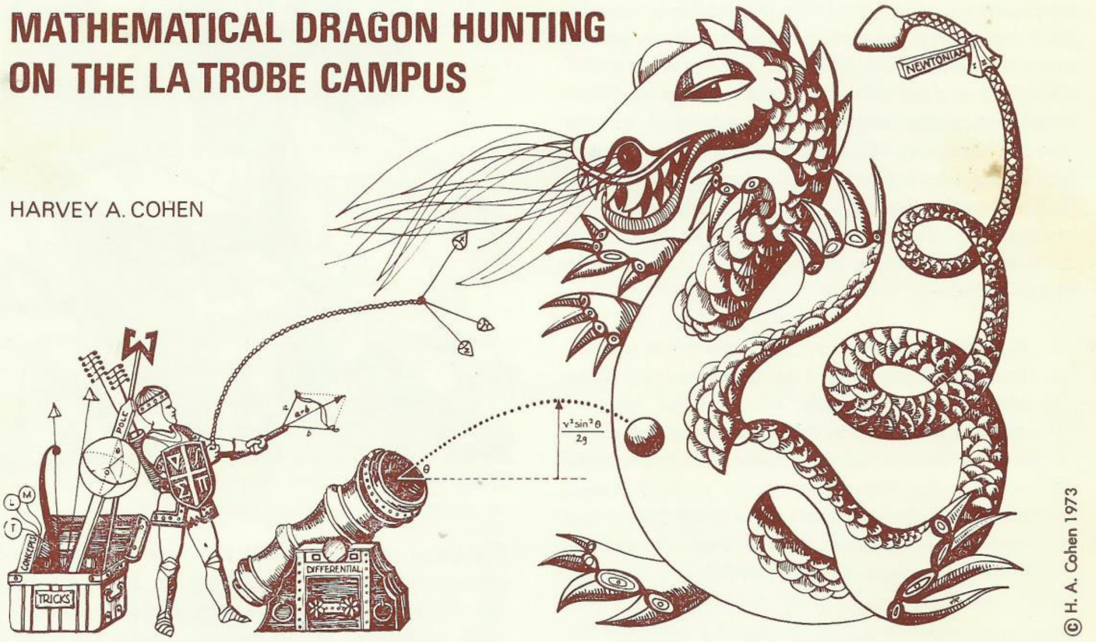
AVCC

education newsletter

MATHEMATICAL DRAGON HUNTING ON THE LA TROBE CAMPUS

HARVEY A. COHEN



Australian academics are becoming more concerned not only with how best to teach but also what best to teach. In the past, most university teachers have taught much the same [albeit updated] subject matter that they themselves were taught. However, with increasing pressure to scrutinize educational objectives there has been, in many instances, growing dissatisfaction with traditional curricula. The greatest amount of soul – searching in this connection is taking place in the medical schools, but it may also be found in most other fields.

In the following item Dr. Harvey A. Cohen, Senior Lecturer in Mathematics. La Trobe University argues that what is traditionally taught in applied mathematics courses does not include training in certain skills essential to being a creative mathematician. Given the very limited space available to him he manages to give the reader something of the flavour of the heuristic approach he is developing – **Ed**

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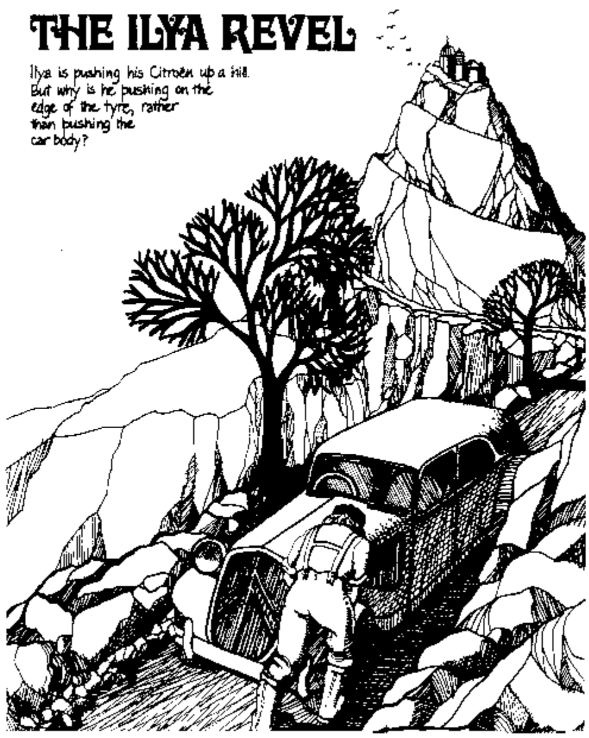
Despite the ‘New Maths ‘ which has meant major changes at the elementary levels, mathematics teaching methods at High School and University have not basically altered since Descartes. In fact the basic style is that of rote learning, with reinforcement by the repetitious rendering of set tasks. As a first step in changing this deplorable situation and to stimulate the intellectual growth of students a new style of student exercise, the Dragon, has been devised and utilised in a course in applied mathematics at La Trobe University.

When the world, what’s going on out there, is portrayed in the language of mathematics, what one has is a picture in the idiom of mathematical models. Thus, there are descriptions in terms of mathematical models in the physical and biological sciences, in the social and behavioural sciences, and even mathematical models for management. The traditional emphasis in the teaching of applied mathematics has been in the cranking of such models, so that the subject has appeared to deal solely with the solution of differential equations and the properties of certain ‘special’ functions. Consistent with this emphasis has been the subjection of students to highly formal and precisely defined problems, as instanced by the following example (in actual use as a tutorial exercise for second-year Mechanics at La Trobe.

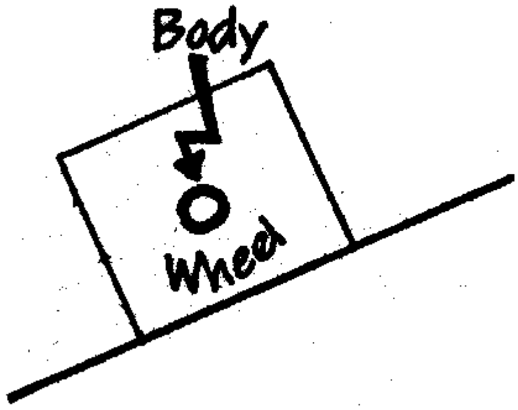
> A particle of mass m is at rest on a smooth horizontal plane and is connected by three elastic strings, each of modulus λ and natural length a, to three points on the plane at the corners of an equilateral triangle of side $2\sqrt{3}a$. Prove that, if the particle is displaced in the direction of one of the strings and then released, it will perform oscillations of period $(4\pi/3)\sqrt{(1m/\lambda)}$.

Now such student exercises can be criticised on the grounds that being stylised they do not permit students to gain fluency in mathematical language trough self expression, but only opportunity to parrot certain standardised algorithms. However, there is a deeper criticism that comes from a philosophical analysis of the nature of science and of mathematics in particular. The starting point of this critical line is the definition of the applied mathematician as a manipulator of mathematical models. The truly great mathematicians, the geniuses of their time, have articulated entirely new mathematical models. The creative applied mathematicians have taken existing mathematical models and applied them to new and surprising situations. The most pedestrian activity in applied mathematics has been the exploration of the direct mathematical consequence of particular models. Yet it is on the last phase that the focus of pedagogic attention has been directed!

The way around these defects in teaching is clearly to devise problems where the emphasis is on the creative selection and utilisation of mathematical models. I term such problems Dragons, and the process of elucidation snaring. An elementary example of a Dragon is provided by Ilya:-

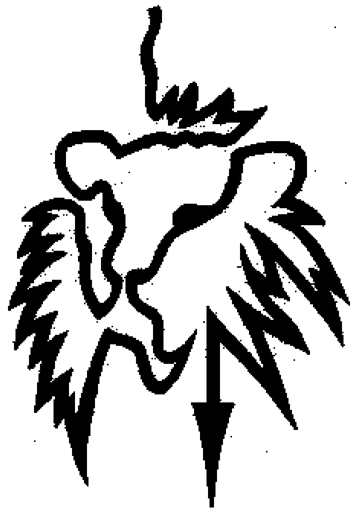


The basic notions needed to snare this particular dynamical Dragon are taught in High Schools. Yet there is considerable and quite understandable difficulty in perceiving that the LEVER concept is relevant, and how to apply it to the backwards REVEL. No such difficulty would be presented by the following formalised rendering of Ilya in terms of the tilting of a block on an inclined plane:-



The key to snaring Dragons lies in organizational (global) comprehension rather than in deductive (linear) thinking, Elsewhere[1] I have explained the art of Dragon Hunting through the drawing captioned Leo:-

LEO



To snare Dragons one has to impose a gestalt (an integrative pattern) such as when the continuous line becomes a roaring lion. In addition to regular Dragons, where no particular gestalt is imposed in advance, there are what I call Monsters: problematical situations to which an inappropriate gestalt is specified. Monsters can be rectified (or adjusted) by the type of perspective shift whereby the roaring lion inverted is seen as a bird on a rock.

A notable feature of Dragons is that they do not call for a unique 'correct' answer or solution: thus they are especially suitable for small discussion type groups where it becomes possible for every student to give original yet different explicatum. It is proposed to introduce (in 1975) a specific course in problem solving **per se**, in which formal lectures devoted to case studies in the history of mathematics and to strategies for problem solving such as those prescribed by **Polya** (in **How to Solve It**) will complement informal discussion groups devoted to Dragon Hunting. Student assessment will be based on evaluation of the tutorial papers.

A pilot study of these ideas was conducted in 1971/2, when a compilation of Dragons was devised with each Dragon illustrated in a playful style – making good visual use of the Dragon theme. This booklet, entitled **What G Killed Ned Kelly?**, was used in conjunction with a compulsory second-year applied mathematics unit AM204 Mechanics presented by the author in 1972. However there were during 1972 no specific tutorials devoted to all second-year Applied Mathematics units, so that by default, especially as tutors were not well equipped for this project, discussion of Dragons was limited to lecture periods, and were one-way monologues (lecturer to 40 students). Despite these administrative defects, students were, on the whole, stimulated and interested in Dragons. Certain Asian students seemed to be especially disadvantaged by language difficulties, but the overall success of the experiment is attested by the explicate ('solutions' to Dragons) prepared by students, in that the length and quality of these tutorial papers represent an outstanding amount of personal mathematical exposition at this undergraduate level. All explicate were collected at the final examination for the purpose of determining a class mark, and retained by the writer for future reference.

In the past year, using the experience gained in the Ned Kelly pilot project, a number of additional Dragons have been devised, each Dragon being illustrated by line drawings, of which Ilya is an example. This collection of new Dragons, together with hints for the tyro, is being published as an art folio, and will be used in the planned course in problem solving. In order to emphasise that the snaring of Dragons involves the artful selection and application of mathematical models, these Dragons have been so devised that an adequate resolution does not require more purely mathematical skills than those specified in the syllabi for matriculation.

[1]Cohen, H. A., **A Dragon Hunter's Box**, Melbourne: Hanging Lake Books, 1973.