

Mathematics Teaching

Is the Future Syncretic?

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EXTENDEND ABSTRACT

Teaching is one of the oldest professions on Earth and mathematics teaching must have had come first, since it appears that numbers had been invented before letters! Yet “mathematics wars” have been raging throughout the XX century and technology has only added fuel to fire: should mathematics be taught as poetry, requiring an inordinate amount of memorising and practising or should teachers concentrate on abstract concepts, with the tedium of calculations left to calculators and computers? Can ordinary learners grasp abstract concepts at all? On top of that, a modern University maths teacher teaching STEM students, particularly, future engineers has to cope with large classes, much larger than most European teachers had to deal with in the past. Can any of the teaching approaches be implemented in such environment in an effective manner? The advent of the XXI century saw mathematics teachers cajoled into employing the “evidence-based” technological solutions that had been shown to work when training University administrators, business managers or technicians. Many resisted, arguing that maths learning is a different process to learning a few words and procedures. Now it is all about Massive Online Open Courses and Flipped Classrooms. Can ordinary engineering students learn mathematics by watching MIT or Khan Academy videos? Can ordinary mathematics teachers facilitate the process by “flipping” in an effective way? I will present my thoughts on the subject, argue against false dichotomies and suggest syncretic solutions, including the ones that rely on cognitive technologies of the future.

I will start discussing several myths that became popular among educationalists:

Only what students discover for themselves is truly learned, while in reality students learn in a

variety of ways. Recent research has shown that basing most learning on student discovery is time-consuming, does not insure that students end up learning the right concepts, and can delay or prevent progression to the next level. Successful programs use discovery for only a few very carefully selected topics, never all topics.

There are two separate and distinct ways to teach mathematics,... conceptual understanding through a problem solving approach and through drill and kill, while according to many experts success in mathematics needs to be grounded in well-learned algorithms as well as understanding of the concepts.

Math concepts are best understood and mastered when presented "in context"; in that way, the underlying math concept will follow automatically, even though it has been repeatedly shown that when story problems take centre stage, the math it leads to is often not practiced or applied widely enough for students to learn how to apply the concept to other problems.

I will move to recent MOOCs data that show that the pass rates of current MOOCs registrants are low and the overwhelming majority of those who obtain the certificate of achievement already have a degree. I will suggest my answers to the question posed by these data “What are MOOCs missing?” I will suggest that they open a door to advanced cognitive tutors that employ the oldest and best teaching method – Socratic dialogue, which allow students to master abstract concepts and practice under “expert supervision” at the time and place of their choosing.

Finally, I will address the suggestion that because of MOOCs in 50 years there will be only 10 institutions in the world delivering higher education. However, I would argue – in line with many other academics – that, particularly in the first year of their academic studies, students, disadvantaged STEM students need intensive guided teaching. This

can be delivered only in person and only by the most experienced teachers capable of not just “talking” – delivering content, but mainly of “listening” – and readjusting their delivery depending on the student immediate feedback. Of course, these experienced teachers and their students would benefit from access to quality MOOCs.

BRIEF BIOGRAPHY

Larissa Fradkin is Emerita Professor, London South Bank University, UK and Associated Professor, Brunel University, UK. Trained as a physicist at St Petersburg University, Russia, from 1974 till 1977 she studied for her PhD in Applied Mathematics at Victoria University of Wellington, New Zealand. From 1978 till 1984 she was employed as a Research Scientist at the NZ Department of Scientific and Industrial Research and from 1985 till 1992, as a Research Associate at the Department of Applied Mathematics and Theoretical Physics of Cambridge University, UK. From 1993 till 2009 Larissa was a member of academic staff at London South Bank University where she created and ran a Research Group on Mathematical Modelling of Ultrasonic NDE (Non-Destructive Evaluation of industrial components and materials) and teaching mathematics on various engineering courses. She is now a Managing Director of an independent research organisation Sound Mathematics Ltd., working on her ultrasonic projects, mainly in collaboration with CEA (the French Atomic Commission) and promoting sound mathematics education of engineers. Larissa is a Fellow of IMA (UK Institute for Mathematics and Its Applications), IOP (UK Institute of Physics) and IET (UK Institute of Engineering and Technology). Larisa has authored and co-authored over a 100 scientific and scholarly publications, lately on pedagogy behind her system of maths teaching and in 2013 Bookboon has published her open access e-textbook “College Algebra and Calculus: The Whys and Hows.” Larissa has been a member of organising committees of several international engineering conferences and is currently a UK National contact person for SEFI’s Maths Working Group (SEFI is the European Society for Engineering Education) and a member of the Committee on Mathematical Education for Engineers, iNEER (International Network for Engineering Education and Research). Larissa lives in Cambridge, England.