Proposing a Way Forward for Compulsory School Mathematics

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Falling mathematics standards?

I would argue against:

1. Compulsory level examination papers (e.g., SEC) are beginning to focus less on ‘facts’ and ‘applications’ and more on ‘reasoning’ (i.e., more emphasis on ‘higher order’ mathematical skills).

2. More and more students are getting certified at end of secondary (e.g., May 2013: SEC grades 1-5 ~ 2703 or 53.7% of registered students) and furthering their studies at postsecondary (e.g., May 2013: IPM grades A-C ~ 229 or 34.9% of registered students / May 2013: APM grades A-C ~ 261 or 42.4% of registered students) and university levels (2013-2014: 44 BEd maths and 156 BSc with one of the specializations maths).

3. Averages may thus be falling more due to increases in student numbers rather than actual lowering of standards.
Can we be complacent?

I would again argue against:

1. Standards are defined almost entirely by high stakes examinations (e.g. SEC & Matriculation) or international benchmarks (e.g. TIMSS & PISA).
2. Examinations remain a failing or distant experience for many students (e.g., in 2013, only 45% of secondary school students obtained the required six SEC results for sixth form studies and half of fifth formers did not sit for SEC exams or did not pass from more than one or two subjects).
3. Students can pass mathematics examinations without acquiring the expected learning.
4. Teaching is pitched mostly towards the student ‘middle group’, leaving the learning needs of students at the top and lower ends largely unaddressed.
So where do we stand?

Standards are defined by and measured against expectations ... so it may well be that we’re doing relatively well by yesterday’s expectations, but not so well by today’s and tomorrow’s.
How ‘authentic’ is this depiction vis-a-vis the mathematics situation in Malta?

“Teachers should offer students more extensive, better developed and more systematic opportunities to engage in activities that go beyond counting in the book according to given rules and solved examples. The teaching does not give students enough opportunities to develop key mathematical skills and capabilities. Furthermore, teachers need to be better at following up and evaluating the organisation of the teaching and the ways of working and looking at how to improve the quality of the teaching, and not least how to increase students’ interest in mathematics.”
Well, it actually refers to Sweden…

- Quote from a Ministry of Education and Research document calling for the strengthening of the teaching of mathematics, science and technology.
- In PISA 2012, 15-year-olds in Sweden placed 34th in mathematics out of 65 participating countries (including 34 OECD countries) with a score (478 points) that was slightly less than the OECD average (494 points).
- Policy makers in Sweden, which is apparently facing a situation that is quite similar to Malta, do not see ‘going back to basics’ as a solution to their problems.
Malta maths results in PISA and TIMSS

**PISA 2009+ (15-year-olds):** In Malta, 66% of students are proficient in mathematics at least to the baseline level at which they begin to demonstrate the kind of skills that enable them to use mathematics in ways that are considered fundamental for their future development. This compares to 75% in the OECD countries, on average.

**TIMSS 2007 (grade 8):** Malta placed 16th out of the 49 participating countries. Our best achievement in the cognitive domains was in the ‘Applying’ domain, with a score of 492. The next best achievement, with a score of 490, was recorded in the ‘Knowing’ domain. However Malta performed least well in the ‘Reasoning’ domain with a score of 475.

**TIMSS 2011 (grade 4):** Malta placed 28th out of the 50 participating countries. In the cognitive domains, the highest achievement of Maltese students was in the ‘Knowing’ domain with a score of 504. The next best achievement, with a score of 497, was recorded in the ‘Applying’ domain. Malta performed least well in the ‘Reasoning’ domain with a score of 475.
Mathematical literacy

- The definition of ‘mathematical literacy’ in the 2009 PISA framework is broad in that it stresses the need to understand ‘the role that mathematics plays in the world’ (OECD 2009), whereas in the 2012 PISA framework it is more specifically focused on the individual, with an emphasis on the ‘individual’s capacity to formulate, employ, and interpret mathematics in a variety of contexts’ (OECD 2012).
Noting a shift in emphasis

The ‘change’ from PISA 2009 to PISA 2012 suggests that the meaning of mathematical literacy in international policy has been displaced from an understanding of the important role of mathematics for the development of society in general to a focus on the individual’s capacity to reason mathematically and use mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena.
It’s all about raising standards...

- **Disclaimer**: what I’m proposing here represents my own ideas and is in no way indicative of either a Faculty position.

- **Principle aim**: the intention is to raise standards in mathematics that go beyond the ‘numbers game’ through better alignment between what mathematics learning is all about and learners’ motivations to learn and future aspirations.

- **Main strategy**: shifting the emphasis from ‘content’ to ‘processes’ in early years, primary and middle school (refer to previous and next slide), to then offer differentiated mathematics curricula for the remaining compulsory school years that cater for the future requirements of all students vis-à-vis ‘content knowledge’, ‘applications’ and ‘functionality’.

- **Holistic reform**: the journey towards achieving this ambitious vision is quite complex – something that requires a holistic approach. It is thus better to plan and implement it over a number of inter-related steps that cover short, medium and long term targets.
A vision for mathematics classrooms...

- **Valued outcomes**: Inquiring minds: critical and creative, Prepared for uncertain future & ill, Understanding of nature of science & math, Interest and positive attitudes towards STEM.

- **Classroom culture**: Shared sense of purpose, justification & ownership, Value mistakes, contributions (Open-minded), Dialogic.

- **Learning environment**: Problems: Open, multiple solutions, experienced as real and relevant, Access to tools and sources, From problems to explanations (instead of from examples to practicing).

- **Teachers**: Foster and value students' reasoning, From telling to supporting & scaffolding, Connect to students' experience.

- **Students**: Pose questions, inquire, engage, explore, explain, extend, evaluate, Collaborate.

- **Higher Order Thinking Skills**: Creating, Evaluating, Analysing, Applying, Understanding, Remembering.

- **Lower Order Thinking Skills**: Not specified in the diagram.
Faculty staff members collaborated with a number of teachers, HoDs and EOs during the PRIMAS project (2010-2013), which focussed on the promotion of inquiry-based learning in mathematics and science.

There was consensus that we continue pursuing collaboratively the promotion of IBL post-PRIMAS (refer to previous slide) in a way that the Directorates and schools acquire ownership over the process. But this failed to materialise for a number of reasons that had mainly to do with repeated changes of key personnel at the Directorates.

As a short term strategy with long term effects, one can consider resuming this collaborative process that was meant primarily to sustain the already visible impact of IBL in local schools.
Medium term strategy

- Across the board (i.e., at class, school and national levels) changes in examinations and the wider assessment systems; renewed emphasis on producing **new assessments** that allow students to show what they know and can do in activities that extend beyond the traditional paper-and-pencil test/examination.

- Create **systemic spaces and incentives** that encourage teachers to learn about IBL and to ‘experiment’ in class with this methodology. This is linked primarily to the short term strategy discussed in previous slide.

- In conjunction with Faculty, offer **CPD opportunities in IBL** for teachers that lead to different levels of certification (e.g., diploma, certificate and even masters).

- Consider the **removal of SEC mathematics** from one of the compulsory subjects to continue with post-secondary studies.

- Subject related decisions to become **less centralized** – teachers and HoDs need to be trusted more and invested with more responsibilities, in the knowledge that they have to operate within national parameters and that they are accountable for their own actions.
Long term strategy I

This strategy is linked to two important developments: (i) compulsory school age extended to 18, with students choosing at age 16 between a more academic form of education and a more vocational form of education*; and (ii) replacement of SEC exams by a national benchmark exercise.

In this scenario, the local school structure could be as follows: early years (K1 to K2); primary school (Yr 1 to Yr 6); middle school (Fr 1 to Fr 3); and senior school (Fr 4 to Fr 7*).

Early years, primary schools and middle schools offer a common curriculum for all students, mathematics included. In senior school, students can be offered a differentiated curriculum in certain subject areas, say mathematics.
Mathematics in this new scenario:

In early years, primary school and middle school the emphasis will be on mathematics processes and content is taught primarily through these processes (i.e., a *processes driven approach* as opposed to a content driven approach). [Implication: an overall reduction of syllabi content]

In senior schools, students are grouped in one of three mathematics strands:

Strand 1: primarily for students who intend to **continue studying** beyond compulsory education in **areas related directly to mathematics** (e.g., BSc; engineering; computing, architecture, etc., and this can be along both academic and vocational routes).

Strand 2: primarily for students who intend to **continue studying** beyond compulsory education in **areas not directly related to mathematics** (e.g., BA, medicine, pharmacy, accountancy, tourism, agriculture, etc., and this can be along both academic and vocational routes).

Strand 3: primarily for students who **do not intend to continue studying** beyond compulsory education and their main intention is to enter the job market.

Students will be allowed to **shift from one strand to another** and, whenever necessary, adequate support will be provided to make such shifts possible (e.g., extra tuition after schools hours, weekends and summer holidays). This is particularly important in the first two years of senior school when students may be less decided about their future.
Long term strategy III

Students will now be entering senior school with an unprecedented baggage of mathematics processes and content knowledge that is very well inter-connected. This should facilitate and encourage the learning of mathematics, whatever the chosen strand, in senior school.

- **Strand 1**: apart from the continued emphasis on processes, the focus here will be on the mathematics content knowledge that students will need to know if they are to study with profit beyond compulsory education in areas that are directly related to mathematics. The emphasis here is on advanced mathematics content.

- **Strand 2**: apart from the continued emphasis on processes, the focus here will be on the mathematics content knowledge that students will need to know if they are to study with profit beyond compulsory education in areas that are not directly related to mathematics. The emphasis here is on the applied aspect of mathematics.

- **Strand 3**: apart from the continued emphasis on processes, the focus here will be on the mathematics content knowledge that students will need to know if they are to enter the job market with profit and meet the mathematical challenges of daily life. The emphasis here is on the functional aspect of mathematics.

The guiding vision for all the three strands will be that all students should aspire and be helped to acquire the best possible level of mathematical literacy.
The main concerns

What is being proposed:

- constitutes a paradigm shift in the teaching and learning of mathematics;
- may be perceived as an attack on the status of mathematics in society;
- may be perceived as an invitation to reduce standards;
- may reap the desired fruits at a very slow pace;
- may be perceived as another upheaval of the education system;
- presupposes differentiated curricula in senior school (especially in the first two years), which may be perceived as being against inclusive policies.
The main challenges

• Many teachers will become deskillled – implications for the training of prospective (ITE) and practising teachers (induction and CPD).

• An IBL approach requires teachers to have very strong content and pedagogical knowledge – meeting this requirement may be more problematic for non-specialist teachers (e.g., early years and primary).

• Convincing stake holders (including students, parents, teachers and SMTs in schools) that it will be a move in the right direction (especially with reference to ‘learning’ vs. ‘achievement’).

• Develop and promote assessment policies and practices (at class, school and national levels) that support rather than hinder the realization of this vision.

• Develop systemic changes in schools that encourage teachers to grow professionally within communities of reflective practitioners.