

Masters Research Handbook

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Contents

Contents	1
1 So, you want to do a research project!	11
1.1 What is academic research?	11
1.1.1 Masters level research	12
1.2 What you will have achieved as a Masters' graduate	14
1.3 The role of your supervisor	15
1.4 What is expected of you	17
1.4.1 Self-direction	17
1.4.2 Critical thinking	18
1.4.3 Time and task management	19
1.4.4 Information management	20

1.5	Key skills	20
1.5.1	Active reading and note taking	21
1.5.2	Digital literacy and tools	22
1.5.3	Bibliographic management tools	22
1.5.4	Keeping track of your digital assets	23
1.5.5	Managing document versions	24
1.5.6	Choosing the right word processor	25
1.6	Takeaways	28
2	The 5-stage Masters project framework	30
2.1	What do we mean by framework?	30
2.2	The research process and its key activities	31
2.2.1	Identifying the research problem	32
2.2.2	Reviewing the literature	32
2.2.3	Setting your aim and objectives	33
2.2.4	Developing the research design	33
2.2.5	Gathering and analysing evidence	34
2.2.6	Interpreting and evaluating findings	34
2.2.7	Reporting	34
2.2.8	Reflecting	34
2.2.9	Planning work	35
2.2.10	Managing risk	35
2.2.11	How the activities relate to each other	35
2.3	The 5-stage framework for your research	37
2.4	Critical success factors	40
2.5	Takeaways	42
3	Stage 1: Scoping your project	43
3.1	Planning your work for Stage 1	45
3.1.1	Milestones, deliverables and tasks	46
3.1.2	Producing a project plan for Stage 1	46
3.1.3	Key practices for managing your time efficiently	48
3.2	Identifying the research problem	49

3.2.1	Choosing a topic for your project	49
3.2.1.1	Qualification fit	50
3.2.1.2	Professional fit	51
3.2.1.3	Personal fit	52
3.2.1.4	Organisational fit	53
3.2.2	What is a research problem	54
3.2.2.1	The context and phenomena of interest	55
3.2.2.2	The knowledge gap	57
3.2.2.3	The justification	58
3.2.2.4	Problem formulation	59
3.2.3	Types of research problems	60
3.2.3.1	Descriptive problems	60
3.2.3.2	Exploratory problems	61
3.2.3.3	Explanatory Problems	63
3.2.3.4	Predictive Problems	65
3.2.3.5	Evaluative Problems	66
3.2.3.6	Design problems	68
3.2.4	Masters-appropriate research problems	70
3.2.5	Formulating your initial research problem	73
3.3	Reviewing the literature	73
3.3.1	The role of the literature in research	73
3.3.2	How to access the literature	74
3.3.3	How to read an article	76
3.3.4	How to review the literature	78
3.3.4.1	Searching and gathering	80
3.3.4.2	Processing	86
3.3.4.3	Assimilating and analysing	90
3.3.4.4	Synthesising	96
3.4	Setting research aim and objectives	103
3.4.1	Articulating your research aim	104
3.4.2	Choosing a title	105
3.4.3	Articulating your research objectives	107
3.5	Developing the research design	109

3.5.1	Types of evidence and data	109
3.5.2	Classes of research methods	111
3.5.3	Ethics and regulations	113
3.5.3.1	The rights of human participants in your research	113
3.5.3.2	Personal data in research	114
3.5.3.3	Equity, Diversity and Inclusion in research	119
3.5.3.4	Research involving animals	121
3.5.3.5	Intellectual property	122
3.5.3.6	Use of generative AI in research	124
3.5.3.7	Bias in research	127
3.6	Managing risk	129
3.6.1	Research project risk	130
3.6.1.1	Technical skills	130
3.6.1.2	Study time	131
3.6.2	Resources	132
3.6.2.1	Ethics and regulations	133
3.6.3	Summarising your project risk	133
3.7	Reflecting	134
3.8	Reporting	137
3.8.1	Putting your research proposal together	137
3.8.2	Assessing and Iterating	137
3.9	Takeaways	140
4	Stage 2: Compiling your literature review and understanding research design	141
4.1	Writing a full draft of your literature review	143
4.1.1	Key skills for synthesising	144
4.1.2	Core practice for academic writing	150
4.1.3	Develop your arguments!	157
4.1.3.1	The BCW model	157
4.1.3.2	Arguments and narrative	160
4.1.3.3	Logical fallacies and cognitive bias	163
4.1.4	Developing your literature review from your theme summaries	165
4.1.4.1	Developing the main body of your literature review	166

4.1.4.2	Choosing headings and sub-headings	171
4.1.4.3	Writing your review introduction and critical summary	172
4.1.5	Assessing your literature review	172
4.1.5.1	Your own assessment	173
4.1.5.2	Getting others to help you	174
4.1.6	Widening your literature review	175
4.2	Developing your understanding of research design	177
4.2.1	Research methods	178
4.2.1.1	Data collection methods	179
4.2.1.2	Data analysis methods	181
4.2.1.3	Modelling methods	183
4.2.1.4	Summary of methods	186
4.2.2	Research strategies	186
4.2.2.1	Summary of research strategies	193
4.2.3	Philosophical traditions	193
4.2.4	Understanding research methods and strategies in articles you have reviewed	199
4.3	Reflecting and reporting in Stage 2	200
4.4	Takeaways	203
5	Stage 3: Developing your research design	205
5.1	Introducing stage 3	205
5.2	Research design foundation	207
5.3	Researcher mindsets	208
5.3.1	Positivist and post-positivism	209
5.3.2	Anti-positivist (interpretivism)	210
5.3.3	Constructivism	211
5.3.4	Critical theory	211
5.3.5	Indigenous	212
5.3.6	What's your mindset?	213
5.4	Research strategies	215
5.5	Defending your claim of new knowledge	216
5.5.1	Weakness types	219
5.5.1.1	Novelty weakness	219

- 5.5.1.2 Validity weaknesses 219
 - 5.5.1.3 Reliability weaknesses 220
 - 5.5.1.4 Bias 220
 - 5.5.2 Addressing weaknesses 221
 - 5.5.2.1 Addressing research weakness: critical literature review 223
 - 5.5.2.2 Addressing research weakness: triangulation 223
 - 5.5.2.3 Addressing research weaknesses: reflexivity 225
- 5.6 Your initial research strategy candidate list 226
 - 5.6.1 Research strategy introduction 227
 - 5.6.2 Survey research 228
 - 5.6.2.1 Knowledge contribution 229
 - 5.6.2.2 Data Generation 229
 - 5.6.2.3 Evaluation 229
 - 5.6.2.4 Is the survey research strategy right for me? 230
 - 5.6.3 Design and creation research 231
 - 5.6.3.1 Knowledge contribution 231
 - 5.6.3.2 Data Generation 231
 - 5.6.3.3 Evaluation 232
 - 5.6.3.4 Is the design and creation research strategy right for me? 232
 - 5.6.4 Experimental research 233
 - 5.6.4.1 Knowledge contribution 233
 - 5.6.4.2 Data Generation 234
 - 5.6.4.3 Evaluation 234
 - 5.6.4.4 Is this strategy right for me? 235
 - 5.6.5 Case study research 236
 - 5.6.5.1 Knowledge contribution 236
 - 5.6.5.2 Variants 236
 - 5.6.5.3 Data Collection 237
 - 5.6.5.4 Evaluation 237
 - 5.6.5.5 Is this strategy right for me? 238
 - 5.6.6 Action research 239
 - 5.6.6.1 Knowledge contribution 239
 - 5.6.6.2 Data Generation 239

- 5.6.6.3 Evaluation 239
 - 5.6.6.4 Is this strategy right for me? 240
- 5.6.7 Ethnography 241
 - 5.6.7.1 Knowledge contribution 241
 - 5.6.7.2 Data Generation 241
 - 5.6.7.3 Evaluation 241
 - 5.6.7.4 Is this strategy right for me? 242
- 5.6.8 Systematic research reviews 243
 - 5.6.8.1 Knowledge contribution 243
 - 5.6.8.2 Focus 243
 - 5.6.8.3 Data Collection 243
 - 5.6.8.4 Evaluation 243
 - 5.6.8.5 Is this strategy right for me? 244
- 5.6.9 Grounded theory 245
 - 5.6.9.1 Knowledge contribution 246
 - 5.6.9.2 Data Collection 246
 - 5.6.9.3 Evaluation 246
 - 5.6.9.4 Is this strategy right for me? 249
- 5.6.10 Phenomenology 249
 - 5.6.10.1 Knowledge contribution 250
 - 5.6.10.2 Data Generation 250
 - 5.6.10.3 Evaluation 250
 - 5.6.10.4 Is this strategy right for me? 252
- 5.6.11 Simulation 252
 - 5.6.11.1 Knowledge contribution 252
 - 5.6.11.2 Variants 253
 - 5.6.11.3 Data Generation 253
 - 5.6.11.4 Evaluation 253
 - 5.6.11.5 Is this strategy right for me? 254
- 5.6.12 Mathematical and logical proof 254
 - 5.6.12.1 Knowledge contribution 255
 - 5.6.12.2 Data Generation 255
 - 5.6.12.3 Evaluation 255

- 5.6.12.4 Is this strategy right for me? 255
- 5.6.13 Mixed methods research 256
 - 5.6.13.1 Knowledge contribution 256
 - 5.6.13.2 Data Generation 256
 - 5.6.13.3 Evaluation 256
 - 5.6.13.4 Is this strategy right for me? 256
- 5.7 What to do now 257
 - 5.7.1 For your chosen research strategy 258
- 5.8 Generating raw research data 260
 - 5.8.1 Data generation 260
 - 5.8.2 Sampling: what, who (and how) to choose 260
 - 5.8.3 Interviews 263
 - 5.8.4 Journalling 263
 - 5.8.5 Observations 264
 - 5.8.6 Questionnaires 264
 - 5.8.6.1 Tools for creating (maintaining, and analysing) questionnaires 266
 - 5.8.6.2 A simple questionnaire design workflow 266
 - 5.8.7 Documents 267
 - 5.8.8 Focus groups 268
 - 5.8.9 Field work 268
 - 5.8.10 Computational thinking 269
 - 5.8.11 Mathematical thinking 269
 - 5.8.12 Statistical thinking 270
 - 5.8.13 Reflexivity 270
- 5.9 Managing your raw data 270
- 5.10 Common analysis methods 272
 - 5.10.1 Using tables to analyse data 272
 - 5.10.2 Statistical analysis 276
 - 5.10.2.1 Descriptive statistics 277
 - 5.10.2.2 Inferential statistics 283
 - 5.10.3 Quantitative analysis resources 289
 - 5.10.4 Qualitative analysis 289
 - 5.10.4.1 Coding qualitative data 289

More here?

5.10.4.2	Presenting qualitative data	291
5.11	Writing up your analysis	292
5.12	Interpreting and evaluating data	293
5.13	Drafting an abstract for your project	294
5.14	Reflecting and reporting in Stage 4	295
5.15	Takeaways	296
5.15	Completing your research	296
5.16	Assessing your research	296
5.17	Finalising and submitting your dissertation	298
5.17.1	Compiling a full draft of your dissertation	298
5.17.2	Revising your draft for compliance to requirements	298
5.17.3	Final check and submission	300
5.18	How your dissertation will be assessed	303
5.19	Takeaways	304
6	Closing	307
6.1	Concluding remarks	307
7	Glossary	308
8	References and further reading	311

Chapter 5

Stage 3: Developing your research design

By now you will have some mastery of the techniques and tools that you need to *do* research at masters level. You may also have ideas about what you still need to do in the next step*.

With the skills you have so far gained, you're developing into an independent researcher[†] and you may feel that this book holds nothing more for you.

Stay with us a little longer though: the next sections aren't as long as those that you've studied already – you'll be doing more yourself, honing the skills you've picked up as you go along – but they might help to keep you systematic and on the path to submission.

You won't be surprised to know that stage 3 comes next; there's another research increment coming.

*If not, don't worry – we've got you covered with this chapter!

[†]Being an independent researcher isn't one of the examined outcomes of masters research, but if you're feeling confident in your research that's a good thing.

5.1 Introducing stage 3

Activity: Understanding the effort needed in this stage

#1

Consider Table 5.1 carefully, taking notice of the entries in the 'Effort within stage' column. Write down the most time-consuming activities in this stage and what is expected under each.

Discussion

Developing your research design further and conducting your pilot work will constitute your major effort in this stage (55% of the study time in total): your pilot work will be an initial test of some aspects of

- LR: update at the end
- LR: to check all activity titles at the end

Table 5.1: Stage 3 activities Update as necessary)

Research activity	Effort within stage	Suggested focus supervisor
Identifying the research problem		
Adjust, if needed	2%	
Reviewing the literature		
Adjust, if needed	3%	
Setting research aim and objectives		
finalise aim and objectives, and define tasks and deliverables	10%	Suitability of tasks and deliverables from objectives
Choosing the research design		
Complete research design, with detailed consideration of data and evidence, research strategy, research methods and procedures	20%	Suitability of research procedures
Gathering and analysing evidence		
Conduct pilot work to test aspects of your research design	35%	Scope of your pilot work
Interpreting and evaluating findings		
n/a	0%	
Reporting, critical reflection and conclusions		
Assess research progress and write up Stage 3 report	25%	Any further improvements required
Work planning and risk management		
At stage start, review work from previous stage and project risk; adjust plan as needed If you have received feedback from supervisor on your previous stage work, adjust plan to include any revision recommended	5%	Any major adjustment required

your research design, including a proof-of-concept application of some of your chosen methods.

5.2 Research design foundation

To make a contribution to knowledge we do research. Practically, to do research, we combine a number of research tasks into a framework. Designing such framework is what we term research design. The framework will depend on the research area, the type of knowledge contribution you wish to make, your mindset as a researcher, and the opportunities and difficulties you may face along the way.

A research framework has many levels. At its foundations are the research framework's "ontology", "epistemology", and "methodology":

Ontology is the philosophical study of the nature of existence* and addresses the question: "What is the reality that I will research?". Practically, ontology translates to determining what *phenomena* exist in the context of your research, the *relations* that exist between them and how they group together into *categories*.

Epistemology is the philosophical study of knowledge† and addresses the question: "How is knowledge generated and from what sources?". Practically, epistemology is about finding out "What people know?", "What does it mean to say that people know something?", and "How do people know that they know?".

Methodology is the system of principles and methods‡ by which you conduct research, that is, investigate, measure, and analyse your research's aim and objectives. Methodology operationalises the "how" question of knowledge generation, so it is about devising concrete strategies to answer "How will I make my contribution to knowledge?".

As you might have guessed, given that the goal of research is to make a contribution to knowledge, epistemology and ontology are incredibly important in defining what knowledge is in any particular research context and what, in that context, can be known about. Once this choice is made, an appropriate methodology can be devised: hence, methodology depends on choices made in relation to ontology and epistemology.

[ADAPTED from <https://proofed.com/writing-tips/the-four-types-of-research-paradigms-a-comprehensive-guide/>]

*If you're interested, there's a fuller discussion of *Ontology* in the Stanford Encyclopedia of Philosophy ([hofweber2023logic](#)).

†If you're interested, there's a fuller discussion of *Epistemology* in the Stanford Encyclopedia of Philosophy ([steup2020epistemology](#)).

‡Even if you are interested, there is (at the time of writing) no Stanford Encyclopedia entry for methodology, unfortunately. But, unlike ontology and epistemology, we go into more detail of methodology below.

Fortunately, many others have thought very deeply about ontology and epistemology and, in most areas and for the vast majority of masters-level research, their answers will suffice. If not, we'd be left in a situation in which even an ostensibly simply statement like "That hat is blue" becomes in need of complex debate (steup2020epistemology).

Methodology, on the other hand, is something we will spend some time on, particularly how individual research methods combine to produce knowledge contributions through research strategies.

You should be aware that 'methodology' has many meanings in the literature, including the study of research methods, which questions the assumptions that underpin their creation and application. Wikipedia says*:

*It could almost be seen as a warning!

Quote

[...] A few theorists reject methodology as a discipline in general. For example, some argue that it is useless since methods should be used rather than studied. Others hold that it is harmful because it restricts the freedom and creativity of researchers. Methodologists often respond to these objections by claiming that a good methodology helps researchers arrive at reliable theories in an efficient way. The choice of method often matters since the same factual material can lead to different conclusions depending on one's method. Interest in methodology has risen in the 20th century due to the increased importance of interdisciplinary work and the obstacles hindering efficient cooperation.

These are not unimportant issues to consider. However, and as for ontology and epistemology, we will leave their discussion to others, content to stand on those giants' shoulders – we take an unapologetically practical approach to research methods, limiting our discussions to what, we feel, are their important characteristics for practice. This doesn't ignore philosophical issues, however: where there are important philosophical considerations to be considered, we address them. This includes questions as to how to choose a particular research method, and what an experienced reader will expect to be answered by it. You can then craft your dissertation to meet those expectations.

5.3 Researcher mindsets

Depending on your background, you may have begun your research studies with a particular mindset – that of a scientist, for instance, or as someone embedded within an organisation. This mindset will flavour your

approach to research, but it shouldn't constrain it – there are many options for research and the right one for you might be outside of your current understanding.

Over time, researchers in different communities and disciplines have developed differing mindsets, which are known in the literature as research paradigms* You can think of a research paradigm as a philosophical way of thinking, a set of shared beliefs which shape a worldview.

[ADAPTED from <https://proofed.com/writing-tips/the-four-types-of-research-paradigms-a-comprehensive-guide/>]

We briefly outline the prevalent ones in this section — there is a lot, lot more to be known around this topic, and this introduction only scratch the surface! We provide some references for you to start your own investigation into this fascinating and complex topic, should you wish to.

*A.k.a. philosophical traditions.

Each paradigm comes with its own ontological, epistemological and methodological choices. Being aware of them, may help you guide your research design choices, so it is important for you to be aware of their existence, even if in practice, you will mainly focus on methodological considerations.

5.3.1 Positivist and post-positivism

The Positivist Research Paradigm assumes that there is a single, objective reality that can be accurately known, described and explained. Positivist researchers depend on observations and measurements of this reality to gain knowledge of it.

Under the assumption of a single objective reality, positivist researchers make claims that they compare against reality to determine the “truth”. Hence positivists seek to confirm their theories through their observations of an objective reality. This removes the researcher as a variable in the research equation so that positivist research is necessarily limited to data generation, and their analysis, and interpretation from an objective viewpoint as the basis of knowledge.

The positivist research paradigm is mostly used in situations where a “single objective reality” is most expected, i.e., the natural sciences, the physical sciences, or whenever very large sample sizes can be used to infer characteristics of a population. It leads the researcher towards quantitative methods, including experiments, tests, surveys and simulations involving formal modelling based on mathematics, statistics or computational thinking.

Positivism leads to knowledge as explanations constructed from hypotheses thus established as laws or facts. As an example, think of Newton's explanation of the action of forces on matter that is encoded as his Three Laws of Motion. These are meant as universal objective truths which apply to the natural world forever.

From <https://image.slidesharecdn.com/lecture21-111207045819-phpapp02/95/research-paradigms-20-728.jpg?cb=1415227903>

With this in mind, and the – almost – universal acceptance of Newton's Three Laws based on their predictive capability, positivism was, for a very long time, the dominant mode of Western thought. So much

so, that it was a bulkhead against a growing number of worrying observations, including the movements of the planet Mercury*, which didn't reinforce – indeed appear to contradict – Newton's Laws. How could an established truth lead that way? Indeed, Einstein's insight into the intimate connection between space and time inspired a substantial move away from the established Newtonian “laws” and “facts”, which were neither any longer **lakatos2014falsificationlaka**.

The need to rethink positivist objective truths was something of a crisis in the positivist movement (see, for instance, **kuhn2012structure**), leading to post-positivism[†] which introduced the idea of falsification: any posited theory must make predictions which are testable, the currency of a theory being determined by whether or not it had yet been proven false[‡].

So, both positivism and post-positivism accrete knowledge by formulating generalisations and cause-effect linkages, based on objective, verifiable observations and measurements, and expressed as theories and laws. However, post-positivism acknowledges some of the limitations in such observations and measurement, so that a theory or law will only remain true for as long as it is not falsified by new observations or measurements. There is therefore a shift from certainty (positivism) to probability (post-positivism), with post-positivist researchers encouraged to take multiple measurements and observations, including triangulating their data, to arrive at an objective truth. Thus you might take a post-positivist approach to establishing the linkage between a drug and the alleviation of symptoms: once a generalisation or cause-effect linkage is established, it applies for as long as it remains un-falsified.

Both positivism and post-positivism assumes an objective reality and do not admit that the researcher's own mindset and values may influence true knowledge: in being objective and verifiable, different researchers must necessarily arrive at the same truth. This denial is often levelled as a criticism of the paradigms, particularly by social scientists, and has led to new ones.

5.3.2 Anti-positivist (interpretivism)

The shift from positivism to post-positivism still preserves the absolute objectivity of reality. In contrast, anti-positivism asserts that different people experience and understand reality in different ways: while there may be only “one” reality, everyone interprets it according to their own views. Simply put, this might mean that generalisations and even cause-effect relationships are subject to individual experience. Think of the way that people interpret the (single) power structure within your organisation: typically, different people will describe it in different ways, as it applies to them.

*See **enwiki:1193607156**, for instance.

[†]Not the most creative name, you must admit.

[‡]Note that falsifiable theories that have been tested and failed can still be useful, perhaps within a restricted context. For instance, Newton's Laws of motion provide a very good approximation at low energies.

See **wikipedia-contributors2023positivism** for a more detail description.

Explaining the name, anti-positivists believe that all research is influenced and shaped by researchers' worldviews, leading to differing interpretations of the same reality. Again, think of the questions you might ask of people within an organisation that leads them to describe the power structure. Different questions can lead to different descriptions.

As a result, anti-positivists gravitate towards qualitative research methods and techniques to understand the different perspectives, placed in an explicative context of their own perspective. These may include interviews and focus groups, participant observations, and review of documentation on a phenomenon of interest (e.g., newspaper articles, reports, or information from websites).

In moving away from objective knowledge, however, anti-positivism raises questions of research validity, that is of how knowledge generated as subjective interpretation can be relied upon. We will discuss validity in the next section.

See **wikipedia-contributors2023antipositivism** for a more detailed description.

5.3.3 Constructivism

The Constructivist Research Paradigm asserts that reality is a construct of our minds and so is absolutely subjective. Constructivists believe that all knowledge comes from our experiences and reflections on those experiences. A distinction is also made between reality which is individually vs socially constructed, the latter being the result of social interaction within a specific cultural or historical context.

Due to its focus on experiences and subjectivity, this paradigm is mostly associated with qualitative research approaches. The researcher focuses on participants' experiences, including their own, constructing knowledge as "individual reconstruction, coalescing around consensus" through understanding, sense making and reconstruction.

Knowledge accumulates through later research adding informed and sophisticated reconstructions, and vicarious or lived experience.

Research validity is also an issue with this paradigm.

See **<empty citation>**

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<https://image.slidesharecdn.com/lecture21-111207045819-phpapp02/95/research-paradigms-20-728.jpg?cb=1415227903>

5.3.4 Critical theory

The Critical Theory Research Paradigm originated in the fields of sociology, philosophy and political theory, and asserts that social science can never be 100% objective or value-free. Therefore, like interpretivism, it assumes multiple interpretations of reality in social contexts. However, it goes a step further by asserting

that reality is shaped by those who are powerful, who legitimate particular ways of perceiving the world: ‘truth’ is inherently political, defined by those in charge to the disadvantage of many, and challenged by those who wish to promote equality. As a result, critical researchers seek to challenge the status quo and perceive research as transformative at a social level*, confronting ideology and trying to discover and challenge the mechanisms through which exploitation and disadvantage are perpetuated in society.

This paradigm is focused on enacting social change through scientific investigation. Critical theorists question knowledge and procedures and acknowledge how power is used (or abused) in the phenomena or systems they’re investigating.

Researchers using this paradigm can offer structural and historical insights as the basis of knowledge, approaching knowledge contributions through “critique and transformation, restitution and emancipation”. The recognition of researcher values is welcomed as a formative influence on the research.

Even though very different in approach, Critical Theory research can lead to generalisations via similarly, although these tend to be historically situated. This of the.

Quality judgements in Critical Theory tend to be “Historical situatedness; erosion of ignorance and misapprehensions, action stimulus”

See **wikipedia-contributors2023critical** for a more detailed description.

*As a result, this paradigm is also called ‘transformative’ in the literature.

see <https://image.slidesharecdn.com/lecture21-111207045819-phpapp02/95/research-paradigms-20-728.jpg?cb=1415227903> for this, needs further investigation

Add example here

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5.3.5 Indigenous

The traditions described so far are attracting increasing criticisms in that they are seen as Western-European centric and often imposed on other indigenous cultures as a result of colonialism.

In counterposition, an indigenous research tradition has emerged with a social and political agenda of decolonising indigenous societies. It emphasises the connection between the researcher and their own culture and the natural world, in the sense that cultural practices and forms of expressions should be reflected in the way the research is conducted, including language, metaphors, oral traditions and knowledge systems.

It also advocates an holistic approach which strives to reach a balance between different areas of life, integrating intellectual, social, political, economic, psychological and spiritual dimensions.

In being a relatively recent paradigm, the ontological and epistemological stance of indigenous research is still the subject of debate, so that a consensus has yet to emerge.

More can be found at...

add references

5.3.6 What’s your mindset?

Table 5.2 summarises the main paradigms we have discussed based on their ontological, epistemological and methodological standpoints*. From a methodological perspective, we have indicated the main tendency of the paradigm, although the quantitative vs qualitative distinction is not as stark in practice, and a mix of methods is often applied.

*Indigenous is omitted given the ongoing debate around its ontological and epistemological stance.

Table 5.2: Summarising research paradigms

	Positivism	Post-positivism	Anti-positivism (Interpretivism)	Constructivism	Critical theory
Ontol- ogy	one discoverable external reality	one discoverable external reality that can only be known imperfectly	one external reality which is interpreted subjectively	reality as the construct of one’s mind	one external reality determined by socio, political and economic power factors
Episte- mology	objective laws and theories that can be confirmed empirically	objective laws and theories that can be falsified empirically	subjective interpretations	subjective constructions	social and historical constructions, acknowledging issues of power and social injustice
Re- searcher’s role	objective, neutral	objective, neutral, aware of cognitive limitations	subjective, bringing own values, experience and bias	subjective, bringing own values, experience and bias	subjective, aware of own social position
Main meth- ods	quantitative	quantitative, with triangulation	qualitative	qualitative	qualitative

Your own mindset may lead you to gravitate towards one or more of these paradigm, or even somewhere in between. The next activity should help you reflect on this point.

Activity: Deep reading on Non-Random Sampling

#2

Consider the following question and describe how you would go about answering it:
“What is the colour of swans?”
Then compare your approach to each of the paradigm. Which one is it closer to and why?

Guidance

If you can think of more than one way to approach the question, then describe and reflect on each of them in relation to the paradigms.

Discussion

I can think of a couple of ways I could tackle this question.

The first would be to start by observing the swans that live on the lake near my home, and record my observations. From that I would put forward an initial hypothesis, say that all 'swans are white,' as those are the only ones I can observe locally. I would then look online for images of swans from around the world to see if they match my observations. Having found images of black swans alongside white ones, I would then revise my hypothesis to "All swans are either white or black." This process would continue until I'm satisfied there is no further contradictory evidence I can find, hence conclude that in all probability swans are either white or black. I would have to admit that there may be swans of other colours I've yet to come across, so the statement is open to future challenges. I would also need to be convinced that I'm a neutral observer, able to determine the colour of a swan correctly and reliably. This approach closely aligns with the post-positivist paradigm, specifically: I've made observations, triangulated my direct swan observations with the review of online swan images, and formulated, rejected and then reformulated hypotheses as part of my enquiry process.

My second approach would be to ask other people. For instance, I could set up a crowd-sourcing survey inviting participants to answer the question. By analysing their answers I could then decide if there is enough consensus on the colour of swans, like most participants may have identified swans to be either white or black, although some may have provided more nuanced answers, like yellowish or other. From my analysis I would draw my conclusions which may or may not be the same as in my previous approach. In this case, I would have to worry about who participated in my research. Were there enough participants from around the world to provide sufficient and diverse evidence? To which extent may their colour perception may differ? What else could I do to check the validity of this outcome? This approach aligns with the interpretivist paradigm: I have to accept that, like me, each observer in my study will make their own interpretation of what the colour of a swan is, so that I would have to account for this in my conclusions.

5.4 Research strategies

Each research area has its more-or-less well-worn paths to a successful knowledge contribution. In Stage 3, you're now at the point where you'll join researchers in your chosen area on one of those paths: as you get deeper and deeper into your research, the steps you'll take will become more and more specialised.

To identify and take such steps, you will need to devise a research *strategy*, by which we mean a collection of recipes for doing research that will, if followed accurately, lead to a contribution to knowledge *even in the presence of uncertainty*. When devised, a research strategy consists of research tasks that interact in more or less complex ways, but which are sufficiently detailed that the researcher knows what to do next, even if that means making a choice between two or more next steps.

With uncertainty a product of many contextual characteristics, including the researcher's view-point, the simpler research strategies stem from contexts with lesser uncertainty. Thus, highly constrained contexts, such as the natural sciences, tend to have simpler strategies as there is less uncertainty to contend with.

to rephrase/expand, but not sure how

There's good news and bad news in choosing a research strategy:

- The bad news is that there are many possible choices you could make at any point.
- The good news is that, for your particular area in masters research, there will likely be only a small subset that you need to know about.

To help you in your choice, our approach in this chapter is unapologetically practical. We will layout the options that you have together with reasons for choosing them and reasons for not choosing them. Each comes with a list of evaluation questions the answers to which you will be expected to present as part of your dissertation. Amongst other things, the answers you give will justify how and why your work makes a contribution to knowledge. These evaluative questions in turn give you targets to aim for throughout your research, you will need to answer each of them – they will be the driver for your research and your writing up.

Comment on the completeness of the questions?

While your own research strategy will be specific and unique to your project in the way it informs the research you will conduct, standard research strategies have emerged over time, influenced both by research paradigms and research practice within specific disciplines. There are many of them, often with many variants: those we consider in this book are detailed in Section 5.6. For each, after a brief description of the strategy, we delve into the following details:

- describe what the kind of knowledge contribution it makes

- ask “Is this strategy right for me?”
- describe any variants that exist and the choices that constitute them
- describe the ways in which data is generated for the strategy
- describe how a contribution to knowledge using the strategy will be evaluated
- a number of references that give more detail if you are seriously considering the strategy.

The outcome of working through this chapter should be your choice of a research strategy that:

- is a good fit for your research problem, i.e., that will allow you to develop a contribution to knowledge arising from your research problem
- makes the most of your current research skills and resources, i.e., the background knowledge and skills you bring to the research, the time that is available to you, and it fits with your research context.
- a list of questions that could be asked of it by a knowledgeable evaluator, such as an examiner.

From the first two of these, you will gain an understanding of which steps you will be required to take to generate and analyse research data that, when complete, will make your contribution to knowledge. From the third of these, you’ll be able to structure your research report – your dissertation – by describing your answers to the evaluative questions that will be asked of your research process.

5.5 Defending your claim of new knowledge

Being able to assert that you have made a contribution to knowledge is the point of structuring your research through a well thought-out research strategy. Even having made your assertion, however, you still need to defend it in your dissertation. That means considering, essentially, everything that could have gone wrong with the application of your research strategy – any weaknesses in the research strategy. This section shows you how to address such weaknesses.

There are four main classes of weakness in all claimed knowledge contributions (see figure 5.1):

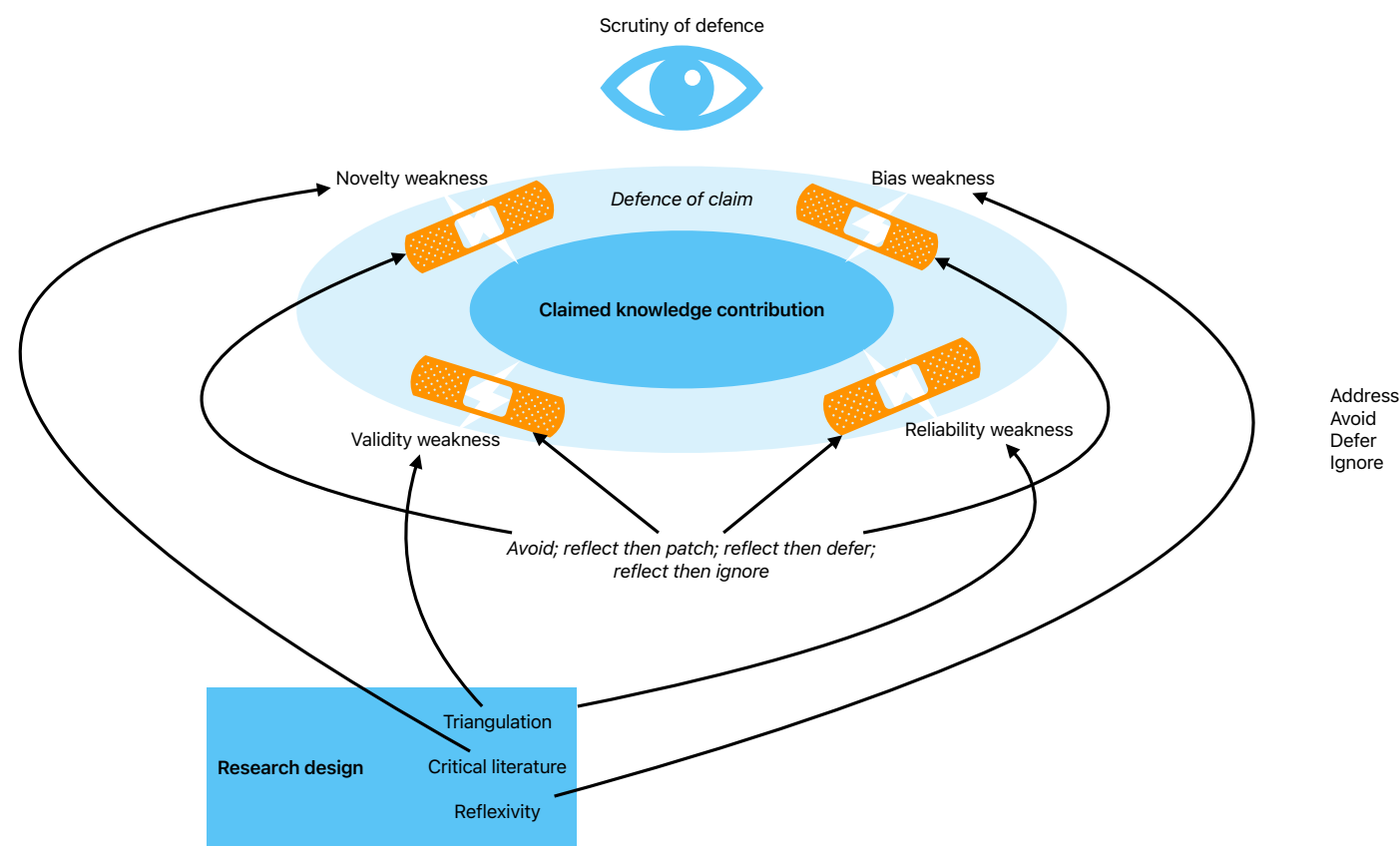


Figure 5.1: Research vulnerabilities

- novelty weaknesses, i.e., the hole in the literature that you claimed existed doesn't actually exist – perhaps you missed some key papers in your literature survey or, perhaps in the time that you've taken to complete your research, someone else has made a similar contribution to knowledge as that you claim. If there is no hole, then you cannot have made a contribution to knowledge.
- validity weaknesses, i.e., the claim you have made to new knowledge isn't sufficiently credible, trustworthy, or accurate to be considered knowledge.
- reliability weaknesses, i.e., the procedures that you have used to establish your claim of new knowledge are not sufficiently repeatable in different circumstances.
- bias weaknesses, i.e., the claim you have made to new knowledge has been affected by your implicit or explicit biases, making the new knowledge unreliable.

Each potential weakness needs to be considered in turn – ignoring them leaves yourself open to a negative outcome of expert scrutiny – and, for each, arguments made as to why your claim doesn't suffer them, or if it does to some extent, that there is still a contribution to knowledge arising from your research.

You can deal with potential weaknesses in three ways*:

- avoid the weakness, i.e., choose a research strategy which is not troubled by the weakness. Part of the justification for the choice of research strategy can then be a discussion, if necessary, that the weakness doesn't arise.
- address the weakness, i.e., be aware of the weakness during the research and put in place further strengthening research. This might be, for instance, a second of further iteration of the research strategy which addresses discovered weaknesses in earlier research. This would be reported as part of the research design.
- acknowledge and defer[†], most usually at the end of the research period when the research is complete, i.e., write a reflection on the effect the weakness had on the outcomes and commit to addressing that weakness in future research. This would be reported as part of your “Discussion” and “Conclusion and future work chapter”.

*There is actually a fourth way, which is to be aware of the weakness but to ignore it. We do not recommend this as your examiner of your dissertation is likely to have detailed understanding of the research strategy you have chosen, including its potential weaknesses, and is likely to pick any methodological omissions up.

[†]Although it may seem to have similar outcomes, this is a much better strategy than simply ignoring the weakness as, although you don't address it, you make the examiner aware that you are aware of it. It can also give you a very neat way of filling out your future work.

5.5.1 Weakness types

In this section we recall many of the common weaknesses under each of the categories we have introduced. All research projects are subject to some or even most of them, so awareness of them will help you better inform your choice of research strategies and the step to take to address them.

5.5.1.1 Novelty weakness

To identify your research problem, you will have found a hole in current knowledge through the literature you will have surveyed and reflected critically upon. During subsequent research you may find that you were:

- unable to contribute knowledge in that area, or not able to contribute as much as you had initially hoped;
- found further sources that had already made a contribution.

If you do encounter this weakness, you will not be the first – virtually all researchers find that their initial aspirations for a knowledge contribution has to be reduced or altered as their research – and understanding – progresses.

5.5.1.2 Validity weaknesses

There are a number of recognised validity weaknesses* upon which an evaluation of research validity is made.

- Mismatch between quantitative and qualitative samples
- Imbalance between an insider's and outsider's views
- Insufficient knowledge of research question, theory, hypotheses, statistical tests, and analysis
- Occurrence of unrelated events or conditions during data collection
- Insufficient or biased knowledge of earlier studies and theories
- Lack of descriptive validity of settings and events during data analysis and interpretation
- Population, time, and environmental validity in quantitative research

*These are often called “threats to validity” in the literature. We prefer *weakness* as it suggests that there is an issue caused by the research strategy application rather than by the environment.

why this list? where does it come from?

- Lack of cognitive and empathy training of researchers
- Value or ideologically based conflicts in collaboration between quantitative and qualitative researchers
- Difficulty in persuading consumers to value the meta-inferences from both qualitative and quantitative findings.

5.5.1.3 Reliability weaknesses

refers to the trustworthiness and consistency of the procedures and data generated in research. It is concerned with the extent to which the results of a study or measure are repeatable in different circumstances. Reliability can be demonstrated through methods such as inter-rater reliability, test-retest reliability, and internal consistency.

5.5.1.4 Bias

[Adapted from **simundic2013bias**]

“Bias is any trend or deviation from the truth in data collection, data analysis, interpretation and publication which can cause false conclusions. Bias can occur either intentionally or unintentionally (1). Intention to introduce bias into someone’s research is immoral. Nevertheless, considering the possible consequences of a biased research, it is almost equally irresponsible to conduct and publish a biased research unintentionally.

It is worth pointing out that every study has its confounding variables and limitations. Confounding effect cannot be completely avoided. Every scientist should therefore be aware of all potential sources of bias and undertake all possible actions to reduce and minimise the deviation from the truth. If deviation is still present, authors should confess it in their articles by declaring the known limitations of their work. ”

simundic2013bias

simundic2013bias then goes onto detailed four forms of bias:

- data collection bias: including selection bias, volunteer bias, admission bias, survivor bias, and misclassification bias
- data analysis bias: including
 - data fabrication: reporting non-existing data from experiments that were never done;

- data elimination: eliminating data which do not support a hypothesis (outliers, or even whole subgroups);
 - using inappropriate statistical tests to test your data;
 - performing multiple testing (“fishing for P”) by pair-wise comparisons, testing multiple end-points and performing secondary or subgroup analyses, which were not part of the original plan in order “to find” statistically significant differences regardless of hypothesis.
- data interpretation bias: including
 - discussing observed differences and associations even if they are not statistically significant (the often used expression is “borderline significance”);
 - discussing differences which are statistically significant but are not otherwise meaningful;
 - drawing conclusions about causality, even if the study was not designed as an experiment;
 - drawing conclusions about values outside the range of observed data (extrapolation);
 - over-generalisation of the study conclusions to the entire general population, even if a study was confined to the population subset;
 - Type I (the expected effect is found significant, when actually there is none) and type II (the expected effect is not found significant, when it is actually present) errors.
 - publication bias: including
 - funding bias: due to the prevailing number of studies funded by the same company, related to the same scientific question and supporting the interests of the sponsoring company
 - anti-negative bias: scientific journals are much more likely to accept for publication a study which reports some positive than a study with negative findings. Such behaviour creates false impression in the literature and may cause long-term consequences to the entire scientific community. Also, if negative results would not have so many difficulties to get published, other scientists would not unnecessarily waste their time and financial resources by re-running the same experiments.

5.5.2 Addressing weaknesses

If you can’t avoid a weakness and you can’t defer it, you have to address it. Addressing it means that your examiner will have their questions answered about the weaknesses they know occur in the type of research

you're doing. Their evaluation will be through the questions they ask of your research and you must be prepared to answer them. There are two places at which they can be answered:

- in your dissertation
- in any *viva voce* associated with your research course.

As not all masters research have an associated *viva voce* we will assume that weaknesses should be addressed in the dissertation itself. Even if your course does have a *viva voce*, it can be a nerve-racking experience to be confronted by an examiner asking questions to which you have no answer because you haven't thought about it!*. Thus, being aware of any weakness as early as possible for it to be addressed – at the latest, during the write up – is a good plan.

In general, an examiner will explore weaknesses in your claimed contribution to knowledge through a number of questions they ask of your dissertation. For each research strategy, many of these questions† can be predicted. Somewhere where in your dissertation, then, you will need to expose each research strategy weakness and address it.

Here is an example paragraph taken from an actual dissertation (**miles2019dispelling**) with our commentary on specific points to the right, in the margin:

Limitations of Study

My observational study focuses solely‡ on the external elements of the embouchure and what can be seen in real time with the human eye§, through the recording of video images. My analysis, and the conclusions that come from it, has been made from a purely visual perspective, captured by combinations of camera angles, without needing the use of any complex and expensive technologies¶. In embarking on this research project, the initial intention was to measure facial muscle activity using Electromyography. This method proved to be too costly‖ and the heavily mathematic and science based analysis process, out of the current skill set of this researcher**. Furthermore, due to the significant evidence found in the literature regarding the internal embouchure, the concept of the tongue being a pivotal el-

*And, although examiners are very good at asking surprising questions, you should have the ones you suspect they'll asked already answered.

†If not all; although examiners will have their own way of asking them!

‡Being specific on which phenomena are studied...

§...and on the observations made of them...

¶...thus correcting any expectations of what might have been achieved...

‖...contextual factors prevented more sophisticated observations...

**...and initial investigations reveals how difficult this would be

ement in facilitating pitch change has been accepted as fact and deemed unnecessary for further study in this project*. Therefore the ultimate goal of my research is to inform the teaching and learning of brass wind performance, with particular reference to the role of the embouchure†. With this in mind, it is therefore important that the data obtained through this study be identifiable through the simplest means possible, so that it can be of the most benefit to the brass-playing community‡.

5.5.2.1 Addressing research weakness: critical literature review

Alongside reflexivity, described below, addressing novelty weaknesses means returning to your literature survey as your research and understanding increases to cast an increasingly critical eye over it. Each source should be reconsidered for what you thought it originally said and what you now think it says, using any difference§ to drive further reflection on your findings, methods, data generation, or even problem.

As in the example above, your reader can be made aware of this process and how it has altered your research. Deepening the critical nature of your literature review allows your reader to understand that you are a reflective researcher and can turn any novelty weakness into a research strength!

Activity: Choosing your sampling approach

#3

Periods of critical review reflection.

5.5.2.2 Addressing research weakness: triangulation

Triangulation¶ is a strategy used to increase the validity and reliability of research. It involves using multiple data sources and methods to arrive at a singular proposition about the phenomenon being studied. Triangulation is necessary to withstand critique by colleagues and enhance the credibility of research. It involves using multiple methods, data sources, and researchers. Triangulation in social science was first introduced in campbell1959convergent.

Triangulation is “the combination of methodologies in the study of the same phenomenon” denzin1978research. Triangulation involves different types|| such as *data triangulation*, *investigator triangulation*, and *methodological triangulation*. Triangulation:

*There was no knowledge contribution to be made in this particular area...

†...and so the knowledge contribution was ...

‡...and our research goals were set accordingly.

§In the best case, there will, of course, be no difference!

¶Adapted AI summary of mathison1988triangulate.

||These are explained below.

- involves using multiple data sources and methods to reach, ideally, a singular conclusion about the phenomenon being studied
- helps to enhance the validity and reliability of research findings, and withstand critique by colleagues by showing that many different methods of reaching a conclusion agree
- should use multiple methods and sources of data, regardless of the philosophical or methodological perspective
- can improve research practice by aiding in the elimination of bias and allowing the dismissal of rival explanations.

Because triangulation applies many techniques or derives from many sources it can, however, result in inconsistent or contradictory findings, which may themselves pose risks to the validity of research or evaluation findings. It is important to understand that triangulation does not guarantee convergence on a single proposition about a phenomenon. Instead, it provides a rich and complex picture that requires careful interpretation and explanation by the researcher. Triangulation should be used cautiously and researchers should be prepared to explain and make sense of the various outcomes it may produce.

Data triangulation refers simply to using several data sources, the obvious example being the inclusion of more than one individual as a source of data. However, Denzin expands the notion of data triangulation to include time and space based on the assumption that understanding a social phenomenon requires its examination under a variety of conditions. So, for example, to study the effect of an inservice program on teachers, one should observe teachers at different times of the school day or year and in different settings such as the classroom and the teachers' lounge.

Investigator triangulation involves more than one investigator in the research process*, is also considered good practice. This perhaps more than other types of triangulation is usually built into the research process because most studies simply require more than one individual to accomplish the necessary data collection. However, the decision about who these multiple researchers should be and what their roles should be in the research process is problematic (**denzin1978research**). How much hands-on data collection the principal investigator needs to do in order to analyse the data, and how much data analysis is relegated to field workers because much of the analysis occurs as data are collected, are both relevant and not easily answered questions.

*Because there is more than one researcher involved, it is unlikely that you will be required to perform this form of triangulation. You may, however, be a researcher in the triangulation of another's research – your supervisor, for instance – which means that you should be prepared to be involved. Be sure to schedule some time with your supervisor to discuss their needs, should this be the case.

Methodological triangulation is the most discussed type of triangulation and refers to the use of multiple – or mixed – methods in the examination of a social phenomenon*. Psychologists have long used Denzin’s notion of within-method triangulation in assessing psychological traits. Multiple scales comprise a psychological assessment such as an intelligence test in an effort to assess the different aspects of intelligence. The lie detector scale in some psychological inventories is another example. Denzin suggests that the within-methods triangulation approach has limited value, because essentially only one method is being used, and finds the between-methods triangulation strategy more satisfying. Other researchers seem to follow this lead and focus primarily on between methods triangulation. “The rationale for this strategy is that the flaws of one method are often the strengths of another: and by combining methods, observers can achieve the best of each while overcoming their unique deficiencies” **denzin1978research**. It is with this type of triangulation that Denzin relies most heavily on the work of Webb et al. (1966) to suggest that the use of appropriate multiple methods will result in more valid research findings.

*We deal with mixed method research later in this Stage.

find ref

Activity: Do I need to know about interviews

#4

Read these sources on triangulation

5.5.2.3 Addressing research weaknesses: reflexivity

“Reflexivity is the process of a researcher acknowledging how they influence the study (Creswell and Miller 2000; May and Perry 2017; Berger 2015). Part of this process includes the researcher acknowledging their position of power and privilege from which they approach the research study (LeCompte and Schensul 2010). Reflexivity admits that the researcher isn’t necessarily an unbiased observer of truth, as might be asserted in the more positivist approaches, but someone interacts with and influences their surroundings. Reflexivity has applications in all types of research, but its recording is most prevalent in the more qualitative forms.

Source material, needs adapting

As potentially biased instruments of data collection and analysis, researchers should critically reflect on the ways in which they shape their ‘study topics, sampling, interpretation of the findings, and conclusions through their writing’ (Lincoln, Lynham, and Guba 2018; Creswell 2013; Johnson 2009).

There are a variety of ways to research reflexively (Genoe and Liechty 2016), for instance through the keeping of field notes, when ‘the researcher reflects on their actions, feelings, opinions, and assumptions throughout the process of observation’ (May and Perry 2017) and even to questioning the theories, methods, and research strategy used.

The goal of reflexive practice is to achieve a more honest and transparent research process and product (May and Perry 2017). In qualitative research, typically authors will include a section about positioning themselves in the study, where they reveal their various identities and the ways these may have influenced their interpretations of the data (Creswell 2013).” **usher2023case**

Rewrite for our purposes

Activity: Deep dive into interviews

#5

Read these sources on reflexivity.

It is the nature of research that new weaknesses are being discovered regularly. Some are specific and to the point, others of only marginal importance in specific research designs. The presentation below will not bring you up to the leading edge in “research weakness” research, but it will allow you to address the most important, research-strategy-specific ones.

5.6 Your initial research strategy candidate list

Activity: Do I need to know about Journalling

#6

Take a look at Table 5.3 and count the number of research strategies that you are going to read about. Make a note of what you are being asked to complete.

Activity: Deep dive into journalling

#7

The next activity you should complete is lengthy and may take a long time to complete, with auxiliary reading, up to one week.
The aim of this activity is to complete the following table, Table 5.3, which will track your progress in choosing a research strategy. Although it make not look much, completing each line is a substantial piece of work.

Table 5.3: Research strategy choice

Research Strategy candidate	Considered	Excluded	Reason excluded
Survey	<input type="checkbox"/>	<input type="checkbox"/>	
Design and Creation	<input type="checkbox"/>	<input type="checkbox"/>	
Experiment	<input type="checkbox"/>	<input type="checkbox"/>	
Case study	<input type="checkbox"/>	<input type="checkbox"/>	
Action research	<input type="checkbox"/>	<input type="checkbox"/>	
Ethnography	<input type="checkbox"/>	<input type="checkbox"/>	
Systematic research	<input type="checkbox"/>	<input type="checkbox"/>	
Grounded theory	<input type="checkbox"/>	<input type="checkbox"/>	
Phenomenology	<input type="checkbox"/>	<input type="checkbox"/>	
Simulation	<input type="checkbox"/>	<input type="checkbox"/>	
Mathematical and logical proof	<input type="checkbox"/>	<input type="checkbox"/>	
Mixed methods	<input type="checkbox"/>	<input type="checkbox"/>	

5.6.1 Research strategy introduction

Below we detail 12 candidate research strategies.

For each, we give a brief introduction – a brief paragraph explaining the focus of the strategy – followed by the type of knowledge contribution that can be made through it. You will be able to compare these with your research problem to check whether that research strategy should be a candidate. When you have done this, you can fill in the first tickbox column in Table 5.3 – I’ve considered the strategy. If there’s a clear mismatch between the knowledge contribution and your research problem, you might even be able to fill in the second tickbox column – that that research strategy has been excluded – and give a reason why you have excluded it – the knowledge contribution it makes is not of the correct form – and you can move onto the next research strategy.

The “Reason excluded” column will be used in the your dissertation to justify your choice of research strategy so think deeply about what you write here – you can use the text of the knowledge contribution and subsequent subsections to frame your reason for excluding it. Whatever you do, don’t leave it blank!

If you have not been able to exclude the research strategy, then you should read further – next come the techniques you would have to use for data generation. This gives you another reason to exclude a research strategy* – that you do not have access to the data generation techniques or the skills to perform them. If

*Of course, you will need to choose *one* research strategy, so be careful not to exclude something that wouldn’t be too access or to gain skills for.

this analysis leads you to exclude the research strategy, complete* the second tickbox column and record the reason and you can move onto the next research strategy.

If you get to the “Evaluation” section, then you’ve got a candidate strategy. Read through the evaluation section†.

The “Is this strategy right for me” section is next and lists a number of other things you should consider that might allow you to exclude it. If this leads you to exclude it, then fill in tickbox column 2 and give a reason for the exclusion and you can move on to the next research strategy.

Otherwise, you’ll have identified a(nother) candidate research strategy and will – through the final activity – have a number of academic resources that you should read to deepen your understanding of it.

There are three possible outcomes:

- you find yourself with a single candidate research strategy: in which case you should go for it!
- you find yourself with a number of candidate research strategies: in which case you can make a choice based on your skillset, how much fun you think you could have applying it, or any other criteria you wish. You may also like to think about mixing up bits of each to give a mixed methods research strategy
- you find yourself without a choice: in which case you’ve probably been too picky... and you should try again, perhaps discussing your decision with your supervisor – you can’t do research without a research strategy and you’re unlikely to come up with one not on this list – a completely novel one.

*This time, the reason will be something to do with data generation technique not accessible.

†Perhaps taking notes on things you haven’t immediately understood.

Activity: Do I need to know about Observations

#8

Title says it all, really.

5.6.2 Survey research

Survey research provides – potentially large – amounts of up-to-date, focussed, real-world data, collected in a systematic way, that represent in summary form characteristics of research subjects that are statistically valid and accurate for some population forming the focus of the research (**secor2010social**).

5.6.2.1 Knowledge contribution

The contribution to knowledge of survey research is to uncover patterns that can be generalised to the population of focus.

5.6.2.2 Data Generation

Suggested by the name, a survey – a standardised set of questions administered to a number of respondents – allows the researcher to gather information about a population. Surveys can take many forms, from interviews to questionnaires to focus groups, but authors vary on what they consider appropriate.*

Typical data generation methods for surveys are via the internet (more traditionally by mail), over the phone, and through face-to-face interviews, although surveys can also be conducted via pre-existing documents. Mixed-mode surveys combine these options into more complex instruments, perhaps using a broader but simpler questionnaire to identify potential participants for a deeper face-to-face interview.

5.6.2.3 Evaluation

The following questions are typically asked of the knowledge contribution made through survey research (oates2008researching):

1. Is coverage of the parent population appropriately wide and inclusive? Typically, this reduces to the question of whether the sample size is large enough, but may need more analysis in some cases (see stats section).
2. Is there a reflection on the adequacy of the sample frame? Would additional data would have been useful?
3. Are the data generation methods used appropriate and feasible? Has their design and construction been adequately described?
4. Are the sampling frame – the source database from which a sample is drawn[†] – and sampling techniques used adequately explained?
5. Is the response rate adequate? If not, was there appropriate reflection on the effects on the current survey and on future surveys? How were non-respondents handled?

*Be sure to consider any supplied preparatory reading on the survey research strategy to ensure that you meet your supervisor's (or other's) expectations of what will be appropriate.

[†]Although it may not be an actual computer database

6. Is there an adequate discussion on the differences between respondents and non-respondents? Is any significant differences discussed in the context of this and future work?
7. If generalisations have been made about the parent population, are they appropriate? What reasoning chains have led to the generalisations made?
8. What limitations, flaws, errors and/or omission are there in your use of surveys?
9. Overall, has the survey research strategy been successful?

5.6.2.4 Is the survey research strategy right for me?

Evaluation sets certain requirements of the researcher for them to be successful. These include that:

1. you're in a position in which you have access to the population so that deep analysis can be performed. If this is not possible, for instance, because this is your first time accessing the population, you might like to consider use case study research instead;
2. the phenomena and characteristics of the population are measurable through questions asked through a survey. If this is not the case that then you're not going to be able to make a contribution to knowledge about those phenomena or characteristics: if this is the case, you might like to consider phenomena that can be measured, or a different population for which those phenomena can be measured.
3. conducting a survey means that you'll be analysing phenomena using point data, i.e., data that were collected at a point in time – that time at which the survey was answered. If your research requires longitudinal data, i.e., data that could change over time, then survey research becomes more difficult as you might need two or more surveys to collect the changing data. It's not impossible to do this, but it adds many complications: earlier participants might not be available for later surveys, their mindsets might have changed in the intervening period, etc. If this is the case, then consider whether the choice of phenomena is appropriate. Alternatively, you might like to consider one of the experimental research strategies described below.
4. the difficulty of conducting two or more surveys also mitigates against trying to establish causes and effects. Again, reconsider phenomena or use an experimental research strategy instead;

5. conclusions from survey research rely on the veracity of the responses received. If there’s any reason to doubt your respondents’ honesty, additional care should be taken. There are techniques to avoid this (see **<empty citation>** for instance) but they add complexity to the strategy. If the development of a relationship of trust between research and population is critical to the research, then some form of ethnographic research might be more appropriate.

Activity: Do I need to know about questionnaires

#9

Having read the above subsection, do you consider Survey Research to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **dillman2014internet; kalaian2008encyclopedia**

5.6.3 Design and creation research

The design and creation research strategy* focuses on developing new solutions to problem, a problem being a need in context. The new solution can be an artefact, process, policy, model, method, anything that satisfies the need in context.

*AKA Design science research strategy.

5.6.3.1 Knowledge contribution

The contribution to knowledge is that which can be learned from the creation of an artefact as the solution of a problem. Knowledge contributions therefore come from an exploration of the artefact itself, or from its design, development, use, or other characteristics of the real-world problem solving process.

5.6.3.2 Data Generation

Typically the process of problem solving – the interactions between actors (customers, clients, designers, others), technologies and/or knowledge – is the source of data. This includes the nature of the problem solving process, whether it is linear or iterative, for instance, or the ways in which problem and solution understanding and validation are conducted.

5.6.3.3 Evaluation

Evaluation of the design and creation research strategy typically consists of the following questions (oates2008researching):

1. Is an artifice designed and created to the satisfaction of the stakeholders?
2. Is there novelty in its design, development, and/or creation?
3. Have you described the development methods used in adequate detail for someone else to follow?
4. Do you discuss all stages of the problem solving process, including interactions with stakeholders? Is the discussion convincing?
5. How is the artifice evaluated? Are the evaluation criteria documented? Are the criteria appropriate? How were they determined?
6. Do you make generalisation from the design and creation of the artifice? Are the generalisations appropriate?
7. Overall, how effectively do you think the design and creation strategy has been reported and used?

5.6.3.4 Is the design and creation research strategy right for me?

Although the design and creation research strategy may explore the development of new skills for a product, most often those skills will need to be learned by the developer (if you don't already possess them). This might be valuable from a personal perspective, but will not, by their nature, make a contribution to knowledge – learning them means that they exist already! Learning new skills is a time consuming task even for those with the right propensity for development. Ask yourself if the skills you will need can be fitted into your research, and assess carefully whether they are a realistic addition to the time that your research will take.

The design and creation research strategy will typically work with in a customer/developer relationship, with developer and creator not being the same person. The customer/client will set the requirements and context for the product, with the developer working on its development for that context to emmet those requirements. If you do not have access to a real-world problem owner then this strategy is not applicable.

If there is a customer, but their need for a solution to their problem is urgent, it may be that its embedding within a research project will not lead to a timely solution. This might be the case if your employer, for

instance, is looking to you to solve a pressing business problem, and looks to your research studies as the way to achieve this.

To make a contribution to knowledge there should be demonstrable novelty needed to produce the solution, or in the process, or som other aspect of the development. If you cannot clearly identify that novelty, then you will not be able to claim a contribution to knowledge.

Activity: Improving your questionnaire design

#10

Having read the above subsection, do you consider Design and creation research strategy to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **oates2008researching; brocke2020introduction**

5.6.4 Experimental research

Experimental research provides a controlled environment in which cause and effect relationships can be investigated, expressed as a hypothesis. The strength of an experiment is that it can reduce the influence of confounding factors on a cause-effect relationship.

The potential scope of application of the experimental research strategy is wide, ranging from scientific experiments under laboratory conditions to natural experimental studies in which “in which individuals (or clusters of individuals) are exposed to the experimental and control conditions that are determined by nature or by other factors outside the control of the investigators.” **enwiki:1195800578**

Typically, an experiment will be repeatable, so that the codification of the experimental and its procedures must be described as part of the research in a level of detail for an independent third party to repeat it.

5.6.4.1 Knowledge contribution

The experiment strategy contributes to knowledge through allowing cause and effect relationships between real-world phenomena to be established.

5.6.4.2 Data Generation

The experimental research strategy involves around making an intervention within tightly controlled parameters. Observations are made of before the intervention and after the intervention and a comparison is made. The difference between observations is assumed associated with the intervention made.

Depending on the complexity of the relationship between cause and effect, more or less complex experimental designs can be used. Those involving an inaccessibly large population of individuals, as might be the case for a medical drug trial, use sophisticated techniques to choose representative samples. Such techniques can use sophisticated statistics.

However, even simpler “local” cause-effect hypotheses may rely on the availability of a fully equipped scientific laboratory to work.

5.6.4.3 Evaluation

Evaluation of the experimental research strategy typically consists of the following questions (oates2008researching)

1. Was a hypothesis or predicted outcome of the experiment clearly stated?
2. Are the independent and dependent variables manipulated or measured in the study adequately described? What additional information is given?
3. Has sufficient information been supplied so that the experiment can be repeated by an independent third party? What are the experimental protocols?
4. do I have access to all equipment I will need to successful test the hypothesis?
5. do I have or can I gain the statistical skills I need to be able to complete data gathering and analysis?
6. In a social setting, what information is given about any participants and how they were found?
7. In information about how representative the sample is of the wider population sufficient to draw conclusions on representativeness? Are you satisfied that the sample is representative?
8. What information is given about the apparatus and the process the researchers used to make measurements? What additional information would you like?
9. What limitations in their experimental research do the researchers recognise and document?

10. Have flaws or omissions in the researchers’ experimental protocols or reporting of their experiment been identified and acknowledged?
11. Is the experimenter’s statistical analysis adequate, have the statistical tools been used and their use justified? Are the statistical and other analyses convincing of the conclusions?

5.6.4.4 Is this strategy right for me?

Although widely applicable, the experimental research strategy is not universally so. Counter-indications to its use include:

- can my research question be expressed as an hypothesis between a cause and an effect – for instance, as *Does phenomenon X cause phenomenon Y?*. If not, cross experiments off you candidate list, and consider other methods.
- when the cause/effect relationship is complex, for instance, depending on many factors;
- when confounding factors and variable cannot be isolated;
- when no falsifiable hypothesis can be identified;

In these cases, another research strategy should be chosen*

*Can we give guidance on which one?

Activity: Deep dive into questionnaires

#11

Having read the above subsection, do you consider experimental research strategy to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **field2002design**

5.6.5 Case study research

Case study research proceeds through the study of a single instance of the phenomenon to be investigated. The study of a single phenomenon requires the researcher to delve deeply into the context of that phenomenon, whether that be a project, an organisation, an engineered system, a policy, or any other thing, relationship, or context.

5.6.5.1 Knowledge contribution

The knowledge contribution is a detailed insightful description of the phenomenon, including when appropriate its relationships with other phenomena and the processes in which it engages.

5.6.5.2 Variants

Case studies come in many forms:

- exploratory: in which the researcher explores a research problem sufficiently to be able to conduct a further study. If you're considering studying for a PhD after your masters research, then this might provide a head start for future research (oates2008researching);
- multiple: in which the researcher provides a “rich, detailed analysis of a phenomenon and its context”. This provides an opportunity, for instance, for multiple stakeholder views to be taken into account as they experience the phenomena in context in different ways, in some ways moving toward a phenomenological account or in which the relationships between phenomena can be analysed (oates2008researching);
- longitudinal: in which the researcher considers the state of a phenomenon over time. This offers a natural storytelling context in which change in the phenomenon and/or its context can be analysed (oates2008researching);
- in combination: in which combinations of the above are analysed, including how relationships between phenomena and/or stakeholders develop over time or in response to contextual factors.

5.6.5.3 Data Collection

In case study research, data collection can happen through any appropriate data collection technique, whether through observation of the phenomena *in situ* and the context and process in which it participates, surveys of those that deal with the phenomena (through interviews, questionnaires, *etc*), documentation that directly or indirectly describe the phenomena.

Case studies are particularly appropriate for those embedded alongside the phenomenon of study as might be the case, for instance, of an employee of an organisation takes to investigate a phenomena through a research study; in this case the techniques of ethnography and action research might also apply.

Depending on context, both qualitative and quantitative data will be collected and data analysis can be very rich and complex.

5.6.5.4 Evaluation

An experienced researcher evaluating case study research will ask the following questions:

oates2008researching

1. Have the criteria for choosing the particular case study been described and justified? Is the choice appropriate for the phenomenon studied?
2. Has the variant of case study research been clearly described?
3. Which data generation methods were used? Did they generate the right type of data about the phenomenon in sufficient quantities?
4. Was the researcher able to work in the case study context? If so, how long was spent there? If not, how was a detailed investigation of the phenomena conducted?
5. Have you commented on the limitations experienced in the case study research due to any limitations on access to the phenomena? How was, for instance, commercial-in-confidence information handled?
6. Does the research adequately describe any dynamic relationships between phenomena and the processes in which the phenomena participate?
7. What generalisation were made from the case study research? Are the generalisations appropriate for the phenomena and its context?

8. What use of theory of the phenomenon is made in the case study? IS the theory chosen appropriate? If no theory was used, how is the theoretical basis of the research covered?
9. What limitations in the case study research have been recognised?
10. Overall, how effectively was the case study research strategy applied and reported?

5.6.5.5 Is this strategy right for me?

From the evaluation, you’ll see that an experienced case study researcher will be looking for rich, detailed descriptions of the phenomena and its relationships. Case study research therefore requires you to have access the a phenomena at an intensity at which such richness and detail can be perceived.

As an example, if you’re not a teacher, it might be difficult to gain access to a classroom to study student/teacher interactions. Should you not have appropriate access then another research strategy would be a better choice in which such access isn’t detrimental. This might include systematic research reviews, for instance, which work from secondary sources.

As an other example of potential difficulties, as well as access to the engineering context understanding the processes by which an engine controller in an aircraft is designed may require detailed understanding of technical documentation, language and even mathematical or computational theories. Constructing this knowledge background from zero as part of your research studies may consume a lot of time; the success of your research will depend critically on climbing any learning curve quickly and successfully*.

Access to policy, processes, and procedures within an organisation will require interaction with others. Even if you already have a good relationship with them they might not have the time to assist you sufficiently for your data generation to be successful.

*Even if that learning curve looks like El Capitan!

Activity: Do I need to know about documents

#12

Having read the above subsection, do you consider case study research to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: oates2008researching

5.6.6 Action research

“The Action Research strategy is used to address practical problems that appear in real-world settings. An action researcher does not only strive to generate new knowledge but also to solve important problems that people experience in their practices.” **johannesson2014research**

5.6.6.1 Knowledge contribution

The knowledge contributed through the action research strategy originates in real-world needs, which might a problem that a stakeholder or collection of stake holders experience. The action research strategy “immerses the researcher in real-world situations, rich contexts, and the actual problems experienced therein.” **oates2008researching**

5.6.6.2 Data Generation

???

5.6.6.3 Evaluation

An experienced researcher evaluating action research will ask the following questions:

(**oates2008researching**)

- Has the work used an iterative cycle of plan-act-reflect? How many cycles were conducted?
- Did the action research reach its goal? Is any shortfall accounted for?
- Do you make explicit your *framework of ideas, methodology* and *area of application*?
- What data generation methods do you used? Were they appropriate, and was enough data collected?
- Is the level of participation achieved discussed? Are any limitations in your outcomes due to a shortfall in participation? Which were they? Are they substantially accounted for?
- Is there a reflection on self-delusion and group-think of participants? How was this mitigated? Was the mitigation successful? If not, what was the outcome?
- Are any claims for practical and research outcomes appropriate for action research context?

- Which limitations, flaws, and omissions in the use of action research have been identified?
- Overall, has the effectiveness of the action research strategy been reported and used?

5.6.6.4 Is this strategy right for me?

Adapted from **oates2008researching**

- Will your supervisor/external/readership be receptive to the use of the action research strategy? If not, consider the case study research strategy or the design and creation research strategy as this is
- Do you need high levels of rigour? High levels of rigour might not be possible using the action research strategy, or may only be possible if you already have them in your skill set and bring them to the research.
- Do you need to establish a cause and effect between phenomena? Action research is ostensibly a real-world problem solving research strategy and may not be suitable complex cause-effect relationships. If so, consider experimental strategy
- Do you need to be able to generalise your research widely? If so, consider case study strategy.
- Will the organisation in which you are embedded require you to work for them, rather than to conduct research? If so, ensure they are clear that you are not a consultant.
- Do you envisage issues working with others in complex, problematic and unpredictable real-world situations? If so, consider ???

Activity: Deep dive into documents

#13

Having read the above subsection, do you consider action research to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **oates2008researching**; **johannesson2014research**

5.6.7 Ethnography

The Ethnography research strategy attempts to describe people or cultures. It has its roots in anthropology.

5.6.7.1 Knowledge contribution

Ethnography contributes to knowledge through the study of phenomena in their natural epistemo-socio-technological setting, where their context influences how they are reacted to (**oates2008researching**), providing a rich, detailed picture of a particular situation or work practices, placing them in their real-world context (**oates2008researching**).

5.6.7.2 Data Generation

5.6.7.3 Evaluation

(**oates2008researching**)

- Have the lifestyles, meanings and beliefs of the epistemo-socio-technological setting been described adequately?
- Are the data generation methods that were used described? Did they lead to sufficient data having been collected?
- Was adequate time spent in the field? What reflection has been done on the time spent in the field?
- Is the approach holistic (<**empty citation**>), semiotic (<**empty citation**>), or critical (<**empty citation**>)?
- Is the ethnography a standalone description, or has it been linked to theory, other ethnographies or issues in other cultures?
- Does the research include a reflective account of the researcher?
- To which extent is the research presented as an ethnographic construction rather than as a literal description?

- What limitations in the ethnography have been recognised?
- Which other flaws and/or omissions in the reporting of the ethnography have been described?
- Overall, how effectively has the ethnography research strategy been?

5.6.7.4 Is this strategy right for me?

(**oates2008researching**) Ethnography requires you to be a researcher located within the context of your situated research. This can take extensive amounts of time, such as might be the case if the context of your research is the organisation for which you work. However, if you have yet to have identified the context, or have yet to reach out to it, then this requirement may mean that ethnographic research will not be successful. If you are not already close to your context of research, you may wish to consider case study research instead.

Even if you are already located within the context of your ethnographic research, the context must be accepting of an ethnographic approach for your research to be successful. An organisation, for instance, in which there is a culture of strict compartmentalisation may not provide sufficient opportunities for ethnographic research.

In ethnographic research you allow the culture to determine the outcomes of the research. This precludes bias and prejudice. If there is any possibility that you could be biased to a particular outcome – as might happen if you feel you already know the outcome and are simply trying to confirm this – then ethnography is unlikely to lead to a successful outcome for your research. Any competent ethnographer will be particularly sensitive to expressions of bias, even if they aren’t even intentional. Indeed, such bias may preclude any successful research strategy being applied.

Ethnography is analytical in the extreme. Should you not have an analytical mindset, then ethnography should be avoided.

Activity: Do I need to know about focus groups #14

Having read the above subsection, do you consider ethnography to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **oates2008researching;**
johannesson2014research

5.6.8 Systematic research reviews

A systematic research review provides a definitive guide to the literature for a specified research topic. MAY allow further conclusions from across the literature to be drawn where, for instance, there is insight from across the literature not contained in individual research papers.

5.6.8.1 Knowledge contribution

Systematic research reviews relies on explicit, reproducible methods for identifying all relevant primary research the world over in all languages; similarly for the critical appraisal of identified research; the results of studies systematically brought together. Acts through literature searching, screening, data extraction, and analysis (**wright2007write**).

5.6.8.2 Focus

See **moher2009preferred** for PRISMA statement, a 27-item check-list. The aim of the PRISMA Statement is to help authors improve the reporting of systematic reviews and meta-analyses. PRISMA may also be useful for critical appraisal of published systematic reviews. However, the PRISMA checklist is not a quality assessment instrument to gauge the quality of a systematic review.

5.6.8.3 Data Collection

Systematic review research involves the process of systematically bringing together the results of any research, including qualitative or mixed methods research studies; the identification of all primary research relevant to the defined review (research) question, a critical appraisal of this research, and a synthesis of the findings (**pollock2018systematic**).

5.6.8.4 Evaluation

Evaluation of the systematic research review will involve answers to the following:

- has the researcher accessed all relevant primary research in the area? Are the criteria they have used to find the primary research explicit and reproducible? Were there any deviations from this protocol and, if so, is there clear reasons where and why documented?

- Have the relative strengths and weaknesses of the research reviewed been described? To which extent have any identified conflicts between sources been identified and resolved?
- To what extent has a definitive synthesis from the literature been achieved?
- To which extent have statistics been used across the survey to, for instance, produce overarching conclusions? To which extent has precision and/or generalisability been improved through the systematic research review?
- given the research question, to which extent is the review type the most appropriate (**pollock2018systematic**)?
- have implications for future research and practice been discussed both for the research question and in other areas that were raised by the review?
- do you discuss the updating of the review (**pollock2018systematic**)?
- To which extent is the limits of current knowledge described?

5.6.8.5 Is this strategy right for me?

Are you able to consult all available literature, i.e., do you have access to a university library with a large research collection in your chosen discipline? If not, although there are ways of obtaining research that isn't in your library's collection, such as by contacting the author(s) directly. Although most authors will be happy to send their published research to you, the round trip time can introduce lengthy delays in the research process, or make analysis of the literature in a particular area more difficult and systematic as you wait for the requested research to arrive. You may also need to be persistent to ensure that a busy author is aware of your research need.

The most successful systematic research surveys begin from a broad focus that is, perhaps, narrowed down as research progresses. The original question should not therefore be so narrow as to restrict the initial literature down too far – there must be some opportunity for conclusions from *across* the research to be reached. Moreover, in an area in which there is little room for disagreement, it may be that study heterogeneity (**wright2007write**) precludes meta-analysis.

You will be expected to have stated the explicit inclusion and exclusion criteria for the survey research so that another research would be able to find the same collection. The particular choice of focus may make this a difficult task. For instance, survey research in the area of information technology (IT) may lead to

a search term in which “IT” is part of your search terms, and this may have the unfortunate effect of not revealing anything useful – “it” is a very common word.

You should not allow any inherent bias that you have influence your documentation of the literature. This is often difficult to do.

Activity: Deep dive into focus groups#15

Having read the above subsection, do you consider systematic research survey to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **wright2007write; moher2009preferred; pollock2018systematic**

5.6.9 Grounded theory

“Grounded theory aims to understand social phenomena by systematically collecting and analyzing data without preconceived notions or theoretical frameworks. The process involves iterative coding and constant comparison of data to generate concepts, categories, and relationships.” **drew202310-grounded**

“Grounded theory is a research strategy that strives to develop theories through the analysis of empirical data. In contrast to experiments, grounded theory does not start with a hypothesis to be tested but instead with data from which a theory can be generated. Grounded theory also differs from research strategies, such as ethnography, which are content to provide rich descriptions of particular situations, but no theories. Grounded theory challenges a top-down theorising approach, in which the researcher first develops a theory and then checks whether it conforms to empirical data. Instead, grounded theory insists that empirical data is the starting point, upon which theories are to be built. Theory emerges through analysis and is grounded in the data.” **johannesson2014research**

“Grounded theory is an innovative way to gather qualitative data that can help introduce new thoughts, theories, and ideas into academic literature. While it has its strength in allowing the “data to do the talking”, it also has some key limitations – namely, often, it leads to results that have already been found in the academic literature. Studies that try to build upon current knowledge by testing new hypotheses are, in general, more laser-focused on ensuring we push current knowledge forward. Nevertheless, a grounded

theory approach is very useful in many circumstances, revealing important new information that may not be generated through other approaches. So, overall, this methodology has great value for qualitative researchers, and can be extremely useful, especially when exploring specific case study projects. I also find it to synthesize well with action research projects.” **drew202310-grounded**

5.6.9.1 Knowledge contribution

A theory derived from empirical data*

*Examples here: <https://helpfulprofessor.com/grounded-theory-examples/>

5.6.9.2 Data Collection

Empirical data is extant; “In fact, Patton (1990), a qualitative evaluation researcher, made the comment, ‘Qualitative evaluation inquiry draws on both critical and creative thinking – both the science and the art of analysis’ (p. 434). He went on to provide a list of behaviors that he found useful for promoting creative thinking, something every analyst should keep in mind. These include (a) being open to multiple possibilities; (b) generating a list of options; (c) exploring various possibilities before choosing any one; (d) making use of multiple avenues of expression such as art, music, and metaphors to stimulate thinking; (e) using nonlinear forms of thinking such as going back and forth and circumventing around a subject to get a fresh perspective; (f) diverging from one’s usual ways of thinking and working, again to get a fresh perspective; (g) trusting the process and not holding back; (h) not taking shortcuts but rather putting energy and effort into the work; and (i) having fun while doing it (pp. 434–435). (**patton1990qualitative**)” **strauss1998basics**

5.6.9.3 Evaluation

“The success of a research project is judged by its products. Except in unusual instances when these are only orally presented, the study design and methods, findings, theoretical formulations, and conclusions are judged through publication. Yet, how are these to be evaluated and by what criteria? When judging qualitative research it is not appropriate, we have asserted, to use criteria ordinarily used to judge the procedures and canons of quantitative studies. It has been one of the aims of this paper to show how the grounded theory approach accepts the usual scientific canons but redefines them carefully to make them appropriate to its specific procedures. In the instance of any grounded theory study, the specific procedures and canons as described above should be part of its evaluation.” **corbin1990grounded**

Are concepts generated? “Since the basic building blocks of any grounded theory is a set of concepts grounded in the data, the first question to be asked of any publication is: Does it generate (via coding-categorizing activity) or at least use concepts, and what is or are their source or sources? If concepts are drawn from common usage (such as, “uncertainty”) but not put to technical use, then these are not concepts in the sense of being part of a grounded theory, for they are not actually grounded in the data themselves.” **corbin1990grounded**

Are the concepts systematically related? “The name of the scientific game is systematic conceptualization through conceptual linkages. So, the questions to ask here of a grounded theory publication are whether such linkages have been made and do they seem to be grounded in the data? Furthermore, are the linkages systematically carried out? As in other qualitative writing, the linkages are unlikely to be presented as a listing of hypotheses or in propositional or other formal terms but will be woven throughout the text of the publication.” **corbin1990grounded**

Are there many conceptual linkages and are the categories well developed? Do they have conceptual density? “If there are only a few specified conceptual relationships, even if grounded and identified systematically, this leaves something to be desired in terms of the overall grounding of the theory. A grounded theory should be tightly linked, both in terms of categories to their subcategories and between categories in the final integration in terms of the paradigm features conditions, context, action/interaction (strategies) and consequences. Also categories, as mentioned in the body of the paper, should be theoretically dense (have many properties that are dimensionalized). It is the tight linkages, in terms of the paradigm features and density of the categories, that give a theory its explanatory power. Without these, the theory is less than satisfactory.” **corbin1990grounded**

Is there much variation built into the theory? “Some qualitative studies report only about a single phenomenon and establish only a very few conditions under which it appears, and specify only a few actions/interactions that characterize it, and a limited number or range of consequences. By contrast, a grounded theory monograph should be judged in terms of the range of its variations and the specificity with which these are spelled out in relation to the data that are their source. In a published paper, the range of variations touched upon may be more limited, but the author should at least suggest that the fully study included their specification.” **corbin1990grounded**

Are the broader conditions that affect the phenomenon under study built into its explanation?

“The grounded theory mode of research requires that the explanatory conditions brought into analysis are not restricted to those that seem to have immediate bearing on the phenomenon under study. That is, the analysis should not be so “microscopic” as to disregard conditions that derive from more “macroscopic” sources: for instance, those such as economic conditions, social movements, trends, cultural values, and so forth.

These also must not simply be listed as background material but directly linked to phenomena through their effect on action/interaction, and through these latter to consequences. Therefore, any grounded theory publication that either omits these broader conditions or fails to explicate their specific connections to the phenomenon(a) under investigation, falls short in its empirical grounding.” **corbin1990grounded**

Has “process” been taken into account? “Identifying and specifying change or movement in the form of process is an important part of grounded theory research. Any change must be linked to the conditions that gave rise to it. Process may be described as stages or phases and also as fluidity or movement of action/interaction over the passage of time in response to prevailing conditions.” **corbin1990grounded**

Do the theoretical findings seem significant and to what extent? “The question of significance is generally thought of in terms of the relative importance of a theory for stimulating further studies and for giving useful explanations of a range of phenomena. We have in mind here, however, the adequacy of a study’s empirical grounding in relation to its actual analysis insofar as this combination of activities succeeds or fails, in some degree, at producing useful theoretical findings. If the researcher simply follows the grounded theory procedures/canons without any imagination or insight into what the data are reflecting - because he or she fails to see what they are really saying except in terms of trivial or well known phenomena - then the published findings can be judged as failing on this criterion. Recollect that there is an interplay between the researcher and the data, and no method, certainly not the grounded theory one, can insure that the interplay will be creative. This depends on three characteristics of the researcher: analytic ability, theoretical sensitivity, and sensitivity to the subtleties of the action/interaction (plus sufficient writing ability to convey the findings). Of course, a creative interplay also depends on the other pole of the researcher-data equation: the quality of the data collected or utilized. An unimaginative analysis may in a technical sense be adequately grounded in the data, but actually it is insufficiently grounded for the researcher’s theoretical purposes. This is because the researcher either does not draw on the fuller resources of data or fails to push data collection far enough.” **corbin1990grounded**

“This double set of criteria, for the research process and for the empirical grounding of the theoretical findings, bear directly on the issues of how verified any given grounded theory study is and how this is to be ascertained. When the study is published,, if components of the research process are clearly laid out and if there are sufficient cues in the publication itself, then the presented theory or theoretical formulations can be assessed in terms of degrees of plausibility. We can judge under what conditions the theory might fit with “reality”, give understanding, and be useful (practically and in theoretical terms). Researchers themselves can be rendered more aware of precisely what their operations have been and the possible inadequacies of these operations. In other words, they would be able to identify and convey what were the limitations of their study.” **corbin1990grounded**

5.6.9.4 Is this strategy right for me?

- Without extant data, grounded theory cannot get started, use Experiment instead
- A theory is not the goal state: if no theory is required, use ethnography instead
- the research question is too focussed*:

*Meaning?

Activity: Do I need to know about field work#16

Having read the above subsection, do you consider case study research to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **smith1997understanding; corbin1990grounded; strauss1998basics; gibson2013rediscovering; charmaz2014constructing**

5.6.10 Phenomenology

“Phenomenology is a research strategy that focuses on the perceptions and experiences of people as well as their feelings and emotions.” **johannesson2014research**

5.6.10.1 Knowledge contribution

“The goal of a phenomenological study is not to establish cause and effect relationships or to describe a population through statistical means. Instead, it aims to describe and understand the lived experiences of people and thereby provide insight about the topic being studied.” **johannesson2014research**

5.6.10.2 Data Generation

Data generation for the Phenomenology research strategy is mainly through the long, unstructured interview, designed for the subject to: “really tell their own story without being unduly influenced by the researchers.” **johannesson2014research**

“interviews, follow-up interviews (to address any gaps in data like misunderstandings, missing information, unclear information, etc.), focus groups, field notes, journaling, audio recording, and video recording. A combination of instruments is ideal rather than one so that findings are rich, but dissertation students should also be realistic about choosing various instruments so that they do not overwhelm themselves with unrealistic expectations.” **office2020the-phenomenological**

5.6.10.3 Evaluation

(**office2020the-phenomenological**)

- Will the experience as described be understandable to any reader and can be identified by anyone who has had that particular experience?
- Is the description of the phenomenon clearly presented so that experience differs from other experiences that are similar? **what does this mean?**
- Are quotations from the data used to demonstrate the emergence of themes?
- Is there a discussion of discrepancies among participants and how those discrepancies were factored in data analysis?
- Have meaning units, themes, and summaries been described?
- Are meaning units grouped together to form themes?

- Are themes combined to form a composite summary of the phenomenon?
- Are quotes used to support the findings?
- Research participants will have their individual ways of experiencing a certain phenomenon. Have you looked for these common to all or most of the participants and not clustered meaning units together where significant differences exist?

and the research process

- Bracketing/Epoché/Phenomenological reduction - have you discussed how judgments were suspended to focus on analysis of experience. How did you use suspend your judgments to focus on the analysis of participants' experiences?
- Horizon - during data analysis, what was your present experience, your horizon? The horizon cannot be bracketed so you will need to discuss that not everything could have been realized by you, the researcher. This discussion might also lead into a discussion about future research implications in Chapter 5.
- Intentionality - discuss your level of scrutiny of the data you analyzed. How did you keep your focus on the topic you were studying? Perhaps you slowed down and dwelled on each narrative and did not pass over the details of the account as if you understood it already.
- Dasein - How has your Dasein (being-there) affected the research? How did the research affect your Dasein?
- Fore-sight/Fore-conception - What was your preconceived knowledge about the phenomenon you were studying?
- Hermeneutic Circle - How did were your understandings revised as you analyzed the data?

and (**office2020the-phenomenological**)

- have you described the “what, when, where, and how” of the study? What has be done? When the steps were sequenced? Where each step happened? How each step happened?
- have you described where will data be collected? Who collected the data? How often and how much data was collected? How long it took to collect the data? How the data was recorded? (ex: transcriptions, video recordings, audio recordings) Were there follow ups to interviews?

5.6.10.4 Is this strategy right for me?

- is your audience expecting scientific rigour? If so, choose ???
- does your data (source) allow analysis above the data, or will the outputs be mostly descriptive?
- are you short of time for data collection? If so, consider ???
- do you appreciate the value of deep philosophical discourse?
- ...

Activity: Deep dive into field work #17

Having read the above subsection, do you consider phenomenology to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: merleau1956phenomenology; anderson1991qualitative; smith2018phenomenology; shudak2018phenomenology; academic-educational-materials2019understanding; office2020the-phenomenological; groenewald2004a-phenomenological; hycner1985some

5.6.11 Simulation

The simulation research strategy builds an explicative mechanism to imitate the behaviour of a real-world artefact.

5.6.11.1 Knowledge contribution

“[S]imulation helps answer the question ‘What if?’” dooley2017simulation

5.6.11.2 Variants

The three main schools of simulation practice are (**dooley2017simulation**):

- Discrete event simulation, which involves modeling the organizational system as a set of entities evolving over time according to the availability of resources and the triggering of events.
- System dynamics, which involves identifying the key “state” variables that define the behavior of the system, and then relating those variables to one another through coupled, differential equations.
- Agent-based simulation, which involves agents that attempt to maximize their fitness (utility) functions by interacting with other agents and resources; agent behavior is determined by embedded schema which are both interpretive and action-oriented in nature.

5.6.11.3 Data Generation

“Simulation enables studies of more complex systems because it creates observations by ‘moving forward’ into the future, whereas other research methods attempt to look backwards across history to determine what happened, and how.” **dooley2017simulation**

Depending on the context in which the simulation is studied or used. May include:

- observations, interviews, questionnaires, documents, in-depth description when supporting social objectives
- accuracy, predicative capability, when used to model real-world processes – think weather forecasting
- ...

5.6.11.4 Evaluation

For computer simulations:

- Good development: has a documented set of requirements been maintained? Has a change control process been implemented? Is there a corresponding document (or version) control process.
- Has the architecture been documented? What is its relationship to the model?

- Have a variety of testing methods, including code walk-throughs, scenario testing, and user testing been used to establish code quality?
- Was a project plan for coding and testing developed?
- how close is the simulation’s behaviour to the “real” answer? Do the results make sense?
- has the simulation been compared to any extant quantitative behaviour available? Does it match exactly, distributionally (a variable of interest has statistically similar characteristics), or pattern-wise (variables are generally related to one another in a valid manner, but perhaps differ from reality)?
- Which experimental set-up was used? Was it appropriate?
- Have observations from analysis been noted, and results discussed in order to sense-make? Has over-interpretation of the results been avoided so that retrofitting to theories is avoided?

For simulation:

- ...

5.6.11.5 Is this strategy right for me?

Do I already have the computing/mathematical/statistical skills that I need to underpin the research?
Do I have access to documentation sufficient to allow a simulation to be built?

Activity: Do I need to know about computation thinking #18

Having read the above subsection, do you consider simulation to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **dooley2017simulation**

5.6.12 Mathematical and logical proof

“A proof is a rigorous deductive argument that demonstrates the truth of a certain proposition.” **johannesson2014research**

5.6.12.1 Knowledge contribution

Establishes the absolute truth status of a proposition.

5.6.12.2 Data Generation

No data generation, although iteration and extensive exploration through examples may be needed to identify the extent to which proof is possible.

5.6.12.3 Evaluation

Formal evaluation by the community of mathematicians within some logical system. Potential for automated checking should computational tools exist.

5.6.12.4 Is this strategy right for me?

Do I have a formal background in logic? One way to determine whether my background is suitable would be to read the first few pages of **lakatos2015proofs*** and consider my level of engagement with the process of proof.

*Up to page 9 is available through google books

Do I have a community of mathematicians that would be willing to check my proof as it develops?

Is the situation to which I want to apply formal proof amenable to formalisation? If not, then the notion of formal proof might not apply. Even if a formalisation is possible, does it already exist or would I also need to formalise the area first. If you have difficulty answering this question, it may be that this research strategy is not for you.

Am I trying to predict future behaviours of a system? If so, mathematical, statistical or computational modelling might be a better option.

Activity: Deep dive into computation thinking

#19

Having read the above subsection, do you consider mathematical and logical proof to be a serious candidate for your research strategy?

Guidance

If so, add the following references to your list of reading: **Kleene1964introduction; lakatos2015proofs; antonini2011examples**

5.6.13 Mixed methods research

“Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.” **johnson2007toward**

5.6.13.1 Knowledge contribution

The Mixed methods research strategy combined the knowledge contributions of each method used. In addition, “[the methods] can be adapted, altered, or synthesized to fit the research and cost situations of the study (modified form mixed methods).” **johnson2007toward**

“[P]lanfully [combining] methods of different types (qualitative and quantitative) to provide a more elaborated understanding of the phenomenon of interest (including its context) and, as well, to gain greater confidence in the conclusions generated by the evaluation study.” **johnson2007toward**

5.6.13.2 Data Generation

Those of the individual methods, combined with those of the methods mixed. The latter form provides for triangulation: “the combination of methodologies in the study of the same phenomenon” **denzin1978research**: “If a proposition can survive the onslaught of a series of imperfect measures, with all their irrelevant error, confidence should be placed in it. Of course, this confidence is increased by minimizing error in each instrument and by a reasonable belief in the different and divergent effects of the sources of error.” **webb2000unobtrusive**

5.6.13.3 Evaluation

5.6.13.4 Is this strategy right for me?

Mixed methods research requires competence in more than a single research method, which takes time; it is unlikely that at this stage in your research career you will have a developed understanding sufficient to apply the mixed methods research strategy. However, it may be that your work is part of broader mixed methods research, perhaps led by your supervisor. If that is the case, then refer to the description of the particular method you are being asked to work with.

Even if you are contemplating mixed methods research, perhaps as an extended research agenda leading to a PhD, at this point it may be that a focus on a single method as part of the mixed methods research will achieve what is required. If this is that case, then you should discuss with your supervisor.

5.7 What to do now

Activity: Do I need to know about mathematical thinking

#20

Schedule some time with you supervisor to discuss the thought processes and outcomes of choosing a research strategy.

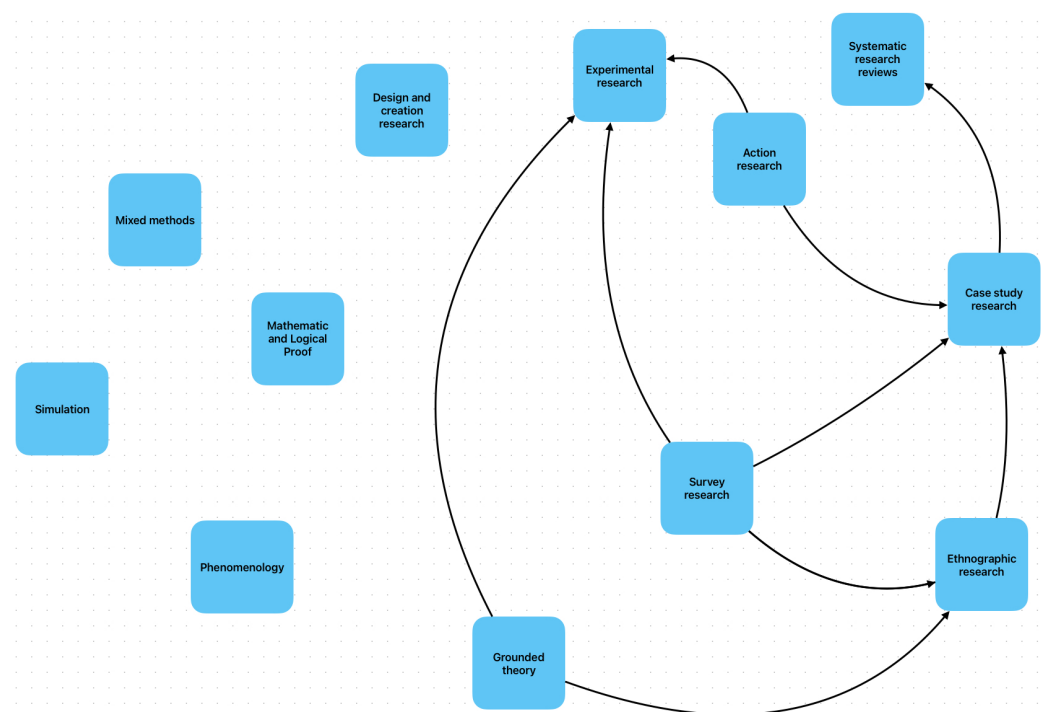


Figure 5.2: Research strategy choices

5.7.1 For your chosen research strategy

Activity: Deep dive into mathematical thinking

#21

Whichever tool you've chosen in which to write your dissertation, create chapters entitled “research strategy”, “method”, and “Evaluation”.

Guidance

For the research strategy chapter, make notes from the paper you've read on the general form of the research strategy.

For the method chapter, add details on the methods that are used in the research strategy. For a complex strategy such as ethnography, you may not use all of them, but you will need to be explicit – when you come to complete it – as to which you have excluded and the reasons for their exclusion.

For the evaluation chapter, create subsections for each of the questions of your chosen research strategy from the lists above.