ANALYZING CHALLENGES IN SOFTWARE ENGINEERING CAPSTONE PROJECTS

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Presenters’ resume

Yvonne Sedelmaier holds a diploma and a PhD in pedagogy with a major focus on adult learning and continuing education at the University of Bamberg, Germany. Her research interests are teaching and learning software engineering at universities and software engineering didactics.

Dieter Landes is a full professor of software engineering and database systems at the University of Applied Sciences, Coburg, Germany. His research interests are in requirements engineering, software engineering education, and data mining.
Outline

Context

Intended Learning Outcomes

Educational Context

Research Questions & Design

Results

Discussion

Summary & Outlook
Software Engineering ...

... is concerned with

- building complex systems
- in a team of developers
- over an extended period of time
- for a more or less precisely known group of users.
Teaching Software Engineering – A Challenge

- Various social and personal competencies needed, e.g. communication within a team and across disciplinary boundaries
- Various technical roles within the software development process
- No two identical software development projects
- Methodological and problem-solving skills required
- Rapid change of factual knowledge requires lifelong learning
Educational Context
Software Engineering Capstone Project (1)

Goal:

- tie together what has been learned in terms of methodology and technologies
- exercise soft skills in a typical professional setting, in conjunction with technical skills

Realistic Project Setting:

- run through all phases of the development cycle
- real customer with genuine interest in using results
- pre-defined team roles
Educational Context
Software Engineering Capstone Project (2)

Approach:

Mix of students from a bachelor and a master program in informatics

per Team:

five bachelor students (on average) in their final year
technical / development focus
one Master student
focus on process and management issues
Intended Learning Outcomes (1)

for Bachelor Students:

- understanding and combining chunks of technical knowledge, which up to then have been isolated, into one big picture
- integrating in a team, which includes fostering communication skills

for Master Students:

- organizing and leading a team (training of communicating with team members, structuring tasks, and motivating team members for effective teamwork)
Intended Learning Outcomes (2)

for both groups of students:

- Intended learning outcomes are mainly competences and, consequently, assessment is competence-oriented as well.
- Self-reflection as a key competence addressed
  - Anonymous self-reflection reports, structured according to several guiding questions
- Post-mortem session
Research Data: Students’ post-mortem self-reports

- Over nine years
- 79 reports from 81 students in 13 teams
  - Each team guided by a master student, in one case two master students (Scrum master plus product owner), i.e. 14 self-reports written by master students.
- average length of reports: two pages of prose text
Research Design

- mixed methods approach with focus on qualitative analyses

- applying the basic strategy of Grounded Theory

- in combination with Mayring’s content analysis

- generating codes in a multi-stage procedure while reading, abstracting and interpreting the texts
## Initial Results – Overview (1)

<table>
<thead>
<tr>
<th>Students’ Challenges in SE Capstone Projects</th>
<th>Percent (valid)</th>
<th>Percent</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human factors</td>
<td>87,5</td>
<td>79,75</td>
<td>63</td>
</tr>
<tr>
<td>Organizational Matters</td>
<td>75</td>
<td>68,35</td>
<td>54</td>
</tr>
<tr>
<td>Professional &amp; Technical Issues</td>
<td>72,22</td>
<td>65,82</td>
<td>52</td>
</tr>
<tr>
<td>Internal Communication</td>
<td>50</td>
<td>45,57</td>
<td>36</td>
</tr>
<tr>
<td>Big Picture / Complexity</td>
<td>47,22</td>
<td>43,04</td>
<td>34</td>
</tr>
<tr>
<td>Other Challenges</td>
<td>40,28</td>
<td>36,71</td>
<td>29</td>
</tr>
<tr>
<td>Leadership (-)</td>
<td>25</td>
<td>22,78</td>
<td>18</td>
</tr>
<tr>
<td>DOCUMENTS with Code(s)</td>
<td>100</td>
<td>91,14</td>
<td>72</td>
</tr>
<tr>
<td>DOCUMENTS without Code(s)</td>
<td>-</td>
<td>8,86</td>
<td>7</td>
</tr>
<tr>
<td>ANALYSED DOCUMENTS</td>
<td>-</td>
<td>100</td>
<td>79</td>
</tr>
</tbody>
</table>
Initial Results – Overview (2)

Challenges Percent (valid)

- Human factors: 87.5%
- Organizational Matters: 75%
- Professional & Technical...: 72.22%
- Internal Communication: 50%
- Big Picture / Complexity: 47.22%
- Other Challenges: 40.28%
- Leadership (-): 25%
# Initial Results – Top Issues in Human Factors

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of codes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration Bachelor and Master students</td>
<td>32</td>
<td>10.49</td>
</tr>
<tr>
<td>Motivation</td>
<td>31</td>
<td>10.16</td>
</tr>
<tr>
<td>Collaboration</td>
<td>25</td>
<td>8.2</td>
</tr>
<tr>
<td>Communication with Third / Other Disciplines</td>
<td>20</td>
<td>6.56</td>
</tr>
</tbody>
</table>

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Initial Results – Top Issues in Organizational Matters

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of codes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time aspects / Timeliness</td>
<td>34</td>
<td>26.15</td>
</tr>
<tr>
<td>Management in general</td>
<td>33</td>
<td>25.38</td>
</tr>
<tr>
<td>Software Process Modell</td>
<td>16</td>
<td>12.31</td>
</tr>
<tr>
<td>Distribution of Tasks and Responsibilities</td>
<td>16</td>
<td>12.31</td>
</tr>
<tr>
<td>Communication</td>
<td>13</td>
<td>10.00</td>
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</tbody>
</table>
## Initial Results – Top Issues in Professional & Technical Issues

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of codes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation</td>
<td>27</td>
<td>21.77</td>
</tr>
<tr>
<td>Software Requirements</td>
<td>25</td>
<td>20.16</td>
</tr>
<tr>
<td>Technical Knowledge</td>
<td>17</td>
<td>13.71</td>
</tr>
<tr>
<td>Effort Estimation</td>
<td>12</td>
<td>9.68</td>
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<tr>
<td>Tools</td>
<td>10</td>
<td>8.06</td>
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</tbody>
</table>

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## Initial Results – Top Issues in Professional & Technical Issues

### Top 3 Issues in Category “Other Challenges”

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of codes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Organisation</td>
<td>12</td>
<td>29.27</td>
</tr>
<tr>
<td>Shared Vision</td>
<td>9</td>
<td>21.95</td>
</tr>
<tr>
<td>Individual Situation</td>
<td>5</td>
<td>12.20</td>
</tr>
</tbody>
</table>

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Discussion (1)

- Technical issues play only a minor role with respect to the “success” of a student project.

- Other aspects tend to become crucial, e.g. collaboration within the team and beyond, project management and organisation, or methodological issues related to requirements engineering and effort estimation.

- Issues related to project planning are some challenge.
Discussion (2)

- more fine-grained insights compared to related work
- allowing for more sophisticated hypotheses to be tested subsequently
- E.g., project organisation (and not just planning), individual motivation and individual deficiencies in setting or adhering to deadlines not mentioned as important issues in related research
Summary and Outlook

well-founded qualitative approach to analysing educational data, in this case in the context of software engineering capstone projects.

19 main categories of challenges that students face in capstone projects.

19 main categories correspond to semantic clusters of issues raised in more than 70 textual post-mortem self-reports.

self-reports may be analysed from various additional perspectives
Questions?

Thank you for your attention!