A SYSTEMATIC LITERATURE REVIEW ON MISCONCEPTIONS IN SOFTWARE ENGINEERING

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- studied Industrial Engineering (M.Sc.) at the Mannheim University of Applied Sciences, Germany (2012 - 2014)
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Agenda

1. Introduction – What is a misconception?

2. Context

3. Systematic Literature Review (SLR)
   a. Phase 1: Initial Planning
   b. Phase 2: Examination Process
   c. Phase 3: Results
      i. Title & Abstract
      ii. Full Text
      iii. Misconceptions Found

4. Conclusion
Introduction – What is a „Misconception“?

is an individual conception that is "at odds with modern scientific theories" [1, p. 2]

the wording implies "the wrongness of a student’s conception, and can thus be seen as critical of the holder of the concept" [1, p. 2]

On the basis of various concerns numerous „synonyms“ have developed:

- Preconceptions [1, p. 1f.; 4, p. 99; 5, p. 66; 6; 7, p. 61]
- Students’ conceptions [1, p. 1f.; 3, p. 119]
- Alternative conceptions [4, p. 99; 8]
- Naïve conceptions [1, p. 1f.]
- Beliefs [9, p. 15]
- Naïve beliefs [3, p. 119]
- Alternative beliefs [3, p. 119; 6]
- Alternative frameworks [1, p. 1f.; 10, p. 7]
- Naïve theories [1, p. 1f.; 11]
- The „standard term“ as named by Smith et al. [3, p. 119] and others: Misconceptions [1, p. 1f.; 4, p. 99; 7, p. 61; 9, p. 15; 12, p. 325; 13, p. 60].
Constructivism: Learning is to be understood as an active, individual, situated, social, and cognitive psychological process

Each individual builds own knowledge by combining new concepts based on previous knowledge

This means, learners form conceptions and models to explain phenomena, processes, and artifacts before confronted with them in institutional learning

These possibly alternate from scientific or expert perspectives

Twofold significant impact on the learning process:

- On the one hand, they can **serve as the basis for learning**
- On the other, they can also **contradict the educational content** and thus hinder the learning process

Therefore: Didactics should do justice to the learners’ “points of departure” [1, p. 6]

**Question:**

Which misconceptions in Software Engineering are already known?
SLR-Phase 1: Initial Planning

1) Research Question(s):
To what extent does research on misconceptions in SE already exist? Which misconceptions in SE are known/documentated?

2) Search Strategy:
   a) Language Selection: German and English
   b) Queries and Synonyms: (English Search Query covering a broad variety of synonyms of the term “misconception” combined with Software Engineering)
   c) Database: Electronic literature databases [28-37] are selected

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**Selection of Electronic Databases for SLR based on [25] [26]**

<table>
<thead>
<tr>
<th>Source</th>
<th>IEEE</th>
<th>ACM</th>
<th>SD</th>
<th>SC</th>
<th>SL</th>
<th>ERIC</th>
<th>WOS</th>
<th>CS</th>
<th>arXiv</th>
<th>dblp</th>
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<tbody>
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<td>Information and Software Technology</td>
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<td>Journal of Systems and Software</td>
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<td>IEEE Transactions on SE</td>
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<td>IEEE Software</td>
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<td>Communications of the ACM</td>
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<td>ACM Computer Surveys</td>
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<td>ACM Transactions on SE</td>
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<td>Software Practice and Experience</td>
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<td>Empirical SE Journal</td>
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<td>IEEE Proc. Software (now: IET Software)</td>
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<td>Proc. Int. Conference on SE</td>
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<td>Proc. Int. Symp. of Software Metrics</td>
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</table>

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(“software engineer*” OR “software development*” OR “software process*”)
AND
(“preconception*” OR “conception*” OR “belief*” OR “misconception*” OR “naive theor*” OR “alternative framework*” OR “intuitive theor*” OR “intuitive science” OR “prior knowledge”)
SLR-Phase 1: Initial Planning

3) Selection Strategy: Controlled by predefined Inclusion (IC) and Exclusion Criteria (EC)
   IC.1 The publication is written in English or German language.
   IC.2 It is explicitly about the discipline Software Engineering.
   IC.3 Misconceptions in SE are explicitly mentioned.
   EC.1 The contribution is an abstract, workshop, or similar.

4) Quality Assessment: Determined Quality Criteria (QC)
   QC.1 Traceability: How do the authors know this misconception?
   QC.2 Validation: Has it been confirmed that it is a MISconception?
      How did the authors validate the conception to be “at odds with modern scientific theories” [4, p. 2]?
   QC.3 Occurrence in the population: Does this misconception exist in the population?
      Did the authors test the misconception in a specific target group?
SLR-Phase 2: Examination Process

1) Stage 1: Conducting the Automated Search
   • If possible, use of extended/advanced search functions, wildcards (e.g., “misconception*”), and Boolean operators was made.
   • Search is limited to document title and abstract, as recommended by [27].

2) Stage 2: Applying the In-/Exclusion Criteria
   • Relevance of publication is determined in a two-stage process:
     i. Title and abstract are examined and evaluated on the basis of the predefined criteria.
     ii. Papers included are then rechecked regarding the in-/exclusion criteria; this time considering the full text.

3) Stage 3: Backward Snowballing
   • “the references of the selected papers [are] reviewed and any missing candidate papers [are] assessed against the inclusion/exclusion criteria” [27, p. 2052] as well; this is referred to as ‘backward snowballing’.

4) Stage 4: Data Analysis
   • Assessment of quality using the predefined quality criteria.
SLR-Phase 3: Results (Title & Abstract)

- Automated search completed between April, 30th and May, 1st 2020
- Search was not limited to a date range (review process timewise included every research found, covering papers as of 1970)
- Number of search matches: \( n = 2,158 \)
- Excluding data sets that contained entire proceedings/compilations instead of contributions as well as duplicates: \( n = 1,481 \)
- After applying the inclusion and exclusion criteria to title and abstract: \( n = 128 \)
SLR-Phase 3: Results (Full Text Search)

- Inclusion and exclusion criteria are then applied to the paper candidates based on the full text of the contributions: \( n = 15 \)
- Papers are excluded that cover the topic ‘misconception’, but did not explicitly mention at least one statement
- The subsequent backward snowball search (checked against the IC and ECs): \( n = 18 \)

### Summary of SLR Results After Applying In-/Exclusion Criteria on Full Texts

<table>
<thead>
<tr>
<th>Search Engines</th>
<th>IEEE</th>
<th>ACM</th>
<th>SD</th>
<th>SC</th>
<th>SL</th>
<th>ERIC</th>
<th>WoS</th>
<th>GS</th>
<th>arXiv</th>
<th>dblp</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper Candidates (see Table III)</td>
<td>29</td>
<td>40</td>
<td>4</td>
<td>37</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>128</td>
</tr>
<tr>
<td>IC.1a: English</td>
<td>29</td>
<td>40</td>
<td>4</td>
<td>37</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>128</td>
</tr>
<tr>
<td>IC.1b: German</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IC.2: SE Discipline</td>
<td>29</td>
<td>40</td>
<td>4</td>
<td>37</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>127</td>
</tr>
<tr>
<td>IC.3: Mention Misconceptions</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>15</td>
</tr>
</tbody>
</table>

| Papers Found | 5   | 3   | 1  | 2  | 0  | 0   | 0   | 1   | 3     | 0    | 15   |
| Backward Snowballing | 27  | 5   | 0  | 2  | 0  | 0   | 0   | 1   | 4     | 0    | 39   |
| Already Included in SLR | 2   | 1   | 0  | 1  | 0  | 0   | 0   | 0   | 2     | 0    | 6    |
| After Applying Selection Criteria | 0   | 0   | 0  | 1  | 0  | 0   | 0   | 0   | 2     | 0    | 3    |
| Result        | 5   | 3   | 1  | 3  | 0  | 0   | 0   | 1   | 5     | 0    | 18   |

Note: Through the selection process in Stage 2 and Backward Snowballing in Stage 3 as a whole, we double-checked the contributions by assessing each paper. As Kitchenham et al. suggest, publications are included if we cannot make a consensual decision [27, p. 2052].
The misconceptions named in the papers (n = 18) are then checked against the QCs.

Misconceptions sufficiently meeting the QCs singularly are marked gray in the following Table:

<table>
<thead>
<tr>
<th>Misconceptions explicitly named</th>
<th>Papers Found</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [53] [54] [55]</td>
<td>17</td>
</tr>
<tr>
<td>Misconceptions reasonably argued</td>
<td>[38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [53] [54] [55]</td>
<td>16</td>
</tr>
</tbody>
</table>

The intersection of the QCs results in n = 20 misconceptions found in the papers [45, 53, 54].

Papers [54] and [53] only deal with the topic 'defect prediction'.

The authors of [45] look at SE covering the software life cycle more holistically; see thematic structuring on the next slide.

Note: [45] would actually not be included in the intersection, as it is not explained where the misconceptions come from (QC.1). But the authors validated them (QC.2) and tested their occurrence concerning students (QC.3). Thus, the misconceptions listed are hypotheses, that have been empirically confirmed; thus, nevertheless, they are included in the intersection.
# SLR-Phase 3: Misconceptions Found

## List of Misconceptions Matching the Quality Criteria

<table>
<thead>
<tr>
<th>Topic(s)</th>
<th>Misconception</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>A defined software process is only important when you are working with people who are less skilled.</td>
<td>45 (1)</td>
</tr>
<tr>
<td>X</td>
<td>A good software developer will often choose to work alone on a project in order to get it done faster.</td>
<td>45 (2)</td>
</tr>
<tr>
<td>X X</td>
<td>When you have a team of good programmers who work well together, a software process will usually get in the way.</td>
<td>45 (3)</td>
</tr>
<tr>
<td>X</td>
<td>My code should take advantage of the implementation details in other code.</td>
<td>45 (4)</td>
</tr>
<tr>
<td>X</td>
<td>It is expected that clients will describe their requirements accurately before a team begins programming.</td>
<td>45 (5)</td>
</tr>
<tr>
<td>X</td>
<td>As a software developer, most of my time will be spent designing and implementing new algorithms and data structures.</td>
<td>45 (6)</td>
</tr>
<tr>
<td>X</td>
<td>Most of the time when I start a new programming task in industry, I will be working on a new project.</td>
<td>45 (7)</td>
</tr>
<tr>
<td>X</td>
<td>Developers do not need to know the high-level context of the system; this allows them to concentrate on their task.</td>
<td>45 (8)</td>
</tr>
<tr>
<td>X</td>
<td>A software project is successful only if it ships with very few known defects.</td>
<td>45 (9)</td>
</tr>
<tr>
<td>X X</td>
<td>Software engineering is about producing lots of documentation on the requirements and implementation of the project.</td>
<td>45 (10)</td>
</tr>
<tr>
<td>X</td>
<td>The majority of the cost of a successful software project will be the initial implementation effort.</td>
<td>45 (12)</td>
</tr>
<tr>
<td>X</td>
<td>A file with a complex code change process tends to be buggy.</td>
<td>53 (B1), 54 (S2)</td>
</tr>
<tr>
<td>X</td>
<td>A file that is changed by more developers is more bug-prone.</td>
<td>53 (B2), 54 (S14)</td>
</tr>
<tr>
<td>X</td>
<td>A file with more added lines is more bug-prone.</td>
<td>53 (B3), 54 (S4)</td>
</tr>
<tr>
<td>X</td>
<td>Recently changed files tend to be buggy.</td>
<td>53 (B4), 54 (S7)</td>
</tr>
<tr>
<td>X</td>
<td>Recently bug-fixed files tend to be buggy.</td>
<td>53 (B6), 54 (S10)</td>
</tr>
<tr>
<td>X</td>
<td>A file with more fixed bugs tends to be more bug-prone.</td>
<td>53 (B7), 54 (S11)</td>
</tr>
<tr>
<td>X</td>
<td>A file with more commits is more bug-prone.</td>
<td>53 (B8), 54 (S12)</td>
</tr>
<tr>
<td>X</td>
<td>A file with more removed lines is more bug-prone.</td>
<td>53 (B9), 54 (S13)</td>
</tr>
</tbody>
</table>

### Thematical Structuring

- **P** = Project
- **PM** = Process Models
- **TS** = Team Skills
- **R** = Requirements
- **I** = Implementation
- **De** = Defects
- **Do** = Documentation
Conllusion

• Paper’s purpose: **Identify and analyse known misconceptions in SE**
• Overall goal: To use these insights in higher education

• Predefined search queries have been applied to search **10 databases**
• Out of **2,158 publications**, 18 could be identified as appropriate for the selection criteria.

• These contain **167 statements**, which the authors of these papers refer to as misconceptions.
• **20** of them met the quality criteria specified; i.e. only 3 publications cover valuable data.

• To conclude, the results show...
  • ... currently evidence-based research on misconceptions in SE is limited
  • ... there is not enough research on evidence-based misconceptions in SE to use these insights

➢ So, in addition a primary study to identify misconceptions in SE is indispensable before addressing them.
Thank you very much for your attention.
References


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