Fuzzy concepts and large literature corpi: Addressing methodological challenges in systematic reviews.

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Theoretical Background
The use of learning technologies does not necessarily make learning more successful

(Tamim et al., 2011)

However: Learning technologies have the potential to make teaching and learning processes different and more intensive (Kerres, 2013)
Several systematic reviews analyze the impact of a specific educational technology tool or didactic approach on learning outcomes or student engagement, e.g.:

• the influence of virtual reality-based instruction within different learning environments (Merchant et al., 2014)
• the influence of flipped classroom in nursing education (Betihavas, Bridgman, Kornhaber & Cross, 2016) or engineering education (Karabulut-Ilgu, Cherrez & Jahren, 2018)
• the effect of podcasts on learning in higher education (McLoughlin & Lee, 2007)
• the effect of serious games in medical education and surgical skills training (Graafland & Schijven, 2012)

The studies explore very specific conditions
However, practitioners have to implement the learning environments that are conducive to their pedagogical goals

(Kerres, 2018)

These kind of studies do not help to select the optimal design for learning goals
Fuzzy Concepts
Under which *conditions* does *educational technology* support *student engagement in higher education*?
Under **which conditions** does **educational technology** support **student engagement in higher education**?
## Facets of positive student engagement

<table>
<thead>
<tr>
<th>Affective</th>
<th>Cognitive</th>
<th>Behavioural</th>
<th>Agentic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enthusiasm</td>
<td>Deep learning</td>
<td>Time on task/staying on task/Persistence</td>
<td>Proactive contribution</td>
</tr>
<tr>
<td>Interest</td>
<td>Self-regulation</td>
<td>Participation/Interaction/Involvement</td>
<td>Enriching learning activity</td>
</tr>
<tr>
<td>Sense of belonging</td>
<td>Stay on task/focus</td>
<td>Positive conduct / following rules</td>
<td>Students personalising lessons</td>
</tr>
<tr>
<td>Positive attitude about learning</td>
<td>Learning goals</td>
<td>Effort</td>
<td></td>
</tr>
<tr>
<td>Positive interactions with peers,</td>
<td>Investment in learning</td>
<td>Concentration</td>
<td></td>
</tr>
<tr>
<td>teachers</td>
<td>Positive self-perceptions and self-efficacy</td>
<td>Attention/Focus</td>
<td></td>
</tr>
<tr>
<td>Values learning</td>
<td>Operational reasoning</td>
<td>Attendance</td>
<td></td>
</tr>
<tr>
<td>Sense of connectedness</td>
<td>Preference for challenging tasks</td>
<td>Study habits</td>
<td></td>
</tr>
<tr>
<td>Pride</td>
<td>Positive perceptions of teacher support</td>
<td>Homework/assignment completion</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Follow-through/care</td>
<td>Action/initiation</td>
<td></td>
</tr>
<tr>
<td>Vitality/Zest</td>
<td>Purposeful</td>
<td>Attempting</td>
<td></td>
</tr>
<tr>
<td>Excitement</td>
<td>Thoroughness</td>
<td></td>
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</table>

## Facets of student disengagement

<table>
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<tr>
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<tbody>
<tr>
<td>Boredom</td>
<td>Aimless</td>
<td>Procrastination</td>
</tr>
<tr>
<td>Disinterest</td>
<td>Helpless</td>
<td>Giving up</td>
</tr>
<tr>
<td>Frustration</td>
<td>Resigned</td>
<td>Restlessness</td>
</tr>
<tr>
<td>Anger</td>
<td>Unwilling</td>
<td>Half-hearted</td>
</tr>
<tr>
<td>Sadness</td>
<td>Opposition</td>
<td>Unfocused/inattentive</td>
</tr>
<tr>
<td>Worry/anxiety</td>
<td>Avoidance</td>
<td>Distracted</td>
</tr>
<tr>
<td>Shame</td>
<td>Apathy</td>
<td>Mentally withdrawn</td>
</tr>
<tr>
<td>Self-blame</td>
<td>Hopeless</td>
<td>Burned out/exhausted</td>
</tr>
<tr>
<td></td>
<td>Pressured</td>
<td>Unprepared</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Absent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor conduct</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Task incompletion</td>
</tr>
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</table>

(Skinner & Pitzer, 2012; Martin, 2012)
Research questions

Arising from our systematic review, two unusual methodological challenges have been encountered so far:

1. How to plan a systematic review when the constructs of interest are fuzzy?

2. What options are there to deal with a large article population?
Dealing with fuzzy concepts
<table>
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<th>Topic and cluster</th>
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</tr>
</thead>
<tbody>
<tr>
<td>student</td>
<td>learner* OR student*</td>
</tr>
<tr>
<td>higher education</td>
<td>“higher education” OR universit* OR college* OR undergrad* OR graduate OR postgrad* NOT (&quot;K-12&quot; OR kindergarten* OR &quot;corporate training&quot;* OR &quot;professional training&quot;* OR &quot;primary school&quot;* OR &quot;middle school&quot;* OR &quot;vocational education&quot; OR &quot;adult education&quot;)</td>
</tr>
<tr>
<td>Educational technology</td>
<td>“educational technolog*” OR “learning technolog*” OR “digital technolog*” OR “digital media”</td>
</tr>
<tr>
<td>Tools</td>
<td>“social media” OR “social network”* OR “social web” OR vodcast* OR podcast* OR “digital broadcasting” OR blog* OR weblog* OR “electronic publishing” OR microblog* OR “interactive whiteboard”* OR simulation* OR forum* OR “computer-mediated communication” OR “computer * network”* OR ePortfolio OR e-Portfolio OR eAssessment OR e-Assessment OR “computer-based testing” OR “computer-assisted testing” OR OER OR “open educational resource”* OR “open access” OR “open source”* OR “information and communication technolog*” OR “information technolog*” OR “social tagging” OR tablet* OR “handheld device”* OR “mobile device”* OR &quot;smart<em>phone”</em> OR “electronic book”* OR eBook*</td>
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</tr>
<tr>
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# Comprehensive Search Strategy

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No student engagement in the search strategy
77,508 sources identified through search of four electronic databases

23,740 excluded duplicate sources

18,068 abstracts and titles screened

13,916 excluded papers

62 duplicates
253 not articles
114 before 2007 or after 2016
1,556 not empirical
259 not primary research
648 not HE
750 description of a tool
1978 no technology
445 evaluation
2522 no learning setting
5329 no student engagement

4,152 potential includes

SAMPLING

PRISMA diagram (slightly modified after Brunton & Thomas, 2012, p. 86; Moher et al., 2009, p. 8)
Limited to:

- English-language
- Journal articles
- Published between 2007-2016

Database:

1. Web of Science
2. ERIC
3. Scopus
4. PsycINFO

Total article number: 38,202 articles

The 38,202 were then searched using facets of student engagement. 18,068 articles were then screened on title and abstract.

we compared our abstract screening results with three raters → interrater reliability: $\kappa = .95$

All unclear abstracts were discussed in group

a population of 4,152 articles to screen on full were left
Dealing with a large article population
2 different standard methods in sample size estimation (Maxwell, Kelley & Rausch, 2008)

• Power analytic perspective (Cohen, 1988; Murphy & Myors, 2004; Friston, Holmes & Worsley, 1999)

• Accuracy in parameter estimation perspective (AIPE) (Hahn & Meeker, 1991, Kupper & Hafner, 1989)
2 different standard methods in sample size estimation (Maxwell, Kelley & Rausch, 2008)

• **Power analytic perspective** (Cohen, 1988, Murphy & Myors, 2004, Friston, Holmes & Worsley, 1999)


• Population: 4153

• Confidence level: 95%

• Confidence interval: 5%

• Percentage: .5
Sample size estimation

2 different standard methods in sample size estimation (Maxwell, Kelley & Rausch, 2008)

• **Power analytic perspective** (Cohen, 1988, Murphy & Myors, 2004, Friston, Holmes & Worsley, 1999)


• Population: 4153

• Confidence level: 95%

• Confidence interval: 5%

• Percentage: .5

→ **Sample size estimation with R-Package MBESS** (Kelley, Lai, Lai & Suggets, 2018): 351 articles * 2

Stratified sampling by year
Validation

Explorative
351 articles, large coding set, creating hypothesis

Confirmatory
351 articles, limited coding set, validating hypothesis, specify the deviation, validation the method

The two subsamplings were parallelized by matching the cases according to the nearest Chi^2 distance

Matching variables are: Method (quantitative, qualitative, mixed), Journal (learning or field journal), pages (categorized), number of citations (categorized)
Problems

- The concepts are still fuzzy in detail.
- We have to resample a lot of articles – this iterative process needs a lot of time
- The studies are very heterogenous, maybe not enough evidence for subgroup analysis
Discussion

• Systematic reviews must be able to handle larger issues to be relevant in praxis
• So many problems arise due to the scope of the topic and the literature
• It is necessary to refine the research in this area
• Our approach is a learning by doing task
Systematic Review

• a method to synthesize knowledge from a body of research
• a sophisticated methodology
• to deliver new insights and research knowledge

meta-analysis in Edu Tech research
• are restricted to identify positive / negative effects
• do not provide insights into the components of successful learning
• do not help in designing new learning environments
Thank you

For further questions, remarks and ideas: Katja Buntins
katja.buntins@uni-due.de


