Thesis Writing for Scientists and Engineers

Structuring a Thesis & Writing Introductions
Language: Academic Writing Style

Introductory Task

What is your opinion of the following strategies for academic writing in English? Put G by the strategy if you think it is a good one, and B if you think it is bad.

a) If you do not do so already, learn to think in English.

b) Write something - even if only a couple of sentences - every day.

c) Make certain that you reproduce as exactly as possible the ideas of your teachers. In this way you can be certain that what you write is correct.

d) Copy out and join together sections from books, the Web etc and present them as your own work. This is an even better way of making sure that you are correct and that you do not make mistakes.

e) Read for at least two hours a day in your subject area to improve your familiarity with previous work, and the way it is discussed.

f) Learn lists of specialised words in your subject area, and of typical academic linking expressions such as 'however', 'moreover' etc. This will make what you write sound important and impressive.

g) Learn to plan your writing by using diagrams (tables, mind maps etc.) as a way of stimulating ideas, and of deciding on the organisation of the writing.

In groups of 3 of 4, introduce yourselves, talk about your research interests, and discuss where you *disagree* about the above statements.

I. Structuring the Thesis

An **MSc thesis** will normally consist of the following sections:

- Title page
- Abstract (or Synopsis)
- Introduction
- Methods (or Methods and Materials)
- Results
- Discussion of Results (or just Discussion)
- Conclusion
- References
- Appendices

There may also be a Literature Review section.

A **PhD thesis**, on the other hand, will begin in the same way (Title Page, Abstract, Introduction), but then continue with a number of chapters based on the key topics of the research.

Example:

- Title page
- Abstract (or Synopsis)
- Chapter 1: General Introduction
- Chapter 2: Interspecific crossability relationships in the tuber-bearing Solanums
- Chapter 3: Embryo Culture
- Chapter 4: Transformation of *S. Ljertingii* using *Agrobacterium tumefasciens*
- Chapter 5: Protoplast isolation and culture
- Chapter 6: Electrofusion of potato protoplasts
- Chapter 7: General Discussion

In general the thesis moves from the **general** (big picture) to the **particular** (narrow focus) and then back to the **general**:

- The Introduction introduces the **general** concepts that relate to the experiment/problem but ends by stating the ***particular*** aims of the experimental work.
- The Methods and Results section presents a description and the results of the ***particular*** experiments carried out.
- The Discussion of Results relates the ***particular*** results obtained to the **general** theory and other results described in the literature.
- The Conclusion makes a number of **general** statements as a way of (i) highlighting the key findings of the research and (ii) linking the current research to future developments and opportunities to explore further.

II. Writing the Introduction

A. Elements of the introduction

There are a number of stages in an introduction[i], each with optional steps:

Stage 1: initiating the research/establishing the field
Possible steps:
a. introducing the topic
b. showing that the research area is important/problematic/relevant
c. summarising items of previous research

d. justifying the research: raising questions about previous research/indicating what is missing in it or how it can be extended

Stage 2: developing the research

Possible steps:

e. stating the aims of the research/ defining the scope

f. announcing main findings

g. indicating the structure that will follow

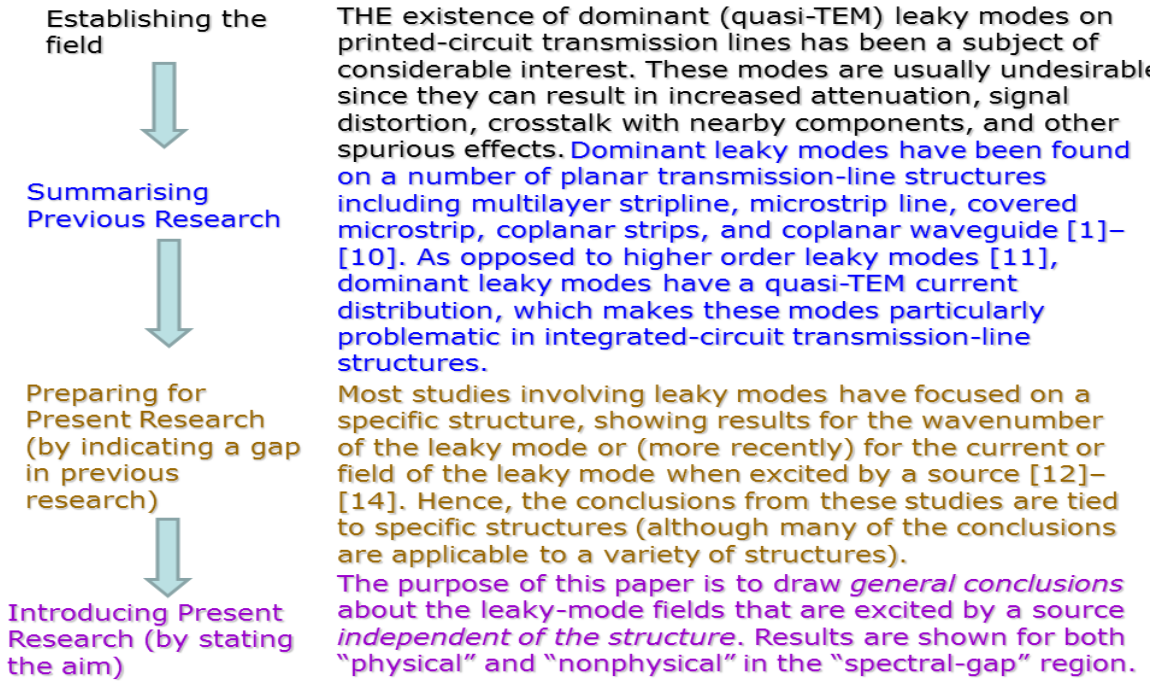
Example[ii]*:*

(a) The existence of dominant (quasi-TEM) leaky modes on printed-circuit transmission lines has been a subject of considerable interest. **(b)** These modes are usually undesirable since they can result in increased attenuation, signal distortion, crosstalk with nearby components, and other spurious effects. Dominant leaky modes have been found on a number of planar transmission-line structures including multilayer stripline, microstrip line, covered microstrip, coplanar strips, and coplanar waveguide [1]–[10]. As opposed to higher order leaky modes [11], dominant leaky modes have a quasi-TEM current distribution, which makes these modes particularly problematic in integrated-circuit transmission-line structures.

(c) Most studies involving leaky modes have focused on a specific structure, showing results for the wave number of the leaky mode or (more recently) for the current or field of the leaky mode when excited by a source [12]–[14]. **(d)** Hence, the conclusions from these studies are tied to specific structures (although many of the conclusions are applicable to a variety of structures).

(e) The purpose of this paper is to draw *general conclusions* about the leaky-mode fields that are excited by a source *independent of the structure*. **(g)** Results are shown for both "physical" and "nonphysical" in the "spectral-gap" region.

To summarise, a model that is typically followed in science papers is as follows:



Task 1

Try and identify any steps in the following two journal article introductions. Not all the possible steps are present, and sometimes 2 are taken at the same time.

1. Design considerations for inspiratory muscle training systems[iii]

Recent studies of respiratory muscle training have lent support to its ergogenic influence upon time trial performance [1], as well as on the time to the limit of tolerance during moderate intensity exercise [2-4]. In contrast, studies that have utilized either incremental tests to the limit of tolerance [5, 6] or very strenuous fixed-intensity tests [7-9] have failed to observe any statistically significant effect upon performance. It is clear that both respiratory and inspiratory muscle training can improve exercise performance under certain conditions. However, it is possible that exercise performance could be improved further if a superior training technology were available. There are a wide range of commercially available devices, all of which are suboptimal in their functionality. The present paper describes the limitations of existing technologies and explores novel means of overcoming these shortcomings. Potential design solutions are defined and compared.

2. Towards deflection prediction and compensation in machining of low-rigidity parts[iv]

Achieving the right profile in machining low-rigidity ('flexible') parts increasingly depends on the use of computer aided design/manufacture (CAD/CAM) packages for defining optimal cutting strategies and tool paths. The NC part programming for complex surfaces has been well supported by significant developments in tool path modelling and verification techniques. However, most of the existing techniques and models are based on idealized geometry and do not take into account factors such as variable cutting forces, part/tool deflection and static and dynamic compliance during machining [1], leading to additional machining errors that are difficult to predict and control. The current industrial practices employed to compensate for such errors are based on extensive experimentation using trial-and-error approaches leading to increased cost and lead times.

Recently a number of research efforts have been reported that take into account the tool/part deflection during machining. Kline and DeVor [2] linked a cutting model with deflection models of the tool and the part and used the results to predict and control surface finish by modifying cutting parameters. Lim and Menq [3] proposed a model for prediction of surface errors using a ball end mill cutter that took into account different cutting strategies. Feng and Menq [4] have improved the above model by taking into account the instantaneous and regenerative feedback of the cutting system deflection to establish the chip geometry in the cutting force algorithm. The deflection and cutting models were also enriched by considering additional sources of error such as machine set-up error, spindle and axis tilt, vibration and cutter centre offset run-out [5]. Work has also been reported using artificial neural networks (ANNs) for force and form error prediction [6] that have claimed results superior to those of similar analytical models with the added

advantage of relatively easy implementation and low cost system maintenance [7]. A number of specialist finite element analysis (FEA) software packages are being used to simulate manufacturing processes such as metal cutting. These packages use mathematical theories and non-linear numerical algorithms to model plastic flow, heat conduction, thermomechanical coupling, dynamic behaviour and contact mechanics with friction [8, 9]. Several different methods are also being used for cutting simulation and numerically controlled (NC) verification based on Z-map, dexel, discrete vector and voxel based representations [10].

Despite the significant developments in NC simulation and verification there is still a knowledge gap in identifying the impact of deflection on the process of metal removal and there is a lack of systematic approaches to modelling and prediction of the component errors due to deflection in thin-walled structures.

This paper reports on a new integrated methodology and initial validation results for predicting and compensating surface errors due to deflection in machining of low-rigidity components.

B. Guiding your Reader

A **thesis** introduction is likely to be much longer than a journal article introduction (as in the 2 examples above), and this will have consequences for the organisation.

In particular, Stage 1 (establishing the field), is likely to be broken up into more sections. We are likely to begin with a very general topic, and then break it down into more specific topics.

We can analyse how a writer develops a paragraph by imagining the questions it answers. The writer does not ask these questions in writing, but imagines the reader is asking them in response to the previous sentence (or in some cases the previous heading).

In the example below, the first sentence answers the question: *Why do we need to improve solar systems*, and the second sentence answers *Where is this particularly important?*

Example: The Development of a Solar Water-Heating System for use in Developing Countries

The need to improve existing solar systems in terms of efficiency, cheapness and simplicity, is clear in the light of an impending world-wide fuel crisis. The need is particularly urgent in the developing world where imports of foreign fuels are a heavy drain on limited sources of foreign exchange and where the intensity of sunshine is often considerable.

Task 2

What were the questions answered by the other sentences in this introduction (below)? Match the questions A-H with each sentence.

A. What materials were tested for that component?/ What did the tests consist of?
B. What materials have been used?/ How do they work?
C. What components do such systems have?/ What are the existing systems like?
D. Which seems to be most suitable for developing countries?/ What type has been most popular?
E. What field trials were carried out?/ Where were the tests done and why?
F. What was the aim of the project described?/ What was the project about?
G. How many basic types of water heater are there?/ Are there different types?
H. What specific component was investigated?/ What aspect of the systems were looked at?

1. Nearly all such systems developed to date have consisted of a heat absorbing surface which transfers heat to circulating water that can be stored in an insulated tank.

2. Traditionally these systems have made use of expensive conducting materials such as copper wire and copper sheeting and have incorporated an electric motor.

3. There are two basic types of solar water heater, the closed type and the open type.

4. Attention has been focused on the former because in much of the developing world climatic conditions are such that the exposed older open type is easily contaminated by dust and algae.

5. The aim of the project was to develop a solar water heating system for use in developing countries.

6. In particular, it has concentrated on an investigation into the cost, durability and efficiency of different types of absorber.

7. Various metal absorbers were tested, particularly those of tinned-tube and prefabricated plate design, and the possibility of using synthetic materials were examined.

8. The three prototypes that were found most satisfactory in laboratory tests were tried out in field conditions in India with the cooperation of the Institute of Advanced Studies in Poona.

Task 3

Here is the introduction to a dissertation.

The 4 paragraphs have been mixed up. Bearing in mind what you know about steps and about anticipating reader questions, put them in the right order and then compare your answer to a neighbour's.

The Thermal Conductivity and Specific Heat of Epoxy-Resin from 0.1- 8.0K

A. Nevertheless more experimental data are required and in particular it would seem desirable to make experiments on glassy samples whose properties can be varied slightly from one sample to the other.

B. The thermal properties of glassy materials at low temperatures are still not completely understood. The thermal conductivity has a plateau which is usually in the range 5 to 10K and below this it has a temperature dependence which varies approximately as T2. The specific heat below 4K is much larger than would be expected from the Debye theory and it often has an additional term which is proportional to T.

C. The present investigation reports attempts to do this by using various samples of the same epoxy resin which have been subject to different curing cycles. Measurements of the specific heat (or the diffusity) and the thermal conductivity have been taken in the temperature range 0.1 to 80K for a set of specimens which covered up to nine different curing cycles.

D. Some progress has been made towards understanding the thermal behaviour by assuming that there is a cut-off in the phonon spectrum at high frequencies (Zaitlin and Anderson 1975a,b) and that there is an additional system of low-lying two-level states (Anderson 1975, Anderson et al. 1972. Phillips 1972).

III. Language: Academic Writing Style

As you will know from experience, academic writing in the sciences is generally formal and quite impersonal. This is because it deals with objects, theories, and results rather than people.

There is a lot of information about academic writing style on Canvas. To access this, self-enrol on the self-assessment course and follow the link below:

https://canvas.bham.ac.uk/courses/9197/pages/further-information-about-eisu-services

Task 4

Look at the following statements. Discuss with a neighbour what is wrong with them. Decide together how you would improve them.

1. You can see the results in Table 1.
2. There are desirable benefits to be gained from increasing research into these materials.
3. The implementation of computer-integrated-planning has brought about some serious problems.
4. The results of a lot of different projects have been pretty good.
5. Continuous process technology was adopted. This was because of its greater efficiency.
6. The problem doesn't have many viable solutions.

How can you learn the appropriate style?

(i) Read other articles and theses in your discipline (search by subject on ***http://etheses.bham.ac.uk/***)

(ii) Notice useful common academic expressions (e.g. *The aim of the project was to develop...)*

(iii) If you worry about the level of formality of your writing, book a one-to-one consultation with a BIA lecturer by emailing Ms Angela Stewart: a.stewart@bham.ac.uk.

(iv) Look at the bank of academic language provided by the Academic Phrasebank: http://www.phrasebank.manchester.ac.uk/

Task 5

On the left side of the table below are some examples of 'informal technical' language collected from lectures at Birmingham University in the Departments of Plant Biology, Minerals Engineering, and Civil Engineering.

This language is appropriate when speaking, but how would you express the same ideas more formally in your academic writing?

Complete the more formal version of what the lecturer said by filling in the missing word from the box. You can make the task more challenging by not looking at the box.

Missing words: collide, deal, eliminate, executes, extracted, identify, inserted, occurs, recovered, reduces, supports, tolerate

Informal	Formal
1. In practice we can't cope with all of the species.	In practice it is impossible to _____ with all of the species.
2. The word 'diversity' crops up frequently in the literature.	The word 'diversity' _____ frequently in the literature.
3. We feed in different values for Z into the equation.	Different values for Z are _____ into the equation.
4. There is evidence that firms up Lab Report 1132.	There is evidence that _____ Lab Report 1132.
5. Very fine solids are picked up in the cyclone.	Very fine solids are _____ in the cyclone.
6. The particles bump into each other.	The particles _____ with each other.
7. When we recompact a soil we cannot get rid of the last 5% of air.	When we recompact a soil we cannot _____ the last 5% of air.
8. In the type B roaster, part of the gas stream is pulled out through the second cyclone.	In the type B roaster, part of the gas stream is _____ through the second cyclone.
9. The use of a large freeboard area cuts down the amount of recycling needed.	The use of a large freeboard area _____ the amount of recycling needed.
10. In certain cases DNA can put up with one incorrect base pair.	In certain cases DNA can _____ one incorrect base pair.
11. It is difficult to pin down the factors involved.	It is difficult to _____ the factors involved.
12. The computer chews its way through the program.	The computer _____ the program.

KEY

Introductory Task

Broadly speaking: a) G, b) G, c) B, d) B, e) G, f) B g) G.

a) GOOD ADVICE

- Many students who have continuing problems in writing academic English confess that they think about the topic and do the first drafting (on paper or in their heads) in their first language, and only at the end "translate" it into English.
- Most people would agree that it is a great advantage to be able to think in English: but can we train ourselves consciously to think in a foreign language?
- A technique that works for some people can be derived from the theoretical work of the Russian psychologist Lev Vygotsky (1896-1934). Learning to think in a foreign language involves talking to oneself in that language, first about simple domestic matters ('Where did I put the sugar?' 'Oh, there it is.') and then, increasingly, about more complex and intellectual problems.

B) GOOD ADVICE

In writing, as in any other skill, 'Practice makes Perfect'.

C) DEBATABLE

This is a difficult one!

- It is a good idea to show that you understand what you have been taught, and a few departments/teachers may ask no more than that. Most departments, however, will expect you to show 'critical judgement' of what you have been taught.
- From the everyday use of the words 'critical' and 'criticise' some students imagine that this means they must show where what they have been taught is wrong. In fact, critical' here means much more than that, and may include the ability to consider such matters as:
- The theoretical justification for those ideas
- The relationship between theory and practice
- The relevance of those ideas to your own experience or to conditions in your country

D) VERY BAD!!

- It is easy to understand why some students adopt this strategy:
- They are uncertain about their understanding of the subject
- They have no confidence in their ability to write English to the required standard
- This may be a common strategy in their own countries.
- The first piece of written work presented by the student may contain one or more copied sections which are not detected by the teacher.

This strategy could lead to accusations of Plagiarism, which is discussed in the extract from the University website at the end of this handout.

E) GOOD IDEA

- A warning is necessary: beware of acquiring an inappropriate style of academic writing.
- For example, school and university textbooks (and these notes too) often address the reader as 'you'. This is inappropriate in a university essay or dissertation.
- Similarly, in a textbook you may find 'As will be seen from Figure 10...' while in an essay 'Figure 10 shows that ...' may be preferred.

F) DOUBTFUL

- Learning lists of words is not, in general, an effective way of learning vocabulary, as it is impossible from a list to discover how a word is used in context.
- The same applied to lists of 'linking words' removed from context.
- In both cases it is better to keep a small 'vocabulary notebook' in which you note down useful new words and expressions as you come across them, with the contexts in which you found them. You can also use your mobile phone to note down new vocabulary.
- Don't try to make your writing sound 'important' or 'impressive'.
- Good academic writing is as clear and simple as it can be. If it is genuinely impressive, then that comes from the power and complexity of the ideas you are expressing. (Remember that just because a paper is published, this does not mean the writing is good! You will find lots of example of bad and overly complicated academic writing in published texts.)

G) VERY GOOD

- This is one of the main points we shall be trying to get across during these sessions.
- A well-organised piece of writing will gain credit even if the English shows a number of grammatical mistakes: a poorly-organised piece of work cannot gain credit even if the English is grammatically perfect.

Task 1

1. Design considerations for inspiratory muscle training systems

(a) (c) Recent studies of respiratory muscle training have lent support to ....
(b) (c) In contrast, studies that have ...
(d) However, it is possible that ...
(e) The present paper describes ...
(f) (g) Potential design solutions are defined ...

2. Towards deflection prediction and compensation in machining of low-rigidity parts

(a) Achieving the right profile in machining low-rigidity ('flexible') parts ...
(b) However, most of the existing techniques and models are based on ...
(c) Recently a number of research efforts have been reported ...
(d) Despite the significant developments in NC simulation and verification ...
(e) This paper reports on a new integrated methodology and initial validation results for

Task 2: Key

NB These are suggestions. Other questions may have been possible.

1 C. What components do such systems have?/ What are the existing systems like?
2 B. What materials have been used?/ How do they work?
3 G. How many basic types of water heater are there?/ Are there different types?
4 D. Which seems to be most suitable for developing countries?/ What type has been most popular?
5 F. What was the aim of the project described?/ What was the project about?
6 H. What specific component was investigated?/ What aspect of the systems were looked at?
7. A. What materials were tested for that component?/ What did the tests consist of?
8 E. What field trials were carried out?/ Where were the tests done and why?

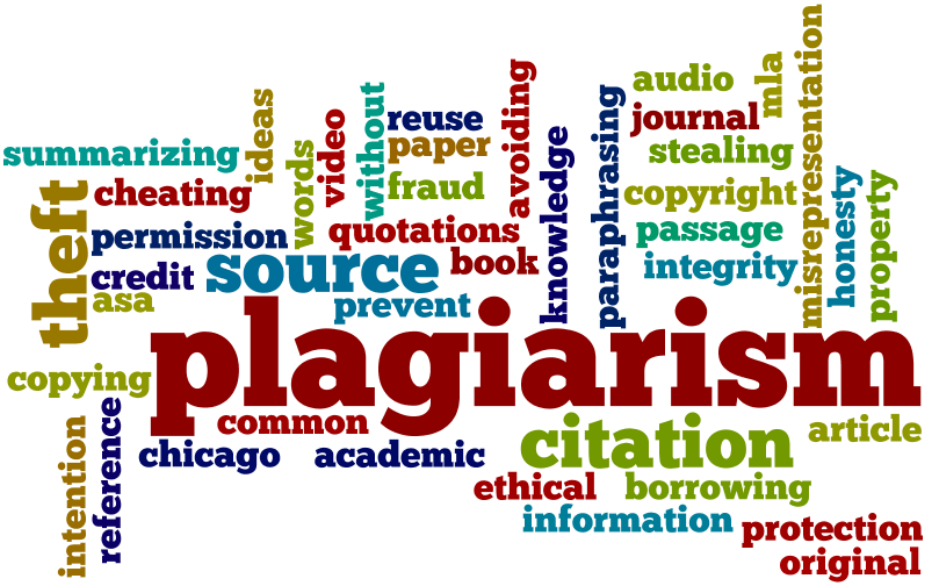
Task 3:
A3, B1, C4, D2, so: correct order: B-D-A-C.

Task 4

1. The results can be seen in Table 1. *Do not address the reader with 'you'.*
2. There are ~~desirable~~ benefits to be gained from increasing research into these materials. *Redundancy: all benefits are desirable.*
3. The implementation of computer-integrated-planning has caused some serious problems. *One-word verbs are more formal than multi-word verbs*
4. The results of ~~a lot of~~ ***many*** different projects have been ~~pretty good~~ **encouraging.** *Informal vocabulary*
5. The reason for the adoption of continuous process technology was its greater efficiency. *Use nouns instead of verbs where possible.*
6. The problem **has few** viable solutions. *Do not use short forms: 'doesn't'= 'does not' and use positive formulations where possible: 'not many'= 'few'*

Task 5

1. deal, 2. occurs, 3. inserted, 4. supports, 5. recovered, 6. collide, 7. eliminate, 8. extracted, 9. reduces, 10. tolerate, 11. identify, 12. executes.



A Note on Plagiarism

What's wrong with Plagiarism? It:

- breaks the University's code of values
- if it involves copying, prevents you from developing your skills and knowledge
- can lead to expulsion in serious cases
- can lead, if undetected, to unfairness in assessment
- can lead to inappropriate feedback to you and to everyone else
- can involve illegal behaviour where it infringes copyright.
- Plagiarism by directly copying the work of others or by deliberately failing to acknowledge the work of others is a disciplinary offence. It also hurts others and hurts you.
- If you are not engaging in assessment activities as expected then you are not giving yourself the chance to make ideas your own.
- As a result, you will not get the right kind of feedback.

- ➢ If plagiarism is widespread it hurts the University community and hence the value of your qualification.
- ➢ If plagiarism becomes widespread, it could lead to a return to greater use of the formal unseen examination.
- ➢ If you allow someone else to copy your work, you are also failing to uphold the values to which the University subscribes.
- ➢ If you give in to peer pressure on this, you are failing to be a good citizen of the University.
- ➢ If you take work from the Internet without selecting, acknowledging and making it your own, you are failing to be a good citizen.

Deliberate plagiarism is cheating. By the end of this document, you should know what plagiarism is. If, given this knowledge, you do plagiarise, then sanctions can be used against you.

Unintentional plagiarism can be avoided by acknowledging, in a proper academic way, the contribution that others have made to the development of your ideas and to the quality of your answers.

Avoid plagiarism by:

- observing School rules governing individual and joint work
- observing School guidance governing practical work
- observing the referencing conventions within your discipline
- using your own words as far as possible when writing an assessment
- providing sources for any direct quotations
- making use of careful own-word summarisation, where appropriate, making sure that the source is given in the text and bibliography
- by keeping your work up to date or by negotiating new deadlines if you get behind
- by checking through your work to see whether you have observed the rules
- by asking for guidance
- by taking careful notes with full references and page numbers as you gather information for a topic, distinguishing between direct quotes and own word summaries.

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[i] Further Reading: Swales and Feak, 1994, Academic Writing for Graduates Students, Michigan.
[ii] From an article by Swales (1990)
[iii] See http://journals.pepublishing.com/content/y66306j630868n0l/
[iv] See http://journals.pepublishing.com/content/7430244266520x79/