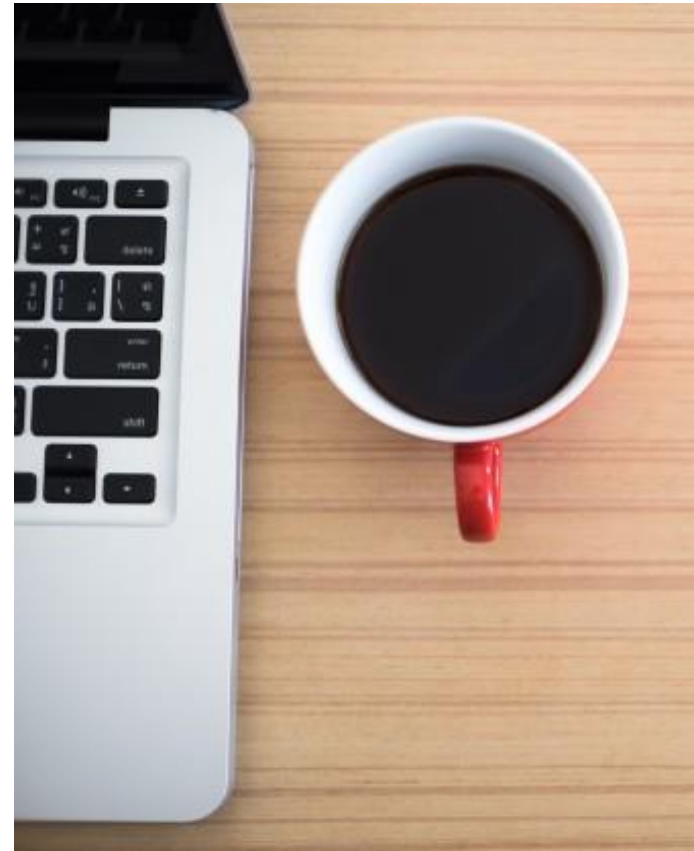
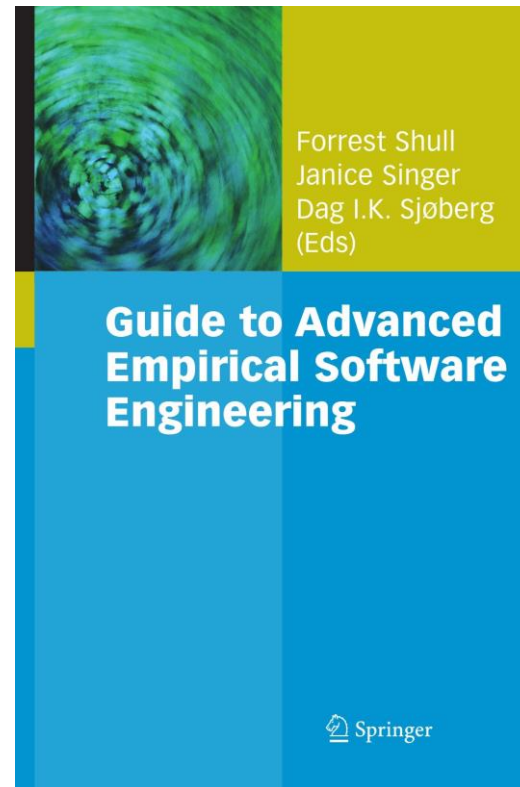


Lecture Objectives

- ✓ What is Research?
- ✓ Research Characteristics
- ✓ Research Process



Textbooks



What is Research?



- **Research** is a **systematic** process of *collecting*, *analyzing*, and *interpreting* information -*data*- in order to increase our understanding of a phenomenon about which we are interested or concerned.

What is Not Research?



- Research is not mere **information gathering**
- Research is not merely **searching** around for hard-to-locate information

Research Types

- **Basic research:** a research approach that is entirely *theoretical* and aimed at *improving or expanding the knowledge-base of a particular field of study*.
 - Search of new knowledge without any assumptions about what it might lead to.
 - May not lead to immediate use or application.
 - Examples: graph theory, algorithms or discrete mathematics

- **Applied research** is designed to focus on providing *practical solutions to a specific problem*. It is a form of investigation that entails solution-oriented inquiries into a phenomenon, a field of study or research subject generally employing *empirical methodologies*.
 - Developed with a specific objective in mind, particularly the conversion of existing knowledge into products, processes and technologies.
 - Immediate application
 - Example: Machine Learning for defect detection

Quantitative vs. Qualitative Research



- **Quantitative research** involves looking at amounts, or quantities, of one or more variables of interest.
- **Qualitative research** involves looking at characteristics, or qualities, that cannot be entirely reduced to numerical values.
- **Mixed-methods research** involves collecting quantitative and qualitative data in a single research project

Quantitative Research

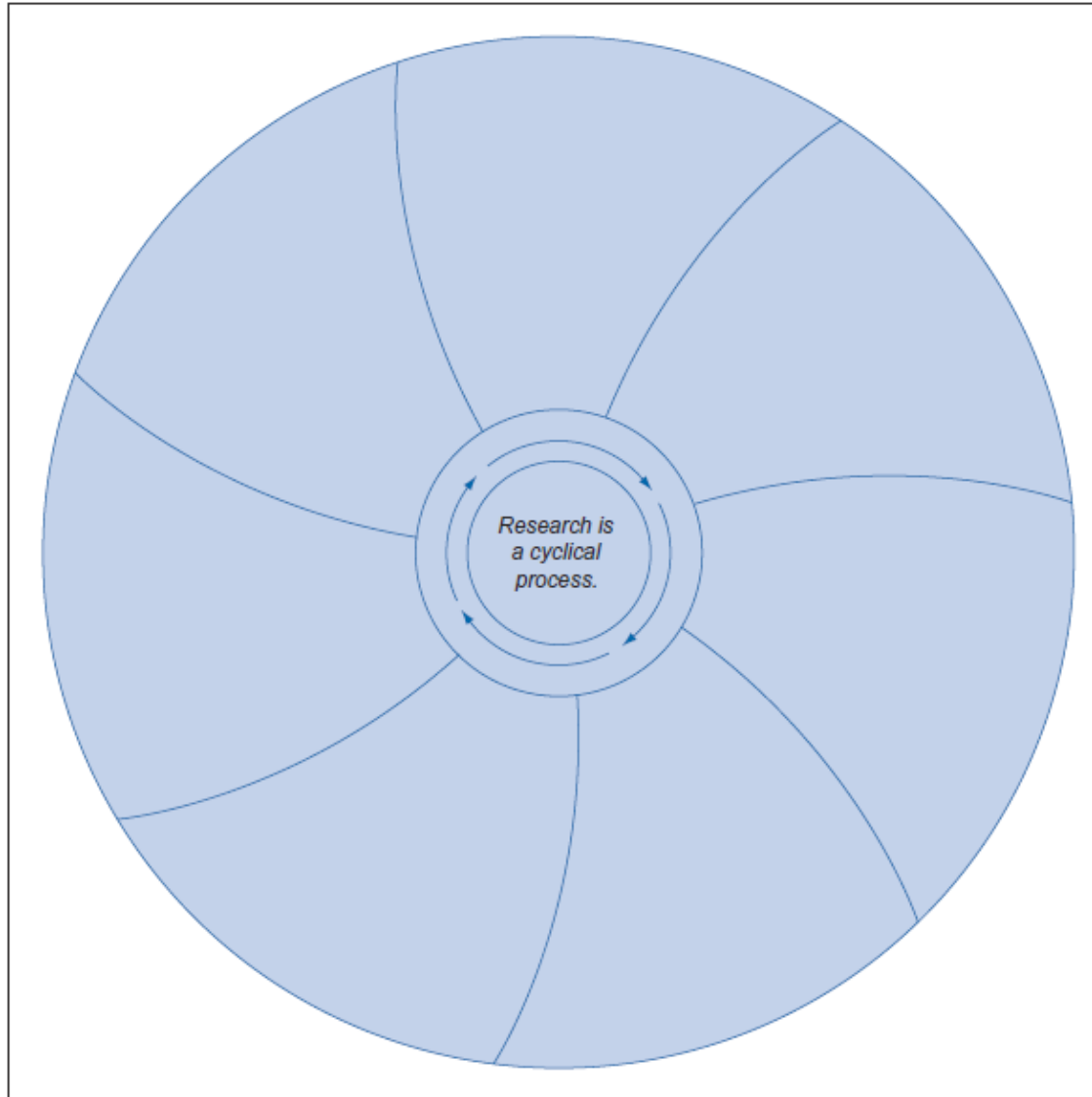
- Used to quantify the problem by generating numerical data or data that can be transformed into usable statistics.
 - Measure variables in some numerical way. By using commonly accepted measures of the physical world (e.g., rulers, thermometers).
 - Quantify attitudes, opinions, behaviors, and other defined variables – and generalize results from a larger sample population.
 - Use measurable data to formulate facts and uncover patterns in research.
 - Data collection methods are structured:
 - Quantitative data collection methods include various forms of surveys – online surveys, paper surveys, face-to-face interviews, online polls, and systematic observations, etc.

Qualitative Research



- Exploratory research to gain an understanding of underlying reasons, opinions, and motivations:
 - Provide insights into the problem or helps to develop ideas or hypotheses for potential quantitative research.
 - Uncover trends in thought and opinions.
 - Data collection methods vary using unstructured or semi-structured techniques.
 - Focus groups (group discussions), individual interviews, and participation/observations.
 - The sample size is typically small, and respondents are selected to fulfil a given quota.

The Research Cycle



Research Characteristics



1. The researcher begins with a problem—an unanswered **question**

- What is such-and-such a situation like?
- Why does such-and-such a phenomenon occur?
- Why a certain country has the highest crime rate?
- What motivate people to do research?
- How much time does it take to develop a software of size X?

.. With questions like these, research begins.



Research Characteristics



2. The researcher clearly and specifically articulates the **goal** of the research endeavor

- “What problem do you intend to solve?”
- How much time does it take to develop a software of size X?
 - To assist software practitioners in effectively calculating the software development time
 - To improve the software efficiency
 - To develop software on time and within budget

.. When you describe your objective in clear, concrete terms, you have a good idea of what you need to accomplish and can direct your efforts accordingly.

Research Characteristics



3. The researcher often divides the principal problem into more manageable **subproblems**

- Main problem
 - How do I get from Dammam to Riyadh
- Sub-problems
 - What is the shortest route?
 - Which one is the low-cost transport?
 - Which one is the risk-free means of transport?

Research Characteristics



4. The researcher identifies **hypotheses** and assumptions that underlie the research effort.
 - Having stated the problem and its attendant sub-problems, the researcher usually forms one or more hypotheses about what he or she may discover.
 - A hypothesis is a logical supposition, **a reasonable guess**, an educated conjecture (assumption).

Research Characteristics



5. The researcher develops a specific **plan** for addressing the problem and its subproblems

- Plan the overall research design and specific research methods in a purposeful way to acquire data relevant to the research problem and subproblems.
- Research *planning* is a plan to answer your research question.
- A research *Methodology* is a strategy used to implement that plan.
 - Clearly state: research activities, research methods, evaluation techniques (how to measure the progress), and communication of result
- State assumptions and limitations
- Plan to collect data
- Plan to analyze data
- Plan to perform experiments
- Plan to evaluate research outcome
- Plan to publish results

Research Characteristics



6. The researcher **collects**, organizes, and **analyzes** data related to the problem and its subproblems.
- Data collection from literature
 - Interviews, Questionnaire, Prototyping, Observation, Experimentation

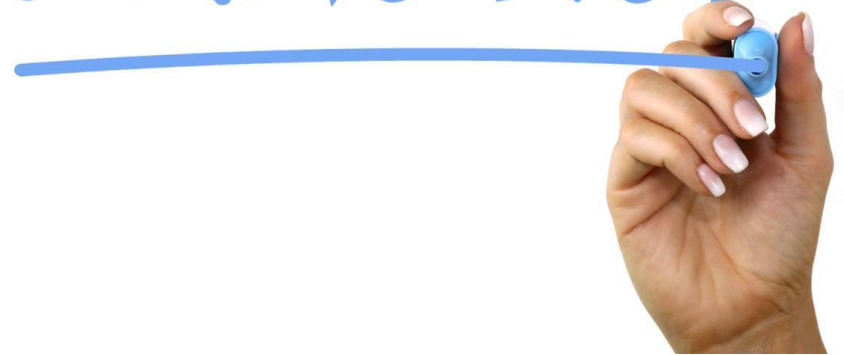
Research Characteristics



7. The researcher **interprets** the meaning of the data as they relate to the problem and its subproblems.
 - The significance of the data depends on how the researcher extracts meaning from them.



PRACTICE



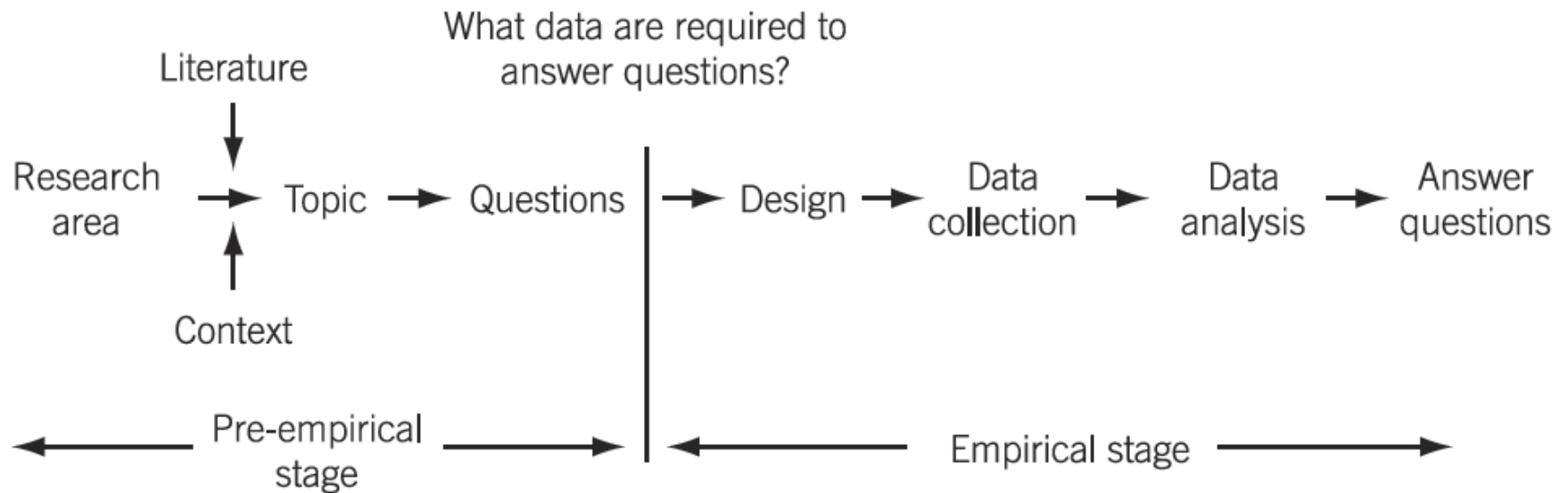
Select a research problem and apply the phases of the Research Cycle

The Research Cycle Characteristics

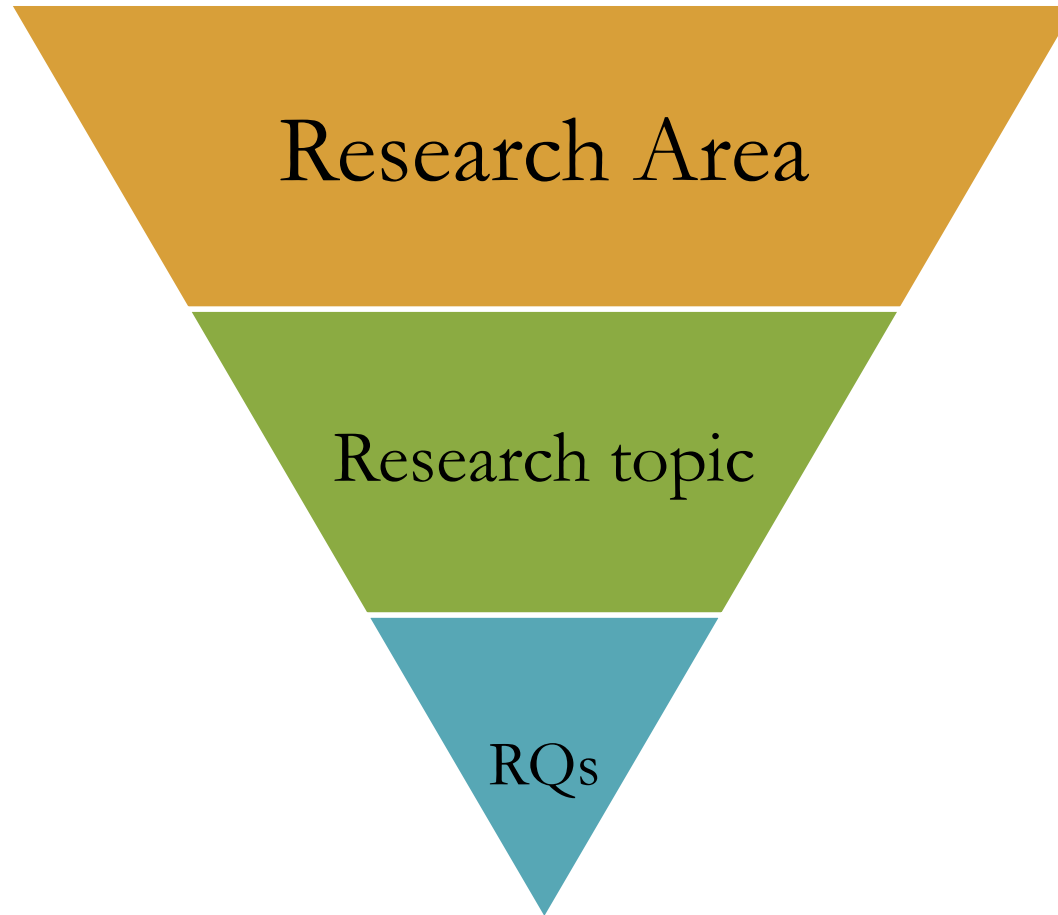


- The process is iterative
- The process is cyclical

Research Process



Research Area to RQs



Selecting a Topic

- Ask your supervisor, manager, friend, colleagues
- Look at previous research work
- Develop some of your previous research, or your practice at work
- Relate it to your other interests
- Think of a title
- Start from a quote that engages you
- Draw yourself a picture or a diagram
- Just start anywhere

... But be prepared to change direction


Literature Review



- Systematic literature review vs. conventional literature review
 - A systematic review is a defined and methodical way to summarise the empirical evidence concerning a treatment or technology, to identify missing areas in current research or to provide background to justify new research.
 - A systematic review proceeds by identifying, assessing and analysing published primary studies relating to a specific research question.
 - Systematic reviews require considerably more effort than conventional literature reviews but provide a much stronger basis for making claims about research questions.

Systematic Review



- Definition and documentation of a systematic *review protocol*
 - Definition and documentation a *search strategy*
 - Description of the explicit *inclusion and exclusion criteria*
 - Description of *quality assessment* mechanisms
 - Description of review and *cross-checking* processes
 - Involving multiple *independent researchers*
- 


Research Questions - Examples



- Why Java is the most widely used OO language used in industry?
- What motivates people to use software quality standards?
- How quality of a software can be improved?
- Why company X decided to use Oracle?

Research Design



- Designing a questionnaire, experiment, interview questions, case studies or any other tool used in the research.
 - Testing and validating the tool.
 - How to control the personal bias.
 - Identifying limitations with the research project.
 - Plan for data collection and analysis.
- 

Data Collection



- All research involves the collection and analysis of data.

- Data vary in their characteristics:
 - Numeric, words, combination of both.
 - Original – never before collected
 - Secondary – already published by someone else.
 - Data from questionnaire, interviews or experiments

- Data access
 - Documents, research articles etc
 - Experts: experiences, opinions, thoughts
 - Archives
 - Institutions and companies

- Ethics
 - What effect your actions might have on others
 - Referencing

Data Analysis and Interpretation



- Analysis is about the search for explanation and understanding of collected data

- Convert numbers and words into some meaningful results and outcomes
 - Concepts are abstract or general ideas
 - Theories are hypotheses which explain or seek to explain something
 - Understanding is perception of the meaning of something

Writing




- Papers for conferences and journals
 - Clear objectives
 - Research questions and/or hypothesis
 - Methodology
 - Contribution
 - Conclusion

- MS/PhD proposals
 - Information about research topic
 - Literature review (gaps)
 - Research questions (If possible)
 - Proposed methodology
 - Research plan
 - Possible contributions

Summary



- Research is a process through which we attempt to achieve systematically and with the support of data the answer to a question, the resolution of a problem, or a greater understanding of a phenomenon.
 - Basic research vs. applied research.
 - Quantitative vs. qualitative research
 - Research process contains different research phase.
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References



- Paul Leedy and Jeanne Ormrod, 2015, “Practical Research: Planning and Design”, Pearson, ISBN 9781292095875, 1292095873
- Loraine Blaxter, Christina Hughes and Malcolm Tight, “How to Research”, 4th Edition.