Writing to Learn Mathematics

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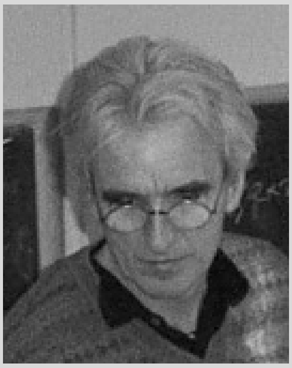


This article first appeared in *Thinking Writing* the newsletter of the Writing in the Disciplines initiative at Queen Mary, University of London (Summer/Autumn 2003). Further information and copies of the newsletter can be obtained from Sally Mitchells, email mitchell@qmul.ac.uk.

The website

www.thinkingwriting.qmul.ac.uk

provides a practical introduction to the Thinking Writing approach.

Since 1997, Franco Vivaldi, Reader in the School of Mathematical Sciences at Queen Mary, University of London, has used short writing tasks as part of his teaching and assessment practices. He spoke to colleagues at a Writing in the Disciplines Exchange of Practice Forum about what he does and why, arguing both that writing can be used as a way of developing students' mathematical understanding, and that students should be expected to learn to write. This article is based on a transcript of Franco's talk.

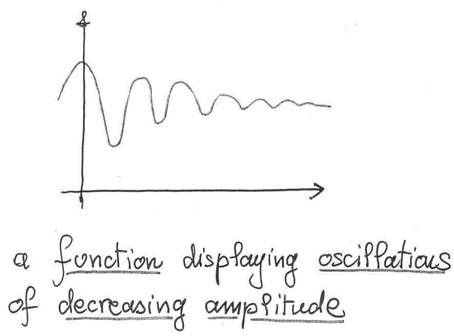
Background

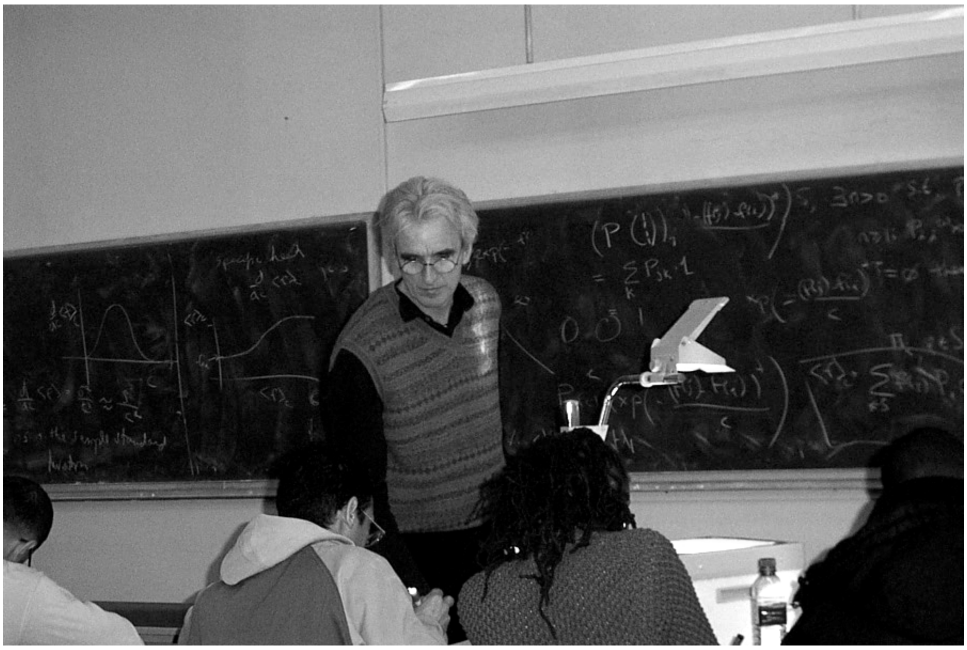
Among mathematicians there are what you might call mathematical nerds. The mathematical nerd has got in his mind this beautiful representation of, say, Galois cohomology, but often cannot communicate this clearly. In fact there are some excellent mathematicians who are almost illiterate. But of course the competent mathematicians who are also excellent writers are far more numerous than the competent mathematicians who cannot write. It is the latter, however, not the former, that are romanticised. And so mathematicians tend to make allowances for colleagues who do not know how to write, and then they extend these allowances to the students, regardless of whether they are good or bad at mathematics. At Queen Mary we also have many students from non-English backgrounds, and some lecturers respond to this by lowering expectations and excusing illiteracy. I've heard lecturers say, 'As long as I understand vaguely what's written, that's enough for me'. Well, it is not enough for me: I regard teaching the students how to express themselves in writing as an essential part of my job as an educator.

Specifics

I am interested in a scheme that can work with large classes. Every week, in every course I teach, I ask the students to write short essays - from one sentence to about 100 words. The trick is to forbid the student from using any symbol whatsoever, and that decision prevents them from copying from books or lecture notes. I have to free lecturing time for this activity, and I do this by putting lecture notes on the web. The allocated time – 30 minutes a week at the beginning of the course, maybe 15 minutes towards the end – is organised around a revision of the material covered during that week. During this process, I teach the language. After introducing the terminology, I show the students how to describe the relevant mathematical objects, from an informal description to a sharp definition. At the end I deal with the more difficult issue of making a synthesis of the material, encouraging the students to abstract the essence without being overwhelmed by detail. Here's an example:

Upon seeing something like this, an untrained person would say, *'Oh this is a wiggly curve'* and this is not bad as a vague description. This object, as presented, does not lend itself to a precise definition, but you would nonetheless expect a person with higher education in mathematics to be able to say something reasonably precise, words that reveal understanding of the underlying mathematical





structure. So if you say *'this is a function displaying oscillations of decreasing amplitude'*, then the process of modelling this function is facilitated enormously. Latching onto the notion of oscillations brings to mind the oscillatory functions, sine and cosine, and noting that the amplitude is decreasing starts you thinking in terms of what the amplitude of an oscillation is and how you may control it.

The English language – much like geometry – is a universal tool for teaching mathematics. Although not all students will benefit equally from it (much in the same way as not all students have geometrical intuition), this is a tool we cannot afford to ignore. It also gives you fantastic X-rays into the students' thinking process. In all these years, I have rarely found a clear mathematical mind hampered by language difficulties, the romantic image of mathematical genius. What I see instead is the inability to write combined with the inability to think mathematically, forming a lethal cocktail of learning deficiencies.

In my experience, the conceptual difficulties students have can partially be addressed by going very carefully through the processes that precede conceptualisation, and for this purpose language is very valuable. It's a well-recognised problem in mathematical education that weak students try to bypass conceptual difficulties by exposing themselves to a large number of worked examples, in an attempt to transform learning into training for examinations. The emphasis on language is very effective in countering this, because writing cannot be reduced to regurgitation of recipes.

With large classes there's a question of training and monitoring those who mark the writing. I've never had any major problem but I do need to tell the markers what I expect from them and then perform some random checks. When I return the writing to the students I must provide as much feedback as possible. Some of this can be done in class, but individual feedback is extremely important. It's not enough to give the markers model scripts: you really have to teach them how to flag and describe problems and how to correct the sentences that can be corrected. Sometimes there is nothing you can do because the writing is incomprehensible. But often you can do quite a lot.

At the beginning of a course, I declare what are the mortal sins - there are very few actually. Spelling mistakes, beginning a sentence without a capital or ending it without a full stop, sentences without subject or verb, and a couple of other things. Predictably, zero-tolerance on few essential items brings about rapid progress on basics, and helps the students to develop the ability to judge what is laughable or totally inadequate, a skill many of them do not have.

Results

Capable students make quick progress, responding positively to someone who has high expectations of them. It's also easy to persuade any reasonably motivated student that the ability to write clearly is a great skill: it's *the* transferable skill. The least motivated students tend to suffer from lack of attendance at lectures and exercise classes: they cannot deal with this problem on their own, and their learning is limited. In this respect, a more forceful policy on attendance would be very welcome. But above all, we need a clear policy across the whole School on what we expect in relation to the quality and uses of students' writing in learning, and what we think should be the minimal standards of literacy for our graduates.