Course: Research Method in Software Engineering

WEEK 2 - Formulation of A Research Problem

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Week 2 - Formulation of A Research Problem

Contents

1. Introduction to the Research Problem
2. Characteristics of effective research problem
3. Sources of Identifying a Research problem
4. Knowledge-Seeking vs. Solution-Seeking Research on Software Engineering

Learning Outcome

- Define and understand the meaning of research Problem
- Understand steps how to formulate precise and insightful research problems.
- Describe the important sources of research problems,
- Understand characteristics of research problem
- Understand modes of software engineering research

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1. Introduction to the Research Problem

What is Research problem?

- The first step in the research process by asking questions that refers to a specific topic, problem, or knowledge gap that a researcher aims to study and address through a systematic review.
- In general, research involves **seven distinct steps.**

1. **Begins with a problem -- >Look around** :- Consider unresolved situations that evoke the following questions: **What** is such and-such a situation like? **Why** does such-and-such a phenomenon occur? **What** does it all mean?

[1] Leedy, P. D., & Ormrod, J. E. (2015). Pracfical research: Planning and design, 11th Edition. Page- 20

[2] https://cleverx.com/blog/how-to-formulate-research-problems/

1. Introduction to the Research Problem ….Cont'd

2. Clearly and specifically articulates the goal of the research endeavor

- Describe our objective in clear, concrete terms to have a good idea of what we need to accomplish.

3. Often divides the principal problem into more manageable subproblems.

- Because most research problems are too large or complex to be solved without subdividing them.
- **sub-problems**—sometimes in the form of specific questions—that are easier to address and resolve. Helps to get a better idea of how to approach the entire research endeavor.

[1] Leedy, P. D., & Ormrod, J. E. (2015). Pracfical research: Planning and design, 11th Edition. Page- 20

1. Introduction to the Research Problem ….Cont'd

Subproblem Versus *pseudo-subproblems*

- **Subproblems :-** Subpart of the main problem that are an integral part of the main problem.
- ***Pseudo-subproblems:-*** Describe the procedure of the study not the problem itself i.e., **it involves decisions** a researcher must make before being able to resolve the research problem and its subproblems.

Examples for *Pseudo-subproblems:*:

- What instruments or methods should be used to gather the data?
- What statistical procedures should be used to analyze the data?

[1]. Leedy, P. D., & Ormrod, J. E. (2015). Pracfical research: Planning and design, 11th Edition. Page –

1. Introduction to the Research Problem ….Cont'd

How to Identify Subproblems ?

- Must begin with the problem itself.
- Write down the main problem, and then carefully study it to detect more specific problems that should be isolated for in-depth study.

Example:- Main problem: How do I get from **Town A** to **Town B**?

- **Subproblems:** 1. What route appears to be the most direct one?

  2. Is the most direct one also the quickest one? If not, what route might take the least amount of time?

  3. Which is more important to me: minimizing my travel time or minimizing my energy consumption?

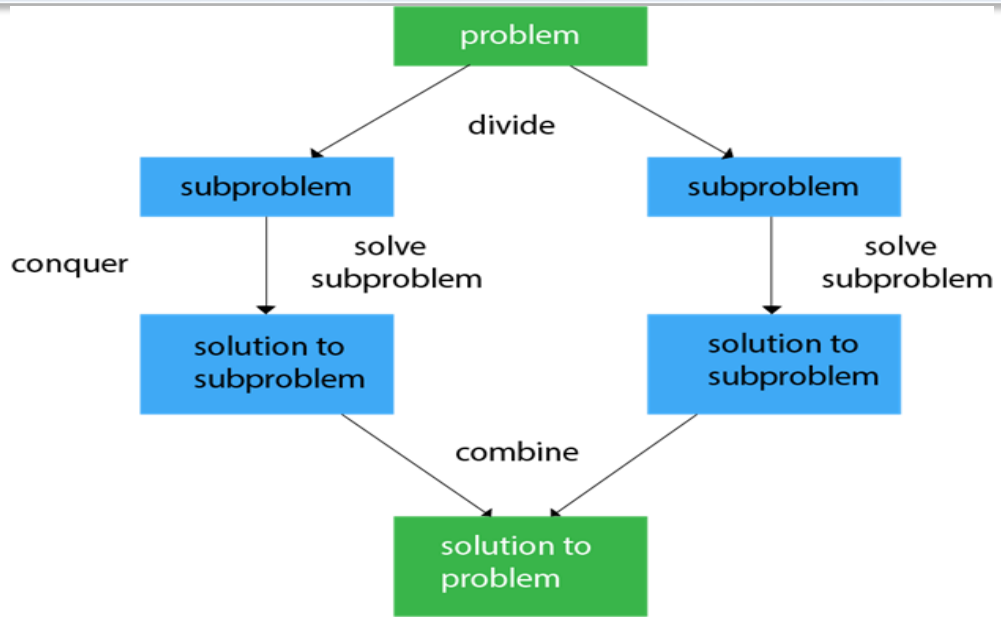

Figure 1. Divide and Conquer
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1. Introduction to the Research Problem ….Cont'd

Key characteristics of subproblems [1]

a. Each subproblem should be a completely researchable unit.

- Might be researched as a separate subproject within the larger research goal.
- The solutions to the subproblems, taken together, can then be combined to resolve the main problem.
- Often stated in the form of a **question** that tends to focus the researcher's attention more directly on the research target of the subproblem.

[1] Leedy, P. D., & Ormrod, J. E. (2015). Pracfical research: Planning and design, 11th Edition. Page- 20

1. Introduction to the Research Problem ….Cont'd

b. Each subproblem must be clearly tied to the interpretation of the data.

- Just as is true for the main problem, each subproblem should involve interpretation as well as collection of data.
- This fact may be expressed as a part of each subproblem statement, or it may be reflected in a separate but related subproblem.

c. The subproblems must add up to the totality of the problem.

- Check the subproblems against the statement of the main problem, i.e., (a) they do not extend beyond the main problem and (b) they address all significant aspects of the main problem.

[1]. Leedy, P. D., & Ormrod, J. E. (2015). Pracfical research: Planning and design, 11th Edition. Page –

1. Introduction to the Research Problem ….Cont'd

d. Subproblems should be small in number.

- If the main problem is carefully stated and properly limited to a feasible research effort, the researcher will find that it usually contains two to six subproblems.
- If we find ourselves in a situations of many subproblems , we should study the individual subproblems to see whether :-
    a. some are actually procedural issues (pseudo-subproblems),
    b. some might reasonably be combined into larger subproblems,
    c. the main problem is more complex than you originally believed.

❖ Reconsider whether the solution to the overall research problem is realistically achievable given the time and resources we have.

1. Introduction to the Research Problem ….Cont'd

4. Identify hypotheses and assumptions

- **Hypotheses :** like a guess or idea that we suggest to check if it's true. It is a statement that brings up a question and predicts what might happen.

E.g. If the temperature of water is increased, then it will change into steam.

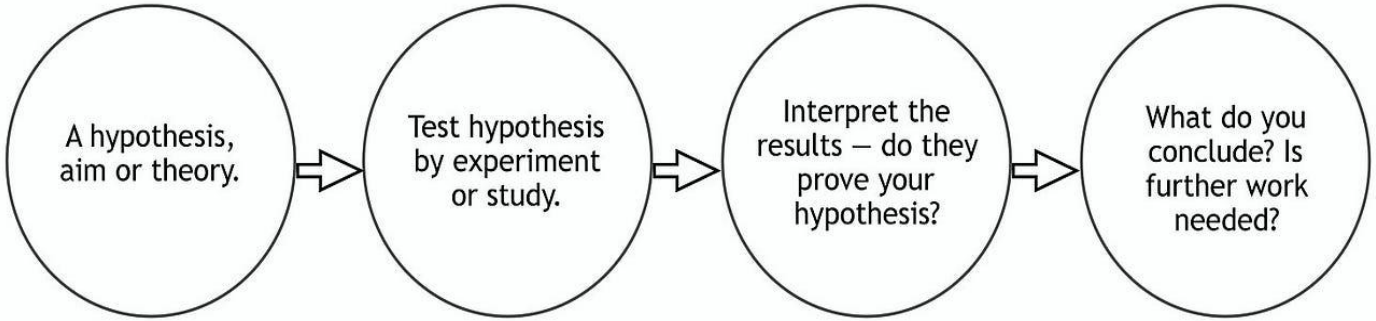

Figure 2. Hypothesis Testing Process.
https://images.app.goo.gl/9aqVmpw3g3uEcDDB9

- **Assumption:-** a condition that is taken for decided, without which the research project would be pointless.

E.g. All the data collected for this research is not a real data.

1. Introduction to the Research Problem ….Cont'd

5. Develop a specific plan for addressing the problem and its subproblems

- Plan overall **research design and specific research methods** in a purposeful way so that they can acquire data relevant to their research problem and subproblems.

Questions must have an answer early in the research process to achieve planning and design

- Are any existing data directly relevant to the research problem?
- If so, where are they, and are we likely to have access to them?
- If the needed data *don't* currently exist, how might we generate them?
- After we have acquired the data we need, what will we do with them?

1.Introduction to the Research Problem ….Cont'd

6. Collect, organize, and analyze data related to the problem

The data collected in research studies take one of two general forms.

- **Quantitative research :** involves looking at amounts, or *quantities,* of one or more variables of interest.
- **Example :-** conduct a survey on 100 students at university and ask them questions such as: "on a scale from 1-5, how satisfied are your with your professors?"
- A statistical analysis can be performed on the data and draw conclusions such as: "on average students rated their professors 5.4**".**
- **Qualitative research** involves looking at characteristics, or *qualities,* that cannot be entirely reduced to numerical values.
  - **Example :** - open-ended interview questions such as: "How satisfied are you with your software engineering studies?-- Based on the answers we can ask follow-up questions to clarify things.

1.Introduction to the Research Problem …..Cont'd

7. 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.
- Interpretation depends on the researcher's hypotheses, assumptions, and logical reasoning processes
- Un-interpreted data are worthless because it can never help us answer the questions we have posed .

2. Characteristics of an effective research problem

For a problem to be researchable, it needs to have several crucial characteristics such as : -

- **Significance :** Should address an important issue or knowledge gap in the field of study, contributing to the existing body of knowledge.
- **Clarity :** Should be precisely stated, avoiding vague or overly general statements and providing a clear and concise description. Enables the definition of research objectives and hypotheses and guides the research process.
- **Feasibility :** in terms of the available time, resources, and skills. It can be realistically pursued, given the researcher's capabilities and study circumstances.
- Sufficient data, research tools, and potential exploration paths should be reasonably accessible.

[2] https://cleverx.com/blog/how-to-formulate-research-problems/

2. Characteristics of an effective research problem …Cont'd

- **Novelty :** Should explore new angles, or dimensions of the subject, offering fresh perspectives or approaches.
  - This characteristic promotes intellectual progress and distinguishes the research from previous investigations.
- **Measurability :** Should be formulated in a way that allows for empirical examination and the generation of quantifiable results.

[2] https://cleverx.com/blog/how-to-formulate-research-problems/

2. Characteristics of an effective research problem ...Cont'd

- **Relevance and applicability:** Should address relevant issues or help develop useful guidelines, regulations, or actions.
    - It is more effective when it impacts multiple stakeholders and has the potential to produce practical results.
- **Interest and motivation** :-Should be intellectually engaging and interesting to the researcher and the academic community.
    - It sparks curiosity and encourages further research, leading to high-quality research output.
- **Ethical consideration:-**
- Should adhere to ethical principles and rules, considering the welfare and rights of participants or subjects involved in the study.

3. Sources of Identifying a Research problem

1. Look around

- Continually ask questions about what we see and hear around
  - Why does such-and-such happen?
  - What makes such-and-such tick?
  - What are people thinking when they do such-and-such?

2. Read the existing research literature about a topic*.*

- Helps to find out what things are already known and believed about our topic of interest.
- Likely to tell us what is not known in the area or, what still needs to be done.

[3]. Walliman, N. (2021). *Research methods: The basics*. Routledge. Page-50

3. Sources of Identifying a Research problem ..Cont'd

3. Seek the advice of experts

- Highly effective strategy for identifying a research problem :- What needs to be done? What burning questions are still out there? What previous research findings seemingly don't make sense?

4. Attend professional conferences

- Conferences are a place where novice researchers can make contacts with more experienced individuals in their field—where they can ask questions, share ideas, and exchange e-mail addresses that enable follow-up communication.

[3]. Walliman, N. (2021). *Research methods: The basics*. Routledge. Page-50

3. Sources of Identifying a Research problem ..Cont'd

5. Choose a topic that intrigues and motivates you.

- As we read the professional literature, attend conferences, and talk with experts, we will expose a number of potential research problems.
    - At some point you need to pick just *one* of them, and our selection should be based on what we personally want to learn more about. And believe is worth our time and effort, and one we are truly passionate about.

6. Choose a topic that others will find interesting and worthy of attention.

- Research advisors, Conference coordinators and journal editors are often quite selective about the research reports they accept for presentation or publication.

3. Sources of Identifying a Research problem ...Cont'd

7. Be realistic about what can accomplish.

- It is important that the problem be a ***manageable*** one and help us keep our project within reasonable, accomplishable bounds.

For example,

- How much time will it take you to collect the necessary data?
- Will we need to travel distances to get the data?
- Will we need expensive equipment?
- Will the project require knowledge and skills far beyond those we currently have?

[3]. Walliman, N. (2021). *Research methods: The basics*. Routledge. Page-50

4. Knowledge Seeking vs. Solution Seeking Research on Software Engineering

- **Modes of software engineering research [4]**
  - **knowledge-seeking and solution-seeking research.**
  - These mode of researches are positioned within the wider context of software Engineering (SE) research, the real world, and the software engineering knowledge base

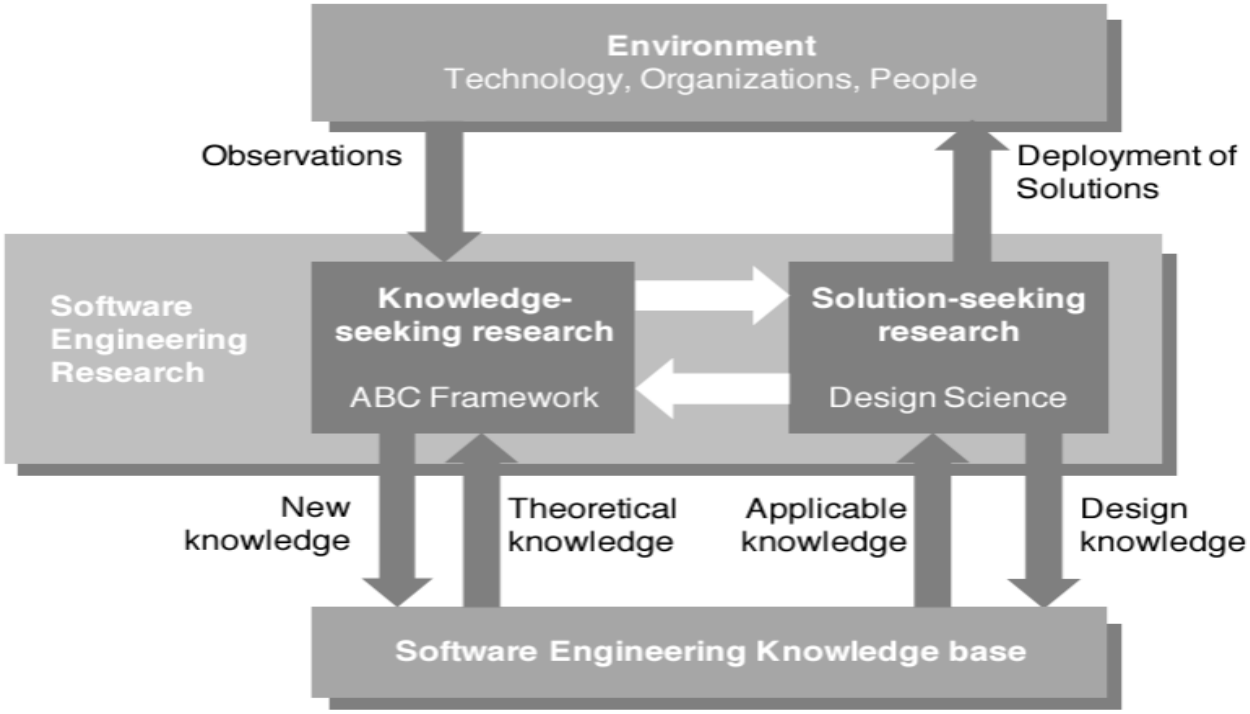

Figure 3. Modes of software engineering research [4]

4. Knowledge-Seeking vs. Solution-Seeking Research on Software Engineering …Cont'd

a) Knowledge-seeking studies

- Aim to learn something about the world around us by making observations in some type of environment—this includes the technologies, organizations, and people in natural, simulated (virtual) settings.
    - Lead to new knowledge, which is typically reported in research papers and books, thereby contributing to the software engineering knowledge base, from which researchers may draw when designing new studies.

- The term '**ABC'** seeks to convey the fact that knowledge-seeking research generally involves **actors (A)** engaging in **behavior (B)** in a particular **context (C)**.

4. Knowledge-Seeking vs. Solution-Seeking Research on Software Engineering …..Cont'd

Solution-seeking studies

- Researchers design, create, or develop solutions for a given software engineering challenge.
  - Outcome of these studies include algorithms, models, and tools.
  - May draw applicable knowledge from the software engineering knowledge base, which might have originated in either knowledge-seeking or solution-seeking research.
  - Much research within the software engineering domain is solution-seeking with resulting **design artifacts**.
  - These artifacts represent "**design knowledge**," in that they embody knowledge on how a particular engineering problem can be solved—and this knowledge is added to the software engineering knowledge base as well.

4. Knowledge-Seeking vs. Solution-Seeking Research on Software Engineering ….Cont'd

Solution-seeking studies …Cont'd

- Implemented solutions can be deployed into the real world, and their effectiveness or utility can be studied using knowledge-seeking research.
- knowledge-seeking and solution-seeking research can be interlinked because knowledge is needed to design solutions, and once designed, a researcher is interested in learning whether the solution works, or how well it compares to other solutions

Summary

- Research problem is the first step in the research process by asking questions that refers to a specific topic, problem, or knowledge gap that a researcher aims to study and address through a systematic inquiry.
- An effective research problem has the following characteristics- Feasibility, Novelty , Significance clarity, measurable, relevance, applicability, interest ,and Ethical consideration.
- Identifying and clearly articulating the problem and its subproblems are the essential starting points for formal research.
- Subproblems is Subpart of the main problem that are an integral part of the main problem. Whereas Pseudo-subproblems describe the procedure of the study not the problem itself.
- Identifying sources of research problems enriches the research process, ensuring that studies are relevant, focused, and capable of making meaningful contributions.
- Knowledge-seeking and solution-seeking are mode of researches in the wider context of software engineering knowledge base.

References

1. Leedy, P. D., & Ormrod, J. E. (2015). Pracfical research: Planning and design, 11th edn., global edition.
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Thank you!