Agreeing to Disagree for the Sake of Formative Evaluation: A Delphi Panel Deliberates on Mathematical Thinking and Doing

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Abstract: In this paper we discuss a Delphi study conducted for the formative evaluation of the Cambridge Mathematics Framework. A panel of curriculum researchers responded to questions arising from our design, theoretical framework and methodology. This paper presents the panel's responses regarding the relevance of motivation to mathematical thinking and doing in our design context. The panel expressed high levels of professional disagreement about motivation and its links to conceptual understanding in mathematics.

Background and context

We are designing and evaluating the Cambridge Mathematics Framework (CMF), a *reference framework* (a superset of disciplinary content used for designing curricula; Cunningham, 2017) for mathematics which is intended to support curriculum and domain coherence in mathematics curricula, as intended, enacted and received. A reference framework makes use of the wider professional knowledge that curriculum designers, resource designers and teachers draw upon and presents that knowledge in multiple ways so that it can be recognised and productively interpreted by members of different professional communities (Stahl, 2006).

The CMF is a digital tool for creating and presenting shared representations of ideas in school mathematics and the connections between them. It draws on a database of mathematical ideas and experiences that we are continuing to build, expressing our interpretation of research we have reviewed. This tool has so far been used to develop curricula and resources and to map existing task and curriculum frameworks to the CMF for analysis and refinement.

Designing to support coherence requires considering many questions which do not have clear answers from prior research or practice. Questions as fundamental as what constitutes mathematical understanding and how it should be represented in education are answered in very different ways in different subfields. In this paper, we report on a portion of this Delphi (expert panel) study concerning how or whether the CM Framework might address elements of mathematical thinking and doing.

There were several questions guiding the Delphi study; we will focus on RQ3: How should we prioritise support in the CMF for the various elements of mathematical thinking and doing which have become important considerations based on our recent literature reviews and past experience? In the narrower scope of this paper, we focus on 'motivation,' an element of RQ3 (see Figure 1 for the full list of elements) as an example of how we were able to identify and learn from expert disagreements relevant to our design considerations. This represents work in progress as we proceed with our analysis, which will be reported fully in a forthcoming paper.

Methodology

The Delphi method is a structured group survey method designed to identify areas of consensus and disagreement among experts around issues which are ambiguous or not explicitly in the literature, but in which experts nevertheless employ heuristics or tacit knowledge to make decisions in the course of their work (Clayton, 1997). Participants on a Delphi panel engage in questionnaire-mediated dialogue with each other around their judgements and ideas, with each round of questionnaires adapted based on previous responses. Consensus is considered a meaningful outcome, but persistent disagreements and unique points raised around issues may be of interest whether they have reached consensus or not.

We recruited 16 experienced leaders in mathematics curriculum research in six countries: UK, USA, Australia, Japan, Ireland, and Spain. As is common in Delphi studies, participants were intentionally selected so that the panel would consist of people whose professional opinions would be highly relevant but also diverse.

The items on mathematical thinking and doing items were featured in each round (see Fig. 1). In all rounds we calculated the median level of agreement and MAD (median absolute deviation) for each item and analysed free response themes with two rounds of coding. In Rounds 2-3 we determined whether the panel reached a consensus after one or more rounds of repetition. We looked at group-level opinion change by calculating the difference in median agreement, and individual-level opinion change by calculating Spearman's Rank Correlation Coefficient, ρ (values closer to 1 indicate less individual opinion change between rounds); these results will be reported in the poster.

Results and discussion

In this paper we highlight the 'motivation' element of mathematical thinking and doing (see Figure 1) because it turned out to be an area of productive disagreement and discussion among the panel members. 'Motivation' did not reach consensus in any category after three rounds. By Round 3, 'motivation' had the lowest median level of agreement and highest MAD out of all elements for categories 1, 2 and 3, and one of the highest levels of group opinion change for cat. 1. Individuals did not change their minds very much about 'motivation' for cat. 1-2, despite cat. 1 having a high level of group change; along with free response results, this suggests they may have doubled down on their positions in response to points made by other panel members.

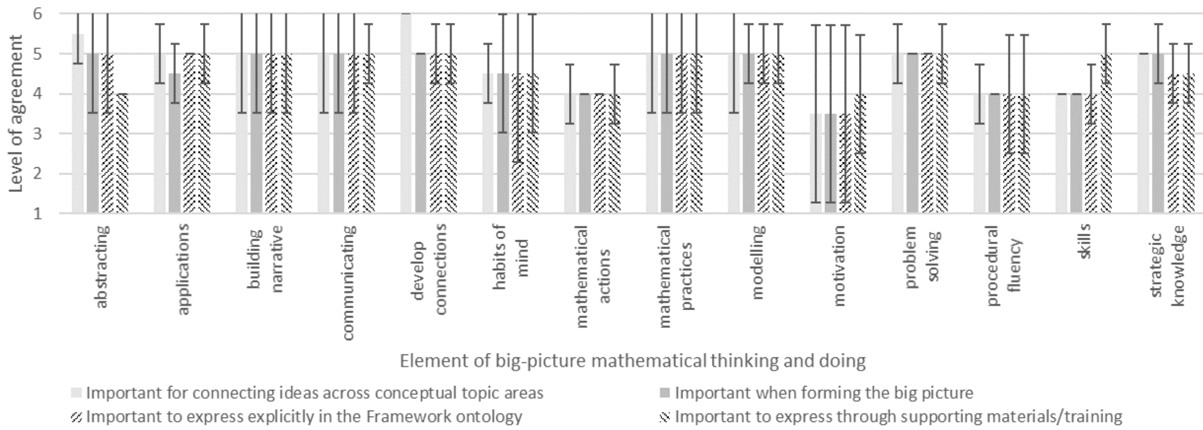

Figure 1. Median responses in Round 3 to a series of six-point Likert-type items with four agreement categories; error bars represent 1 MAD (median absolute deviation).

Based on coding of free response items, for many these results reflected a clear preference to make a distinction between the CM Framework as conceptual and pedagogy as practical and to put support for student motivation on the practical side; for a few, that seems to reflect a research focus on conceptual learning apart from affective or motivational frameworks. Others saw more direct conceptual/cognitive relevance.

We had included 'motivation' because we wanted to consider the major factors in the development of students' abilities to think and act mathematically Motivation is tied to needs and goals (Wæge, 2010), and it can be framed in different ways with respect to cognition or conceptual understanding (DeBellis & Goldin, 2006). The nature of motivation is the same regardless of its degree of intersection with domain-specific activities. However, when someone is motivated to do maths by needs and goals which derive from mathematical thinking or problem-solving which are related to their prior mathematical knowledge, we might consider them to be intrinsically motivated to do mathematics. The panel clarified considerations we could productively pursue through further research, and our engagement with this issue will inform how we design and link up layers in the CM Framework supporting professional development and tasks.

References

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