Masters Research Handbook

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Chapter 5

Stage 3: Second research increment

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

Table 5.1: Stage 3 activities Update as necessary)

Research activity	Effort within stage	Suggested supervisor focus
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

To make a contribution to knowledge we do research. Practically, to do research, we combine a number of research tasks into a framework. The framework is indicated by the research area, the type of knowledge contribution we wish to make, and the difficulties we face along the way.

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

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

Ontology is the study of existence* and addresses the question: "What is the reality that I will research?". Practically, ontology is about finding out what you aim to examine which, in its simplest form, reduces to determining what *phenomena* exist in the context of the your research, the *relations* that exist between them and how they group together into *categories*..

*If you're interested, there's a fuller discussion of *Ontology* in the Stanford Encyclopedia of Philosophy (Hofweber 2023).

Epistemology is the study of knowledge† and addresses the question: "How will I gather the knowledge 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?".

†If you're interested, there's a fuller discussion of *Epistemology* in the Stanford Encyclopedia of Philosophy (Steup and Neta 2020).

Methodology which is the system‡ in which you choose to investigate, measure, and analyse your research's aims and objectives. Methodology answers the "how" question, "How will I make my contribution to knowledge?".

‡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.

As you might have guessed, given that the goal of research is 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. Fortunately, many others have thought very deeply about these things 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 (Steup and Neta 2020, Section 4.1).

Methodology, on the other hand, is something we will spend some time on, or at least a subfield of methodology, that dealing with how individual research methods combine to produce knowledge contributions through research strategies.

Methodology has many meanings, 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, is their important characteristics. 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 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.

There are four well-known research paradigms:

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

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

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

The positivist research paradigm is mostly used in situations where an "single objective reality" is most expected, i.e., the natural sciences, the physical sciences, or whenever very large sample sizes can be used. It leads the researcher to quantitative analysis of objective measurements including techniques from statistics, surveys, and structured questionnaires, and towards simulations, mathematical and computational thinking at the more formal end.

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, for instance.

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

The term "positivism" is suggestive of reinforcement through confirmation: we do experiments which reinforce known true knowledge. You might have this mindset if you don't question received truth.

Activity: Deep reading on Non-Random Sampling #2

On a scale of 0 to 10, with 0 wholly in disagreement and 10 wholly in agreement, to which extent do you agree with the following statement?
I'd know precisely how to check whether "That cat is blue" is true or false.

Guidance

You might think this is an easy exercise to complete. If you do, then you are – most likely – a positivist thinker. If you had to give the answer some thought, or if you had to consult another person to discuss, then you might not be a positivist thinker.
Positivist thinkers tend towards the hard end of quantitative research, including the conducting of experiments.

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?

*See Wikipedia contributors (2024b), for instance.

Einstein's insight into the intimate connection between space and time together that extended Newton, could lead to something of a crisis in the Positivist movement (see, for instance, Lakatos (2014)). If not a complete rethink, then Einstein's work inspired a substantial away from the established "laws" and "facts", which were neither any longer. **laka**

The serious rethink led to post-positivism† which, rather than facts and law, relied on falsification, i.e., any posited theory must be testable, the currency of a theory being determined by whether or not it had yet been proven false. A theory is falsifiable if offers predictions that can be tested.‡

†Not the most creative name, you must admit.

‡However, even in post-positivism, falsifiable theories that have been tested and failed, can still be useful. Like Newton Laws of motion, for instance, which provide a very good approximation at low energies.

Both positivism and post-positivism accrete knowledge by discovering generalisations and cause-effect linkages. Thus you might take a positivist approach to establishing the linkage between a drug and the alleviation of symptoms. And once a generalisation or cause-effect linkage is established (within falsifiability, if necessary, and in context) it applies for all time.

Is this the right term? Do they confirm rather than discover? What do hypotheses have to do with this?

Activity: Choosing your sampling approach #3

On a scale of 0 to 10, with 0 wholly in disagreement and 10 wholly in agreement, to which extent do you agree with the following statement?
Even though the cat is blue, I can imagine situations in which it could be observed as some other colour.

Guidance

If you thought this was easy, you might be a post-positivist thinker. Post-positivist thinkers may tend towards quantitative research.

Technically, neither positivism nor post-positivism admit values on behalf of the researcher. This denial is often levelled as a criticism of the paradigms as, clearly, the mindset of the researcher, their language and their ability to communicate, amongst many characteristics, are key to the outcomes of positivist or post-positivist research.

See Wikipedia contributors 2023c for a more detail description.

The Anti-positivist (AKA Interpretivist) Research Paradigm The shift positivism and post-positivism still preserves the absolute nature of, er, nature. 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 view. 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.

Explaining the name, anti-positivists also believe that all research is influenced and shaped by researchers' worldviews and theories.

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, interpretivists use qualitative research methods and techniques to understand the different perspectives, placed in an explicative context of their own perspective. The researcher is lead towards qualitative, constructed tasks such as interviews and focus groups, together with observations of, and the collection of documentation on, a phenomenon of interest (e.g., newspaper articles, reports, or information from websites).

See Wikipedia contributors 2023a for a more detailed description.

The Critical Theory Research Paradigm asserts that social science can never be 100% objective or value-free. 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 influece on the research

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

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.

Add example here

Quality judgements in Critical Theory tend to be "Historical situatenedness; erosion of ignorance and misapprehensions, action stimulus"

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

See Wikipedia contributors 2023b for a more detailed description.

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, in opposition to the view that there is a single methodology to generate knowledge.

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

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

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

Quality criteria are authenticity and trust in the researcher and others in their lived experience.

See **<empty citation>**

]

[Add illustration of the differences between the four main paradigms.]

Each paradigm is suggestive of the research means by which a knowledge contribution will be made. At the highest level, above the tasks mentioned above, the research means is 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 chosen (or constructed), 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.

*Which depend on many factors, including...

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

For instance, social science research strategy could be as simple as a two group experiment while the strategy described in Andrews (2005, p. 407) for education research has 12 components, arranged in complex interacting feedback loops, with the of including experiments.

Andrews calls it a research model.

Although each research paradigm is sufficiently distinct as to indicate different strategies, strategies do overlap in their application. Every strategy will, for instance, generate data of some form, whether this is readings in some experimental setting or documentation of the lived experience of a community under focus.

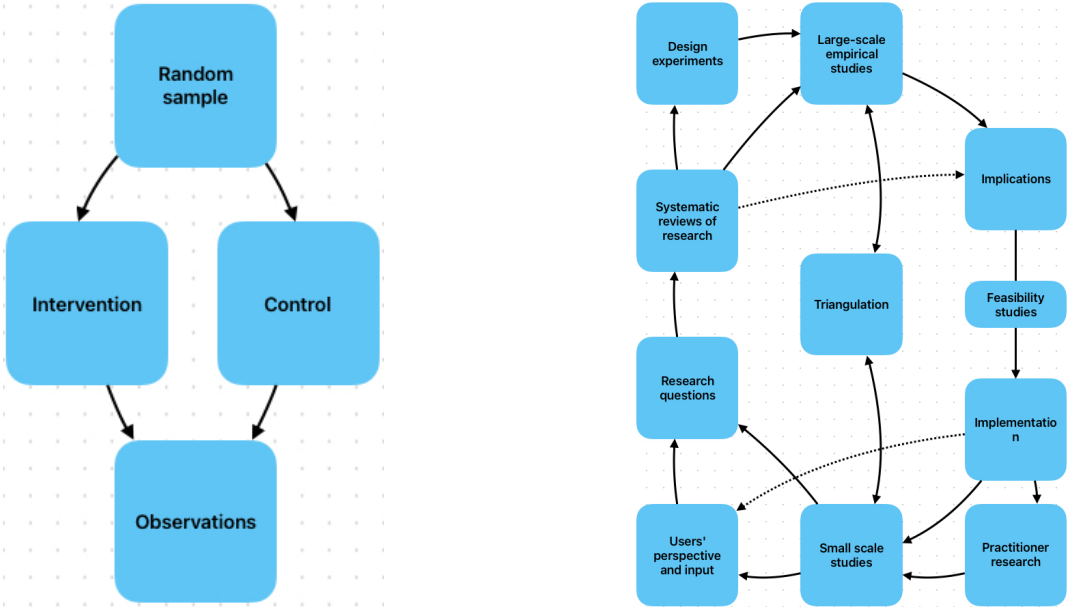

Figure 5.1: (left) A simple two-group experimental design instance (Marczyk, DeMatteo, and Festinger 2005, adapted p. 128); (right) A complex instance of the check systematic reviews research strategy as applied to education (Andrews 2005, figure 1)

Generated research data provide a focus for qualitative and quantitative analysis and, thus, to the synthesis of new knowledge.****

5.4 Research design and knowledge contribution

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. So we need to approach breaking down your research objectives into tasks in a systematic way.

There's good news and bad news:

- 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.

Our approach to this task is unapologetically practical. We will layout the options that you have together with the 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?

Between these are the research task choice that are constrained by (and build up to) the research method. Each task will stem from your research aim and objectives, through the research method you choose, to contribute something to what is evaluated as your knowledge contribution.

Recall from Stage 1 that

- your research aim tells the reader how your research will address the knowledge gap that you have found through your literature review,
- your objectives break it down into 3 to 4 high-level steps you must take to achieve the aim.

You're now at the point where you need to think about how you will meet each of your research objectives. That means breaking them down even further into *research tasks*. Research tasks may not be simple to achieve, but they're last step in your research structure.

5.4.1 Research Design

While a research objective indicates what you need to achieve, **research tasks** tell you the work that you need to complete to get there, so they address the question of what you need to do to meet the objective. Research tasks are the raw ingredients from which research is built.

Research designs are the recipes for good research, combining research tasks into meaningful ways of doing research.

There are many research strategies each with many variants. Those we consider in this book are Survey research, Design and creation research, Experimental research, Case study research, Action research, Ethnography, Systematic research reviews, Grounded theory, Phenomenology, Simulation, and Mathematical and logical proof. In addition, we also consider the combination of research strategies through Mixed methods research.

After a brief description of the strategy, we delve into the following details:

- describe what the knowledge contribution it makes is
- 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 you give more detail if you are seriously considering the strategy.

The outcome of this section should be the choice of a research strategy that:

- is a good fit for your research question, i.e., that will allow you to develop a contribution to knowledge arising from your research question
- 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 its fit 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 what research tasks you will be required to generate and analyse research data that, when complete, will make your contribution to knowledge and

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-known research strategy. Even having made your assertion, however, you still need to defend it in your dissertation. That means considering, essentially, addressing everything that could have gone wrong with the application of the research strategy – any weaknesses in the research strategy. We show how to address weaknesses below.

There are four possible classes of weakness in all claimed knowledge contributions (see figure 5.2):

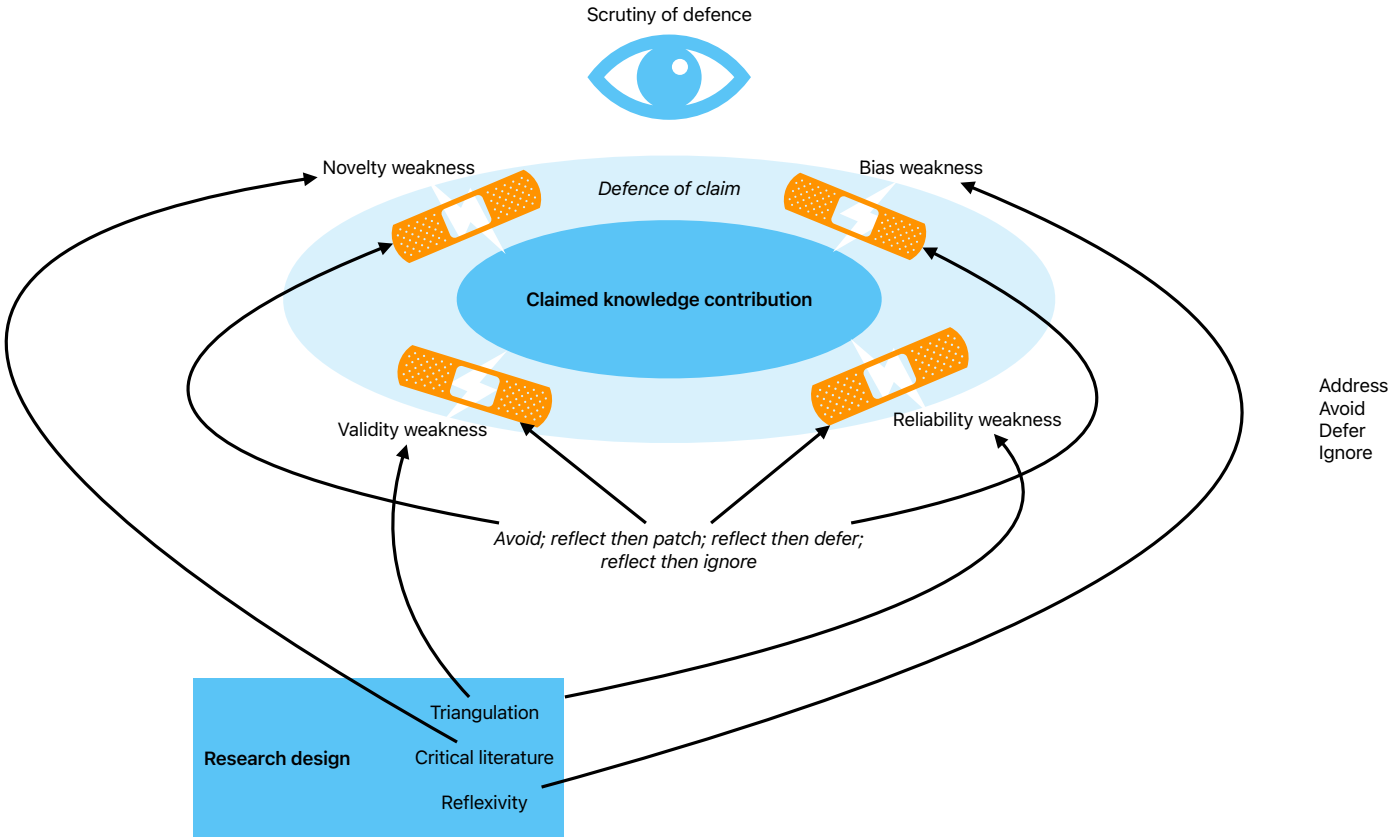

Figure 5.2: Research vulnerabilities

- 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 consider 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.

There are three* ways to dealing with each potential weakness:

- 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., being aware of the weakness during the research and putting 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 method.

- acknowledge and defer†, most usually at the end of the research period when the research is complete, i.e., write a reflection on 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 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 n the type of research you're doing. Their evaluation will be through the questions hey 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 (Miles 2019) with our commentary on specific points to the right, in the margin:

[*]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!

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

[‡]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...

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 element 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§.

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

†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.

5.5.2 Novelty weakness

To construct your research problem, you will have identified a hole in current knowledge you will have surveyed the literature and reflected critically on it. 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.

5.5.3 Validity weaknesses

There are a number of recognised validity weaknesses¶ upon which an evaluation of quantitative or qualitative research validity is made.

- Mismatch between quantitative and qualitative samples
- Imbalance between an insider's and outsider's views

¶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.

- 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
- 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.

5.5.4 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.

5.5.5 Bias

[Adapted from Simundic 2013]

"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. " Simundic 2013

Simundic (2013) 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 re- sources by re-running the same experiments.

5.5.5.1 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.

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

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: Do I need to know about interviews #4

Periods of critical review reflection.

5.5.5.2 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 Campbell and Fiske (1959).

†Adapted AI summary of Mathison (1988).

Triangulation is "the combination of methodologies in the study of the same phenomenon" Denzin 1978, adapted. Triangulation involves different types‡ such as *data triangulation*, *investigator triangulation*, and *methodological triangulation*. Triangulation:

‡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 (Denzin 1978). 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

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

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" Denzin 1978, p. 302. 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.

find ref

Activity: Deep dive into interviews #5

Read these sources on triangulation

5.5.5.3 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)." Usher 2023, adapted

Rewrite for our purposes

Activity: Do I need to know about Journalling #6

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: Deep dive into journalling #7

Take a look at Table 5.2 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: Do I need to know about Observations #8

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 5.2, 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.

5.6.1 Research strategy introduction

Below we detail 12 candidate research strategies.

Table 5.2: Research strategy choice

Research Strategy candidate	Considered	Excluded	Reason excluded
Survey	☐	☐	
Design and Creation	☐	☐	
Experiment	☐	☐	
Case study	☐	☐	
Action research	☐	☐	
Ethnography	☐	☐	
Systematic research	☐	☐	
Grounded theory	☐	☐	
Phenomenology	☐	☐	
Simulation	☐	☐	
Mathematical and logical proof	☐	☐	
Mixed methods	☐	☐	

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 5.2 – 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 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.

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

If you get to the "Evaluation" section, then you've got a candidate strategy. Read through the evaluation section*.

*Perhaps taking notes on things you haven't immediately understood.

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.

Activity: Do I need to know about questionnaires #9

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 (Secor 2010, p.196).

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.

*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.

5.6.2.3 Evaluation

The following questions are typically asked of the knowledge contribution made through survey research (Oates 2008, p.105 (adapted)):

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?

†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: Improving your questionnaire design #10

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:

> D.A. Dillman, J.D. Smyth, and L.M. Christian (2014). *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. URL: `https://books.google.co.uk/books?id=fhQNBAAAQBAJ`
>
> Sema A Kalaian and RM Kasim (2008). "Encyclopedia of survey research methods."

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 (Oates 2008, p.122, adapted):

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: Deep dive into questionnaires #11

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:

> Jan vom Brocke, Alan Hevner, and Alexander Maedche (Sept. 2020). "Introduction to Design Science Research". DOI: 10.1007/978-3-030-46781-4_1
>
> Briony J Oates (2008). *Researching Information Systems and Computing*

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." Wikipedia contributors 2024a

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 (Oates 2008, p.138, adapted)

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: Do I need to know about documents #12

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:

> Andy Field and Graham Hole (2002). *How to design and report experiments*. URL: `https://www.google.co.uk/books/edition/How_to_Design_and_Report_Experiments/LN6QAwAAQBAJ?hl=en&gbpv=1&dq=How+to+design+and+report+experiments&printsec=frontcover`

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 (Oates 2008, p.143, adapted);

- 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 aanlysed (Oates 2008, p.143, adapted);

- 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 (Oates 2008, p.143, adapted);

- 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:

Oates (2008, p.151, adapted)

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 uses? 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*.

*Even if that learning curve looks like El Capitan!

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.

Activity: Deep dive into documents #13

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:

Briony J Oates (2008). *Researching Information Systems and Computing*

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." Johannesson and Perjons 2014, 3.1.6, adapted

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." Oates 2008, p.168, adapted

5.6.6.2 Data Generation

???

5.6.6.3 Evaluation

An experienced researcher evaluating action research will ask the following questions:
(Oates 2008, p.169, adapted)

- 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 Oates (2008, p.168)

- 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 causeal-effect relationships If so, consider experimental strategy
- Do you need to be able got 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 envisage issues working with others in complex, problematic and unpredictable real-world situations? If so, consider ???

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

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:

> Paul Johannesson and Erik Perjons (2014). "Research strategies and methods". Ed. by Paul Johannesson and Erik Perjons
>
> Briony J Oates (2008). *Researching Information Systems and Computing*

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 (Oates 2008, p.182, adapted),

providing a rich, detailed picture of a particular situation or work practices, placing them in their real-world context (Oates 2008, p.181).

5.6.7.2 Data Generation

***

5.6.7.3 Evaluation

(Oates 2008, p.180, adapted)

- 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?

(Oates 2008, p.182, adapted) 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: Deep dive into focus groups #15

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:

> Paul Johannesson and Erik Perjons (2014). "Research strategies and methods". Ed. by Paul Johannesson and Erik Perjons
>
> Briony J Oates (2008). *Researching Information Systems and Computing*

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 (Wright et al. 2007, p.24).

5.6.8.2 Focus

See Moher et al. (2009) 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 (Pollock and Berge 2018).

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 (Pollock and Berge 2018, p.142)?
- 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 (Pollock and Berge 2018, p.142)?
- 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 sent 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 (Wright et al. 2007, p.27) 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: Do I need to know about field work #16

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:

> David Moher et al. (2009). "Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement"
>
> Alex Pollock and Eivind Berge (2018). "How to do a systematic review"
>
> Rick W Wright et al. (2007). "How to write a systematic review."

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." Drew 2023

"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." Johannesson and Perjons 2014, p. 3.1.5

"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." Drew 2023

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). (Patton 1990)" Strauss and Corbin 1998, p.13

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

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." Corbin and Strauss 1990

"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." Corbin and Strauss 1990

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: Deep dive into field work #17

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:

Kathy Charmaz (2014). *Constructing grounded theory*

J Corbin and Anselm Strauss (1990). "Grounded theory method: Procedures, canons, and evalu-

ative procedures"

Barry Gibson and Jan Hartman (2013). *Rediscovering grounded theory*

Keri Smith and Francis Biley (1997). "Understanding grounded theory: principles and evaluation."

Anselm Strauss and Juliet Corbin (1998). ***check reference****Basics of qualitative research: Techniques and procedures for developing grounded theory*

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." Johannesson and Perjons 2014, p. 3.1.7

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." Johannesson and Perjons 2014, p. 3.1.7

5.6.10.2 Data Generation

Data generation for the Phenomelogy 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." Johannesson and Perjons 2014, p. 3.1.7

"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." Office of Teaching and Learning Excellence 2020, 26m29s

5.6.10.3 Evaluation

(Office of Teaching and Learning Excellence 2020, 1h0m39s)

- 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 (Office of Teaching and Learning Excellence 2020, 29m *ff*)

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

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:

Academic Educational Materials (2019). *Understanding Phenomenology*. URL: https://www.youtube.com/watch?v=d5geMLe5tbM (visited on 11/21/2023)

Joan M. Anderson (1991). "Qualitative Nursing Research: A Contemporary Dialogue". Thousand Oaks; Thousand Oaks, California. DOI: 10.4135/9781483349015. URL: https://methods.sagepub.com/book/qualitative-nursing-research

Thomas Groenewald (2004). "A phenomenological research design illustrated"

Richard H. Hycner (1985). "Some Guidelines for the Phenomenological Analysis of Interview Data". DOI: 10.1007/bf00142995

Maurice Merleau-Ponty and John F Bannan (1956). "What is phenomenology?"

Office of Teaching and Learning Excellence (2020). *The Phenomenological Dissertation: Writing Chapters 1-5*. URL: https://www.youtube.com/watch?v=xDTQnBfAG-o (visited on 11/21/2023)

Nicholas Shudak (Feb. 2018). "Phenomenology". DOI: 10.4135/9781506326139.n515

David Woodruff Smith (2018). "Phenomenology". Ed. by Edward N. Zalta. https://plato.stanford.edu/archives/sum2018/entries/phenomenology/

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?'" Dooley 2017

5.6.11.2 Variants

The three main schools of simulation practice are (Dooley 2017):

- 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." Dooley 2017

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: Deep dive into computation thinking #19

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:

Kevin Dooley (2017). "Simulation research methods"

5.6.12 Mathematical and logical proof

"A proof is a rigorous deductive argument that demonstrates the truth of a certain proposition." Johannesson and Perjons 2014, p. 3.1.9

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 Lakatos (2015)* and consider my level of engagement with the process of proof.

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.

*Up to page 9 is available through google books

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

Activity: Do I need to know about mathematical thinking #20

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:

Samuele Antonini et al. (2011). *On examples in mathematical thinking and learning*

S. C. Kleene (1964). *Introduction to Metamathematics*

Imre Lakatos (2015). *Proofs and refutations: The logic of mathematical discovery*

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." Johnson, Onwuegbuzie, and Turner 2007

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)." Johnson, Onwuegbuzie, and Turner 2007, p.119, quoting *Huey Chen*

"[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." Johnson, Onwuegbuzie, and Turner 2007, p.119, quoting *Valerie Caracelli*

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" Denzin 1978, p.291: "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: Deep dive into mathematical thinking #21

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

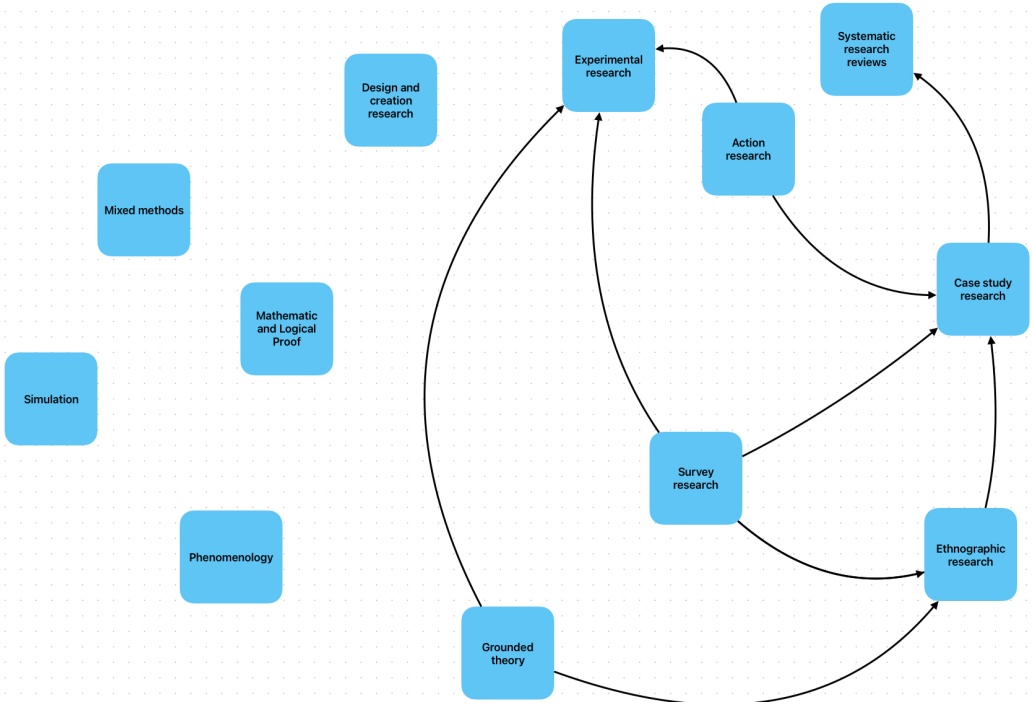

Figure 5.3: Research strategy choices

5.7.1 For your chosen research strategy

Activity: Do I need to know about statistical thinking #22

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.

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Antonini, Samuele et al. (2011). *On examples in mathematical thinking and learning* (cit. on p. 257).

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