

An Introduction to Research Skills

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“A research project consists of an original piece of work that contributes to an area of study.”

Research: Original Work

How original?

- A new approach to a grand unified theory of physics?
- Designing and implementing a graphics kernel based on the physics of light?
- Implementing a quantum computer?
- Developing a new theory of system design for computational systems?

NO! Don't overestimate what is required.

'ORIGINALITY' and 'NOVELTY' - something never done before -
may seem intimidating: it is not!

How original?

In a half-year MSc project:

- Extending, testing or applying something already ‘in the research domain’,
- Developing a small part of a major new system,
- An incremental development, adding a little to our understanding of an area,
- A large worked example or case study, or an implementation, using new principles, of a small system,
- Reworking a previous advance into an improved form (including a previous MSc project),
- Undertaking a not necessarily novel task but in a ‘leading-edge’ technology.

The SCALE of the project is crucial: Use the guidance and experience of the supervisor.

Where do new ideas come from

INSPIRATION: The “blinding flash” from the sky! NO

HARD WORK: YES

- Immersing yourself in the topic and problems,
- Trying many avenues of thought.

Ideas are cheap!

- From 1000 ideas,
- 100 may be worth investigating,
- 10 may make progress,
- 1 may provide a solution.

90% perspiration, 10% inspiration!

Where do new ideas come from? (II)

From critically reading the literature:

- Why does the author use this technique?
- What would the research look like in a different setting?
- Look at the CONCLUSIONS: They say what may be inadequate in the work, or suggest new research directions or improvements.

ACTIVE READING:

Try to make notes to yourself when you read articles or books.

Look for what is omitted as well as what is said.

Where do new ideas come from? (III)

PROBLEM SOLVING - modes of thought:

Phases:

1. Understand problem - often not easy, imprecise and conceptual content not clear,
2. Seek a PLAN for the solution - many sources for plans of different types (see below),
3. Implement plan,
4. Check and evaluate result.
5. Iterate as necessary!

Problem Solving

If you cannot solve a problem, solved a RELATED problem -

How related?

- A particular case: SPECIALISATION
- Something more general: GENERALISATION. How to generalise?
- Something similar: ANALOGY

If you cannot solve a problem, DECOMPOSE it into smaller problems, solve them and COMBINE the solutions: “Design principles”

If you cannot solve a problem, examine (1) the data, (2) the structure of the problem, and (3) the concepts and definitions underlying the problem.

New insights come from -

- Combining two previously distinct views/results/methods,
- Trying a view/result/method in a new area,
- Deep recesses of the brain!

Aids to developing ideas -

- pictures and diagrams
- appropriate notation - often crucial
- introducing new concepts and finding definitions

Problem-solving is TRIAL-AND-ERROR, so BACKTRACKING is a crucial feature.

Literature on problem-solving and invention

There is quite a lot of literature on the psychology of discovery and invention.

There are also good books on methods of problem-solving. See for example:

How to solve it. George Pólya, 1945 (reissued 1990)

Where do new ideas come from? (IV)

From your SUPERVISOR and research environment.

Your supervisor has set the project for

- a half-year
- appropriate research content
- correct level of attainment

DOING RESEARCH is...

- SOLITARY - long periods of working 'alone',
- INTERACTIVE - receiving and communicating ideas - a SOCIAL ACTIVITY with supervisor, research group, seminars, conferences etc
- STRESSFUL - many months occupied on one narrow topic and a deadline for achievement, can mean (1) sapping of confidence, and (2) source of self-doubts,
- FULFILLING - a sense of creation and achievement, of understanding and solving a problem, of contributing in a small way to 'knowledge', or doing something no-one has done previously.

Handy hints for doing research

(1) Days become weeks become months....

- agree short-term goals with your supervisor.

(2) A research day is long....

- leave something easy from the day before to start the days with...
- be aware of the multitude of distractions.. email, games, internet, conversations...
- determine work times realistically:
 - half-a-days concentrated effort is worth 2-3 days of diffuse effort,
 - schedule times for work and recreation.

- (3) Progress seems slow, nothing is happening...
- Stick with it! It is often in the slower periods that real progress is made, realisations arrive and new ideas rise to the surface.
- (4) This is my brilliant idea and....
- Your brilliant idea *may* be so but see ‘1000 ideas’ (above) - ideas are cheap!
 - Test it against your supervisor and other researchers, do not keep it to yourself.
 - Do not waste time: *If you really believe in your idea, you have the rest of your life to pursue it - for the moment the aim is to get an MSc.*
- (5) I’ve lost interest, why should I bother with this?...
- You *will* lose interest. Stick with it!

(6) I can't remember why I decided that... What did I do with that idea I wrote down.... didn't I convince myself that this program would work in the new environment?...

All students should have a LOG BOOK, to record:

- Literature read - with critical comments!
- Daily progress (with dates), including
 - designs
 - decisions
 - ideas
 - what doesn't work as well as what does
 - tasks and goals agreed with supervisor.

This becomes the SOURCE BOOK for writing your dissertation - a foundation for the explanatory parts and justifications of your dissertation.

Choosing a research project

Criteria

- Interest
- Career ideas
- Supervisor and research group

Method

- Choose from a selection of c150 projects on the webpage, THEN talk to the supervisor so that both of you can assess the suitability of the project for you, OR
- If you wish, suggest your own project - but we need to find a suitable supervisor for this option, OR talk to the staff and research groups in areas of interest to seek ideas for a project.

Relationship with your supervisor

It is critical to get this right! A major reason for failing the project is that this relationship is not working.

It is a TWO-WAY PROCESS of CONTRIBUTIONS, DEMANDS and EXPECTATIONS.

What YOU should expect from your supervisor

- Reasonable availability
- Guidance on the topic and doing research
- Encouragement!
- Listening and responding
- Feedback on progress

What YOUR SUPERVISOR should expect from you

- Attendance at meetings!
- Reasonable independence and own management
- Listening and acting on words of wisdom!
- Regular evidence of progress
- Be fun! Be positive!

Frequency of meetings - can vary, sometimes very frequent, other times less so. Usually weekly at the beginning.

BE AWARE of the need for this two-way communication and consider its quality:

ASK: Is my progress good enough? Am I doing this correctly?

Make sure you understand what the supervisor requires.

FINALLY:

- Supervisors want their project done and want it done well - many projects are there to advance the supervisors' research.
- You want the project done and done well for your MSc.

YOUR AIMS ARE THE SAME!

The relationship with the research group

You may be joining the research group of which your supervisor is a member:

Take full advantage:

- Others doing similar research
- Technical and morale support
- Introduce yourself - make friends/colleagues.

PERILS OF JOINT SUPERVISION: if two or more supervisors are appointed... beware! Make sure one is your main supervisor.

Supervision by 'research groups' - not a good idea.

What to do if things go wrong

... with the research

- it will - the nature of research
- admit it as early as possible, THEN go to your supervisor, say where you are and ask for guidance

... with the supervision process

1. try to sort out the problems with the supervisor,
2. if you are not satisfied, go to your Programme Director who should deal with your complaint,
3. formal complaints procedure in the regulations.

How to survive in a predominantly male, western, white, full-time academic environment

BE AWARE! There may be:

- Relation difficulties
- Language difficulties
- Cultural difficulties

Rarely affect research project or supervision, but be aware.

Sources of help

- Supervisor and Programme Director
- Advice Service: Room 2.4, 1.30 - 2.00 daily during term time
- University Counselling Service, Student Union Advice Centre

Literature on research skills and managing research projects

There is a very good collection of books on this subject - see University Bookshop. Some are for science - others more general research.

Example: *How to get a PhD*, E.M. Phillips and P.S. Pugh.

Continuing in:

- RESEARCH: Springboard for a PhD (3 years). Discuss with your supervisor, apply NOW, funding is often available - we want PhD students!
- INDUSTRIAL RESEARCH AND DEVELOPMENT: Supervisor may have contacts. See also Careers Service (excellent).
- ACADEMIC LIFE: !!

Project timetable

- Jan/Feb** Begin preliminary work on Project for Background Report. Contact with supervisor begins. Project background, context, scope, survey of related work, relevant systems, and plan for completion.
- May 9th** Submit project background report. Marked as dissertation - need to pass to complete project.
- May - Mid August** Project completion: Research, development, implementation and results.
- Mid August - Mid September** Write dissertation: Allow at least 4-5 weeks full time writing. Structure and organisation, drafts of contents and chapters - all to be discussed with supervisor for advice. Also talk in this course on research writing, and advice in handbooks. DEADLINE is mid September or earlier.

October/November Examination of dissertations: Two internal examiners (one is your supervisor, the other someone else in the area). Two written reports and marks, independently. External examiner - meeting and moderation.

Examiners require:

- Contribution at right level (Masters), right scope and achievement.
- Evidence that you know the area sufficiently well, have developed the skills and knowledge,
- Submitted a literate and professional account of the research in your dissertation.

See examination form for details.

*** ENJOY ***