

Dublin City University
School of Computing

MSc in Software Engineering (MSE)

**MSc in Security and Forensic
Computing
(MSSF)**

CA640: Research Skills

PART 2: Research Quality and Creativity

Introduction

What constitutes good research ?

- It is important to learn to distinguish good research from poor research, and address the strengths and weaknesses of each.
- Good research will in general make its aims and objectives, claims and limitations clear.
- Poor research may be unsound for many reasons, e.g. literature review, experimental methodology, analysis of data, reporting etc.
- Poor research may nevertheless contain the essence of a good idea.
- It can take skill and imagination to spot such hidden useful nuggets.

Literature Review

The usual starting point for research, whether or not you are starting with a clearly defined research problem, is to read about the subject:

- Find out about the background.
- Identify unanswered questions or controversies
- This can lead to small scale investigations or pilot studies.

Once the problem is defined it can be broken down into a set of specific questions or hypotheses

Breaking down questions and hypotheses should help suggest the most appropriate line of investigation

Literature Review

Exercise: Scan through (without reading in detail) some research papers or existing dissertations or theses

Ask yourself:

- Does each one seem to define the research problem explicitly, e.g. as a list of hypotheses ?
- Does the focus emerge as the research progresses ?
- Is there any indication that the research problem changed in direction or emphasis during the research ?

Research Methodologies

- A research methodology is a rationale for gathering and processing data, deciding on what sequence and what data to use
- It is a well informed and argued case for designing a piece of research in a particular way
- Good argument involves paying attention to counter arguments, and in general justifying your choice against the alternatives.

Exercise: Look for how the methodologies are argued for in some papers and theses; do the arguments seem reasonable to you? Are there omissions or unfounded assumptions ?

Data Collection

Data collection in research investigations needs to be as relevant and accurate as possible,

- It can inspire confidence in the conclusion/solution
- Sometimes something important can turn up, leading to a new and important line of investigation - such observations can only be trusted if the data are known to be accurate.
- Constraints of time and expense can prevent a data collection exercise from being repeated!

Exercise: When reading papers and these consider whether you think that the investigations have been competently conducted

Academic Argument and Discourse

A paper or thesis should be much more than a presentation of the data collected or a report of the work carried out.

It should be a well-documented and well-argued case for one or more specific solutions to a research problem.

The notion of “arguing a case” in the manner of a lawyer can be useful here: to make a case

- Evidence has to be collected and presented to take the argument forward.
- Evidence can be from the literature (properly acknowledged), or data collected in your research

Academic Argument Discourse

- It is vital to distinguish between existing work from the literature and your own work - plagiarism is a serious offense in research degrees (and in research in general).
- Counter arguments need to be explored and dealt with rigourously and fairly.
- The language in which the case is argued should be precise and clear, and not clouded in irrelevancies.
- Selecting what to include and what not to include requires careful thought.
- A thesis or paper should develop the argument like a lawyer, not report events like a journalist !

Academic Argument Discourse

When reading a research article try to identify the case being made for the presented research.

Look in particular at

- the abstract
- the first and last page of the article
- the first and last paragraph of each chapter or section of the report

Do you find the arguments convincing?

Do you feel anywhere that the cases are blurred with “padding” ?

Do you feel that counter arguments are dealt with fairly?

Research Outcomes

- Research sometimes throws up unexpected findings which can change the anticipated direction of the research.
- You should be alert to this possibility in your own work.
- In order to spot unexpected results, you should try to predict what sorts of outcomes you expect to see.
- If something unexpected does turn up, you should then be able to spot it, recognise its potential significance, and consider whether to change research direction.

Use of Literature

- Literature should be used as “evidence” to support argument and counter argument in building a research “case” .
- Mere lists of references in catalogue style are not acceptable.
- Direct quotations should only be used for purposes of illustration, not to replace your own original case.
- But in a thesis you need to show a thorough reading and knowledge of the field, so you need to work carefully to bring references to other work meaningfully into your discussions.

Use of Literature

Exercise: Look at the citation of literature in papers and dissertations.

To what extent is the literature used

- merely to illustrate knowledge ?
- as evidence to make or support a case?
- a mixture of both ?

What type of case are they supporting?

- gap in knowledge ?
- suitability of research design ?
- validity or limitation of data, findings, conclusions ?
- something else ?

Use of the Data

Presenting data is not enough.

It has to be summarised, described and analysed, and meaning imposed on the findings.

Exercise: Examine papers and dissertations.

- Have the data been analysed appropriately ?
 - Are the statistical models correct?
 - Are the statistical tests valid
- Have the authors argued the case for their findings
- Are the conclusions meaningful?

- Is there any argument for the limitations or conditions for which these conclusions is valid?

Data Analysis

At some stage in the project you will need to decide;

- What analysis needs to be done?
- What graphical procedures need to be used?
- Will you write your own programs?
- Will you use a package?

Originality and Significance

- A thesis or research article should make its claim for original contribution clear.
 - In general it is better to state your claim to contribution clearly and succinctly in the Introduction and in the Conclusions, so that there is no chance of the Examiner or Reviewer missing them !
- the higher the level of degree or publication, the greater will be the expected degree of significance.
- Sometimes significance is clear and sometimes not: examiners or reviewers may disagree over the contribution of the work.

Reliability of Research

If other researchers can repeat a piece of research and obtain the same results, it is said to be entirely *reliable*.

Experiments with human subjects based on subjective answers, e.g. happy, tired, cannot be exactly replicated by others in different places at different times. For numerical data the results are generally reproducible, although there may possible be questions over the reliability of numerical values, e.g.

- the competence with which the data was collected.
- the consistency of the instruments used to collect them.

Validity of Research

A piece of research is said to be valid when it is measuring what it was supposed to measure, and when the research results are truthful.

Valid and reliable can be hard to achieve at the same time.

Consider student assessment.

- The most reliable form is tick-in-the-box answers, since they will always be marked the same.
- If an important part of the assessment is to understand thought processes, as well as outcomes, essay questions are more valid.
- But marking essays will be less reliable, since opinions may vary.

Reliability can be increased, e.g. by double marking.

Creative Thinking in Research

- Research is often thought of as involving only logical analysis.
- While logical analysis can be used as a critical tool for the refinement of ideas, new ideas themselves often originate in very different ways - metaphor, analogy, hunches etc.

How Does Intellectual Creativity Work

Common elements of a creative solution for most people:

- There can be considerable time spent “mulling over” the problem before arriving at a solution
 - There is no way of predicting how long this might take !
- The idea for a solution “just pops into their head”
 - Usually when they are not thinking about the problem, or anything else either.

Once the creative part of the solution is over, hard ground work needs to be done to develop a real practical solution to the problem.

Let us look at some techniques which can prove useful in developing creative research:

Talking Things Over

- Talking things over with other people not only provides the benefit of their views and ideas, but people often find that the very act of talking seems to stimulate their own thinking.
- You may choose to talk to an expert in the field in order to get their ideas or comments.
- However this is not necessary if you are talking things over to stimulate your own creativity
- The person merely needs to give you their time and commitment to listen to what you are saying.

Keeping an Open Mind

It is easy to close your mind to alternative solutions or interpretations of the data available to you.

Try to keep an open mind by doing the following:

- Identify all the unlikely or seemingly implausible interpretations and consider if any might have any validity.

Keeping an open mind is particularly important when talking to others; without it one is liable to “hear” (take in) what one is expecting to hear, or what one already knows, rather than what might actually be being said

Braining Storming

- This is a well known problem solving technique, but may not always be useful in academic research.
- Brainstorming is usually carried out in groups, but can be done individually.
- It consists of listing as many ways to move the situation forward as possible, however improbable each suggestion might be, without pausing to evaluate them.
- Only when the list is complete is the value and feasibility of each possibility considered.

Negative Braining Storming

This can again be done individually or in a group.

Negative brainstorming can be useful in solving academic research problems:

- List as many ways as possible as you can think of **not** achieving your objective and then, when the list is complete, consider whether reversing any of them might be productive.
- This may seem a useless idea, and many of the reversed ideas may turn out to be meaningless.
- Nevertheless negative brainstorming really does have a proven worth, and can produce an idea that would never have been thought of via more direct methods.

Viewing the Problem from Imaginary Perspectives

Imagine solving the problem in a different time or place.

Einstein is said to have started work on the Theory of Relativity by wondering what it would be like to ride on a light ray.

Concentrating on Anomalies

- Do not ignore results that do not fit the theory.
- Concentrate on anomalies and see if they represent something worth investigating.

Focusing on Byproducts

Look for unexpected results, e.g. unpredicted trends within your results.

Even if your results fit existing theories, look among them to see if there are any other unexpected trends or details which suggest further investigation and/or might require an extension of an existing theory, or a completely new theory, to explain them.

Interrogating Imaginary Experts

Imagine you are able to interrogate an expert in your field: what questions would you ask ?

Just developing the questions can open up unexpectedly original and valuable ways forward in your research.

Viewing from the perspective of another discipline

Talk the problem over with people from other disciplines to see how they would approach it.

They may not technically fully appreciate your problem, but their comments and ways of exploring the problem may inspire new insights or research ideas.

Tools for Research

- Library
- Web (Scholar)
- R statistical and graphical system (Analysis)
- Latex (Writing up)

Reference: Helmut Kopka, Patrick W. Daly (2003).
A Guide to Latex, 4th ed, Addison-Wesley

TeXhniCenter: a front end for Latex, can be obtained at from <http://www.toolscenter.org/>.