

Research Methods

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What is research?

What are 'research
methods'?

Modes of research
study

Doing research

Examination

Mechanics, etc.

The OECD's *Guidelines for Collecting and Reporting Data on Research and Experimental Development* (2015): research is 'creative and systematic work undertaken to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications'.

The Merriam-Webster online dictionary: 'a studious inquiry or examination; especially: investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws'.

The Gale Encyclopedia of Education: the purposes of research 'include exploring, describing, predicting, explaining, or evaluating some phenomenon or set of phenomena'.

What is research? ...

In school or a University coursework subject, research is usually the process of **exploring existing knowledge**:

- ▶ Finding material in books, research papers, articles, ...
- ▶ Synthesising and explaining that material in a systematic way.

For a graduate researcher or a student in a thesis subject,

- ▶ 'Research is **how we create knowledge**.'
- ▶ 'The art of asking questions that have useful answers that can be methodologically determined.'

COMP90044, University handbook (2019): 'Research is a process of acquiring new knowledge by systematically and rigorously applying methods to address **well-formulated questions**. To be valuable, new knowledge must address a significant theoretical question, be supported by evidence, and be able to stand up to critical scrutiny; and its presentation to other researchers or to the public must be persuasive.'

COMP90044 Research Methods

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'This subject is an introduction to research thinking, skills and methodologies as they apply to computing and related disciplines. The subject will foster the development of critical thinking, a sceptical and rigorous approach, and awareness of research ethics.'

- ▶ Introduction to the skills & tasks involved in doing research.
- ▶ Overview of what is expected of a research student; and of a researcher.
- ▶ Guidance on the steps towards completion of a substantial research project.
- ▶ Advice and insights on how to write a strong thesis.

Introduction to skills

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- ▶ Finding, reading, and understanding research papers; and what to say about them.
- ▶ Formulation of research questions.
- ▶ Writing about your own research and how to present it to others.
- ▶ Library skills for researchers.
- ▶ Planning and scheduling.
- ▶ Methodologies: experiments, human studies, and study design.
- ▶ Statistical methods for research data.
- ▶ Ethics and research conduct.

Research projects, research students

Multiple cohorts of student:

- ▶ IS (Information systems) vs CE (computing or engineering)
- ▶ MBC (M.Sc or MIT or MIS) vs GR (MPhil or PhD)

MBC = masters by coursework; GR = graduate research.

There are variations in lectures and assessments between the different cohorts – make sure that you are doing the **right** activity!

- ▶ See the tab 'weekly schedule' in the LMS.

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- ▶ Minor theses: duration of one semester (alongside other subjects) to two or sometimes three semesters full-time;
Typically tightly defined and scoped, with limited aims.
- ▶ MPhil: eighteen months (but can stretch to two years);
Typically a thorough exploration of a narrow question, often a stage on the path to a PhD.
- ▶ PhD: three years (but can stretch to four years);
Typically a thorough exploration of a substantial question.
Identification and clarification of the question may be a significant part of the the project.

Theses range in length from around 8000 words to up to 100,000 words.

Research projects

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Despite the differences between the kinds of thesis, and regardless of the scale of projects, the **processes** of doing the research and achieving the outcomes are much the **same**.

- ▶ Identification of research questions & **hypotheses**.
- ▶ Reading and assessing **literature**.
- ▶ Development of **methods**.
- ▶ **Data** collection, **experimentation**, **mathematical proof**.
- ▶ **Analysis**, interpretation, and critical evaluation.
- ▶ **Write-up** & **presentation**.

The process of research

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Speculate – develop a **concept**, follow a train of thought, have a hunch that an **idea** is worthwhile.

Encapsulate – form a specific **research question**.

Observe – **gather preliminary data**, make an initial implementation, sketch out some proofs.

Hypothesise – make testable **predictions** based on a strong understanding of the research question.

Test – **design instruments**, undertake **mathematical analysis**, systematically gather data, perform robust experiments.

Analyse – **use critical argument** to link the results to the hypothesis, thus demonstrating whether it is supported or contradicted.

Write-up – use the **results** and analysis to **convince** skeptical examiners that your **conclusions** are **interesting** and **correct**.

Project outcomes

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A thesis ...

- ▶ Minor thesis – usually examined within the **School**.
- ▶ MPhil or PhD – examined by internationally recognized experts.

New knowledge ...

- ▶ Student projects are **research training** – but most PhDs (and some Masters) do lead to **publishable** research outcomes.
- ▶ Refereed journal or conference papers.

New skills: communication, critical thinking, independence.

New experiences: teaching, conferences, internships, ...

CIS coursework Masters examination guidelines (2018)

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To achieve $\geq 75\%$:

Organisation of thesis and clarity of expression. Up to the standard expected of a good conference paper or business report. Well organised. Pleasant to read.

Grasp of the problem and review of the relevant literature. Thorough literature review including important papers. Demonstrating a good understanding of the literature.

Research method. Well designed and executed. Demonstrates understanding of research methodology.

Presentation of results. Critical presentation of the results. Places the results in a broader context.

Conclusion. Detailed analysis of the outcomes. Understands both strengths and weaknesses of the findings.

Contribution. Novel, of interest to others and possibly significant.

UoM PhD examination guidelines (2010)

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- ▶ Does the candidate show sufficient familiarity with, and critical understanding of, the relevant literature?
- ▶ Does the thesis provide a sufficiently comprehensive investigation of the topic?
- ▶ Are the methods and techniques adopted appropriate to the subject matter and are they properly justified and applied?
- ▶ Are the results suitably set out and accompanied by adequate exposition and interpretation?
- ▶ Are conclusions and implications appropriately developed and clearly linked to the nature and content of the research framework and findings?
- ▶ Have the research questions in fact been tested?
- ▶ Is the literary quality and general presentation of the thesis of a suitably high standard?
- ▶ Does the thesis constitute a substantive original contribution to knowledge in the subject area with which it deals?

Analysis of examiners' reports for PhDs

(Extracted from work by John McDonald of the University of Ballarat, reported in detail in Evans, Gruba, and Zobel, *How To Write A Better Thesis*, third edition.)

- ▶ A significant and substantial problem has been investigated.
- ▶ The thesis demonstrates a systematic pursuit of a line of inquiry.
- ▶ It is well-planned and executed, with each section clearly building on the last (that is, there is a coherent macro-level structure).
- ▶ The literature review is critical and evaluative, and sets forth an argument for why and how the study should be conducted.
- ▶ The research design is appropriate and allows the questions to be answered.
- ▶ Advanced analytical skills are used; a clear chain of evidence is laid down.
- ▶ The discussion is disciplined and not excessively speculative.
- ▶ Conclusions are well drawn and convincing; clear claims are made about the exact contributions of the thesis.
- ▶ Elegant, precise, and economical written expression.
- ▶ There is evidence of systematic proof-reading and error correction.

Subject structure

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Coordinator: George Buchanan, george.buchanan@unimelb.edu.au

Guest lecturers (including me!), workshop facilitators ...

There is some activity every Thursday from 2:15pm, varying in type *and* location from week to week. (And, as noted, varying between cohorts.)

Assessment: Details in LMS. Major deadlines:

Week 2: Lodgement of research topic

Week 7: Final submission of assignment 1 (40%)

Week 12: Final submission of assignment 2 (60%)

Minor deadlines: optional **pre-submissions**, to get feedback on drafts.

Academic conduct

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All work is to be done on an individual basis – no group-work. In cases of plagiarism, misuse of resources, etc., everyone involved will be referred to the School of Engineering under the University's disciplinary procedures. See <http://academichonesty.unimelb.edu.au/>.

The LMS, <http://lms/unimelb.edu.au/>, should be your first resource when seeking help. If you send a question by email to the coordinator, if the answer is of general interest the coordinator may post the answer on the LMS. Most face-to-face enquiries should be during or immediately after the lectures, or in the consultation session (see LMS). Other consultations are by appointment only.

Communications with staff should be from your University email address; include the subject code COMP90044 in the subject line to help us understand the context of your message. Mail from other email services (gmail, hotmail, etc.) may be discarded without being read.

Completion of this subject will require around 160–180 hours of effort, including attendance at and preparation for lectures and workshops and preparation of assignments.

Resources

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Supervisors: colleagues, mentors, guides, managers.

MBC: Subject coordinators, course coordinators.

GR: Committee & committee chair.

GR: Graduate research coordinator, Head, Associate Dean.

Peers, team, school, faculty (and MCSHE, Graduate Research).

- ▶ Weaknesses, challenges? Plan to address them.
- ▶ Unappealing tasks? Do them early.
- ▶ Skill gaps? Learn independently, or seek out training.

Justin Zobel, *Writing for Computer Science*, Third ed., Springer, 2015.

Available through the library as a free e-print.

Please: do not share by email; download it yourself.

• **David Evans, Paul Gruba, and Justin Zobel, *How to Write a Better Thesis*, Third ed., Springer, 2014.**

Available through the library as a free e-print.

Please: do not share by email; download it yourself.

• **Paul Gruba and Justin Zobel, *How to Write Your First Thesis*, Springer, 2017.**

Available through the library as a free e-print.

Please: do not share by email; download it yourself.

(Also available as *How to Write a Better Minor Thesis*, Melbourne University Publishing, 2014.)

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Image courtesy Anna Zobel