# CICM 2014 (and ADG 2014)

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# Chapter 1

# Jaime Carvalho e Silva: What can International Comparisons say about the Importance and Limitations of Using Computers to Teach Mathematics in Secondary Schools?

See also [CeS14].

What do other countries do: doesn't automatically translate, but is informative. There is a lot of propaganda as well: "easy" is common. Logo is the most famous teaching language. There is no consensus about teaching programming in schools. Remember turtles?[1] Portugal has a lot of interactive whiteboards in schools, mostly purely decorative!

**Malaysia** 10M children to use Google Apps

**Australia** no more laptops in schools

**Portugal** 100 schools with one laptop/pupil — sold/trained by vendors. This will fail.

[1] But JHD notes turtles have resurfaced in [Dow12], and he has used virtua turtles successfully in teaching rounding, when the turtle turns through $360/n$ degrees, to Computing teachers.

**Minister** (JHD didn't record which country: probably Portugal) All calculators are bad in the first six years of school, but his statements are contradictory

**Finland** This year new exam allowing symbolic calculators in examinations. Need to wait and see.[2]

**French Minister** (Chemist, 1999) "mathematics is in devaluation: there are calculators to do calculations, and soon to draw curves".

**BBC** "do doctors understand test results": a major storyi[3], and the answer seemed to be negative.

What are the principles to follow? Are we (becoming) ICT salesman? To transform an artefact into a useful instrument, we need a human (with appropriate culture) to operate it.

There is opposition to PISA, but I see this as giving us data, which we should be using. It's a very careful (albeit not perfect) experiment, and the data are available. I'll quote three studies.

1. Digital Reading [OEC11, based on PISA 2009]. Korea clearly top, but NZ and Australia came second and third. Digital and classical reading are closely correlated, but not perfectly. In these three, also Ireland, Sweden, Iceland and Macao, the students are digitally better. There is powerful evidence that "digital natives" do not know how to operate effectively in the digital environment. Using a computer at home is related to digital reading performance in all 17 countries. That is not always true for computers at school. Moderate users score better than both extremes! More intensive use of computers at schools is correlated with native scores, but at home positively correlated.

2. "Are the new millennium learners making the grade" [OECD 2010]. "With the right skills and background.more frequent computer use can lead to better performance". "Teacher training,both initial and in-service, is crucial ...".

3. PISA 2012 used computers as part of the assessment, and PISA 2015 will do more. "Competencies relating mathematics and ICT" (e.g. Piechart with wizard). "There is a high degree of consistency in student performance on items delivered on paper and by computer", **but** Shanghai scored 50 points higher (massive) on paper than with calculator.

**Singapore Primary** "Advances in technology have changed the way we teach and learn mathematics"

    1. Achieve a better balance between computation skills and problem-solving skills

[2] JHD is somewhat in touch with this initiative.

[3] `http://www.bbc.com/news/magazine-28166019`.

2. Widen the repertoire of T&L approaches to include investigations
3. Help students with learning difficulties

**USA Common Core** Note this is bottom-up, not federally-pushed. "5: Use appropriate tools strategically" (examples quoted range from protractor to CAS).

**S. Korea** "If cultivation of calculation ability is not the objective, use calculators ...". Samsung is proposing tablets, controlled by the teacher. "This allows learning outside the classroom".

**ICMI Study 17, 2010** "Making technology legitimate and mathematically useful requires modes of integration ..., requires ways of thinking that are not the same as pencil and paper ..." "The slow progress is due to [various sound reasons]". "Implementation of mathematics afforded by digital technologies is more likely to occur when and where there is a shared vision among political leaders, ... [a square in all: all four sides need to cooperate]".

**Personal** Final year exam has graphing calculators, and one question which *needs*them. On a Casio, the default graphing window did not catch the graph.

Final questions:

1. What about numerical methods? Should bisection be taught in elementary schools?
2. When should we introduce CAS?
3. When should we teach programming/coding? Is not an algorithm a mathematical structure?

Note that PISA shows clearly that technology is beneficial. Conway 1997: "We have to embrace technology. I don't mean just tolerate it; embrace it and celebrate it. ... I see mathematics departments rethinking their entire curricula. Otherwise we are out of business."

# Bibliography

[CeS14] J. Carvalho e Silva. What international studies say about the importance and limitations of using computers to teach mathematics in secondary schools. `http://arxiv.org/abs/1405.3943`, 2014.

[Dow12] A. Downey. Think Python: How to Think Like a Computer Scientist. *Green Tea Press*, 2012.

[OEC11] OECD. PISA 2009 Results: Students On Line. *Digital Technologies and Performance (Volume VI)*, 2011.