Teachers' scientific thinking: How does teachers' epistemic thinking relate to their inquiry-based teaching practices?

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Inquiry-based teaching & epistemic thinking

- Inquiry-based teaching is central to science education (National Research Council, 2012)
- The inquiry-based approach is increasingly applied in disciplines outside the sciences (Levy et al., 2013).
- Epistemic thinking is indispensable in inquiry-based teaching (e.g. Windschitl et al., 2008)

Two research traditions epistemic thinking

- Personal epistemology tradition (e.g. Hofer, 2014)
- Nature of science tradition: teachers' epistemic thinking and how this relates to their teaching (e.g. Lederman & Lederman, 2014)

Present study

- Teachers' epistemic thinking and inquiry-based teaching
- Bridging the "personal epistemology" (e.g. Hofer, 2014) and nature of science" research traditions (e.g. Lederman & Lederman, 2014)
  - Personal epistemology tradition: developmental framework (Kuhn et al., 2008) and instrument for assessing epistemic thinking (Barzilai & Weinstock, 2015)
  - Nature of science tradition: looking at how teachers' epistemic thinking relates to their teaching practices (Lederman & Lederman, 2014)
- Teachers from different subject areas

Method: participants

- Sharing Knowledge project, 117 teachers from three international, secondary schools in the Netherlands:
  - Subject area groups:
    - Languages (N=48, 41%)
    - Individuals & Societies (N=32; 27%)
    - Sciences (including math) (N=37, 32%)
  - 64% females, 34% males
  - 10% twenties, 31% thirties, 37% forties, 12% fifties, 10% sixties
  - 4% doctorate, 54% master's degree, 34% bachelor's degree, 8% other
  - 63% <10, 29% 10-19, 5% 20-29, 3% 30-39 years of experience in teaching in international secondary education

Method: epistemic thinking

- Epistemic Thinking Assessment Barzilai & Weinstock (2015) based on developmental framework Kuhn (e.g. Kuhn et al., 2008; Kuhn & Weinstock, 2002)
  - Absolutist perspective
  - Multiplist perspective
  - Evaluativist perspective

Method: epistemic thinking

- Epistemic Thinking Assessment (ETA), Barzilai & Weinstock, 2015
- Example statement with three sub-statements:

What should the knowledge about the deformed frogs be based on?										
a. Mainly on interpretations of data	1	2	3	4	5	6	7	8	9	10
b. Mainly on personal points of view	1	2	3	4	5	6	7	8	9	10
c. Only on the facts	1	2	3	4	5	6	7	8	9	10

Note. Option a = evaluativist perspective, option b = multiplist perspective, option c = absolutist perspective

- Cronbach's Alpha's:

	Absolutist sub-statements	Multiplist sub-statements	Evaluativist sub-statements
ETA Biology (11 statements)	.81	.88	.71
ETA History (10 statements)	.74	.76	.76

Method: inquiry-based teaching

- Classroom observations (video recordings)
  - 48 teachers, 2 classes per teacher
  - Classes selected randomly
  - Different days of the week, different grades

- Coding scheme
  - Based on RTOP (Piburn et al., 2000; Sawada et al., 2002)
  - 9 inquiry-based teaching items, 3 scales
  - Inter-rater reliability: r sumscores=.88, percentage agreement =74, Kappa=.64

Method: inquiry-based teaching

- Teaching practices promoting divergent and critical thinking, subscale with 4 items:
  1. Students are encouraged to think critically
  2. Students are encouraged to seek and value alternative approaches to problem solving
  3. Students are reflective about their learning
  4. Students engage in multiple means and media to communicate their ideas

- Each item scored 1 (low) - 4 (high), mean score for analyses

Method: inquiry-based teaching

- Students were encouraged to think critically
  1. Students articulate a single response to an open question, and there is no follow up of further discussion/probing by the teacher
  2. Students articulate at least two different ideas in response to an open question, but there is no further discussion /probing by teacher
  3. Students articulate at least two different ideas in response to an open question and there is further discussion/probing by teacher, but no evidence required
  4. Students articulate at least two different ideas and discussion follows and evidence is included in the discussion

Results epistemic thinking

Table 1. Percentages of teachers showing Absolutist, Multiplist and Evaluativist perspectives in the biology and history knowledge domains

	Absolutist perspective	Multiplist perspective	Evaluativist perspective
ETA Biology (63)	52.4	1.6	46.0
ETA History (54)	20.4	5.6	74.1

Chi2(2)=13.14, *p*=.001

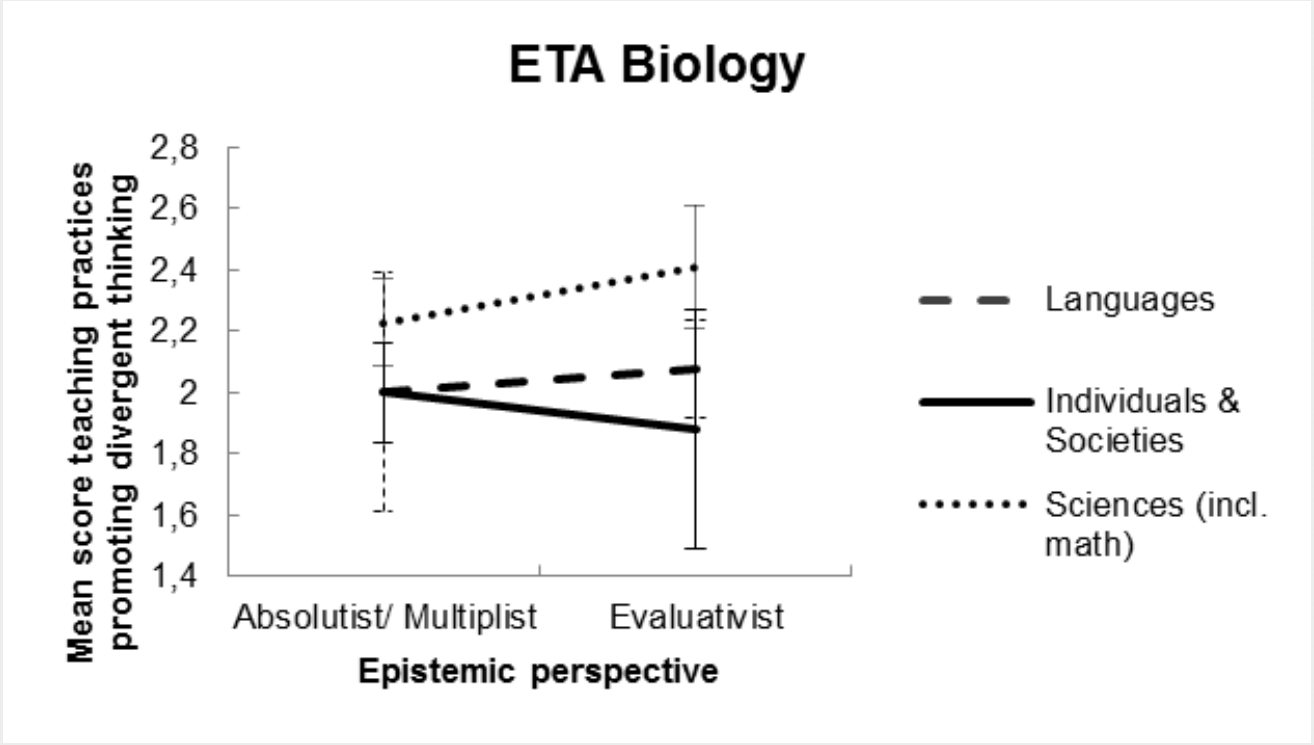
Results epistemic thinking

Table 2. Percentages of teachers per subject area group showing Absolutist, Multiplist and Evaluativist perspectives.

	Absolutist perspective	Multiplist perspective	Evaluativist perspective
Languages (48)	16.7	4.2	79.2
Individual & Societies (32)	53.1	3.1	43.8
Sciences (37)	51.4	2.7	45.9

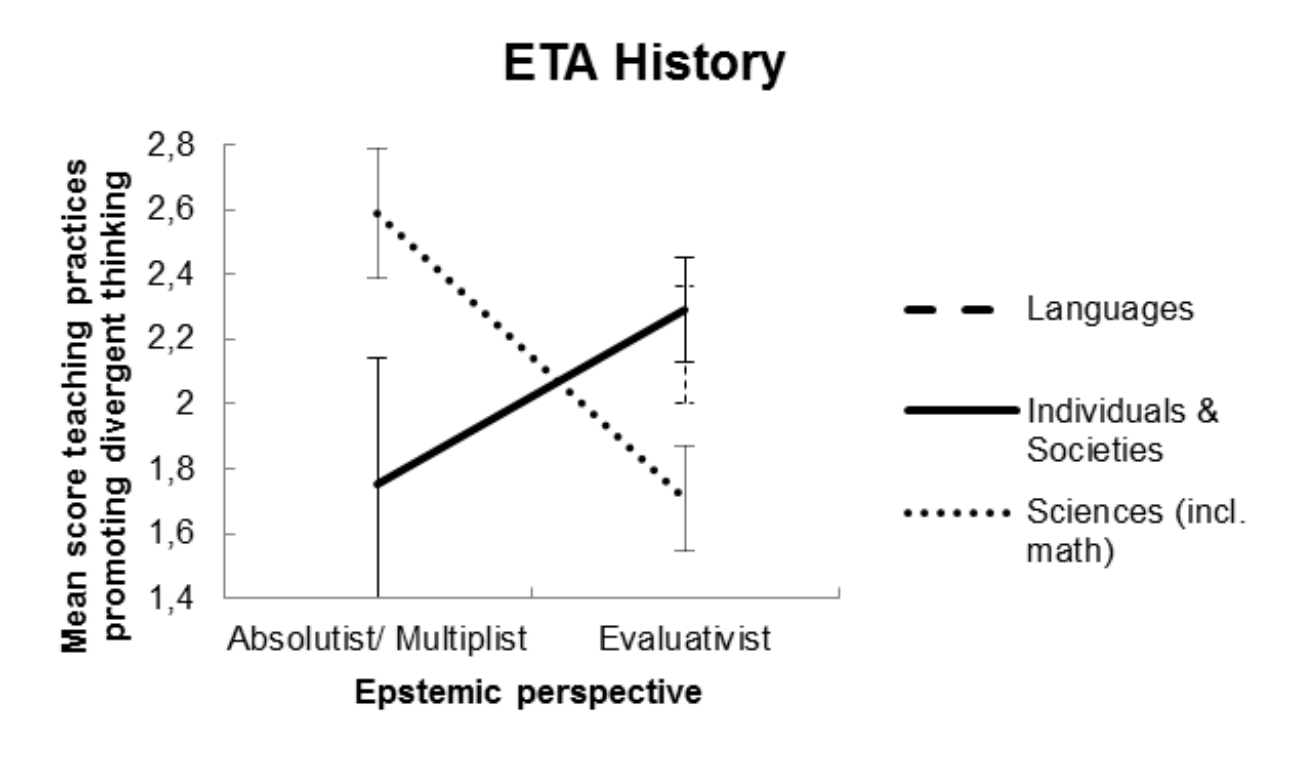
Chi2(4)=16.48, p=.002

Preliminary results epistemic thinking & IBT



F(2,37)=6.16, *p*=.018, partial eta squared=.14

Preliminary results epistemic thinking & IBT



F(2,37)=6.16, *p*=.018, partial eta squared=.14

Conclusion

- Teachers' epistemic thinking was dependent on the knowledge domain in which this was assessed (Barrzilai and Weinstock, 2015; Hofer, 2016)
- Teachers' epistemic thinking was dependent on their subject area group
- Teachers' epistemic thinking was related to their teaching practices promoting student divergent and critical thinking – (contrast: Lederman & Lederman, 2014)

Discussion

- Small sample size
- Feedback?

Sharing Knowledge Project

This study was performed within the framework of the Sharing Knowledge project: a collaboration between the Leiden University Graduate School of Teaching (ICLON), the Amsterdam International Community School, the International School of The Hague, and the Rotterdam International Secondary School. The study was funded by the Netherlands Initiative for Educational Research (NRO). We thank the schools and NRO.

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Extra

Crawford (2014, p. 515):

Teaching science as inquiry involves engaging students in critical thinking skills, which includes asking questions, designing and carrying out investigations, interpreting data as evidence, creating arguments, building models, and communicating findings in the pursuit of deepening their understanding by using logic and evidence about the natural world