Epistemic quality in the intended curriculum: what it is, why it matters, and some implications for policy

Dr Jennie Golding j.golding@ucl.ac.uk

Associate Professor Mathematics Education

UCL Institute of Education

Empirical work drawn on:

- 2014: English curriculum changes aiming to improve students' conceptual fluency, reasoning and problem-solving in mathematics. Internationally, such aspirational goals are widely valued, but have not been achieved at scale.
- 5 linked studies (9 researchers) 2016-2021 exploring the reforms' enactment and impact:
  - 2 studies of provision in primary schools (5-11 year-olds),
  - 2 of provision for 11-to-16 year-olds and
  - 1 for 16-to-18 year-olds.
- All longitudinal and classroom-close, using teacher and student interviews, lesson observations, discussions and surveys, documentary analysis and attainment progression data.
- Voice from ~600 teachers, ~4000 students, >100 schools/colleges.

Epistemic quality

- = quality of epistemic access (Morrow, 2008): here, quality of knowledge made available to learn in/via the classroom
- Hudson (2018) exemplifies high/low quality with brief descriptions of contrasting approaches to school mathematics
- Judged in relation to what is valued as learning (*by whom?)*
- In school mathematics, perhaps characterised as
  - knowledge that is discovered *or* created, including
  - utilitarian knowledge for everyday purposes
  - socially and economically empowering knowledge that enables appreciation and harnessing of the world
  - creative know-how that delights and affirms
  - knowledge of syntax and epistemology of school mathematics as a discipline closely related to (but different from) the parent discipline (Golding, 2018)
- *In your discipline?*

UCL Institute of Education

Epistemic quality communicated in the intended curriculum

- For England's 2014 national curriculum: Our studies show the epistemic quality being communicated is OK. The intended curriculum includes knowledge of procedures and processes, of flexible fluency, communication, problem solving and reasoning, so mathematical 'know-that' and procedural 'know-how' (Ryle, 1946), though it features little syntactic know-how.
- 'Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment. A high-quality mathematics education …provides a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject' (*Purpose statement, NC 2014*).
- We found the epistemic quality is also high in some curriculum resources (which are used by many teachers to interpret the curriculum)
- And in some early, but not later, high stakes GCSE (age 16) assessments
- *In your discipline?*

How is the enactment of such potential constrained by the quality of a teacher's own knowledge?

- In England, most teachers of learners 5-13 are not subject specialists, and many beyond that have limited specialist knowledge
- Teaching for such expansive learning (Engestrom, 2001) as that envisaged, requires wide and deep subject-specialist (including pedagogical) knowledge (Ball, Thames and Phelps, 2008), sophisticated skills, and positive affect, including beliefs (Golding, 2018).
- Our study showed that teachers of all ages, whatever their mathematical background, usually lacked initial capacity to enact the curriculum as intended, though a minority had already developed curriculum-coherent ways of working.
- Deep, often collaborative, teacher professional development coherent with curriculum intentions, supported by external expertise perhaps from high quality teacher-educative resources (Davis and Krajcik, 2005), was generally needed before teachers could make significant progress towards high quality epistemic access.
- *In your discipline?*

Epistemic quality achieved in the enacted curriculum

- High quality epistemic access then depends on teacher capacity and commitment, curriculum interpretation and on the adopted textual hierarchy (Gericke et al's 'transformation'). In our studies this was initially led by teacher-educative resources but later became dominated by high-stakes assessment texts, which came to threaten epistemic quality.
- *In your discipline?*

Epistemic and epistemological ascents

UCL Institute of Education

- The best curriculum resources support an enacted *epistemic ascent* (Winch, 2013) for all learners and there is some nascent classroom growth in this.
- But I'd argue that high quality education also includes *epistemological ascent*, without which learners can't fully participate in the powerful culture of the discipline.
- *Epistemological quality*
  - the opportunity to learn about the nature(s) of mathematical knowledge (contested though that might be: e.g. how is it related to sensed - and intrinsically fallible - knowledge deriving from the world around us?)
  - justification for new(-to-learner) knowledge
  - foundations for mathematical belief?
- is much less well supported in the intended mathematics curriculum.
- Learners need to come to understand wherein lies the *authority* for new knowledge.
- *In your discipline's curriculum*?

What is missing?

- *There is opportunity* to develop epistemological knowledge within the intended curriculum, but this is syntactical know-how, which unlike procedural know-how, is difficult to codify (and especially, to teach). It includes for example:
  - Some mathematics is contested or ill-defined
  - There are easy-to-understand conjectures which are not resolved
  - Definitions of e.g. a^0 are for mathematicians to agree on
  - Although 'proof' is expected, the (insufficient) role of multiple examples or of dynamic demonstrations to constitute proof is not - nor barely, notions of elegance, of infinity, of invariance or equivalence; the competing roles of sense and logic are implicit but not explicit. And the cultural and contextual embedding of mathematical meanings and practices is hidden: are they global and shared, can they assimilate ethnomathematics, or do they have to change to accommodate that?...
- *In your discipline?*

In practice, and in summary…

- *Our studies show*… classroom epistemological quality varies enormously, with authority ranging from 'because the textbook says so' to deeply challenging student experiences developing and fully justifying new-to-them knowledge: we observed the range at each age phase in our studies.
- But teaching for high quality epistemological learning is *highly demanding* on teacher capacity (skills, knowledge, affect – Golding, 2017)
- If young people are to learn that (mathematics) is a meaningful and empowering creative discipline that they can harness for multiple purposes, and communicate to others, requiring shared vocabulary and syntax, then we need
  - A curriculum that overtly values the range of disciplinary epistemology
  - Teacher education that prepares teachers for its (demanding) enactment, and
  - Curriculum materials and learning assessments coherent with that
- *In your discipline?*

References

- Ball, D. L., M. H. Thames, and G. Phelps. 2008. Content knowledge for teaching: what makes it special? *Journal of Teacher Education* no. 59 (5):389-407.
- Davis, E.A. and Krajcik, J.S. (2005) Designing educative curriculum materials to promote teacher learning. *Educational Researcher 34/3*, 3-14.
- Engestrom, Y. (2001) Expansive Learning at Work: toward an activity theoretical reconceptualization, *Journal of Education and Work*, vol. 14, 1: 133-155.
- Golding, J. (2018). Mathematics education in the spotlight: its purpose and some implications *London Review of Education 16(3*), 460-473.
- Golding, J. (2017) Mathematics teacher capacity for change *Oxford Review of Education 43(1) Special Issue: The Best of British*, 502- 517
- Gericke, N., Hudson, B., Olin-Scheller, C. and Stolare, M. (2018) Powerful Knowledge, Transformations and the Need for Empirical Studies across School Subjects, London Review of Education 16(3)
- Hudson, B. (2018) Powerful Knowledge and Epistemic Quality in School Mathematics, London Review of Education 16(3)
- Morrow, W. (2008) *Bounds of Democracy; Epistemological Access in Higher Education*. Pretoria, HSRC Press.
- Ryle, G. (1946). Knowing how and knowing that. In *Gilbert Ryle: Collected Papers*, 212-225. New York: Barnes and Noble.
- Winch, C. (2013). Curriculum design and epistemic ascent. *Journal of Philosophy of Education, 47(1*). 128-146.