Scientific Research in Information Systems: A Beginner's Guide (2nd edition)

Teaching Materials

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Overview

Content
Part 1: Basic Principles of Research
Part 2: Conducting Research
Part 3: Publishing Research

Chapter 3:
Planning your Research

What have we covered last time?

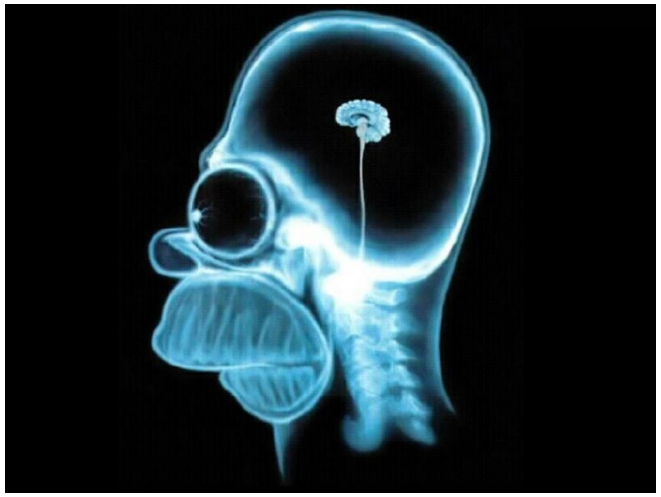
- What are general principles of science?
  - Independence
  - Replicability
  - Precision
  - Falsification

- How do we construct research questions worth pursuing?
  - Motivation, Specification, Justification
  - Type-1 and type-2 questions
  - Gap-spotting and problematization

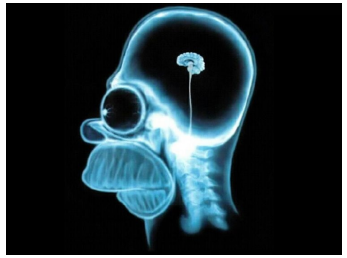
What do we cover today?

- Research Design
  - Induction, Deduction, Abduction
  - Exploration, Rationalization, Validation
  - Research Design Choices
  - Research Methodology
  - The Role of Literature in Research Design

Research Design – WarmUp Example



A Simple Example – or not?



How do we define smart?
How do we define job satisfaction?
What do we measure?
Where/how do we measure?
How do we plan to collect and analyse any data?

Research Design - Overview

- Once your research question is well specified, the next challenge is to craft a plan of action to answer the question and test your theory about its answer.
- That is what we call a **research design**.
- A **research design** is the blueprint for the collection, measurement, and analysis of data.
  - Typically requires a combination of reasoning skills such as *induction*, *deduction*, and *abduction*.
  - Typically also involves different research strategies such as **exploration**, **rationalization**, and **validation**.

Induction vs Deduction (vs Abduction)

- **Induction**
  - A form of logical reasoning that involves inferring a general conclusion from a set of specific facts or observations.
  - allows tentative hypotheses and propositions to be formulated that declare general conclusions or theories. used to infer theoretical concepts and patterns from observed data or known facts to generate new knowledge by proceeding from particulars to generals.
  - Example:
    - Every life form we know of depends on liquid water to exist.
    - Therefore: All life, including that we don't know of, depends on liquid water to exist.
  - Problems:
    - Inductive arguments cannot be proven or justified, only supported or not supported.
    - Inductive arguments can be weak or strong. The induction "I always hang pictures on nails. Therefore: All pictures hang from nails" is an example of a weak induction because the observation is too limited to lead to such a broad generalisation.
  - Verdict:
    - an accepted and often useful pathway for constructing explanations or hypotheses because conclusions are offered based on educated predictions: "I studied phenomenon X in Y number of cases and I have always found the particular relationship or phenomena Z to be at work. Hence, the evidence collected in my observation leads me to formulate the tentative proposition that Z is related to X in this or that way."

Induction vs Deduction (vs Abduction)

- **Deduction**
  - a form of logical reasoning that involves deriving arguments as logical consequences of a set of more general premises. It involves deducing a conclusion from a general premise (i.e., a known theory), to a specific instance (i.e., an observation).
  - commonly used to predict the results of hypotheses or propositions, an approach to science called the hypothetico-deductive model: a hypothesis is treated as a premise, and from it some not obvious conclusions are logically derived, tested, and revised if necessary.
  - an attempt to test concepts and patterns known from theory using new empirical data
  - Example:
    - All men are mortal.
    - Socrates is a man.
    - Therefore, Socrates is mortal.
  - Problems:
    - Deductive soundness and validity: we can deduce logically sound but if the premise is incorrect, the deduction becomes invalid: “Only quarterbacks eat steak. John eats steak. Therefore, John is a quarterback.”
  - Verdict:
    - Induction and deduction both play an important role in many scientific processes, from setting up a plan to collect data to the intellectual challenges of developing new theory. However, neither is sufficient or complete.

Induction vs Deduction (vs Abduction)

- Abduction
  - the process of making sense of an observation by drawing inferences about the best possible explanation.
  - not a process of inference or deduction but a trial-and-error search for a satisfactory explanation for an observed consequence after the fact.
  - also called a form of educated or informed guessing.
  - involves a creative process rather than a logical process
  - Verdict:
    - Abduction is an operation geared toward the discovery of entirely new ideas (e.g., a new theory) rather than a mode of justification (through deduction) or formal inference (through induction).

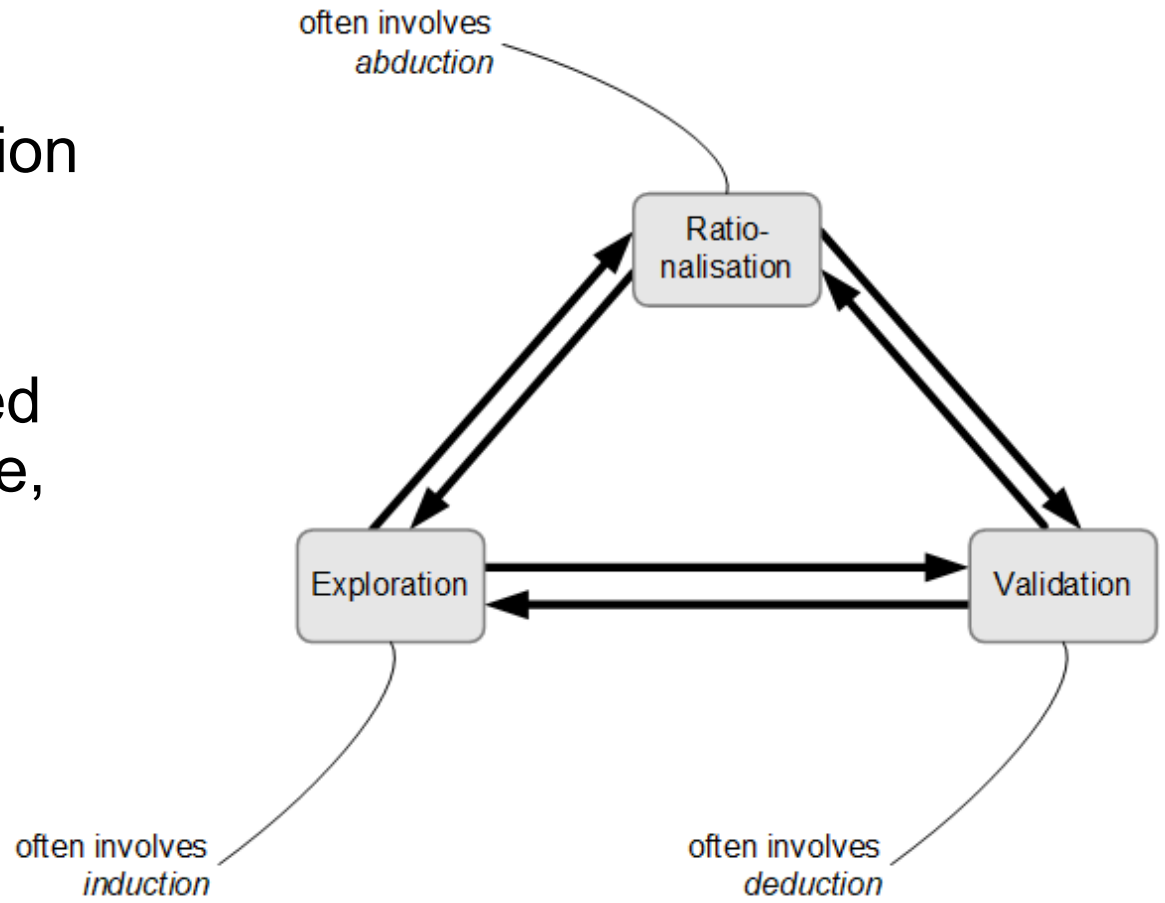
Induction vs Deduction vs Abduction

Form of reasoning	Example
Induction	Observation: These beans are from this bag. Reasoning: These beans are white. Conclusion: All the beans from this bag are white.
Deduction	Premise: All the beans in this bag are white. Observation: These beans are from this bag. Conclusion: These beans are white.
Abduction	Rule: All the beans from this bag are white. Observation: These beans are white and near the bag. Conclusion: These beans are probably from this bag.

Why these distinctions matter.

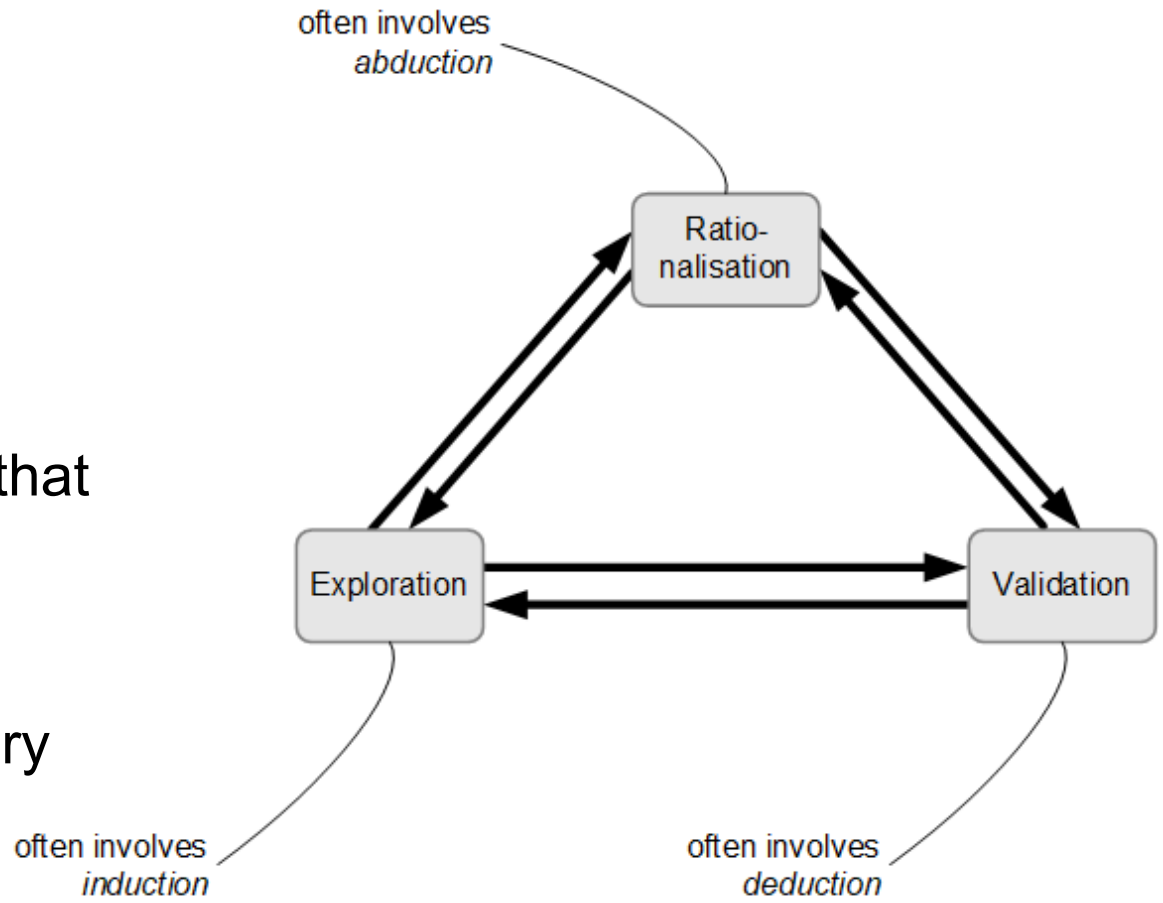
- Good research involves strategies for exploration, rationalization, and validation

- Different research methods can be used as a tool to support inductive, deductive, or abductive reasoning.



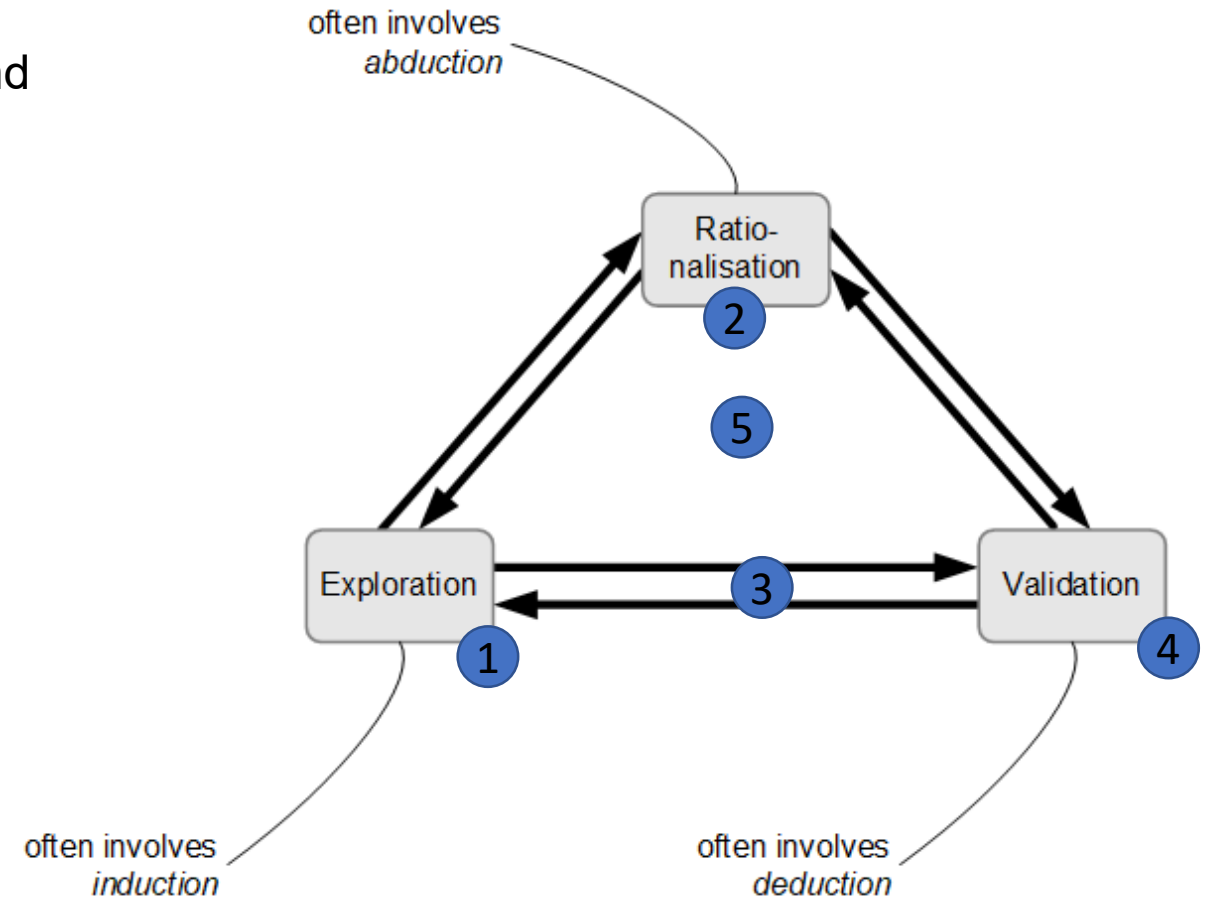
Why these distinctions matter.

- **Exploration**
  - The systematic discovery of things or phenomena encountered in common experience.
- **Rationalisation**
  - Making sense of the puzzle or problem that interests us.
- **Validation**
  - Subjecting an emergent or existing theory to rigorous examination and testing.



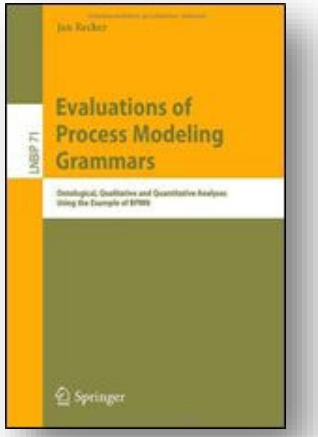
Research Design - Example

- The emphasis of any one study can be on either end (1,2,4) or in combination (e.g., 3). Often, only so-called research programs (combinations of multiple studies) can achieve all (5).
- The choice of emphasis is influenced by
  - Maturity of the field
  - Accepted methods
  - Availability of evidence
  - Research interests



Research Design - Example

- My PhD: A research program on ontological evaluation of process modelling grammars
- Research elements
  1. Recker, J. "Opportunities and Constraints: The Current Struggle with BPMN," Business Process Management Journal (16:1) 2010, pp 181-201.
  2. Recker, J., Rosemann, M., Indulska, M., and Green, P. "Business Process Modeling: A Comparative Analysis," Journal of the Association for Information Systems (10:4) 2009, pp 333-363.
  3. Recker, J., Indulska, M., Rosemann, M., and Green, P. "The Ontological Deficiencies of Process Modeling in Practice," European Journal of Information Systems (19:5) 2010, pp 501-525.
  4. Recker, J., Rosemann, M., Green, P., and Indulska, M. "Do Ontological Deficiencies in Modeling Grammars Matter?," MIS Quarterly (35:1) 2011, pp 57-79.
  5. Recker, J. Evaluations of Process Modeling Grammars: Ontological, Qualitative and Quantitative Analyses Using the Example of BPMN Springer, Berlin, Germany, 2011.



Choosing a Research Design

How do we choose?

Spectrum	One end of Continuum		Other End of Continuum
Aim	Exploratory	vs.	Explanatory
Method	Qualitative	vs.	Quantitative
Boundary	Case	vs.	Statistical
Setting	Field	vs.	Laboratory
Timing	Cross-sectional	vs.	Longitudinal
Outcome	Descriptive	vs.	Causal
Ambition	Analysing	vs.	Designing

The key benchmark against which your research design must be aligned is the problem statement as specified in the research question(s), so the research design must match logically the research question, not the other way around. It dictates, for example, whether a more qualitative, explorative inquiry is warranted or a more quantitative, statistical one.

Research Design Considerations

- Data:
  - What type of data is required? What type of data might be available?
  - Where can I collect observations or other forms of evidence?
  - How will I sample the relevant data?

Research Design Considerations

- Risks:
  - What are the potential dangers associated with execution of the research design? For example, what is the likelihood of a case organisation not being available for study anymore? What are strategies available to minimise or mitigate these risks?

Research Design Considerations

- Theory:
  - How much literature concerning the phenomena of interest is available?
  - What are problems with the knowledge base? What findings have been produced to date that might have an impact on my work and influence choices in my research design?

Research Design Considerations

- Feasibility:
  - Can the research design be executed within the constraints associated with a study (e.g., the PhD program) such as time limitations, resource limitations, funding, experience, geographic boundaries, and others?
  - Is guidance available to me to support me in the study?

Research Design Considerations

- Instrumentation:
  - How will my constructs of interest manifest in reality? How can they be measured?
  - Will my construct operationalisation be appropriate given the choice of research methodology and set of data available?

Research Methodology

- Describes the strategy of inquiry used to answer the research question(s).
- Probably the most critical choice to be made in research design.
- Specifies the procedures carried out in a research study.
- Main Strategies of Inquiry:
  1. Quantitative methods
  2. Qualitative methods
  3. Design science methods
  4. Computational methods
  5. Mixed methods

1. Quantitative Methods

- Procedures that feature research methods such as experiments or surveys and which are characterized by an emphasis on quantitative data (think of these procedures as having a focus on “numbers”).
- approach phenomena through quantifiable evidence, and often rely on statistical analysis of many cases (or across intentionally designed treatments in an experiment) to create valid and reliable general claims.

Quantitative Methods - Overview

- A set of methods and techniques to answer questions (e.g. about the interaction of humans and information technologies), with an emphasis on quantitative data
- Quantitative data means that data is collected about quantities of something, and where numbers represent values and levels of constructs and concepts
- We interpret such numbers as evidence of how a particular phenomenon works.

Quantitative Methods - Overview

- Because of the focus of numbers, there is typically an association with statistics (the study of the collection, organization, analysis, and interpretation of data).

- Ontologically, quantitative research is based on the idea that theories can be proposed that can be falsified by comparing theory to carefully collected empirical data.
- Example: Einstein's theory of relativity really became trusted when in 1919, Eddington's eclipse observation showed that Einstein's predictions were correct and Newton's predictions incorrect.

Popular Quantitative Research Methods

- Field experiment
- Lab experiment
- Simulation
- Survey

Quantitative Methods - Exercise

- We want to find out whether the blockage of Online Games on work computers has a noticeable positive effect on work performance.

- Key questions:
  - What are the constructs?
  - What are appropriate measures?
  - How do we design the study?
  - How can we demonstrate
    - Reliability?
    - Validity??
    - Causality???

2. Qualitative Methods

- Procedures that feature research methods such as case study, ethnography or phenomenology and which are characterized by an emphasis on qualitative data (think of these procedures as having a focus on “words”).
- emphasize understanding of phenomena through direct observation, communication with participants, or analysis of texts, and may stress contextual subjective accuracy over generality.

Qualitative Methods - Overview

- are strategies of empirical inquiry that investigate **phenomena within a real-life context**.
- are helpful especially when the **boundaries between phenomena and context** are not apparent, or when you want to study a particular phenomenon in depth.
- are well suited for **exploratory research** where a phenomenon is not yet fully understood, not well researched, or still emerging.
- are also ideal for studying **social, cultural, or political aspects** of a phenomenon.
- stresses on the “**why**" and “**how**" of things rather than the “what," “where" and “when" of things. It involves detailed study of a small sample or group.

Examples

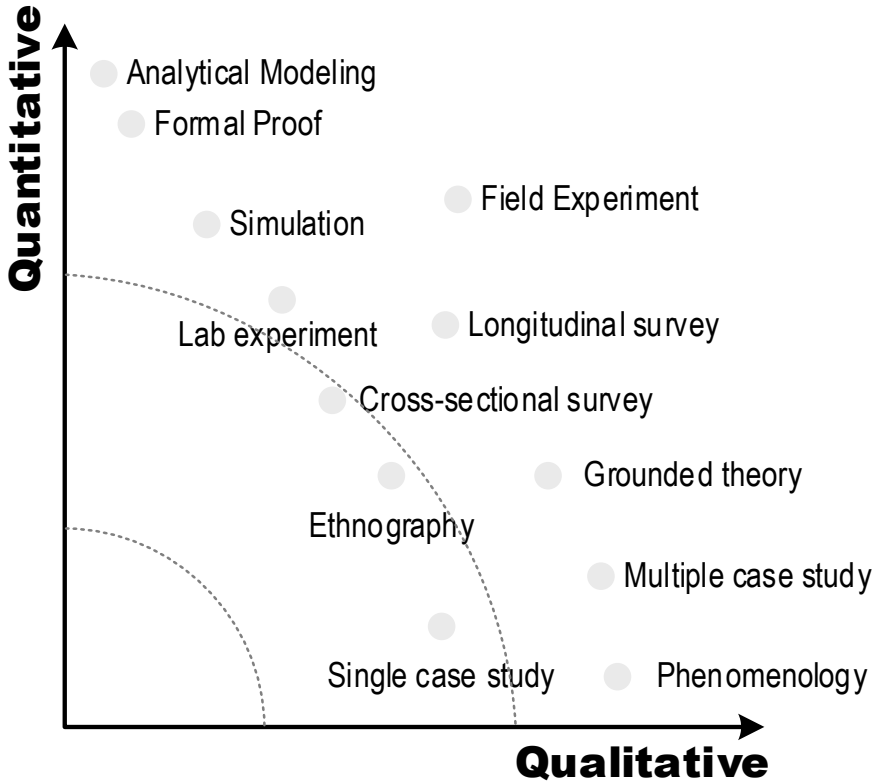
- Alan Peshkin's 1986 book God's Choice: The Total World of a Fundamentalist Christian School published by the University of Chicago Press
  - Peshkin studies the culture of Bethany Baptist Academy by interviewing the students, parents, teachers, and members of the community, and spending eighteen months observing, to provide a comprehensive and in depth analysis of Christian schooling as an alternative to public education.
  - Paskin's work represents qualitative research as it is an in-depth study using tools such as observations and unstructured interviews, without any assumptions or hypothesis, and aimed at securing descriptive or non-quantifiable data on Bethany Baptist Academy specifically, without attempting to generalize the findings to other schools.

- Victor of Aveyron (https://en.wikipedia.org/wiki/Victor_of_Aveyron)
  - broke new ground in the education of the developmentally delayed.

Quantitative “vs” Qualitative Research

	Quantitative	Qualitative
Purpose	to explain & predict; to test, confirm and validate theory	to describe & explain; to explore and interpret; to generate theory
Research Process	focused; deals with known variables; uses established guidelines; static designs; context free; objective	holistic approach; unknown variables; flexible guidelines; 'emergent' design; context bound; subjective
Form of Reasoning	deductive - from general case (theory) to specific situations	inductive - from specific situation to general case
Nature of Findings	numerical data; statistics; formal and 'scientific'	narrative description; words and quotes; personal voice; literary style
Researcher Beliefs	there is at least some objective reality that can be measured	there are multiple, constructed realities that defy easy measurement or categorization
Research Literature	relatively large	relatively limited
Research Question	confirmatory or predictive	exploratory or interpretive
Research Skills	statistics and deductive reasoning, and able to write in a technical and scientific style	inductive reasoning, attentiveness to detail, and able to write in a more literary, narrative style

Qualitative “vs” Quantitative research is not a dichotomy

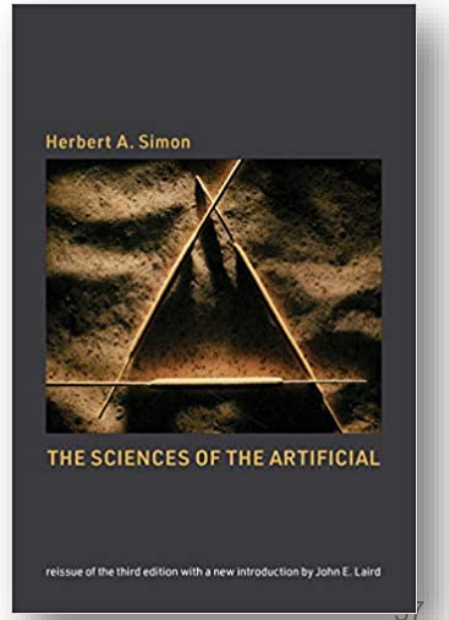


3. Design Science Methods

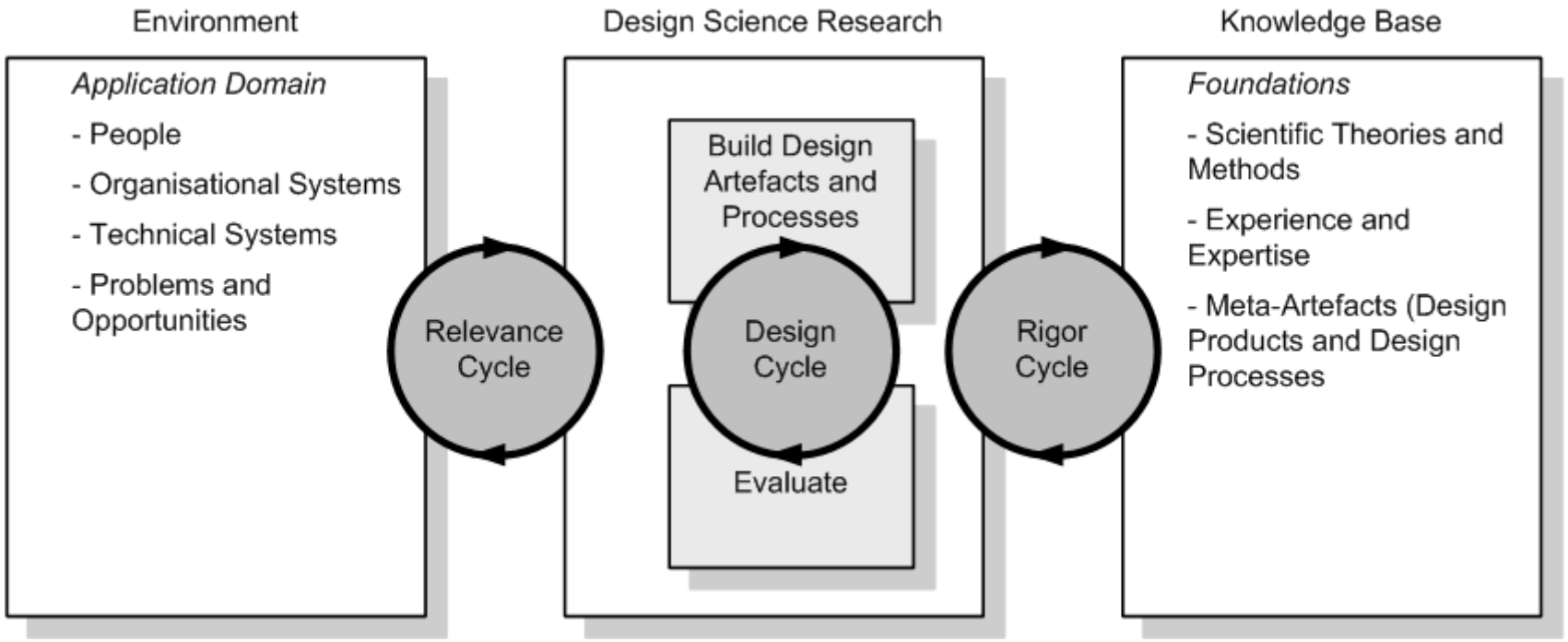
- Procedures that feature methods to build and evaluate novel and innovative artefacts (such as new models, methods or systems) as outcomes and which are characterized by an emphasis on the construction of the artefact and the demonstration of its utility (think of these procedures as having a focus on “artefacts”).
- a research paradigm in which a designer answers questions relevant to human problems via the **creation of innovative artefacts**, thereby contributing new knowledge to the body of scientific evidence. The designed artefacts are both **useful and fundamental** in understanding that problem.

The Artifact as Knowledge

- Human-created, artificial objects.
- In design science, the research interest is on creating or changing such artefacts with the aim of improving on existing solutions to problems or perhaps providing a first solution to a problem.
- Different types of artefacts exist
  - Constructs (vocabulary and symbols)
  - Models (abstractions and representations)
  - Methods (algorithms and practices)
  - Instantiations (implemented and prototype systems)
  - Design theories (improved models of design or design processes)



Design Science Methods - Overview



Hevner, A.R. "A Three Cycle View of Design Science Research", *Scandinavian Journal of Information Systems (19:2) 2007, pp. 87-92.*

4. Computational Methods

- Procedures that involve the use of digital software tools for research processes such as
  - data generation or discovery,
  - data processing or cleansing, and
  - data analysis or interpretation.

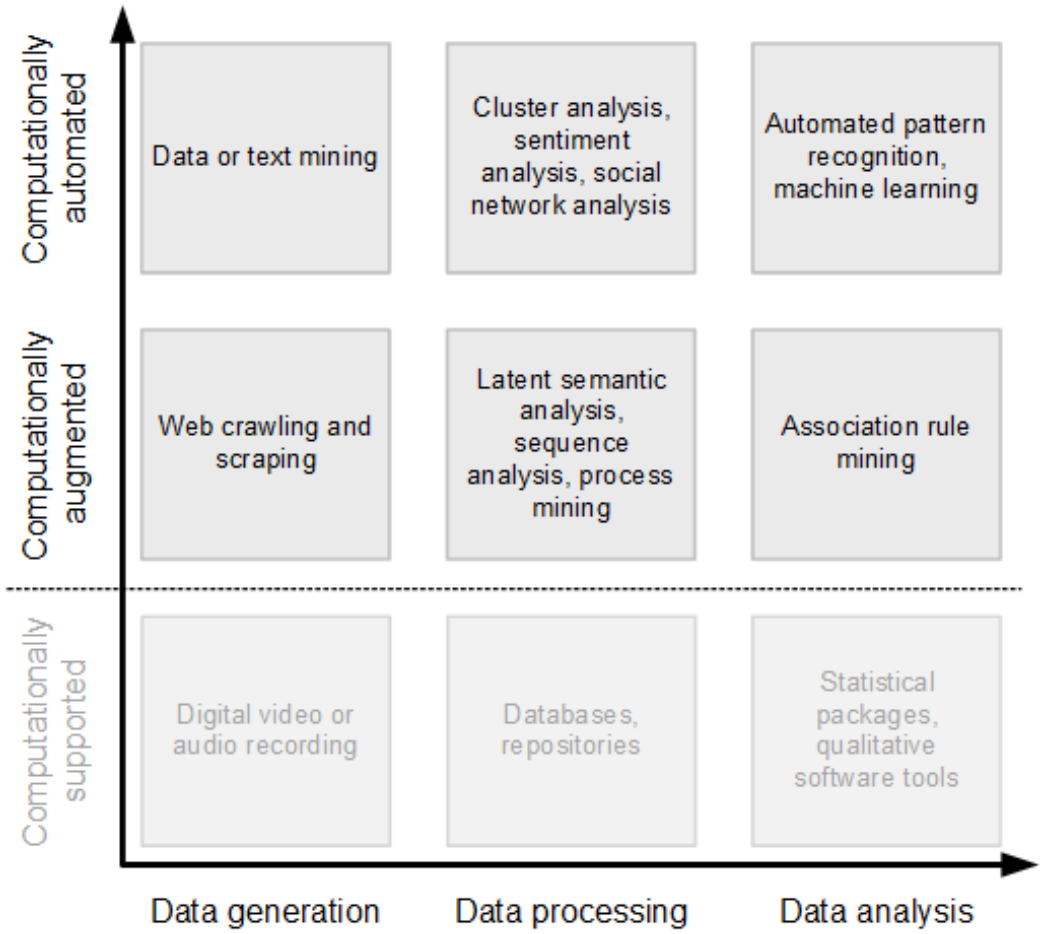
- **Rely on algorithms** to support, augment, or automate manual research activities carried out on basis of **digital trace data**.

Digital trace data

- Evidence of activities and events that are logged and stored digitally.
- Example:
  - Pentland et al. (2021) studied digital trace data in the form of the electronic medical records data of more than 57,000 patient visits to four dermatology clinics. They noticed in the data several sudden changes in record-keeping that occurred simultaneously in all four clinics. When they asked the clinical staffs to explain what had happened, they were unaware that anything had changed at all. Through the analysis of the digital trace data, Pentland et al. identified a change in policy and the advent of flu season as the two main drivers for the record-keeping process having changed.

Pentland, B. T., Vaast, E., & Ryan Wolf, J. (2021). Theorizing Process Dynamics with Directed Graphs: A Diachronic Analysis of Digital Trace Data. *MIS Quarterly, 45(2), 967-984.*

Computational research tools



Computational research tools

- **Augmentation tools**: complement and amplify, rather than supplant, human activity.
- *Examples*: Latent semantic analysis, web crawlers

- **Automation tools**: carry out algorithmic data generation, processing, or analysis with little to no human intervention or oversight.
- *Examples*: Text mining, social network analysis, sentiment analysis, pattern recognition

5. Mixed Methods

- Procedures that feature combinations of different methods in either sequential or concurrent fashion.
- Usually involve mixing of quantitative and qualitative strategies (think of these procedures as having a focus on “numbers and words”).
- More recently, also involves the mixing of design and qualitative/quantitative methods, or the mixing of different computational methods.

Purposes of Mixed Methods Research

- **Triangulation**: establish convergence of and corroborate results from multiple methods and designs used to study the same phenomenon.
- **Complemetarity**: elaboration, enhancement, illustration, and clarification of the results from one method with results from another method.
- **Initiation**: finds paradoxes and contradictions in the study from one method that lead to a re-framing of the research questions using another method.
- **Development**: using the finding from one study to inform the other method.
- **Expansion**: widen the breadth and range of research by using different methods for different components of an inquiry.

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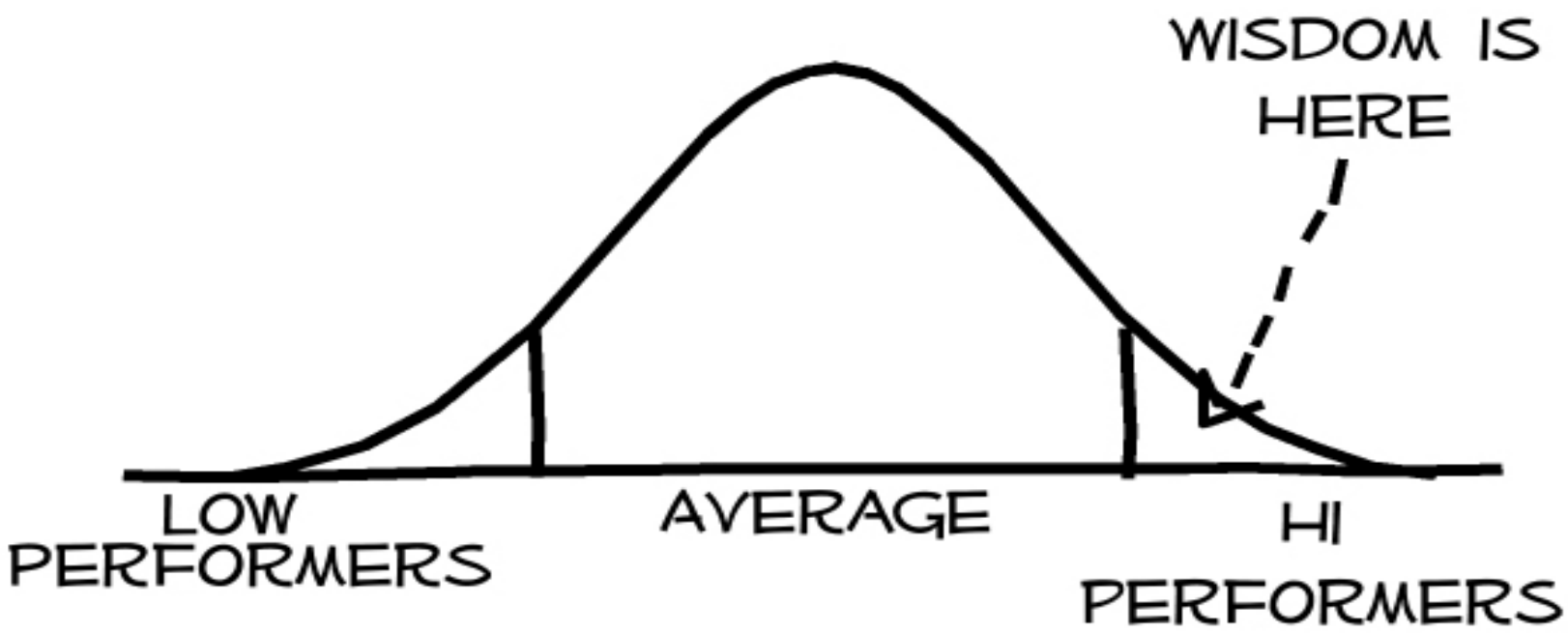
Venkatesh, V., Brown, S.A., and Bala, H. "Bridging the Qualitative-Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems," *MIS Quarterly (37:1) 2013, pp 21-54.*

Example: Research on Positive Deviance



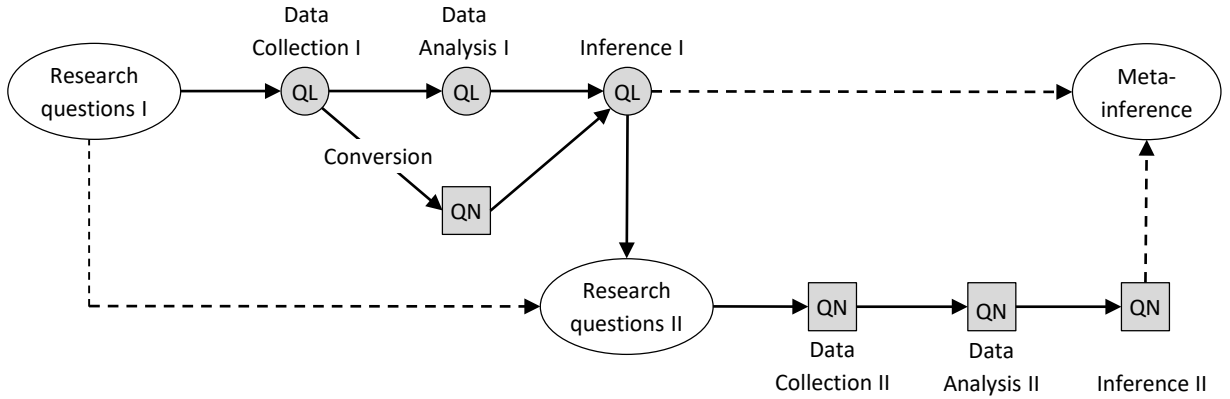
The origin of Positive Deviance: Stew!

- Sociology and nutrition research in the 1960s found
  - In any poor community, usually a few families, *the Positive Deviants*, manage to stay healthy, or raise healthy kids, despite their poverty.
  - Examining their practices revealed a number of violations of “norms”.
    - E.g., washing their hands more often, cooking food differently, consuming crops considered taboo
  - Widespread adoption of these practices can result in large scale community change.

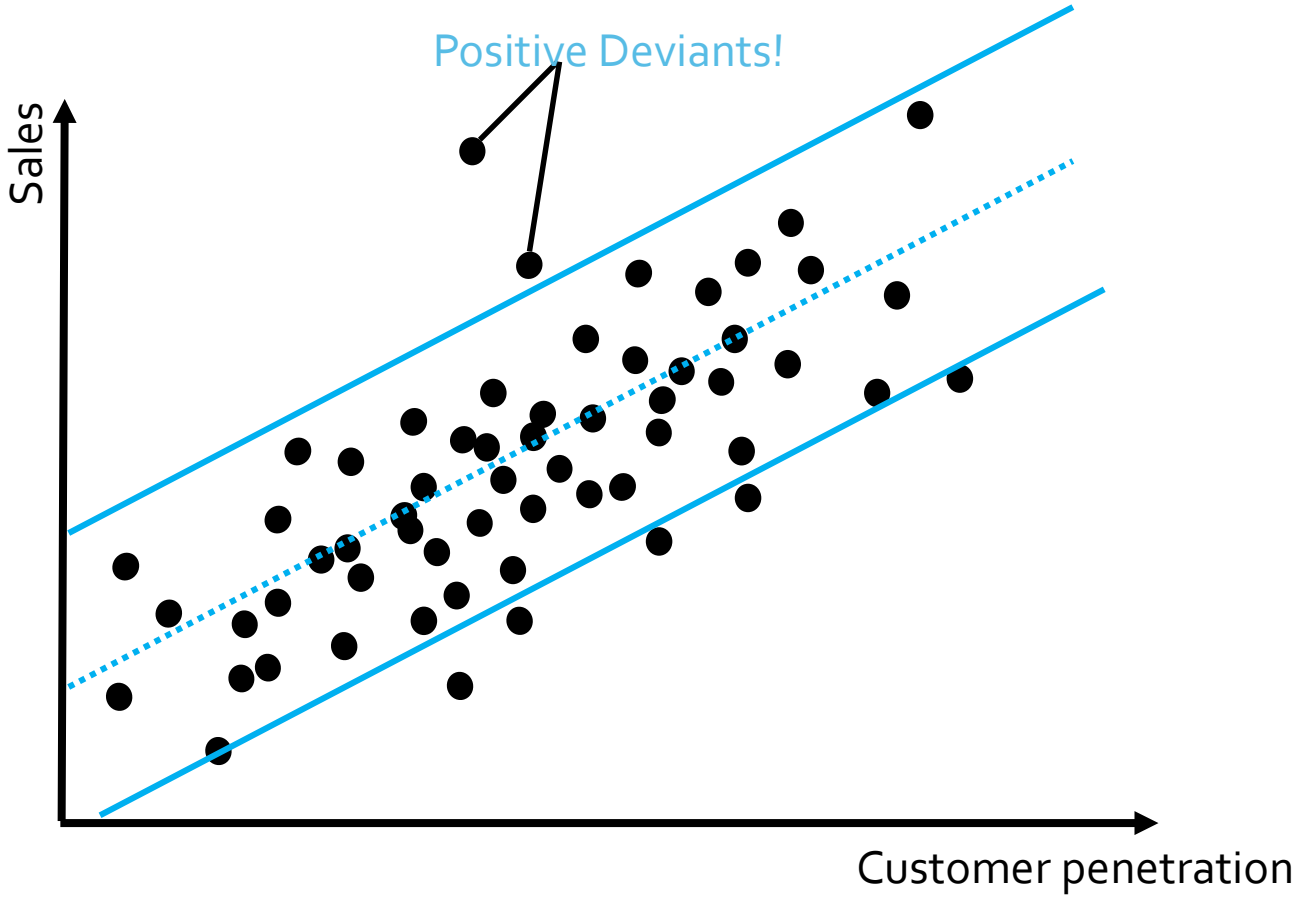
Research Setting

Mixed Method Design

- Study of Positive Deviance, Management and Leadership
- Involved qualitative exploration of 19 stores across Australia
- Measurement development and theorizing through engagement with literature
- Cross-sectional multi-level survey (managers and dept. managers)



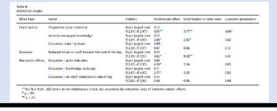
Sampling



Qualitative Conduct

Vignettes

Mixed Method Findings



Mertens, W., Recker, J., Kummer, T.-F., Kohlborn, T., Viaene, S. (2016): Constructive Deviance as a Driver for Performance in Retail. Journal of Retailing and Consumer Services, Vol. 30, pp. 193-203.

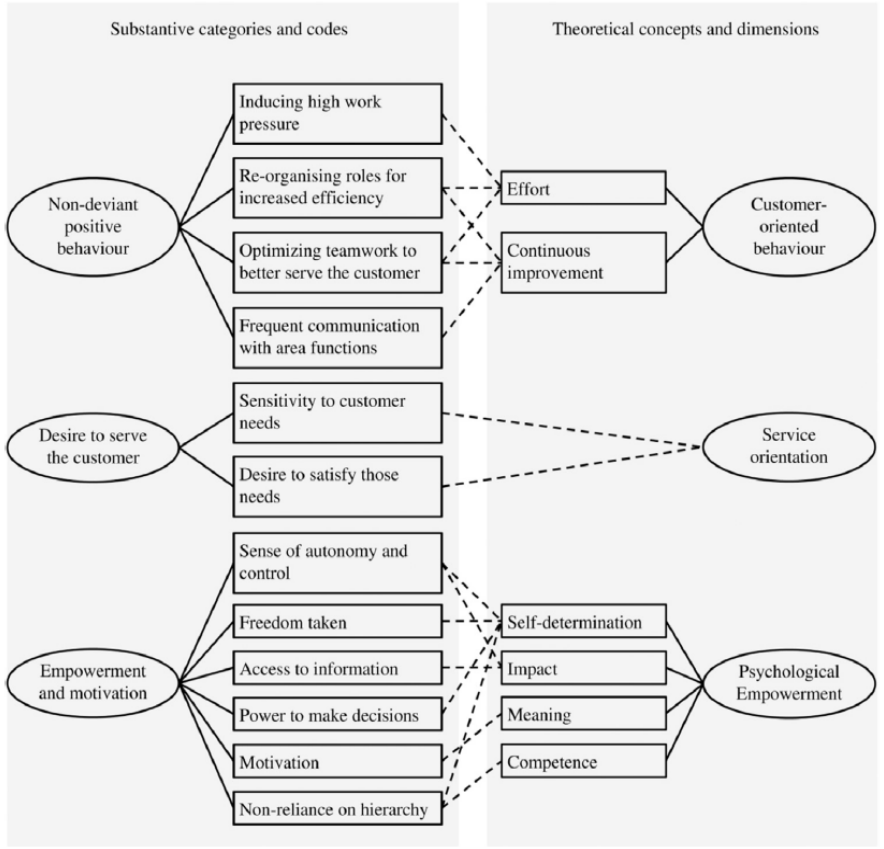
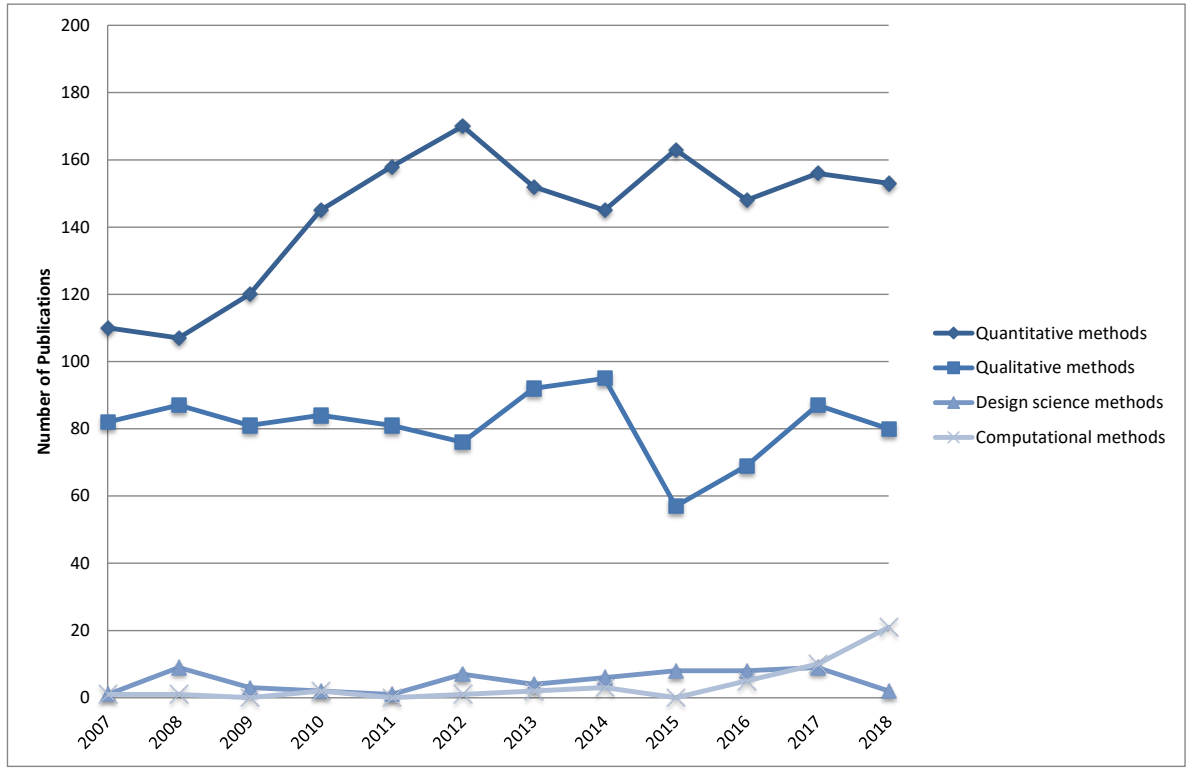


Fig. 2. Mapping of substantive categories and open codes to the dimensions of the identified theoretical constructs derived from the literature.

Choosing between the different methodological options

Research Methods in Use in IS Research



Mazaheri, E., Lagzian, M., & Hemmat, Z. (2020). Research Directions in Information Systems Field, Current Status and Future Trends: A Literature Analysis of AIS Basket of Top Journals. *Australasian Journal of Information Systems, 24.* https://doi.org/10.3127/ajis.v24i0.2045.

Research Strategy Differences

Requirement	Qualitative	Quantitative	Design Science
Controllability	Low	Medium to high	High
Deductibility	Low	Medium to high	Very low
Repeatability	Low	Medium to high	High
Generalizability	Low	Medium to high	Low to very low
Explorability	High	Medium to low	Medium to low
Complexity	High	Medium to low	Medium to high

The role of literature in choosing a research design

- Three types of knowledge are relevant to doing research:
  1. Knowledge about the domain and topic of interest that relate to your chosen phenomena
  2. Knowledge about relevant theories and available evidence that help you frame questions and phenomena, and
  3. Knowledge about relevant research methods that you can apply to develop new knowledge, build innovative artefacts, or articulate new questions

Knowing this literature already during the planning of your research is essential.

- The literature informs the extent, type, and nature of potential research problems.
- The literature informs where gaps of knowledge are about a particular phenomenon or question and where other problems with the extant knowledge are (e.g., inconsistency, false assumptions, inconclusiveness).
- The literature informs the extent to which current theories can explain the particularities of a phenomenon or problem and where they fail to do so adequately.
- The literature contains strategies and methodologies that have been used to research the same phenomena or problem and similar phenomena or problems.
- The literature contains theories that can be used to frame an investigation.
- The literature contains the current body of knowledge about research methodologies that are available.

Examples: Theory and Method Knowledge in IS research

- A Wiki on Theories used in IS research
  - https://is.theorizeit.org/wiki/Main_Page
- Online resources for different methods:
  - Qualitative: https://www.qual.auckland.ac.nz/
  - Quantitative: http://www.janrecker.com/quantitative-research-in-information-systems/
  - Design Science: http://desrist.org/design-research-in-information-systems/

End of Chapter 3