What is Research?
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How to do Research
How to do Research: solve a problem, publish
Dissecting the Dimensions of Research:
topic, novelty, technology, scope, mode, methods, ideology, politics, utility
Reassembling the Dimensions: quantitative vs qualitative research

Dissecting the Dimensions of Research
My understanding of the various kinds of research advanced when I identified various dimensions (components) of research.
A former colleague regarded such analysis as a trivial pursuit.
If you find a better way to understand research, let me know.
Meanwhile consider these dimensions:
topic: physical–biological–psychological–sociological
novelty: create new vs review published data or info
technology: develop new vs use existing methods
scope: study a single case vs a sample
mode: observe vs intervene
methodology: qualitative vs quantitative (info vs numbers)
ideology: objective vs subjective (positivist vs interpretivist)
politics: neutral vs partisan
utility: pure vs applied
reassembling the dimensions

Topic: what are you researching?
biophysical clinical behavioral psychological economic social

Examples
Clinical: the effect of a herb on performance.
Psychological: factors affecting work-place satisfaction.
Behavioral: how can we reduce truancy at this school?
Economic: characterize the productivity of new immigrants.
Social: develop risk-management procedures at a gym.
Finding a good question/problem to address can be hard.
It helps to have a good supervisor, good colleagues, and/or knowledge or practical experience of and affinity for a topic.
You must read journal articles to find out what's already known.
Authors also often point out topics for future research.

Novelty: creating new or reviewing published info?
create review

Most research projects are so-called original investigations.
You obtain new data or information about a phenomenon.
You reach a conclusion and try to publish it.
Some research projects are reviews of the literature.
You use other researchers' published data or info about a phenomenon.
A quantitative statistical review is called a meta-analysis.
You should "earn your spurs" doing original research before taking on a stand-alone review.
But a write-up of an original investigation always has to include a short review of literature.

Technology: develop new or use existing method(s)?
develop new use existing

Sometimes a legitimate topic for study is methodological.
For example, development or novel investigation of…
a measuring device
a psychometric instrument (questionnaire or inventory)
a protocol for a physical performance test
a diagnostic test
a method of analysis.
You usually include or focus on a reliability and/or validity study of the measure provided by the method.
Validity = the relationship between observed and true values.
Reliability = reproducibility of observed values.
**Scope: case or sample?**

- **Are you solving a single case of something, or is it a sample that will allow you to generalize to a population?**
- **In a case study…**
  - You are interested in "what happened or will happen here".
  - Your finding applies only locally: to the case you studied.
  - The quest for an answer can be like that in a court case.
  - Qualitative methods are often required.
  - You reach an answer by applying logic (= common sense?) and skepticism to your knowledge and to the information you gather.
  - Be wary of conventional wisdom and your own prejudices.
  - It may be possible to estimate probabilities of benefit or truth of various answers.

- **In a study of a sample…**
  - You are interested in "what happens in general".
  - Rarely, "what" is simply descriptive: the frequency, mean value or other simple statistic of something in the sample.
  - Most often, the "what" is the value of an effect statistic: the relationship between the thing of interest (a dependent variable, such as health, performance…) and something else (a predictor variable, such as training, gender, diet…) in the sample.
  - Examples of effect statistics: difference or change in a mean value; ratio of frequencies (relative risk); correlation coefficient.
  - You control for other possible predictor variables either by holding them constant or measuring and including them in the analysis.
  - Example: the effect of physical activity on health, controlling for the effect of age on health.
  - In controlled trials (interventions), a control group accounts for any effect of time that would have happened anyway.

**More about studying a sample…**

- You study a sample, because it is impractical and wasteful (and therefore unethical) to study a population.
- "What happens in general" refers to the average person or situation in a population represented by your sample.
- "Population" is a defined group, not the entire human race or all possible situations.
- You make inferences about that population, that is, you generalize from the sample to the population.
- You can make inferences to other populations only if you can argue that those populations are similar to your sample with respect to the effect you have studied.

**Mode of Enquiry: observational or interventionist?**

- **In an observational study…**
  - The aim is to gather data or information about the world as it is.
  - So you hope the act of studying doesn’t substantially modify the thing you are interested in.
- **In an interventionist study…**
  - You do something to the world and see what happens.
  - You gather data or information almost always before and after the intervention, then look for changes.

**In a study of a sample…**

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**There are several ways to generalize from sample to population…**

- Old: develop a null hypothesis about a relationship, then test the hypothesis (that is, try to falsify it) using statistical significance based on something called the P value.
  - New: identify a relationship, measure its magnitude, state the uncertainty in the true value using confidence limits, then make a conclusion about its clinical or practical importance in the population.
- Sample size is a big issue.
  - The smaller the sample, the more the uncertainty.
  - A stronger relationship needs less certainty.
  - So a stronger relationship needs a smaller sample.
  - Unfortunately most relationships are weak or trivial, so you usually need large samples.

**The following comments refer to observational and interventionist studies with samples.**

- The estimate of the magnitude of a relationship is less likely to be biased (that is, not the same as in a population) if…
  - the sample is selected randomly from the population, and…
  - you have a high compliance (low proportion of dropouts).
- An observational study of a sample…
  - usually establishes only an association between variables rather than a causal relationship.
  - needs hundreds or even thousands of subjects for accurate estimation of trivial or small effects.
Types of observational study with a sample, weak to strong:

- Case series, e.g. 20 gold medallists.
- Cross-sectional (correlational), e.g. a sample of 1000 athletes.
- Case-control (retrospective), e.g. 200 Olympians and 800 non-Olympians.
- Cohort (prospective or longitudinal), e.g. measure characteristics of 1000 athletes then determine incidence of Olympic medals after 10 years.

In an intervention with a sample...

- You can establish causality: X really does affect Y.
- You may need only scores of subjects for accurate generalization about trivial or small effects.
- The outcome is the effect of a treatment on the average subject.
- Researchers usually neglect the important question of individual responses to the treatment.

Types of intervention with a sample, weak to strong:

- No control group (time series), e.g. measure performance in 10 athletes before and after a training intervention.
- Crossover, e.g. give 5 athletes a drug and another 5 athletes a placebo, measure performance; wait a while to wash out the treatments, then cross over the treatments and measure again.
  - Ethically good, because all subjects get all treatments.
  - But can't use if the effect of the treatment takes too long to wash out.
  - Each subject can receive more than two treatments.
- Controlled trial, e.g. measure performance of 20 athletes before and after a drug and another 20 before and after a placebo.
  - You need up to 4x as many subjects as in a crossover.

In interventions, bias is less likely if...

- Subjects are randomly assigned to treatments.
- Assignment is balanced in respect of any characteristics that might affect the outcome.
  - In other words, you want treatment groups to be similar.
- Subjects and researchers are blind to the identity of the active and control (placebo) treatments.
  - Single blind = subjects don't know which is which.
  - Double blind = the researchers administering the treatments and doing the measurements and analysis don't know either.

Methods: quantitative or qualitative?

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<th>quantitative</th>
<th>qualitative</th>
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With quantitative methods...

- You gather data with an instrument, such as a stopwatch, a blood test, a video analysis package, or a structured questionnaire.
- You derive measures or variables from the data, then investigate relationships among the variables.
  - Some people think you have to do it by testing hypotheses.
- Error of measurement is an important issue.
  - Almost all measures have noise or other errors.
  - Errors affect the relationship between measures.
  - You attend to errors via validity and reliability.
  - A pilot study to investigate error can be valuable.

With qualitative methods...

- You gather information or themes from texts, conversations or loosely structured interviews, then tell a coherent story.
  - Software such as NVivo can help.
- The open-ended nature of these methods allows for more flexibility and serendipity in identifying factors and practical strategies than the formal structured quantitative approach.
  - The direction of the research may change mid-stream.
- Formal procedures enhance trustworthiness of the information.
  - Triangulation—aim for congruence of info from various sources.
  - Member checking or respondent validation—the subjects check the researcher's analysis.
  - Peer debriefing—colleagues or experts check the analysis.
- Hybrid or mixed method: analyze a sample of cases qualitatively, then code information into values of variables to make inferences about a population quantitatively.

Ideology: objective or subjective?

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<th>objective</th>
<th>subjective</th>
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<td>positivist</td>
<td>post-structuralist</td>
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- Others refer to this dimension as paradigmatic or philosophical.
  - A paradigm sometimes has religious status for its adherents: thou shalt not question it!
- Positivist or objective
  - We make and share observations, identify problems and solve them without disagreement about the nature of meaning or reality.
  - This so-called dominant paradigm is responsible for our current understanding of life, the Universe, and almost everything.
• Post-structuralist
  • The researcher views people as subjects of discourses (interrelated systems of unstable social meanings).
  • Although the subjectivity of research is emphasized, the researchers attempt to achieve objectivity. Do they succeed?
  • Many people find post-structuralist papers hard to understand.
    • Alan Sokal, a physicist, wrote a nonsensical paper—Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity—and got it accepted by the journal Social Text.

• Interpretivist
  • Part of the truth of a situation can be found in the researcher's interpretation of the self-understandings of participants.
  • Truth is discovered partly by thought as well as by observation.
  • Grounded theory of social science is interpretivist: truth emerges from your observations; you do not test a hypothesis.

Utility: pure or applied?

pure --------------------------------- applied

• In pure, basic, theoretical or academic projects, the aim is to understand the cause or mechanism of a phenomenon.
• Applied or practical projects impact directly on health, wealth, or culture (art, recreation…), or on development of a method.
• Even so, try to include mechanisms in an applied project.
  • It will help you publish in a high-impact journal, because their editors and reviewers can be snooty about pure research.
  • Understanding something may give you ideas for more projects.
  • A mechanism variable in an unblinded intervention can help exclude the possibility of a placebo effect.
• Pure is sometimes lab-based, lacking naturalness.
• Applied is sometimes field-based, lacking control.

Politics: neutral or partisan?

neutral --------------------------------- partisan

• Most researchers aim to be politically neutral or impartial by presenting all sides of an argument.
• Sometimes the researcher is overtly partisan or adversarial.
  • In social science such research is known as critical or radical.
    • The researcher attempts to raise understanding about oppression and to facilitate collective action against it.
    • Some commentators regard critical research as a specific paradigm in social science, but...
  • In my experience even biomedical researchers sometimes adopt an overtly partisan or adversarial stance on an issue.
  • Or there are often hidden agendas and biased reporting.
  • Maybe that’s OK, because their stance stimulates debate.

Resassembling the Dimensions

• A given research project is a point in multidimensional space.
• Some regions of this space are popular:
  • biophysical --------------------------------- topic quantitative
  • sample -------------------------------------- scope method
  • interventionist ---------------------- qualitative
  • objective ----------------------- methodology subjective
  • neutral ---------------------- politics partisan

These often go together as: quantitative research. qualitative research.
This pigeonholing doesn’t apply to the novelty, technology and utility dimensions.

• Some regions are less popular, but worth visiting. For example:
  • Action research is a subjective intervention with a case or sample.
    • Dealing with the problems of everyday life is an informal kind of action research.
  • Some researchers identify the extreme subjects in a quantitative survey, then interview them subjectively/qualitatively as cases.
  • Others do a qualitative pilot study of a few cases to identify a problem and the appropriate measures for a larger quantitative study of a sample.
  • A project based in an unusual region may give new insights...
    • But you may struggle to publish in journals devoted to more popular regions.
  • Researchers who mix qualitative methods (such as intensive interviews) with studying a sample (for generalizing to a population) can run into a sample-size problem, as follows...

• Qualitative methods applied to a sample often result in a small sample size because...
  • subjects are hard to get, or...
  • the interviews are too time consuming, or...
  • the researchers dislike the idea of large samples.
• But a study with a small sample can adequately characterize only strong associations (large effects) in a population.
• So these small-scale qualitative studies are not definitive for a small or trivial effect.
• Furthermore, open-ended inquiry is equivalent to assaying many variables, so there is a high risk of finding a spurious association.
• If the sample is small, the spurious association will be strong.
• Therefore small-scale qualitative studies are not definitive even for a moderate or large effect.
• Bottom line: when using qualitative methods to generalize to a population, you need a large sample to characterize small effects.
In Conclusion...

- A given research project can be characterized by topic, novelty, technology, scope, mode, methods, ideology, politics and utility.
- This dimensional view may help you sort out a good approach to a specific project, but...
  - I may have missed or mangled some dimensions.
  - There may be better ways to understand research.
- Your work needs to be credible to some people and preferably also published if it’s to have any impact.

This presentation is updated from a paper at:

SPORTSCIENCE  sportsci.org
A Peer-Reviewed Site for Sport Research