

Editorial

If you were asked to summarise your vision for how mathematics education should develop over the next 20 years or so, what would you say? The Royal Society has been thinking hard about this question (in the broader context of science and mathematics) and in June published its *Vision for Science and Mathematics Education* [1]. As might be expected, the committee that was responsible for the report was made up of numerous extremely distinguished individuals and it is nice to be able to report that the Chair of the group was a mathematician (Sir Martin Taylor). The Vice-Chair, Professor Dame Julia Higgins, spoke about the *Vision* at the IMA@50 event that took place at the Royal Institution in October. Incidentally, this was a great event made even more special by being the first time that I had ever been in the lecture theatre that is used for the Christmas Lectures. The knowledge that I was in the very room where Faraday enthused audiences in the 19th century more than made up for the lack of leg-room!

One of the most attractive features of the Royal Society's report is the question it seeks to address. By adopting a 20-year time-frame there is a clear signal that this cannot be achieved during the career of any one education secretary, or indeed any one government, and so there is a chance of the discussion being elevated away from the short-term thinking that pervades modern politics. The full 116-page report has been synthesised into a number of key messages. The first is that by 2030 all young people study mathematics and science up to the age of 18. Of course this does not mean that all school children should take mathematics A-level. Nor is this driven by a desire to generate more professional mathematicians or scientists (though this might be a positive outcome). The idea is that a solid grounding in mathematics and science is essential if we are to empower future generations to actively participate in the technological world in which they will live and to equip them with the knowledge and skills they will need in order to understand and influence those charged with making decisions critical to their lives. To quote the report 'Scientific and mathematical understanding is fundamental to fostering an inclusive and effective democracy'. This is bold statement. As a statement about the 21st century, I agree with it, though we need to be careful not to make it sound as if it is sufficient.

How might the provision of mathematics and science education for all up to the age of 18 be achieved? Not by tinkering, that's for sure. The *Vision* proposes that we need something more akin to the baccalaureate-style education system common in Europe. In other words the focus should be clearly on breadth rather than depth and there should be a blend of academic and vocational courses of equally high quality. Is this right for the young people of tomorrow? I certainly think so. The challenges that would have to be overcome to implement such a system are considerable, not least ensuring that we have enough appropriately qualified teachers, but that does not make the goal the wrong one. The knock-on effect on universities would be considerable, it might

even lead to revolution in the nature of higher education in the UK. Uncertainty can cause apprehension but here the prize is so great I think that excitement at the scale of the opportunity is a better response.

The notion that it is acceptable to be mathematically illiterate is deeply ingrained in British culture and it will take a great deal of time and effort to remove it. But there is another culture shift that has to happen. The mathematics community needs to embrace the people who are involved in this new style of education, be they teachers or learners. For too long, the mathematics profession has concerned itself primarily with the generation and nurturing of the next generation of professional mathematicians rather than taking ownership of mathematics as a subject which is important to everybody. Even at university we say our farewells to students graduating with a maths degree and going on to train as accountants as if they are leaving the mathematics world and are no longer of any interest to us. Mathematics will be best served when the subject is pervasive and acceptable in society, when policy makers have some knowledge of the subject, and when the subject leaders are respected for their expertise. The Royal Society *Vision* contains nettles that we, as a community,

would be wise to grasp.

Another key message concerns the way curricula are developed and monitored. The *Vision* pictures a world where science and mathematics curricula evolve under the control of independent expert bodies, providing quality and coherence in 5–18 STEM education, rather than being changed radically at the whim of each new education secretary. It is envisaged that professional bodies would have a very important role to play here. The inadequacy of the present make-up of the professional bodies that represent mathematics is all too evident, however. The *Vision* suggests, quite reasonably,

that biology, chemistry and physics should be entrusted, respectively, to the Society of Biology, Royal Society of Chemistry and Institute of Physics. For mathematics we get the unimpressive statement: 'CMS [Council for the Mathematical Sciences] and ACME [Advisory Committee on Mathematics Education] are good starting points'. Actually, I think the IMA, as the only society within the mathematics community that defines itself by its inclusivity rather than being a special interest group might be a better place to begin. Nevertheless, the weakness in mathematics due to the fragmented way we organise ourselves continues to be a source of immense frustration to me. Going back to the general point, I would urge a degree of caution about entrusting any professional body with this role. The curriculum must remain current and attractive to young people and I have concluded, largely through my interactions with the various accreditation processes that universities go through on a regular basis, that many professional bodies can become self serving rather than operating in the interests of the next

generation. So I think it is important that the intended outcomes from a curriculum should be influenced by a very broad stakeholder group, including employers and politicians, even if then the specific design is left to the subject experts.

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Clearly it will be very hard to achieve any significant progress without a strong supply of high-quality science and mathematics teachers. There is an obvious need to widen access to mathematics teaching and enhance its appeal to prospective entrants and returners. It is vital in my view that the mathematics community plays a leading role in the promotion of teaching as a career, particularly to high-performing undergraduates, and does everything that it can to help raise the profile and enhance the reputation of mathematics teaching. The IMA has taken a lead through its involvement with the Chartered Mathematics Teacher designation and Mathematics Teacher Training Scholarships, but it is a culture shift that is required and this will take time. It is also important that education policy and practice are better informed by evidence. While this seems self-evident there is a problem when it comes to mathematics and that is the historical tensions that have existed between mathematics and mathematics education researchers. So as to enhance collaboration and communication between these two groups I would advocate, and I have tried to put into practice at my own institution, embracing mathematics education within mathematics. Another issue which often gets in the way of letting evidence drive policy and practice is the natural desire that scientists and mathematicians have for quantitative evidence. Qualitative research is also important when it comes to many questions concerning education and, given that most mathematicians are not well-versed in the social sciences, it can be very hard to persuade people who think in numerical terms of the value of what is necessarily a more subjective approach.

It has been recognised for many years that many children get turned off from science and mathematics when at school and partly this is because they don't see the relevance of what they

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are learning to their lives. And yet as we all know, quite the opposite is true. Part of the problem here, and this goes back to the point about curriculum design, is that material taught at school is often there because it was important a generation ago, or because it will be useful if you study that subject at university. It appears to me that there is much more value in providing children with the desire to learn more about science and mathematics, even at

the cost of learning a little less theory. And the idea that you should reduce the importance of practical work at school because it's hard to assess is just plain bonkers. It is also critical that pupils, and their parents, get regular opportunities to find out about the value of STEM education in helping to gain access to all sorts of professions and careers. My

own anecdotal experience of talking to prospective university students at open days is that careers advice provided by schools is usually extremely poor, so there is no doubt that there is a lot of work to do here.

I have only skimmed the surface of what is a comprehensive and thoroughly researched document; you can read more about it on page 284. But I think it is a *Vision* that serves as a very useful starting point for a drive to improve the way science and mathematics is taught at school. Equally, in my view, it serves as a wake-up call to mathematicians. The future of science and mathematics education is so important that the mathematics community should be engaged fully with the many different agendas that are in play. This will never happen while we operate within silos, each trying to protect its own special interest.

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REFERENCES

- 1 royalsociety.org/education/policy/vision/