short and simple sentences will be monotonous and boring to the reader. In short, a writer should take into account the factors mentioned above in writing in an appropiate style. With respect to this, Kirkman (1966: 151) states as follows:

> The best style for writing about scientific subject is a direct, simple and unadorned choice of words and structures, designed to convey your meaning with economy and precision. A scientific paper is not the place for evocative and emotive word-play or leisurely indulgence in poetic flights of imagery. This is not to prohibit the use of analogy, metaphor, and simile: all these may be vital to effective description and explanation, it is to stress that ini a scientific writing, the resources of language must be controlled to produce a style appropiate to your purpose. Your purpose is usually to transmit ideas and information as economically, unemotionally, and unambiguously as possible: accordingly, you should choose language which will be as economical, unemotional and explicit as possible.

Other points which should be borne in mind are clarity and readability. Sometimes the clarity and readability of scientific text are blurred by inappropiate choice of words, syntactical complexities, etc. The reason is that the writer perhaps, whises to impress the readers by choosing unfamiliar words and very long complicated sentences and by so doing his writing may look highly scientific whereas the result is the opposite: he fails to convey the information to the readers. In this respect, Muir (1983) advises as follows: "If your writing is not lucid, you will convey nothing. The passage of information from one person to another is never improved by complexity, indeed the opposite is true, as complexity may itself distort the information". Consider the following statement:

It must show low mammalian toxicity and phytotoxicity.

(Kirkman 1966: 152)

Most readers will be exasperated at such a statement, which will only be understood by the specialist concerned at first reading. But what the writer means is not more than “It must be harmless to animals and plants”. The second version, accordingly, is much more communicative because it is shorter and uses more familiar words; most readers will find it easier to digest than the stifffer, more scientific version.

The following is an example of inappropiate/ appropiate phraseology (Kirkman 1980: 17):

NOT	BUT
alate and apterous aphids	Winged and wingless aphids
hyperbaric oxygen	High-pressure oxygen
perform a function analogous to	Acts like a
occupies a juxta-nuclear position	is next to nucleus
postnatally	After birth
contralaterally	on the other side
oleophobicity	oil-repellency
rates being increased by a factor of two	Rates being doubled, etc.

Good scientific writing should be objective, impersonal, precise and concise, but some writers are trapped into writing long, unnecessary complex sentences as they are afraid of not being sufficiently scientific in their writing. The result is that unnecessary, long and complicated sentences are often found in scientific writing. Consider the following statements:

1. **Original:** Experiment conducted to determine the lowest temperature at which the reduction reaction could be initiated indicates reduction began at 27 degrees centigrade.
   Revision: Experiments showed the lowest temperature at which reduction began was 27 degrees Centigrade.
2. **Original:** Comparison of data obtained with these paints using Barco with those using Lenol reveals that use of Barco solvent slows the drying appreciably (approximately doubling the time in most cases) but has very little effect on the viscosity characteristic obtained.
   Revision: The data show(s) paints using Barco as no more viscous that those using Lenol, but dry only about half as fast. (Gunning 1968: 261-2)

4. Style

The language of scientific writing should also be formal. In this regard, Jordan distinguishes between formal written English (scientific English) and informal spoken English. The language of scientific English usually does not use language style as follows:

1. Contractions: it didn’t; they’ve; I won’t.
2. Hesitation fillers: er, um, well, you know.
3. Verb phrases or prepotitional verbs:

formal	**informal**
conduct	carry out
discover	find out
investigate	look into

4. Personal pronouns: In scientific writing the writer generally does not use personal pronouns such as **I, You, We**. Impersonal style such as preparatory **it, there, one, passive voice, etc** are often found in scientific writing. The following is an example of formal written English and informal spoken English:

Informal/ spoken

Economics?-Yes, well, um-economics is, I suppose, about people trying to-let me see-match things that are scarse-you know-with things that they want,-oh yes, and how these efforts have an effect on each other-through exchange, I suppose.

Formal/ written

Economics is the social science that studies how people attempt to accomodate society to their wants and how these attempts interact through change.

Scientists undertaking research must comment on and interpret their results and relate them to others in the field. It is the accepted convention in scientific writing to express these comments and interpretations in an objective and personal way. In expressing their opinions and attitudes, they can use certain structures and words. These may include:

1. modal adjuncts which the writer uses to comment on what he is writing; eg.
   Unfortunately the water supply system did not work.
2. modal auxiliaries (e.g. can, could, may, might, etc.)
   a. which reflect the writer's judgement on how likely or how usual something is or isn't; e.g.
      The water supply system *may* be defective.
   b. which reflect the writer's judgement on what should or should not be done; e.g.:
      Local staff *should* operate the water supply system.
      It is *expected* that local staff operate the water supply system.
   c. lexical items, especially adjectives which express the writer's attitude, eg:
      a *red* car (objective)
      a *beautiful* cart (subjective)
3. projecting verbs of feeling, seeing, thinking and saying which project the writer's opinion, e.g.:
   I feel that...(personal)
   It is felt that...(impersonal)

(Fitzgerald L., 1993)

5. Sentence Variety

In writing scientific papers the variation of sentence patterns and diction should also be taken into account. A scientific paper which merely consists of long and complicated sentences will baffle the reader; on the contrary, a scientific paper which uses a series of short and simple sentences will also be monotonous and uninteresting to the reader. Accordingly, the best style is combination between long and short sentences. With regard to this, Campbell (1961: 107) states:

A short sentence is strong and forceful but only if it has longer sentences beside it. To have too many short sentences beside it. To have too many short sentences merely gives a very jerky effect. One should try to vary complex and compund and simple sentences, and long sentences. For example, 'Soon it was dark' is good if on each side it has a longer sentence but it is of a little value beside other very short sentences.

6. Effective Sentences

Besides diction, writing effective sentences will also clarify the message delivered to the

reader. In relation to this, Troyka (1987: 306-8) gives some ways of writing effective sentences:

1. *Combining sentences*
   - Two sentences: The Titanic was discovered seventy-three years after being sunk by an iceberg. The wreck was located in the Atlantic by a team of French and American scientists.
   - Combined sentence: Seventy-three years after being sunk by an iceberg, the Titanic was located in the Atlantic by a team of French and American scientists.
2. *Reducing clauses*
   - The Titanic, which was a huge ocean liner, sank in 1912.
   - The Titanic, a huge ocean liner, sank in 1912.
   - When they were confronted with disaster, some passengers behaved heroically, while others behaved selfishly.
3. *Reducing phrases*
   - Although loaded with luxuries, the liner was thought to be unsinkable.
   - The luxury liner was thought to be unsinkable.
4. *Using strong verbs and avoiding nouns formed from verbs*
   - Weak verbs: the proposal before the city council *has to do with* locating the sewage treatment plant outside city limits
   - Stronger verbs: the proposal before the city council *suggests* locating the sewage treatment plant outside city limits.
   - Weak verbs: We *oversaw the establishment of* a student advisory committee.
   - Strong verbs: We *established* a student advisory committee.
5. *Eliminating unneeded words*
   - Padded: The bookstore *entered the order for* the books that the instructor has said will be utilised in the course sequence.
   - Concise: The bookstore ordered the books for the course.

7. Diction

Diction is also very essential in deciding the quality of a scientific paper. An inappropiate choice of words may obscure the meaning and the sentences become less vivid. On the contrary, an appropiate choice of words will give a clear and precise meaning. For a descriptive writing, the words used should be precise, vivid, and concrete. For instance, to describe someone who is walking it will not be effective if we just use the simple word 'walk'. There are many words to express the ways of walking and using one of these instead of 'walk' will give a more exact meaning. 'Stroll', 'wander', 'limp', 'trudge', and 'plod', will appeal to the reader's sense (visual); they will give a specific picture of walking. It is also unnecessary to use three words where one will do: there is no need to say 'in a speedy manner' when ' speedily', 'quickly', or 'hastily' will do just as well.

It is always effective, especially in a descriptive writing, to choose concrete words rather than abstract ones, particular words rather than general ones. Therefore, instead of writing 'all kinds of boats' write 'ocean liners, tramps, yachts, rowing-boats; instead of saying 'a large amount of merchandise' write 'a great load of oranges' or 'a huge packing-case' or 'an enormous bale of cloth.' The reader will more easily picture 'a great load of oranges' than 'a large amount of merchandise.' (Campbell, 1961: 106-7)

Scientific texts of any disciplines also exhibit special lexical features which sometimes create

a serious problem for the reader. In scientific texts, we may find three categories of lexis: highly technical, sub-technical, and general. Every subject has its set of highly technical terms which are an intrinsic part of the learning of the discipline itself. A biological student studying the circulation of the blood will meet such items as atrium, ventrile, arteriole, and venule in the course of his studies. While in sub-technical vocabulary we may find words which are not specific to a subject speciality but which occur regularly in scientific and technical texts-e.g. reflection, intense, accumulate, tendency, isolate, and dense. And many words, both technical and sub-technical, are made up of root plus sufixes and prefixes like **cyto-, extra-, -logy, -meter** which can carry meaning. (Kennedy & Bolitho, 1984: 58).

Meanwhile Godman (1976: 72) classifies the words in the vocabulary into three groups. The first group belongs to the scientific language. Some of these words derive from Greek and Latin; for instance, 'atom', 'antenna', 'oxygen'. The second group consists of words used in both scientific and general language texts, but used with a restricted meaning in scientific language. For example, a 'flower', restricted in meaning to the reproductive structures of a flowering plant; this includes grasses; 'conductor', a material which conducts heat and electricity; 'salt', an ionic compound; 'metal', a term restricted to an element, and excluding alloys. The third group is composed of grammatical and logical words, together with words from the general language used with their ordinary meaning, for example, 'cut' and the member of its semantic systems.

8. Conclusion

In conclusion, to write a good scientific paper we should take into account some linguistic aspects such as tense choice, style, clarity and conciseness, sentence variety, word choice, etc.

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