
# *Research Methodology in Computer Science - Introduction -*

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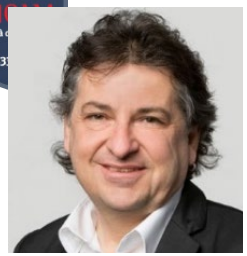


# About Knut

OMLAB

insiders technologies

DFK

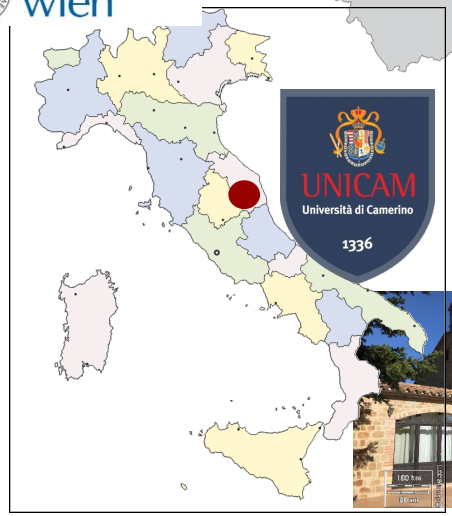
FAW

n|w

**FHNW** – University of Applied Sciences and Arts Northwestern Switzerland

UNIVERSITÄT KAISERSLAUTERN

universität wien





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# Students

- Please introduce yourself
  - Name
  - Topic of Research
  - State of the research
  - Supervisor

# Course Material

http://didattica.cs.unicam.it/doku.php?id=didattica:ay2122:rm:main

# *Motivation*

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# *Why are we here?*

We want your studies to end at the right place ..

Thanks to Prof. Alta van der Merwe

# *Why are we here?*

We want to understand what we are busy with ..

Thanks to Prof. Alta van der Merwe

# *Why are we here?*

We want to end with a well-constructed thesis ..

Thanks to Prof. Alta van der Merwe

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# *Why are we here?*

We don’t want to do unnecessary work due to bad planning ..

Thanks to Prof. Alta van der Merwe

# *Why are we here?*

We don’t want any surprises after the examination process ..


Thanks to Prof. Alta van der Merwe

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# *In writing a good thesis*

- You should be able to:
  - Complete a good research-based work and present it in a well-structured and well-written manner in a reasonable time.
- You prove to your university (and the research community) that you can do it.
- Victory is walking out with a degree in your hand!
- Writing a good thesis is a skill that can be learned

Thanks to Prof. Alta van der Merwe

# *Things to remember ..*

- Few people will ever read your work ..
- Three factors that are predictive whether or not you will complete your thesis:
  - If it is your **goal** and focus on that – you will complete.
  - You need to know your **process**. What to do, how to do it, and when to do it.
  - You need **discipline**. Many many hours!

Thanks to Prof. Alta van der Merwe

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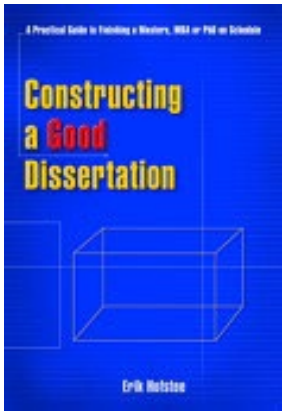
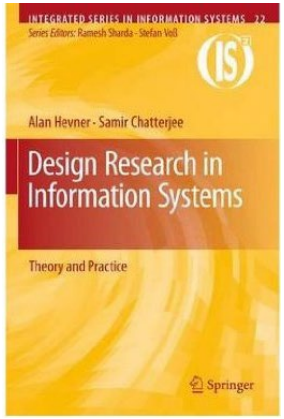
# *Acknowledgement*


- I am thankful to Prof. Alta van der Merwe from University of Pretoria – she was an inspiration and I use some of her slide
- Some material is from a course I taught at FHNW with Prof. H. F. Witschel and Prof. T. Hanne.

# Literature

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# *What is Research?*

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# *Definitions of Academic Research*

- Make a Google Search and get a definition of what is research
- Research is …

> … the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.

> … a process of systematic inquiry that entails collection of data; documentation of critical information and analysis and interpretation of the data/information, in accordance with suitable methodologies set by specific professional fields and academic disciplines.

> … a careful consideration of study regarding a particular concern or problem using scientific methods.

# *What is Research*

Research is something that people undertake to find out things in a systematic way, thereby creating some new knowledge

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# Two Components of Research

## Environment

*Data*


*Knowledge*

## Body of Knowledge


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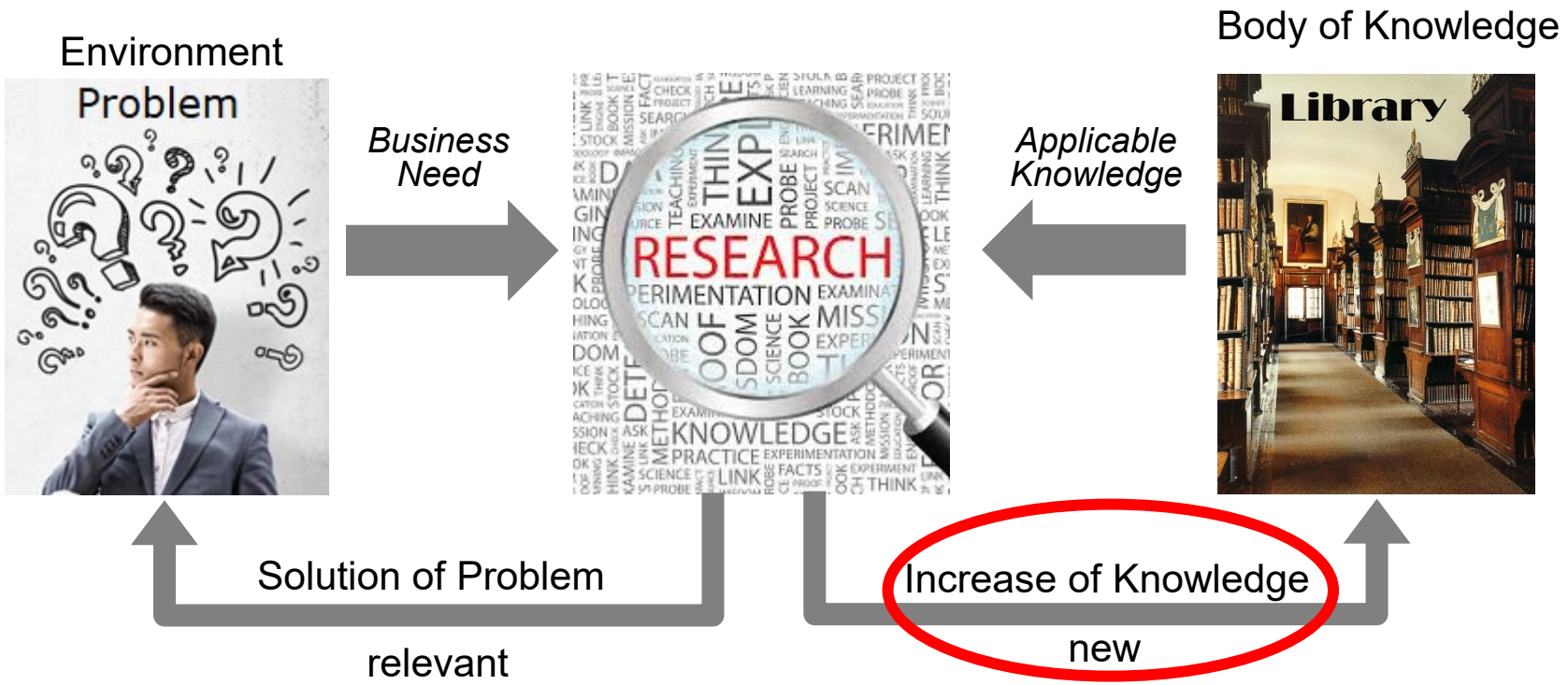
# *Research adds new and relevant Knowledge*

- Research  builds on  existing knowledge
- Research must collect and analyze information and/or data
- Research enhances the body of knowledge
- Research contributes to the solution of a research problem

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# *What does «New» and «Relevant» mean?*

- A “yes” answer to one of the following questions :
  - Will a known gap in the body of knowledge be filled?
  - Will previous research be replicated and expanded by looking at a different category of participants, environment, and/or constructs/variables?
  - Will previous research be expanded by more thoroughly examining some identifiable aspect?
  - Are there specific, identifiable, and documented problems with the currently available solutions?

(Creswell, 2005)

# *What is not research?*

Research is **not** …

… just information gathering

- *A student going to the library and reading information on African Elephants is not doing research*

… rearranging facts

- *A student writing a report on behavior of pendulums without analyzing data is not doing research*

… finding out something individually unknown

- *A student finding learning how to model a business process is not doing research – there are numerous studies on it*

… writing a computer program

- *Research is about new insights or contributions or methods; a program is an artifact to can be used to demonstrate or proof of new methods.*

# Criteria for Research

- **Originality:** Finding out something what we don't know
- **Significance:** What we want to find out must be sufficiently interesting for others, e.g.
  - ♦ of **general** interest
  - ♦ of interest in a research community
  - ♦ of interest for other practitioners
- **Validity/Evidence:** Others must be convinced that the research result is valid
  - ♦ having applied an accepted research methodology

Criteria for new knowledge

Criteria for systematic approach

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# *Types of Information Systems Research*

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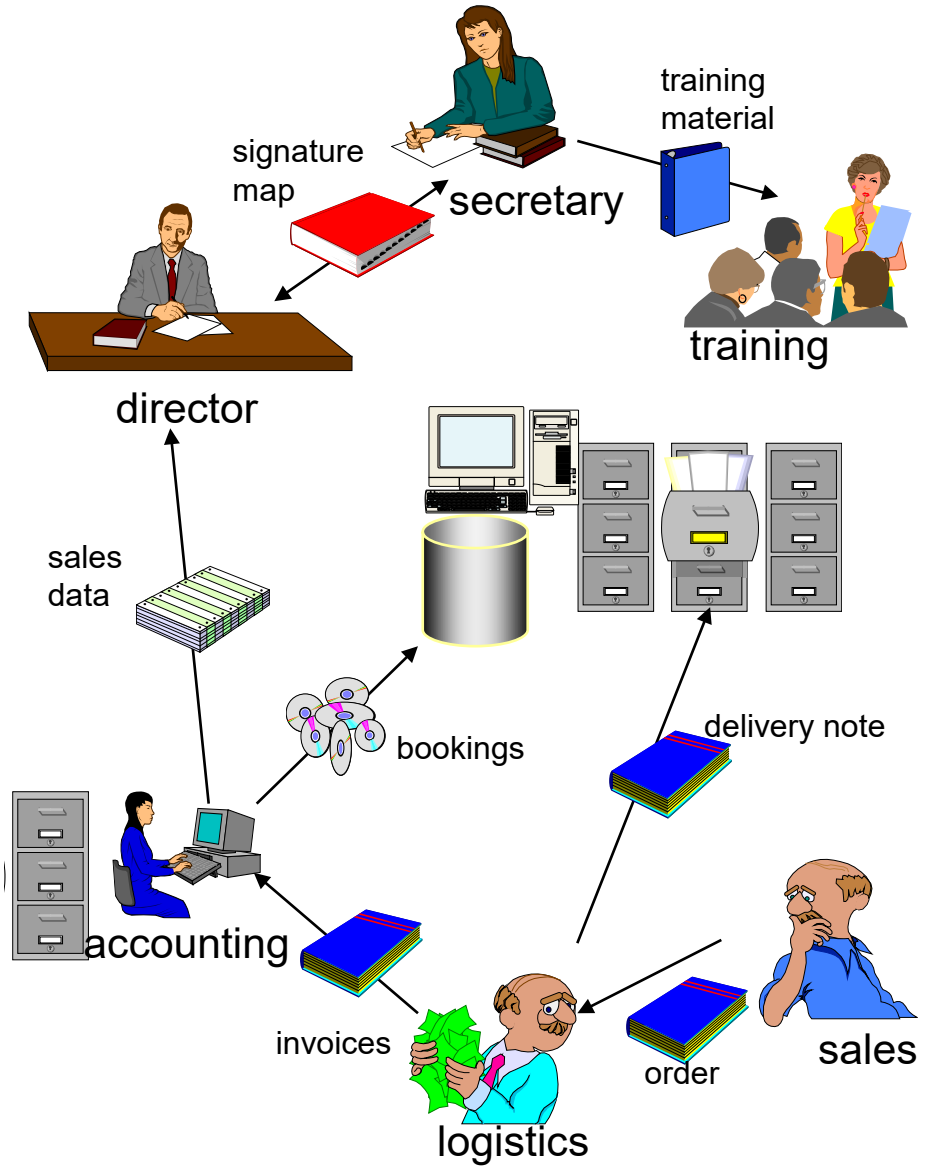
# Information Systems

- Information systems are sociotechnical systems consisting of
  - ♦ People (human agents)
  - ♦ Organisation (structure, processes)
  - ♦ Information
  - ♦ Technology

  and their relationships

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# *Analytical vs. Design-oriented*

- **Behaviorism-based / Analytical** research
  - ♦ analysis of information systems as a phenomenon in order to identify causal relations

- **Design-oriented** research
  - ♦ Creating artefacts: innovations of information systems
  - ♦ systems are constructed and not just observed

*(Österle et al. 2011)*

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# *Types of Artifacts in Information Systems Research*

- **Constructs**
  - ♦ e.g. concepts, terminologies, languages, formulas
- **Models**
  - ♦ representations of existing or possible real-world systems
- **Methods**
  - ♦ processes, procedures, algorithms, guidelines
- **Instantiations**
  - ♦ Concrete solutions implemented as prototypes or production systems (e.g. software, start-ups, process)

Concrete manifestations of such artifacts can be axioms, guidelines, frameworks, norms, software, business models, enterprise start-ups, and much more

*(Österle et al. 2011)*

# *Principles of Design-oriented Research*

Each artefact must …

…be applicable to a class of problems → **Abstraction**

…substantially contribute to the advancement of the body of knowledge → **Originality**

…be justified in a comprehensible manner and must allow for its validation → **Justification**

…must yield benefit – either immediately or in the future – for the respective stakeholder groups → **Benefit**

*(Österle et al. 2011)*

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# *Basic vs Applied*


| | | |
|---|---|---|
| **Intention** | Expand general knowledge | Improve understanding of a particular problem |
| **Result** | Universal principles | Soution to a particular problem (→ not researchl |

Source: Robert Barcik. Research Methods for Business Students, Udemy course

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# *Examples*

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# *Is the following research?*

- You are running a shop for do-it-yourself products. To decide how many products you have to order from the supplier, when you are running out of stock for some products, you compare the sales of the last weeks with the products you still have on stock and also take into account the delivery periods for the products.
- Is this research?

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# *Is the following research?*

- Your mother bakes the best cakes in the world. She uses a recipe that she got from her grandmother. To be able to bake a bigger cake, she experimented with the combination of ingredients and found that if she wanted a cake that is double the size she'd need to double all the ingredients except for the eggs, where she should take 5 instead of 4.
- Is this research?

*thanks to Alta van der Merwe for this example!*

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# *Is the following research?*

- The university faced the problem that students are cheating when doing home assignments. You write a system that compares students' contributions and checks whether two assignments are copies of each other. You want to publish your unique approach to compare texts.
- Is this research?

# *Research must have a Contribution to the Body of Knowledge*

- New insights: Originality
- Uniqueness: Originality
- Generalisable: Significance
- Comparison: Validity
- Testing: Validity

AHA moment!

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# *The Research Process*

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# *The Academic Method*

- Academic research: explaining the unexplained.
- You will at the most basic level have to:
  - Identify a research problem
  - Find out what other academics have written
  - Develop a research question or thesis about it (make a guess about the solution or take a stand about something)
  - Figure out a way to answer your research question
  - Apply that to your thesis
  - Analyse your results
  - Come to a conclusion.

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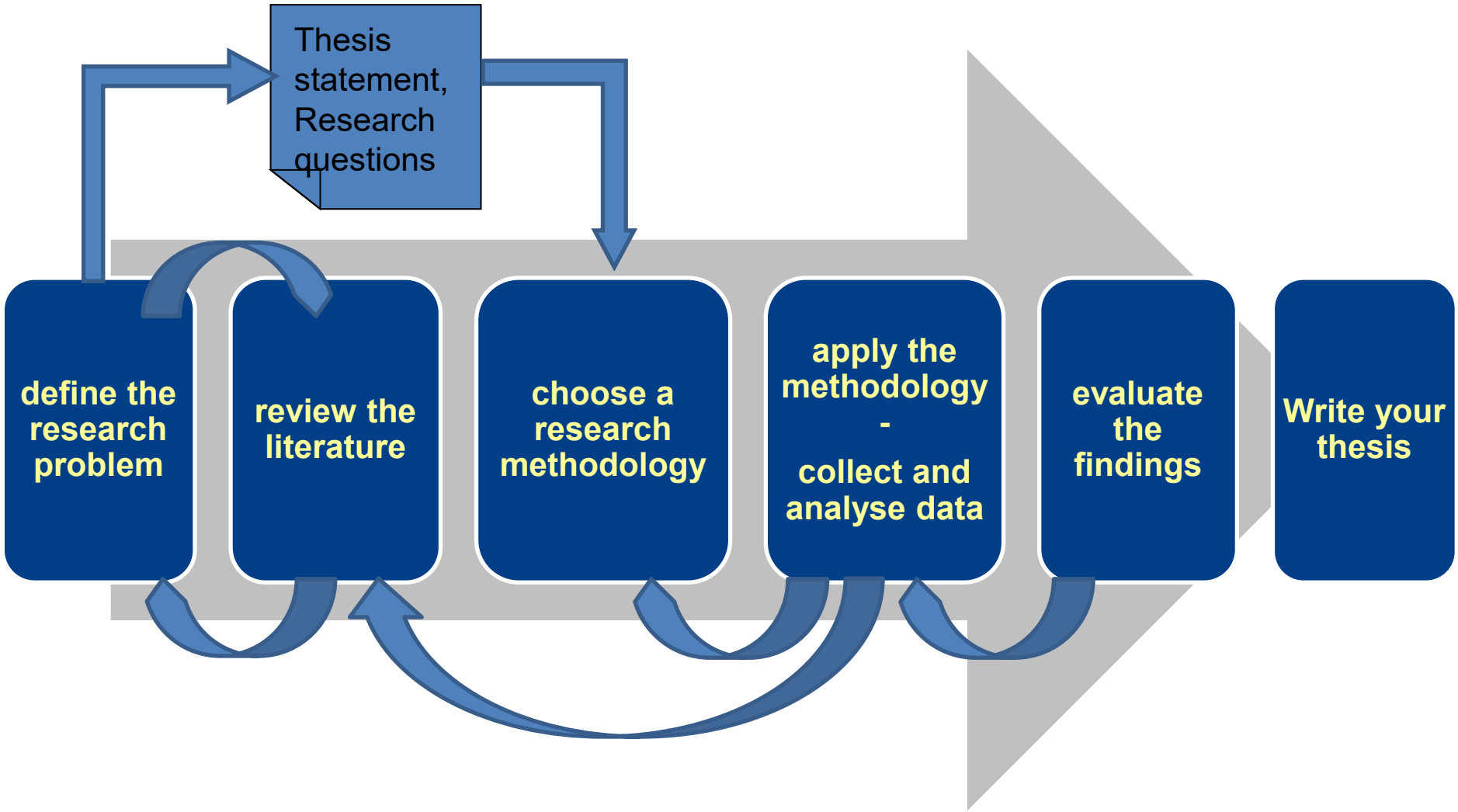
# Research Process

The research process is meant as a guidance for you



# *Research Process and the Structure of your Thesis*

| | Creating a software artefact | Structure of a research paper |
|---|---|---|
| Problem | Cheating of students … | Introduction |
| Question | What are the similarity characteristics of assignments | |
| What do we know? | Existing approaches for text comparison and classification | Literature Review |
| What do we want to do? How? | Plan! | Research Methodology |
| What did we do? | Build the software … | <Body of work> |
| Is it working? | Testing | Evaluation |
| Why is it worth something? | General approach for text similarity | Conclusion |

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