EDITORIAL: REGENERATION

RICHARD BARWELL

There is a long-running British science fiction series, *Doctor Who*, in which the principal character, the Doctor, is, from time to time regenerated. The body of the Doctor dies, through age or from being attacked by aliens; but the Doctor does not die. Instead, the body of the Doctor is transformed into a new one, with the same history and experience, but a new physical appearance and personality.

This issue of FLM is my last as editor, after a mostly enjoyable term of six years—not long enough to feel like a prison sentence (or be attacked by aliens); but long enough to be ready to relinquish the role and its responsibilities to someone else. That someone else is David Reid, Associate Editor since 2014 and long-time member of the Advisory Board.

Handing over the editorship to David feels a bit like the Doctor's regeneration. The physical manifestation of the Editor departs, but the Editor lives on, transformed into a new body with its own personality, but with the same history and experience. To be clear, I don't mean that David will become me, any more than I have incarnated any of my four predecessors. What I mean is that we have all not simply done the editing; we have each been the Editor, inhabiting a role that shapes us, as much as we shape it. Indeed, as David wrote in the hundredth issue, "FLM is a history of recursive structural changes in which all the participant systems change together congruently. The readers change, the authors change and the articles change" (Reid, 2014, p. 11). He might have added that the editor changes too, while remaining the Editor.

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The suggestion to writers (inside back cover) that FLM is "a place where ideas may be tried out and presented for discussion" invites the possibility of future-oriented writing. Indeed, for the hundredth issue of FLM (34, number 1), I asked Advisory Board members to write "for the learning of mathematics for the future". Our lives and societies seem to change so rapidly, that I wondered what learning mathematics could or should be like in response. Will mathematics in school remain relevant for future generations? Will schools still exist? How else can mathematics be learned? What will mathematics teachers be doing (if anything)? What mathematics will be taught?

The pages of FLM offer a range of visions, hints and speculations. In the current issue, Olsher, Yershalmy and Chazan offer a glimpse of how technology could serve mathematics teachers in the future by providing detailed real-time information about the thinking of each student in a mathematics class. Their work is innovative and has real potential. It also reminds me, rather uncomfortably, of how supermarkets and department stores now collect real-time data from individual shoppers (through their phones), the better to offer them products and tempting deals.

Technology, of course, has long been a topic for future thinking. Christine Keitel was thinking about it in FLM in 1986. I've included an extract of that article in this issue—she died earlier this year. For Keitel, technology might allow for mathematics in school to move away from the societally "useful" to something more like "appreciation"; her analogy is the study of literature. The question, inevitably, is "useful for whom"—for supermarkets and department stores, or their customers?

The tension between useful mathematics and appreciation of mathematics has never really gone away, as can be seen in Hertel's contribution to the current issue. He examines something of the content and form of mathematics studied in New England in the eighteenth and nineteenth centuries, focusing on mathematics related to navigation—in that place and at that time, sailing was significant. Students (including George Washington) proceeded from Euclidean geometry to exercises in navigational calculations, including "plane sailing". Presumably plane sailing was the most straightforward, through its simplifying assumption that the Earth's surface is a plane (see Dimmel's communication in this issue for some discussion of whether or not it actually is a plane). For the students whose work has been preserved, navigational calculation methods were not just useful, they were critical; errors could lead to disaster. Their work appears to include much mechanical practice, presumably justified, even then, in the name of the "useful". It is less clear, though, how much they were encouraged to appreciate mathematics, beyond its instrumental value for steering ships (for the slave trade, among other things, I presume).

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James Lovelock long ago proposed the Gaia hypothesis that states that the collective ecosystem of all life on Earth can be thought of as a single self-regulating organism. The dynamics of Gaia are non-linear. Humans, of course, are just one part of the collective ecosystem, although one that, in the past two centuries, has started to provoke huge changes, including climate change, mass extinctions and habitat destruction. Since humans are part of this ecosystem, these changes are entirely "natural"; we are not separate from nature. On the other hand, we do (individually and collectively) have awareness of these changes and, to some extent, of the collective impact of our species. Awareness brings the possibility of acting differently—only awareness, as Gattegno said, is educable.

Ubi D'Ambrosio has, in recent years, made regular calls for mathematics education to consider how to respond to this situation, pointing out the link between mathematics, technology and environmental crisis. In the hundredth issue, for example, he wrote of how "The evolution of mathematics and the world scenario are intimately related" (d'Ambrosio, 2014, p. 3). I am puzzled, therefore, at how little attention mathematics education researchers have given to environmental topics. Why is this? There is plenty of research on social justice, democracy and critical pedagogy in mathematics education, so it is clear that, as a field, we do not avoid difficult, politically charged societal challenges. Do we, as a field, believe that mathematics education should not address environmental issues? That such topics are already covered under other headings, such as mathematical modelling or statistical literacy? Or in other subjects, like science or geography? Do we believe that our job is to provide our students with the ("useful") mathematical tools they need to deal with such questions, but not directly address the questions themselves in our work? Is it that the mathematics of Gaia is just too difficult—all those complex systems, differential equations and stochastic processes? Why are we not doing more?

Perhaps one challenge is that environmental crisis requires more than tweaking the mathematics curriculum, or the inclusion of environmental topics as a context for doing mathematics. In the first issue of my editorship, Moshe Renert argued that the most meaningful response would entail a wholesale rethinking of mathematics, teaching and schooling. Even in the pages of FLM, it is rare to see genuinely radical proposals for new kinds of mathematics education (even if many authors pretend to such a thing). Is the task just too difficult? Are we constrained by the inherent conservatism of our imaginations?

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Several eminent scientists, including Stephen Hawking and James Lovelock have recently predicted that computing power will reach a point at which artificial intelligence will take over. Artificially intelligent machines will become capable of self-generation. Such machines may eventually conclude that humans are dispensable, rather like Hal in the film *2001: A Space Odyssey.* In fact, there are already examples of tools designed by computers, including microchips and internet congestion control algorithms. Even if the idea sounds far-fetched, it raises interesting issues. We tend to think of technology as serving us, as being a tool with which to enhance (control?) our environment (including other people—like supermarket customers). As Ole Skovsmose has argued in these pages, however, our lives are already greatly shaped by technology, and therefore by mathematics, often without us realising. So much of our lives is organised by algorithms—by mathematics. The environmental crisis seems like an unintended consequence of humans' amazing skill at designing new tools to make our lives better. Technology never quite goes according to plan, in our lives or in our classrooms. What of mathematics, then, should we teach the next generation of students?

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FLM is particularly valuable for *thinking* about mathematics education. Thinking—good thinking—needs fertile ground: carefully considered ideas; an awareness "that the learning and teaching of mathematics are complex enterprises about which much remains to be revealed and understood" (inside front cover); and dialogue. The pressures of academic life can make it difficult to find time to think.

Dialogue requires participants to speak and listen to others with awareness of their perspectives. (To get a sense of how hard this can sometimes be, see, in this issue, the communications coordinated by David Guillemette and Cynthia Nicol, and the conversation between Sean Chorney, Robyn Ruttenberg-Rozen, Tanya Noble and Mamokgethi Setati Phakeng.) Dialogue is, however, more than an exchange of words. Dialogue involves the interaction of voices, of ideas, and it is in this sense, above all, that FLM is a *dialogic* journal. At its best, FLM buzzes with ideas interacting, connecting, clashing, disputing, provoking and generally having a good time.

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The question isn't whether mathematics is "useful" for good ends (curing diseases, social justice, shopping) or terrible ones (environmental destruction, robot take-overs, shopping), or whether mathematics education should be guided by usefulness or appreciation. Mathematics is all of these and more: a technology and an art that is implicated in enriching and damaging our lives and the rest of the ecosystem. In the hundredth issue, Jean-François Maheux wrote (or rather drew) "I like how technology never completely works, et comment l'éducation mathématique non plus n'est jamais sans difficultés" (2014, p. 26). This position is fundamentally dialogic: thinking with no definitive end point, featuring curious juxtapositions and unexpected turns. There are always difficulties in mathematics education and so there will always be a need for FLM.

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Being a dialogic journal means that the editor interacts with many others. Thank you, first, to authors without whose voices, there would be no journal. Thank you, too, to: the members of the Advisory Board, who have commented on submissions when asked, and responded to my various requests and invitations so positively; my editorial assistants over the years—Sheena Sumarah, Maria Bastien, Tracey Parker and Pam Rogers—and the Faculty of Education, University of Ottawa, for paying them; Dave Wagner, for taking care of the back-office duties; my associate editors, Nathalie Sinclair (2011-2016), Steve Lerman (2011-2013) and David Reid (2014-2016); my predecessors, David Pimm, Laurinda Brown and Brent Davis, for suggestions and advice from time to time, and David Wheeler, who I never met, for creating the whole thing. Particular thanks go to the ever-patient Rachelle Painchaud-Nash, designer of FLM under four (soon to be five) editors. I have felt, throughout, part of and supported by a wonderful community. It only remains to wish David Reid plane sailing...and to thank you for reading.

References

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