
Communication for Laboratory Engineers

Guidelines for Communicating in Scientific Research

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Preface

This handbook aims at students at high schools, tertiary technical and scientific institutes, to help them in their written and oral communication on Life Sciences topics. When conducting research work in life sciences, communication plays an important role (such as meetings, gatherings, reporting on experiments, telephoning, writing plan of approaches, reports, letters and emails). This book provides a number of guidelines.

There are plenty of guidelines on how to write text. There is also an abundance of literature (books, guides, websites) on how to write a thesis, how to communicate in business and good writing style. There are numerous resources for learning English. However, when it comes to writing, presenting, discussing science topics few useful work is available to students, and none in the area of laboratory research.

Communication for Laboratory Engineers offers 12 useful chapters to both students and professionals. By first outlining common sense steps on any writing task, the next chapters provide guidelines on various types of laboratory reports including a number of examples from specialists' areas. Useful suggestions on scientific English are given in Chapter 4, followed by a detailed account with many examples on using illustrations in science texts. Chapter 7 provides accessible suggestions on finding and using scientific literature in specialised lab science contexts. Chapter 8 helps users to present their work, both in formal presentations, posters and on the web. Guidelines on meetings in science contexts are given, including interviews for placements and jobs. The final chapters provide hands-on suggestions on thesis writing and manual writing, giving examples and guidelines from controlled technical English.

The comprehensive 200 page booklet has an index, a bibliography, and many checklists and examples to help laboratory scientists and scientists-to-be communicate effectively and efficiently in English.

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3.4.4 Acknowledgements (possibly)

Possible acknowledgements belong in the preface. You may use them in the (larger) reports on a placement or graduation assignment or thesis. The style is *business-like*.

3.4.5 Report size

All written papers (reports, texts, etc.) are printed on standard A4-size (21×30 cm) paper. Depending on the requirements the pages are printed one- or two-sided. On the left is a margin of 3.4 cm. Use standard line spacing (sometimes 1.5). All pages are *numbered*, as are possible appendices. Only lab journals must be written.

3.4.6 Lay-out and typography

The lay-out and typography give the impression your reader gets when seeing your printed or written pages, without having read a single letter. Ideally you want this impression to be positive.

Be sure to check if the format or look of the pages is always *correct*: clear, balanced and well-structured. Avoid both large illustrations and pages with text only. Use paragraphs of equal length, and use numbered headings (see Chapters 6 and 8 for details). Your text is your 'business card': if it has a disorderly, untidy lay-out, it will leave a bad impression on its readers. Therefore check the lay-out of pages in study books and/or manuals for attractive examples.

3.4.7 Titles, headings, numbering

concise titles

Chapters and paragraphs are supplied with a short and informative title. With chapters you try to concisely describe the contents in several words. For paragraphs you can usually use the most important catch words of the paragraph concerned as its title. When dividing your text even further, subparagraphs should also be supplied with catch word titles or subheadings. Capitalise headwords only.

Additionally, use a standard numbering system. Take a look at the numbering and division of this book for example. Do not carry subdividing too far; four digits (2.1.1.3) can be used if necessary, but five (2.1.1.3.4) definitely not. Two or three numbers should suffice. See also Chapter 12.

3.4.8 Table of contents

table of contents

Finally, the table of contents with page references is made. This table of contents should quickly give readers a clear indication of the structure of the text and should enable them to go to the part they wish to read.

The table of contents should be in the front, immediately after the title and the (possible) summary of the paper. Check the table of contents of this book as an example.

3.5 A 'good paper'

What makes a paper a good paper? When reading a good paper or report, the reader is intrigued and not distracted from the content of the report by all kinds of errors and inaccuracies. In any laboratory education programme, your teachers read every paper; in any real-world laboratory, however, colleagues quickly put aside a sloppy, long-winded or chaotic report because there are more pressing matters at hand.

When you want your report to receive the attention it deserves, pay attention to:

- ◆ a good summary;
- ◆ well-formulated conclusions;
- ◆ clear tables and graphs;
- ◆ a neat transparent structure and logical sequence;
- ◆ good readability;
- ◆ a well-cared for appearance;
- ◆ accurate and correct contents.

When you have met these demands, the predicate 'good report' may be appropriate (cf. Appendix 1 for a complete checklist). For English your safest bet is to use the Modern Language Association style in all its details (www.mla.org, March 2006) and to stick to your assignment.

When things are not clear yet, a teacher or librarian can provide you with some examples. Critically review these examples and try to improve them if necessary!

Assume you are writing the paper for submission to a scientific journal.

- A lot of the formatting details can be learned by carefully modelling another APA journal article. It would be a good idea to acquire a few fairly recent articles, because the format was revised in 1995. Try the *Psychological Record* or *The Bulletin of the Psychonomic Society*. Both of these journals publish relatively short articles that are not too complicated.
- Avoid excessive use of the terms 'I', 'me', and 'my', as well as the phrase 'personally speaking...'
- Avoid the use of sexist language, for example, consistently referring to a person as a 'him'. Since using '(s)he' or 'him/her' all of the time can also be awkward, try using the plural form or use the word 'person' instead.
- Avoid using 'empty words' or words which serve no purpose. For example, 'In the Smithe (1990) study it was found that...' should read more like 'Smithe (1990) found that...'
- Generally speaking, use past tense in the abstract, introduction, and method. Results and discussion sections can be in the present tense.
- Get friends to read it. If they cannot understand it, then it needs work.

5.2.1 Tables

When designing a table, the following rules should be taken into account:

making tables

- ◆ Use *columns* and not rows; numbers placed underneath each other can be surveyed better and more quickly. Small tables do not require a grid. The independent variables are on the left hand side of the table. Categories that are compared are placed across the top. All columns have headings.
- ◆ Use numbers that readers can work with, so $3.69 \cdot 10^{-4}$ and not 0.000369.

clear title

- ◆ Clearly indicate per column which *quantity* the numbers apply to and in which *unit* or *dimension* the numbers are expressed, for instance concentration (mol.l^{-1}) or *E* (mV). This is your legend.
- ◆ Use SI-units as much as possible; abbreviate them correctly ('gram' is g and not gr). Only diverge from the SI-units when this has advantages and is internationally accepted (for instance volume in litres instead of cubic meters) and include them in the list of abbreviations!
- ◆ Give your table a *number* and a short, informative *heading* at the top. Tables should be transparent and be comprehensible without consulting the text. Leave a blank between heading and data.
- ◆ Check which data do and do not have a function in the table; leave out all superfluous data. Not all data from the journal have to end up in the table. Over-detailed (and thus incomprehensible!) tables are skipped by your reader! Check what is required; in practical experiments for instance, *weighting data* and *burette levels* should be included in the mini lab report, but not in placement and graduation papers.
- ◆ If a table includes data you have not measured or calculated yourself, but which you have derived from literature for example, this should be indicated clearly.
- ◆ Use as many *significant* (sensible) digits in a number as *measurement accuracy* permits.

For several examples of good use of tables in a journal, consult Illustrations 2.1 and 2.2.

Below you will find an example of a *poor table* from the report on a graduation assignment:

example poor table

Table 5.0

Ph	12.6	10.5	7.4	4.0	1.1
Gram/100mL	2.73	2.77	2.56	2.77	2.88
E265	0.613	0.612	0.581	0.613	0.625
E1 1%cm	224	221	216	221	222
E after extr.	0.053	0.006	0.008	0.031	0.563
K	10.4	91.3	67.6	18.8	0.11

Evident are the following errors in this table:

- The table is incomprehensible. The text suggests that we are dealing with the determination of the distribution coefficient (K) of substance X, of which the extinction of the watery solution was measured at 265 nm and again after extraction with chloroform. The change in extinction forms the basis of calculating the distribution coefficient.
- Based on the E-values measured, K can never be calculated in three significant numbers.
- The values for $E_1^{1\%}$ cm measured are superfluous in this table.
- The table is obscure because rows have been used instead of columns.
- The table has not been given a title.

If the essential data are grouped correctly, the following *appropriate table* is obtained:

example good table

Table 5.1 The distribution coefficient (K) of X for the system water-chloroform as a function of the pH. Consult the text for the calculation of K.				
weigh-in	Ph	E (265 nm) before extraction	E 265 nm after extraction	K
2.73	12.6	0.613	0.053	10
2.77	10.5	0.612	0.006	90
2.56	7.4	0.581	0.008	70
2.77	4.0	0.613	0.031	19
2.88	1.1	0.625	0.563	0.1

Avoid using a table when there are only one or two measurement values!

5.2.2 Graphs

making linear graphs

The following guidelines apply to making graphs:

- ◆ If needed, use *graph paper* (millimetre paper) of a appropriate size (usually A4 or A5). Use a thin (refillable) pencil (maximum 0.5 mm), hardness HB. Remember that the red grid of the graph paper becomes clearly visible when copied, whereas a green grid almost disappears. When using a *computer* you can usually process the output first, before printing the graph. Possible notes can then be typed or written with a pen or pencil in the margin.
- ◆ In addition to linear graph paper, special graph paper can be used.
- ◆ The size chosen (the scale of the graph) should correspond with the accuracy achievable in the experimental method used. When for instance the extinction (E) can only be read in two digits, it is misleading to be able to read the concentration in three significant numbers. When E varies from 0 - 1 with a concentration change of 0 - 1 mmol/litre, a calibration graph of 10 cm by 10 cm is large enough with a reading accuracy of two digits.

scale

7.1.2 Search for a review work

overviews

When designing a study it is useful to look for a *review work* or *review article*. This is a (chapter of a) book or journal article in which the author gives a review of the data known so far. These reviews contain a large amount of literature references (and possible keywords) that you can use to go *back* in time to look for the desired information.

7.1.3 Search for citations

Science Citation Index

The *Science Citation Index* (SCI) gives an overview of all publications that are referred to in literature. This citation index indexes over 3,100 scientific, technical and medical journals. Once you have found a relevant, recent publication, it is possible to find out whether other publications have been published that refer to your publication using this citation index. You often find related studies. SCI allows you to search *forward* in time; this way you can find more recent publications on your topic!

You use the *Citation Index* by first looking for the first mentioned author of the article you have (mind the first names with frequently occurring last names!). You then look up the author's article found. With the second (and the other) authors you will find a reference to the first author. The full title and a bibliographical description of the articles that refer to your article can be then found in the accompanying *Source Index*.

Patent Citation Index

Patents are listed in a separate *Patent Citation Index*. A *Corporate Index* can be used to check which articles have been published by a certain company or institute.

In the *Permuterm Subject Index*, characteristic words from article titles (the *title words*) can be searched for, and the citations displayed can subsequently be looked up in the accompanying *Source Index*. These title words are not always good entries (like the previously mentioned search terms!).

Searching with the Science Citation Index is much faster with the help of a computer. Some libraries have the so-called *Science Citation Index Expanded* (SCIE) database (sometimes using the name *Web of Science*).

Web of Science

In the *Web of Science* database, around 5,700 journals are currently indexed. Since 1991, short summaries of the articles and extra keywords have been added. The file currently contains about 17 million references.

There are two search options: *Easy Search* and *Full Search*. The first has fewer search options and gives only 100 titles as a result, but is easier to use.

Easy Search has the following search options:

- ◆ *topic search* (searching by subject): finds words in titles and, if available, in summaries and in keywords
- ◆ *person search* (searching by author): finds articles of and about persons, or articles that cite that person
- ◆ *place search* (searching by institute/company): finds articles of authors per organisation or location

- ◆ *general search*: finds words in titles, in summaries, in keywords, author names, journal names, authors' addresses or a combination of these entries
- ◆ *cited reference search* (searching for citations): finds author and/or publication cited. This search option offers a field for the author (exact entering with initials!) and a field for the publication to be cited. For journal articles, enter the correct title of the journal (use the list of the program). Titles of books must be abbreviated (for instance 'The application of opaque semi crystalline sulphur polymers' use [application sulphur polymers]).

Web of Knowledge

A university library may also enable you to search via the *Web of Knowledge* (e.g. <http://wok.mimas.ac.uk>). This is an integrated combination of the Web of Science and the Journal Citation Reports'. It provides an even higher chance of success for finding relevant information.

For the material sciences, a bimonthly cd-rom version Materials Science Citation Index is available, which enables you to find practically every article about a certain material (every year about 115,000 articles from 8,000 journals and books are processed!). In addition to the bibliographical data, the cd-rom version contains an extract of the article in question.

7.1.4 Updating one's literature

For keeping up to date with the literature you should regularly study a *good* selection from the journals and books on file or keep up with the specialised reference literature (see the previously mentioned reference files). If you wish to check the most recent publications (1-3 months after publication) you should consult the notification publications like Current Contents.

Current Contents

Current Contents has seven editions – *Physical, Chemical & Earth Sciences; Life Sciences; Clinical Medicine; Agriculture; Biology & Environmental Sciences; Engineering, Computing & Technology; Arts & Humanities* and *Social & Behavioural Sciences* – it is especially useful for laboratory engineers. Every week a new issue of Current Contents is published in which the tables of contents of many scientific journals (circa 7,000) and books (circa 2,000) are described. Per issue you can search for relevant literature with *keywords*. The disc or cd-rom version allows you to search with *combinations* of keywords and, in addition to a bibliographical description, you can read an extract of the article concerned.

Review articles can also be found in Current Contents (keyword + Review). For more information, consult the webpage: <http://connect.isihost.com> and your local library.

List of acquisitions

Magazines may also offer a service to keep you informed of new publications. After subscription these are sent to you by email. Many libraries publish a so-called list of acquisitions, which lists new books and journals they have obtained.

Example title page with summary

Name intern: Corry Berense
Major: MLE-clinical chemistry
Internship laboratory: CC-lab Futura Hospital Singapore
Supervisor: Dr. B. Han sr
Placement period: January -May 1996

Subject

Determination of sodium and potassium in serum with the help of ion-selective electrodes.

Summary

The purpose of the research was to verify whether the possibility of sodium and potassium in serum could be determined with Ion-Selective Electrodes (ISE) and whether ISE would be an improvement compared to the classic flame photometric determination. Results show the ISE method is quick to execute, but repeatability and linearity are worse than using the flame photometric determination. A high protein level decreases the signal in the flame photometric determination, while the ISE result is decreased when the ion strength of the sample is abnormally high.

It is concluded that the ISE method and the flame photometric method both have advantages and disadvantages. The choice depends on the specific hypothesis and the availability of equipment and resources.

Key words

sodium; potassium; serum; ion-selective electrode.

Handed in: June 1996

Assessment:

Remarks:

Lecturer's signature:

key words

Both in the title as well as in the summary it is important to pick the right *key words* to enable others to find your work.

Sometimes these key words can be listed again after the summary.

A good summary can be included as such in the so-called reference files as mentioned in paragraph 7.1.

Look yourself for examples in your library!

Below you will find examples of a *poor* and an *improved* summary of a graduation assignment.

The graduation topic was the ion pair extraction of oxyphenonium bromide. The *poor* summary written by the student was as follows:

Example poor summary

The ion pair extraction of the oxyphenonium bromide from water to dichloroethane is regarded.

The per chlorate ion is present as a counter ion.

The extraction constant is determined from the experiments conducted.

Dissociation appears to occur as a counter reaction in the organic phase.

Furthermore benactyzine-methyliodide has been synthesized. Extractions have also been carried out with per chlorate as counter ion and dichloroethane as organic phase.

In this case, dissociation in the organic phase was also observed.

Finally, it was assessed whether at lower concentrations of the oxyphenonium bromide and the per chlorate, the ion pair extraction still suffices the relation found earlier between the conditional extraction constant and the concentration measured in the watery phase.

Among other things, this summary has the following limitations:

- ◆ The language is very vague; there is no clear logical connection in the story.
- ◆ No exact information is given.
- ◆ The purpose, the use and the result of the study are not clearly indicated.

On studying the entire paper it was found the summary could be improved.

Example of an improved summary

A study was conducted into the ion pair extraction of the quaternary ammonium ions oxyphenonium and methyl benactyzinium from water to 1,2-dichloroethane in the concentration area 10^{-5} to 10^{-3} mol.l⁻¹. As counter ions, picrate and per chlorate were used.

The conditional extraction constants were determined by spectrophotometric measurement of the picrate in the organic phase; in the case of per chlorate after substitution with picrate.

The extraction constants determined are:

oxyphenonium – picrate : 100×10^3

oxyphenonium – per chlorate : 0.75×10^3

methylbenactyzinium – picrate : 10×10^3

methylbenactyzinium – per chlorate : 0.1×10^3

The occurrence of the 1,2-dichloroethane layer dissociation of the ion pairs was thus proven.

Based on the experiments conducted, it proved possible to extract oxyphenonium and methylbenactyzinium quantitatively from water with picrate or per chlorate as counter ion in the concentration area 10^{-8} – 10^{-6} mol.l⁻¹.

Key words: ion pair extraction; oxyphenonium; methylactyzinium; conditional extraction constant.

Participants often need to look up and/or study information. During the meeting each participant can give his/her opinion and ideas about the meeting issues. When decisions need to be taken (and be recorded). New agenda issues are brought up during the meeting.

Personal diaries need to be taken to any meeting to set follow up actions.

Now participants can make small announcements or ask questions that differ from the meeting issue.

Ideally, meetings are held in the morning when people are fresh, in a special room, and last no longer than 90 minutes.

11.2 Conduction the meeting

conducting the meeting

In meetings a number of base rules are common, like:

- ◆ do not interrupt if other participants speak
- ◆ do not criticize other people's ideas
- ◆ develop other people's ideas
- ◆ remain open and postpone judging/imposing them
- ◆ state a start and stop time
- ◆ everyone should participate and none should dominate
- ◆ complaints are legal provided they are accompanied by solutions/compromises
- ◆ when necessary stick to the agenda and time planning

phases conceptualising

During the meeting in following stages are gone through for each agenda item: conceptualising > opinionating > decision making.

The item discussion starts with conceptualising. This involves collecting information and adopting different viewpoints about it. In sum, analysing the problem definition that is offered. During this process participants may re-formulate the problem and bring up other aspects. Each participant can gradually organise the concepts and form his/her own opinion.

opinionating

After that the range of opinions are assessed. Alternative proposals for solutions can be made. The chair can formulate a conclusion from the discussion or a decision that could be adopted.

decision-making

A decision can then be made on the basis of agreement (consensus) or a vote take place.

tasks of the chair

During the meeting the tasks of the chair are:

- ◆ start the meeting on time
- ◆ enforce the regulations of the meeting
- ◆ participate as group member in the meeting
- ◆ stick to the agenda and keep an eye on time
- ◆ ensures everyone participates, regulate the discussions (or has this done by a discussion leader) and prevents underhand chitchat.
- ◆ has the authority to alter the approach of the meeting
- ◆ ensures the good order in the meeting
- ◆ imposes responsibilities

- ◆ summarises important decisions and actions
- ◆ encourages problem solving

tasks of the scribe

During the meeting, the scribe has the following tasks:

- ◆ visualises ideas without altering these
- ◆ regularly checks if the correct information has been recorded
- ◆ helps the chair in keeping information organised and stick to the agenda
- ◆ writes the minutes of the meeting

In order to carry out these tasks the scribe can use the following suggestions:

- ◆ asks for clarification if you wish to be certain you write the correct information
- ◆ records all keywords and key phrases
- ◆ uses the words he/she hears (verbatim) in the records
- ◆ writes legible on a flip-over or whiteboard (8 cm letters) which are clearly legible for the participants
- ◆ circles or underlines the important ideas, sentences, decisions or action points
- ◆ number the sheets to record information in the right order
- ◆ does not omit ideas or sentences because she/he fails to agree with these
- ◆ has his/her notes regularly checked by the group if the meeting takes long and is technical in nature.

tasks of participants

The participants have a number of tasks during the meeting:

- ◆ be informed well in advance about the purpose of the meeting
- ◆ report whether or not they will be present
- ◆ be well prepared
- ◆ be present on time
- ◆ adopt an open posture and postpone judging others
- ◆ help the chair in reducing distractions and promoting active participation
- ◆ bring up useful ideas
- ◆ support meeting regulations and procedures set for the meeting
- ◆ help reach mutual agreement and solutions to problems.

11.3 Evaluating the meeting

evaluation

After the meeting it is useful to reflect and evaluate on the process of your meeting. A number of questions can be addressed:

- ◆ Is/are the meeting objective(s) reached?
- ◆ Was there sufficient expertise in the meeting to reach the right decision?
- ◆ Are extra data needed to reach a decision?
- ◆ Do participants need extra time to decide on certain issues?
- ◆ Could changing circumstances alter the decision?
- ◆ Could certain participants address the problem more effectively?