Resolving scientific controversies to promote epistemic change: Testing an intervention concept

Tom Rosman, Anne-Kathrin Mayer, and Günter Krampen
Leibniz Institute for Psychology Information, Trier, Germany

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## Epistemic beliefs – Stage models

<table>
<thead>
<tr>
<th>Developmental stage</th>
<th>Description (Kuhn &amp; Weinstock, 2002; Hofer &amp; Pintrich, 1997)</th>
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<tbody>
<tr>
<td><strong>Absolute beliefs</strong></td>
<td>Knowledge ...</td>
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<tr>
<td></td>
<td>- is based on facts → „objective“</td>
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<tr>
<td></td>
<td>- is conceptualized in dualistic contrasts (right-and-wrong or truth-and-untruth)</td>
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<td></td>
<td>- is stable and permanent</td>
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<tr>
<td><strong>Multiplistic beliefs</strong></td>
<td>Knowledge ...</td>
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<td></td>
<td>- is based on personal opinion and the generation of own ideas → „subjective“</td>
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<td></td>
<td>- is dynamic, tentative, and preliminary</td>
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<td>- Truth does not exist and everything is subjective (extreme form)</td>
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<tr>
<td><strong>Evaluativistic beliefs</strong></td>
<td>Knowledge ...</td>
</tr>
<tr>
<td></td>
<td>- is more or less objective resp. subjective – depending on the issue in question and on its context</td>
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<td>- Individuals realize themselves to be part of the process of knowledge by evaluating and weighting knowledge claims</td>
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Epistemic change

- **Epistemic doubt** as a catalyst for epistemic change (Bendixen & Rule, 2004; Muis, Pekrun, Sinatra, Azevedo, Trevors, Meier, & Heddy, 2015)

- Goal of many epistemic belief interventions: Presentation of information that is incompatible with a student’s actual beliefs (e.g., Porsch & Bromme, 2011)

- **Diverging information**: “all types of information that present different, apparently conflicting, viewpoints to the information consumer” (Kienhues, Ferguson, & Stahl, 2016, p. 319).
Epistemic beliefs in “soft sciences”

“Soft sciences”: Ill-defined knowledge structure (Muis, Bendixen, & Harle, 2006)
- Concepts are loosely structured
- Theories are often inconsistent
- Controversial findings are frequent

→ Diverging information is omnipresent
→ Views of scientific knowledge as tentative and subjective (multiplism) are fostered “naturally” (Green & Hood, 2013)

Caveat! Multiplistic beliefs often impede learning
(Barzilai & Eshet-Alkalai, 2015; Bråten, Ferguson, Strømsø, & Anmarkrud, 2013; Bråten, Strømsø, & Samuelstuen, 2008; Rosman, Peter, Mayer, & Krampen, 2016)
Fostering evaluativism

How can we foster evaluativistic beliefs without the risk of simultaneously fostering multiplism?

By presenting controversies (i.e., diverging information) that are resolvable ("resolvable controversies") AND supporting individuals to resolve the controversies.

**Reason:** Resolving controversies is incongruent with...
- absolute beliefs (absolutists neglect the existence of controversies)
- multiplistic beliefs (multiplists neglect the possibility of “resolving” controversies)
Hypotheses

**Hypothesis 1:**
Epistemic belief interventions drawing on “resolvable controversies” reduce absolute as well as multiplistic beliefs and foster evaluativism.

**Hypothesis 2:**
The intervention effects are stronger for students who are supported in their resolution of the controversies.
Resolvable controversies

- 18 text snippets describing (apparently) contradicting studies on gender stereotyping of school teachers

- **General idea:** Neither girls nor boys are *generally* disadvantaged. Gender discrimination depends on moderating factors (e.g., varies over different subject matters).

- Each text includes **cues** pertaining to such moderating factors → allows students to resolve the apparent controversies
Mertes et al. (2014) had 224 German teachers grade essays from secondary school students. Allegedly, the essays were written either by boys or girls. Even though all essays had been written by the researchers themselves, essays allegedly written by boys received significantly lower grades than those allegedly written by girls.

In a study by Meier et al. (2015), 250 physics teachers graded physics tests. Even though all tests had been completed by boys, half of the tests were tagged with girls’ names. Independently of teachers’ sex, tests allegedly completed by girls received significantly lower grades than tests allegedly completed by boys.

Feldmann et al. (2016) instructed 240 history teachers to grade history exams (secondary school level). All exams were originally written by girls. However, the researchers tagged half of the exams with boys’ names. Exams that were allegedly written by boys were neither graded better nor worse than those allegedly written by girls.
**Intervention design**

### Reading task

Students read all 18 text snippets (+9 irrelevant filler snippets)

### Writing task

Three different writing instructions, experimentally varied:

**Resolution instruction:** “Write a 400-word nuanced scientific essay focusing on the conditions under which boys respectively girls are discriminated!”

**Summary instruction:** “Write a detailed 400-word summary on the different studies!”

**One-sided argument instruction:** “Write a 400-word one-sided argumentative essay (i.e., pro-boys or pro-girls). Ignore findings that do not support your position!”
Study 1 – Design

- 3*2 design (3 experimental groups, 2 measurement points)
- \( N = 86 \) sixth-semester undergraduate psychology students (BSc)
- 74 females; \( M = 22.67 \ (SD = 2.21) \) years old

Pretest online

Interventions
1. Reading task (27 text snippets)
2. Writing task (three different instructions)

2-3 weeks delay

No delay

Posttest
Study 2 – Design

- Simple pre-post design (2 measurement points)
- $N = 145$ undergraduate psychology students (BSc) from all semesters
- 131 females; $M = 21.56$ ($SD = 2.92$) years old

### Interventions

1. Reading task (27 text snippets)
2. Writing task (only resolution instruction)

**Pretest**
- online

**Posttest**

- 2-3 weeks delay
- No delay
Measures

**Topic-specific epistemic beliefs** (FREE-GST; adaptation from Krettenauer, 2005)

**Subscales:** Absolutism ($\omega = .82$), multiplism ($\omega = .66$), evaluativism ($\omega = .75$)

**Introduction vignette:** Three controversial positions on the nature and extent of gender-stereotype discrimination in schools

**15 epistemic statements** rated on a 6-point Likert scale

*e.g., “The future will show which position is definitely correct” → Absolutism*

**Domain-specific justification beliefs** (Klopp & Stark, 2016)

**Subscales:** Justification by authority ($\omega = .74$), personal justification ($\omega = .74$), justification by multiple sources ($\omega = .82$)

**9 epistemic statements** rated on a 6-point Likert scale

*e.g., “To be able to trust knowledge claims in psychology, various knowledge sources have to be checked” → justification by multiple sources*

*Note. $\omega =$ reliability (McDonald‘s Omega), calculated with data from Study 1*
Data analysis strategy

**Latent Difference Score Modeling** (McArdle, 2009)

- **Hypothesis 1:** Latent difference score $\Delta \eta = \text{average change of } y \text{ between pre- and posttest}
- **Hypothesis 2:** Latent difference score $\Delta \eta$ and dummy coded variables indicating group membership

![Diagram](attachment:image.png)
Results – Hypothesis 1 (Study 1 and 2)

Point estimation and 95% confidence intervals

- Justification through Multiple Sources (Domain-Specific)
- Personal Justification (Domain-Specific)
- Justification through Authority (Domain-Specific)
- Evaluativism (Topic-Specific)
- Multiplism (Topic-Specific)
- Absolutism (Topic-Specific)

Latent Difference Score
Results – Hypothesis 2 (Study 1)

Point estimation and 95 % confidence intervals

- Justification through Multiple Sources (Domain-Specific)
- Personal Justification (Domain-Specific)
- Justification through Authority (Domain-Specific)
- Evaluativism (Topic-Specific)
- Multiplism (Topic-Specific)
- Absolutism (Topic-Specific)

Predictive Effect of Dummy Variable
Conclusions

„Resolvable controversies“ are well-suited to foster evaluativism without the risk of increasing multiplism

The effects of writing instructions are rather small → Do students “automatically” resolve the controversies while reading?

Future research:

- Findings transferrable to other “soft” disciplines?
- Gender distribution?
- Other mechanisms of epistemic change apart from epistemic doubt?
Thank you for your attention!

Contact: rosman@zpid.de

References
Klopp, E., & Stark, R. (2016). Entwicklung eines Fragebogens zur Erfassung domänenübergreifender epistemologischer Überzeugungen [Development of a domain-general epistemological beliefs questionnaire]. Unpublished manuscript, Department of Educational Science, Saarland University, Saarbrücken, Germany.