Why Research Skills?

- Presents and explores the processes of scientific research:
  - Forming a research hypothesis.
  - Literature review.
  - Planning the investigation.
  - Analyzing results.
  - Reporting your findings.

- Preparation for the MSc Practicum (CA545/BE594/CA635/CA623)
Why Research Skills?

Notes, slides, assignments, etc for Research Skills:

MSc in Bioinformatics
http://www.computing.dcu.ie/~gjones/Teaching/CA546MBIO/

European Masters in Business Informatics
http://www.computing.dcu.ie/~gjones/Teaching/CA546EMBIN/

MSc in Software Engineering
http://www.computing.dcu.ie/~gjones/Teaching/CA625/

Some Questions

At the start of your postgraduate studies.

If you have not done so before, you may find it useful to consider the following questions.

- Why am I doing a Diploma/MSc?
- Why did I choose this course over others?
- What do I intend/hope to get out of postgraduate study?
  - How am I going to make sure I achieve this?
Transferrable Skills

This module will give you the opportunity to develop the following transferrable skills, and probably others as well.

- Locating sources of information.
- Review, interpretation, contrastive analysis and summarized reporting of existing work.
- Planning (work plans, time plans)
- Team working.
- Reporting results (considering the audience, written reports, oral presentation).

Postgraduate Study

- Shouldn’t treat it as simply an extension of undergraduate study.
- Plan to take responsibility yourself for your learning.
  - comes back to - what do I intend to get out of postgraduate study?
- You should not feel restricted to only studying the course material.
  - e.g. if a topic is interesting feel free to read beyond set material.
  - potential employers/research supervisors will often look beyond your qualifications to find out about your real interest in a subject.
  - although of course you need to focus on the syllabus and make sure you pass all the assessments!
Introduction to the Research Process

Research is an *original contribution* to knowledge.

- A research project (particularly in science or engineering) typically involves developing and testing an hypothesis.
  - if \( x \) is true then \( y \) must be true as well.
  - if \( a \) and \( b \) occur with \( c \), then they should occur with \( d \) as well.

- A project may involve the testing of a single (possibly quite complex) hypothesis.

- Or the sequential or incremental testing of a number of smaller hypotheses leading to one or more conclusions.

Introduction to the Research Process

Research projects usually involve a cycle of forming and testing hypotheses.

- If the current hypothesis is found to be true, then it is often refined or extended to form a new hypothesis that needs testing.

- If the current hypothesis is found to be false, then the next stage is to refine the hypothesis or to develop a new hypothesis which explain the result. This new hypothesis then needs to be tested.

Thus research in a topic area is often a never ending process of extending knowledge by hypothesis and testing.

Fortunately, research degrees and even larger projects only need to make an appropriate contribution to be deemed successful.
Assessing Contribution

- Appropriate contribution varies depending on the qualification sought.
  - MSc/MPhil requires less than PhD.
- Personal guidance on this should be available from your research supervisor(s).
- It is also a good idea to look at some existing successful dissertations for the same degree from previous students from your course or School.
- At the end of the day the decision of success or failure rests with the examiners!
  - Qualified researchers continue to face this situation repeatedly every time they submit work for publication or proposals for research grant funding. Reviewers will read and accept or reject their submission!

Research Training

- A postgraduate research project is a training qualification in conducting research within your discipline (physical sciences, social sciences, arts, etc, can be quite different in their approaches).
- Reflection on your experience is an important part of the learning process. So you might usefully ask questions such as:
  - Did I spend too long reading before starting the experimental work?
  - Did I start the experimental without sufficient literature review?
  - Was this the best design of experiment possible to make maximum use of my time?
  - Did I wait too long to discuss this problem with my supervisor?
  - Did I rush to speak to my supervisor too quickly?
Research Projects

- A research project may be very clearly defined at the start with a well-defined single hypothesis or series of hypotheses to be tested.

at the other extreme

- The project may only be vaguely defined. Supervisor decides “this is an interesting area to work in, there are lots of interesting and unsolved problems, let’s start work and see where it leads us”

The first option is generally “safer”, but often less exciting with less scope for significant personal contribution from the student.

A word of caution.

- Beware just being the eyes and hands of the supervisor in the laboratory or office.

- It’s great to get strong and enthusiastic support and guidance, but *you* will be assessed on what *you* have done.

- If you are concerned that you are not getting enough support and guidance, or that you are not getting enough freedom to develop your own ideas, discuss your concerns with someone.
  - your supervisor, your course director, the practicum coordinator, your friends/colleagues,... - whoever you are most comfortable talking to.
Goal: Find out what has already been done. And who has done it.

This is vitally important since it:

- delimits the research problem.
- identifies new and current approaches and trends.
- helps in identifying and understanding methods.
- helps prevent you repeating existing work! (although you may want to repeat existing work if you believe it be deficient or that a reassessment would be timely for some reason.)

Relevant literature can come from many sources:

- List of Abstracts, etc.
- Dissertations.
- Journals/conference proceedings.
- Bibliographies/Books.
- Increasingly the Web.
When reviewing literature:

- be open minded.
- work backwards - z cites y which cited x - can lead to the key sources.
- contrast sources and types of knowledge.
- evaluate content over style.
- beware “common knowledge”.
- keep review up-to-date as you find more references.
- synthesize and reference.

Identifying a Research Question

Observe:

- Why is a particular experiment/methodology less than satisfactory?
- What can be learned by studying current practice?
- Why are some topics/measurements difficult to learn/make?
Identifying a Research Question

Derive:

- inspiration from published work, e.g. seek to verify, replicate, refute, extend.
- apply existing theory to your work.
- resolve conflicting or contradictory findings.
- correct methodology in earlier work.

Avoid:

- Unresearchable topics: Is the topic amenable to methods proposed?
- Trivial topics: Is the answer obvious? Will you learn anything? Is there any contribution to knowledge?
- Overworked topics: Do you have a new slant?
Identifying a Research Question

Consider

*Personal Factors:*

- Interested? Unbiased?
- Background and skills?
- Equipment, tools, participants, TIME AVAILABLE?

*General Factors:*

- Will the data/method be applicable, new, worth having?

**Some Common Mistakes**

- Poor definition of context - lack of theoretical or conceptual framework.
- Poor Basis - unsupported claims and assumptions.
- Data/Method - without defined purpose.
- Fitting Questions - to a “batch” of data.
- Poor Review of Professional Literature.
- “One Shot” Research - conducting research unique to a given situation, permitting no expansion or generalization.
- Failure to make assumptions explicit, recognize limitations of approach, anticipate alternatives.
Some Common Errors in Planning

- Time Available: everything takes longer than you think!

- Availability of data, software, equipment. Is it here now? When will it (really!) arrive? Will it be here soon enough?

- Compromising. Limiting the scope of the investigation too soon. Not exploring the alternatives sufficiently.

Research Life

- Researchers have good days and bad days.
  
  Some things work out and some things do not.

- Negative results can lead to the greatest insights or new ideas.

- Research can be highly creative, rewarding, personally satisfying and even fun!