Chapter 19

Conclusion to Interdisciplinary Mathematics Education

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Abstract We summarise the progress made by the works reported in this book for the field of Interdisciplinary Mathematics Education. It is concluded that there is still much to be done in this subfield.

Keywords Interdisciplinary · Mathematics · Education · Conclusion

In our original pre-ICME-13 assessment of the *State of the art* (Williams et al., 2016), we commented on key weaknesses in the field that research needed to address, and this book does address some of these, such as the clarification of the conceptions in the field and its theoretical bases; the different integrative and cross curricular practices studied in cases; and the policies adopted in schools breaking down disciplinary barriers.

However, we can see clearly, that our work still has a long way to go in some of these areas, e.g. the literature reviews in the field need to be based in the theoretical, and conceptual work to produce effective systematic reviews; new fit for purpose measurement tools are desperately needed if systematic quantitative work is to be conducted for evaluations that can accumulate in meta-analyses; and case studies need to be clear about the phenomena they are researching.

At repeated points in this volume interdisciplinarity has raised the question of meta disciplinary knowledge needed to work across disciplines. This was introduced previously in the *State of the art*, but only in its infancy. Disciplinary awareness becomes necessary in teacher education, in policies affording the integration of the curriculum, and in professional practices when disciplinary power has to be negotiated, and to become flexible in the greater good. But most important, we need to learn how to frame the curriculum, pedagogy and assessment for learners in ways that can encourage their own development of disciplinary awareness. It has been argued that disciplinary and interdisciplinary awareness involves knowing when *not* to use a particular discipline as much as when and how to do so: this is arguably

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a key idea for schooling, that we might treasure the capacity of learners to become un-disciplined in this sense. But of course, learning when not to play the game also requires at least some knowledge of when and how to do so.

In all the discussions concerning IdME in the *State of the art*, and in this book, it seems to us that we have almost all missed a rather important element, one that is not particularly discussed in the literature: the distinct and special disciplinary nature of mathematics itself, and how and why this makes mathematics special to inter-disciplinary work and education. Of course, mathematics is discussed, and all the chapters and cases involve mathematics, with mathematics always implicit, and often explicit. But what is missing—or at least hardly emphasised—is a discussion of the particular features of mathematics in relation to the phenomenon of inter-disciplinarity, that is, its particular relationship with other disciplines in problem solving and inquiry, or, for example, its particular position within education, and its particular history of pedagogy and curriculum.

Actually, one thread has been mentioned, and that is the tendency for mathematics to disappear from attention in interdisciplinary problem solving, and integrated studies. The tendency for mathematics to be black-boxed or treated as a tool is part of this tendency. This is not unique to mathematics (other disciplines disappear too, unless they are deliberately upheld, and in many tasks science is irrelevant from the beginning, even when mathematics remains salient). However, interdisciplinarity may take a particular form when involving mathematics, insofar as mathematics may become regarded as a tool by *other* disciplines, as such, taking up much less cognitive space, or of being trivial in demand, compared to these other disciplines, and so less visible to the learners and less powerful than these other disciplines.

Clearly this relates to mathematics as a language of, or for, the sciences. But it also arises from the rôle of a discipline in the service of solving problems arising from outside the disciplines, e.g. modelling in ‘real world problem solving’, rather than for learning the discipline for its own sake. This clearly applies to all disciplines in use in problem solving, while the former is particular to the case of mathematics (and perhaps ‘use of language’—if we take language use to be a discipline).

The relation between mathematics and other disciplines and sciences, then, is a particular topic that needs elucidation if we are to understand interdisciplinarity in mathematics education. Historically, the emergence of mathematics as a distinct discipline could help us: the account, in Williams and Roth (this volume), is a first attempt, and does not yet draw out the particularity of mathematics. But actually, if our purpose is to understand interdisciplinarity in the context of schools and universities, a cultural-historical framing would need to trace the emergence of: mathematics as a separate discipline; the modern school curriculum; the development of the subject teachers’ professions; and the alienation of disciplines from each other, all from the interdisciplinary point of view. All this would be needed to understand how the present came to be, and what separates the school subjects, and what keeps their associated disciplines apart.

For instance, the way school subjects separate the ‘interests’ of teachers’ professional communities is significant in explaining why the mathematics needed in some other subjects is often instrumentalised, or even trivialised. At the level of the

curriculum, for instance, one sees a tendency for even Physics texts and syllabuses to find ways of reducing the necessary mathematics: topics that require minimal mathematics can be emphasised even at degree level. This can be justified by the wish to make the subject more accessible, or even more commercial. Anecdotally, some time ago, during a case study in one university engineering department, some senior staff claimed that they would be concerned about the consequences of a research team sending intending students a questionnaire about mathematics, in case this made them think mathematics was an important pre-requisite, and so decide not to apply to their university.

Then, one can add to this, the historic pedagogy of rote learning in mathematics that can be reflected in teachers of other subjects approach to dealing with mathematics in their subject teaching. In some science text books, it is not uncommon to see the mathematical relation in Physical Laws reduced to a ‘cover up rule’ for the Triangle with V, I, and R at its vertices (with V at the apex) thus making the mnemonic for $V = IR$ iconic. The use of mnemonics are as widespread in mathematics as in science (e.g. SOH-CAH-TOA for trigonometry, or those for the colours of the rainbow). But, if the mathematics in use in other sciences is *always* instrumentalised there, this clearly carries dangers for a ‘hidden curriculum’, not only for mathematics, but for the way interdisciplinary mathematics becomes understood, i.e. for the meta-knowledge of the disciplines.

A further issue is that interdisciplinary mathematics is clearly a very broad church. The range of interdisciplinary work described in the preceding chapters testifies to this, and therein lies a challenge for the future. How do we construct a unifying definition of interdisciplinary mathematics education that supports this broad range of contexts with coherence? It is reasonable to suggest that, unless a suitable, broad, definition can be created, and accepted universally, interdisciplinary mathematics education may suffer the fate of other educational waves of enthusiasm, and become a name for virtually anything that is different from the disciplinary tradition.

This lack of definition, of course, raises a further issue, and that is the lack of research into interdisciplinary mathematics education itself, to provide educators, policy-makers, and politicians, with some boundaries and facts. As mentioned earlier, the definition, and thus, the construction of a discipline, may need research that uses an Activity Theory approach, to ensure that all aspects, including dis-positions, are taken into account.

In conclusion, this volume has added to the state of the art in interdisciplinary mathematics education, but we have here posed some key questions for future research, such as “in what way is ‘mathematics’ special in interdisciplinary education?”

References

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