Statement of Teaching Philosophy

My approach to teaching has developed on the one hand from a wide range of experience, and on the other from concepts and techniques of pedagogy with which I became familiar during my training as a teacher. I believe that the challenges inherent in teaching applied mathematics are fundamentally similar to those in physical chemistry and other numerate disciplines. My approach towards addressing these challenges is founded upon three basic ideas:

- My teaching role is that of a facilitator of learning, rather than merely a transmitter of knowledge;
- A balance in content emphasis between analytical fundamentals and specific applications is vitally important;
- Teaching and research are complementary and equally important processes of scholarship, ideally enriching each other rather than detracting from one another.

Traditional approaches to teaching can be justly criticized for regarding students as passive receptacles of knowledge, but I feel that it is also a mistake to suppose that being a 'facilitator of learning' implies a less active role for the teacher. On the contrary, in the constructivist approach to teaching, the teacher has to engage with the students' conceptualizations of the subject matter and anticipate their questions, rather than merely internalize the exposition presented in the textbook. (My use of the term 'constructivist' is in the narrow sense implied by Piaget's evolutionary epistemology, and has nothing to do with the post-modern 'social-constructivist' theory that all knowledge is socially constructed.) This strategy is best realized with an interactive teaching style, which I prefer to the more traditional "chalk and talk" mode of presentation. But a more important element of my approach is the analysis of the content into specific learning objectives according to the Bloom taxonomy. The students are provided with concise summaries of each lecture, which include these learning objectives and carefully-graded problems that are specifically cross-referenced to them. In this manner, the students are left with no doubt of what they should be able to do as a result of studying the course material.

My experience leaves me with no doubt of the effectiveness of this approach and its popularity with students. But having identified the analysis of the content as a key element of the above approach, it is important to point out that the specific learning objectives have no individual significance. They should not be regarded as corresponding to the 'outcomes' in the so-called Outcomes-Based Education schemes that are currently in vogue among some sociological theorists and politicians - but not teachers - in Australia, as providing a politically-acceptable alternative to traditional norm-referenced assessments. The idea of regarding these narrowly-focused learning objectives as indicative of levels of mastery of the subject as a whole is just as preposterous as the idea that one's ability to play a single note on a piano is a meaningful measure of one's competence to play a Mozart concerto.

Traditional approaches to teaching of both applied mathematics and physical chemistry involve development of the fundamental theory followed by illustrative examples, thus proceeding from the general to the specific. I prefer an heuristic approach, developing the theory gradually, by considering examples that have been carefully chosen to highlight the important issues. The theorems and formal proofs come later, when the students have developed a sound understanding of the significance of the hypotheses. Experience has shown that students prefer this mode of development. It also has the advantage of being more consistent with the manner in which many important mathematical results were arrived at in the first place. As a rule I am inclined strongly to discourage students from memorizing formulae and their derivations. For example, the ability to write down the differential forms defining the thermodynamic potentials is worthless, unless it is accompanied by knowledge either of how these functions can be related to measurable quantities, or of the relevant results of multivariable calculus (such as Legendre transformations, properties of exact differentials, and the chain rule for Jacobians). Being able to prove theorems lies at the very heart of mathematics, but in my view the required insights are far more likely to be developed by constructing knowledge of why the theorems work (and when they don't work), than by rote memorization of proofs.

It is often stated that it is essential for university teachers to be active in research. This is clearly true for graduate courses, where currency of knowledge is essential. But I believe it to be at least as important for university researchers to engage in some form of teaching, even if this is limited to the occasional research seminar. The way in which I think about my subjects has been profoundly influenced by the process of preparing to teach them.

The logical arrangement of facts and concepts required in the preparation of classes is a skill that I have found most helpful in research. But my involvement in teaching has also contributed to my research efforts in more specific ways. For example, my interest in thermodynamics was considerably expanded by my being required to teach courses in this subject, and has since evolved into a research expertise that has considerably enhanced my ability to apply mathematics to the real world.