

## Final Report

Committee for the Advancement of University Teaching: 1995

*Diagnostic Tools for Improving Concept development*

Dr B McInnes  
Dr P Walker  
Dr P Fekete

# 1. Identification

## Name of Project Leader(s)

Dr B McInnes  
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## 2. Project Summary (suitable for publication by UniServe)

Please provide a short summary in the space below suitable for publicity. This summary should be clear to those teaching in a range of disciplines, should identify the learning problem that was addressed and indicate the main benefits in terms of enhancement of student learning. The summary should also warn of difficulties encountered.

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The object of this project was to improve first year students' understanding of underlying concepts in thermal physics. This is done by encouraging an interactive approach to teaching and learning in the lecture environment. What has been achieved includes:

- **identification** of key concepts in thermal physics;
- a **review** of existing thermal physics demonstrations ;
- **modification** of these demonstrations and **development** of associated questions to encourage students to develop "deep learning" strategies using interactive techniques;
- the **establishment** of a database of resources (demonstrations, questions, references to research literature, CD, film and video presentations );
- a **presentation** of the material in a manner **encouraging use by interested academics** via the medium of the world wide web.

### 3. Suggested Applications (suitable for publication by UniServe)

Please identify the discipline areas, teaching and learning methodologies, and teaching and learning formats which you believe would benefit from applying the outcomes of your project.

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**Traditional lectures:** Much of the traditional use of lecture room demonstrations in science and science-related disciplines, particularly in large classes, is to show applications of scientific theories to a passive audience. There is often a failure to articulate the relation between theory and the real world. Some of these demonstrations may be quite polished in their presentation, others are not; sometimes the presentation is leisurely, sometimes it is quite hurried.

**The problem:** Rarely is there opportunity for student participation in a way that involves their preconceptions and stimulates them to critically examine those preconceptions and, where necessary, change them. What was attempted in this project was to try to use the large amount of standard lecture demonstrations to provoke conceptual conflicts among students and encourage them to adopt "deep-learning" strategies. This was done with lecture groups of about 100 students. One aspect of the problem lies in the traditional teaching styles of academics.

**The solution:** What we were looking for was the optimal use of 'lecture-demonstration' apparatus. What had to be done was:

- to produce physical descriptions of collections of apparatus;
- to provide details of the technical aspects of the pedagogical use of the apparatus;
- to make it accessible to practising lecturers.

**Discipline areas:** The kit is specifically designed for the topic of thermal physics. However the teaching and learning format used in this project should be appropriate to:

- other areas of physics (waves, mechanics, electromagnetism, optics, etc) [A CAUT application for 97/98 covers other areas of introductory physics.];
- to other science subjects (biology, chemistry, etc) or science-related courses (engineering, medicine, etc) that makes use of demonstrations either in the lecture room environment or in small-group situations.

**Teaching and learning methodologies:** The resources of this project are intended to encourage deep learning through interactive teaching in large class environments. Conceptual understanding rather than equation plugging is developed through eliciting student understanding of demonstrations and thought experiments presented to them. This work models itself on the constructivist approach to learning where students answer exercises based on their prior understanding.

**Teaching and learning formats:** The material developed in the project and included in the kits is specifically designed for large lecture environments, yet it is also suitable for tutorials or workshop style teaching.

**Innovations:** Many of the innovations of this project should easily carry across into other areas, for example:

- the identification of key concepts in the particular topics;
- the modification of existing demonstrations and the development of new demonstrations;
- the creation of questions, which call on students to predict and observe the outcome of the demonstrations and to explain these outcomes;

- the presentation of the material in a manner encouraging use by academics via the medium of the World Wide Web;
- the provision for ongoing development of the kit.

## 4. Output (suitable for publication by UniServe)

Please provide a list of published papers (with full citations) arising from the project and any other means of dissemination that are available to academic staff in Australia (eg. WWW sites, E-mail lists, unpublished papers, software, etc).

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### Website:

<http://www.physics.usyd.edu.au/teach/thermal/thermal.html>

### Poster presentation:

written by Fekete and McInnes and presented by McInnes,  
1995 CAUT Regional Workshop at UTS, November 1995.  
*Progress in work on project*

### Conference paper :

written by Fekete, Walker and McInnes and presented by Fekete,  
ASERA Latrobe, July 1995,  
*Thermal physics resource kit addressing misconceptions using demonstrations.*

written by Fekete, Walker and McInnes and presented by Fekete,  
AIP Hobart, July 1996,  
*Interactive lectures in thermal physics.*

written by Fekete, Walker and McInnes and presented by Fekete,  
ASERA Canberra, July 1996,  
*Interactive lectures in thermal physics.*

### Colloquium:

written and presented by Fekete,  
School of Physics, University of Sydney, 18 March 1996,  
*Interactive lectures OR how you, not I, can do it better.*

### Papers in preparation:

written by Henderson, Walker, Fekete and Crawford,  
based on Henderson's 1994 honours thesis, which was a platform for the project work,  
to be submitted to RISE (Reports in Science Education),  
*Conceptions of Thermal Physics: Linking Scientific Concepts and Prior Experience.*  
written by Fekete, McInnes and Walker,  
based on the work of the project,  
decision yet to be made as to where it is to be submitted,

## 5. Major Objectives of the Project

Please state what you consider were the main objective(s) of your project. The objectives should include a comment on the improved student learning that was expected.

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The project is about **developing resources** that are to be available for academics to facilitate **deeper learning** in students in lectures and tutorials.

The project addresses the **educational problems** of:

- **poor attention** span of students in traditionally taught lectures;
- **surface learning** approaches in students;
- **preconceptions** that **students** bring to the subject being taught;
- the **constraints** imposed by the crowded first-year physics environment at many universities. (Sydney University has over 1000 students in first year and each lecture contains something like 100 students.) Some universities, with smaller numbers, have done work on interaction using workshops;
- **inadequacies of assessment methods** that allow students to pass exams without understanding the concepts and their relevance to the real world.

These **educational problems** were addressed by developing **interactive** approaches to learning by:

- using a concept-oriented approach;
- using questions and demonstrations to make large lecture classes more interactive;
- making lectures more enjoyable, stimulating, satisfying, challenging, productive and thought-provoking;
- using improved feedback about student preparedness and the effectiveness of teaching and learning to guide on-going course development.

The **improved student learning** expected was:

- that through the intrigue of questions and demonstrations, they would be encouraged to adopt *deep learning* strategies rather than the common *surface* approaches of trying to remember facts, formulae and mathematical techniques;
- that they would have an improved understanding of the fundamental concepts;
- that they would achieve better performance in quantitative problem-solving.

**Evaluation of student interviews showed** that the interactive style of teaching in the lecture course, using the resources developed, increased student understanding of the concepts in Thermal Physics. This process was assisted by improved feedback about student preparedness, by the effectiveness of the teaching methods and by ongoing course development.

## 6. Major Achievements of the Project

Please supply a one page summary of the major achievements of your project. Comment specifically on the role of the project in improving student learning. Please identify any difficulties encountered and describe them honestly for the benefit of others who would take up the development. Please indicate the method of evaluation and whether you consider the objectives were met.

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The **role of the project** in improving student learning was in:

- presenting opportunities for deep learning;
- promoting better conceptual understanding;
- developing greater awareness of links between theory and the real world;
- improving student motivation.

**Difficulties** experienced during the project:

- Both of the original project leaders had substantial career changes during the period of the grant: Dr McInnes took early retirement; Dr Walker took leave of absence to work at University College, London. This left the bulk of the work to the Research Associate, Dr Fekete. Fortunately he was enthusiastic about the project and most competent in his work. Nevertheless it has not yet been possible for him to analyse and evaluate all of the information coming from interviews and tests.
- lack of resources (staff and money) to design and build new demonstrations; hindsight shows that monies should have been specifically requested to cover this need.

**Methods of evaluation** used.

The lecture course given in conjunction with the project development was evaluated by:

- two quizzes (pre and post lecture course);
- individual pre-course interviews for each of three groups of ten students (from three different lecture groups taught in parallel); post-course interviews with almost all of these students;
- examination performance;
- student appraisal of the lecture course;
- sustained attendance of students throughout the lecture course.

Were the **objectives** met?

- key concepts in thermal physics (eg. heat/temperature confusion) have been identified;
- existing demonstrations have been reviewed and adapted so that they can be presented to the students in a way that the students Predict, Observe, and Explain (POE) what is happening;
- POE sheets for feedback in lectures were prepared and used;
- questions to promote deep learning have been developed and used;
- the description of demonstrations, the list of questions and many other relevant materials have been collected and installed on the web at <http://www.physics.usyd.edu.au/teach/thermal/thermal.html> so that it is accessible to those interested;
- provision has been made for others to contribute ideas (eg. new demonstrations), and to ask questions;
- an interactive set of lectures, using a concept-orientated approach, was given;
- student questionnaire responses indicated that the lectures were enjoyable, stimulating, satisfying, challenging, productive and thought-provoking; sustained student attendance throughout the course supported this judgement;
- as a result of the interviews and quizzes, feedback on student preparedness and student understanding was provided to the academics involved with this and the parallel courses;

- students showed greater conceptual understanding (interview and quizzes);
- students performance on traditional examination questions was equivalent to previous years. (It could be argued that these questions did not assess the objectives of this project.);
- anecdotal evidence indicated that some students adopted deeper learning approaches.

## 7. The Teaching Development

In addition to the one page summary, please provide a more detailed statement that addresses each of the topics referred to in the criteria of selection (section 5 of the 1995 Guidelines for Applicants). Please limit this to no more than 4 pages. In the detailed statement please indicate the contribution of the Reference Group, the results of the evaluation, and how your university will implement your development. If your project differed from the original project, please indicate in what ways and why this occurred.

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### 1. What we did and when we did it

The section below lists the achievements of the project as they occurred.

#### Phase 1      **1994** (*not funded by CAUT*)

A literature search of key concepts and student difficulties in thermal physics was carried out. Initial questions and demonstrations were designed.

#### Phase 2      **Jan-Mar 1995**

Dr Pal Fekete was employed as a level B lecturer, to design and supervise the construction of demonstration equipment, to implement and analyse tests and to produce the resource kit itself.

Teaching and administrative relief was arranged for the first part of 1995 for Dr Paul Walker so that he could undertake design and assist Dr Fekete in the development of test questions and demonstrations.

Arrangements were made with the School of Physics for Dr Fekete to lecture the first year thermal physics course in semester 2 in order to trial the material produced.

A concept map linking thermal physics concepts was drawn up: this map was used as a template to help shape the development of resources.

Lecture demonstration material located in the School of Physics was evaluated.

Physics equipment catalogues involving teaching materials were searched for additional equipment.

Other universities were contacted and sites across Netscape and Mosaic were explored for information about any evaluation of lecture demonstrations (little material was found).

A literature search into teaching and learning in thermal physics was completed.

A quiz for use at the start of the semester 2 lecture course was developed.

### Phase 3      **Apr-Jun 1995**

Drs Walker and Fekete taught part of an honours year course, "Concepts of Physics", which included the fundamentals of thermal physics; evaluation of students in this course indicated that concepts from earlier courses had been poorly retained.

Dr Fekete held discussions with local lecturers of thermal physics about how they taught the course, what demonstrations they used and how and why they used them. Surprisingly, not much information was forthcoming in these discussions yet this information is important to people new to teaching such a course. Developmental work on pre-existing demonstrations and short experiments to link with the concept map was started; this continued throughout the project.

An important decision was made to concentrate on pre-existing demonstrations and short experiments rather than develop many new ones.

The work on these demonstrations focussed on exploring ways to use the technique of **Predict, Observe, Explain (POE)**, with the aim of bringing about deeper learning in our students.

**POE** sheets for student use in lectures accompanying the demonstrations and questions were prepared.

Collection and development of software animations to accompany demonstrations was begun.

Not much work was done on the "bank of questions" originally intended for use in the diagnostic tests. We are still exploring the need for this resource in the context of pre-existing banks of questions.

### Phase 4      **Jul-Sep 1995**

In parallel with two other lecturers Dr Fekete delivered the thermal physics course to first year students. He taught interactively, using the materials developed in the project.

One outcome of teaching this course was the realisation of a need for further demonstrations and questions in some areas.

Demonstration and quiz materials developed in the project were incorporated into tutorial sessions.

Dr Fekete interviewed students before and after the course. Approximately ten students were chosen from each of three lecture groups.

A diagnostic quiz to identify student preconceptions was given to all the parallel classes during the first lecture of the course.

The quiz was evaluated and feedback was given to the other lecturers involved with the course.

A second diagnostic quiz was given at the end of course, with questions similar to those used pre-course.

Dr Fekete supervised 2 third-year students in the development of new demonstrations.

Dr Fekete supervised students from the Talented Student Program to assist in the development of a more complex demonstration.

Dr Fekete presented a paper, *Thermal physics resource kit addressing misconceptions using demonstrations*, at the ASERA (Australian Science Education Research Association) conference in July.

### Phase 5      **Oct-Dec 1995**

Mrs Millar and Mr Cooper, who were members of the Reference Group and who were both heavily involved in the organising and teaching of First Year Physics, were, from time to time, involved in discussions with Dr Fekete on the development of the demonstration, questions and assessments.

The resources of the kit were documented for distribution, using a web site:

<http://www.physics.usyd.edu.au/teach/thermal/thermal.html>

Dr McInnes presented a poster session on the progress of the project at CAUT Regional Workshop at the University of Technology, Sydney.

Mr Sefton, a member of the Reference Group, compiled an annotated list of relevant published physics education papers in thermal physics.

Phase 6      **1996 (not funded by CAUT)**      *In progress*

Dr Fekete gave a colloquium to colleagues in the School of Physics at Sydney University: *Interactive lectures OR how you, not I, can do it better.*

Monitoring of use of the web site took place.

Forms for feedback and for submission of material to be included in the kit were added to the web site.

There was ongoing evaluation of the pedagogical tools developed for the kit and new demonstrations, questions and other resources were developed.

Dr Fekete applied to CAUT for a grant for 97/98 to extend this work to other physics topics, with particular emphasis on making the resource available for students.

The School of Physics re-employed Dr Fekete to deliver the thermal physics course. This enabled him to develop further material. It also indicated the School's continued support for the implementation of the aims of the project.

Dr Fekete presented papers, both entitled *Interactive lectures in thermal physics* at the AIP (Australian Institute of Physics) and ASERA conferences.

Dr Fekete is exploring the PIRA system of cataloguing.

Dr Fekete is working on a Teachers' Guide as a separate section for the kit. This guide will explain the relevance of the questions and demonstrations and how likely student responses might be interpreted.

The evaluation of the interviews and quizzes from 1995 will be carried out.

## **2. Description of the Resources provided: the 'Kit'**

An extensive collection of demonstrations, questions and other resources have been developed and/or adapted and are located on the Internet at <http://www.physics.usyd.edu.au/teach/thermal/thermal.html>. As of mid-August 1996, over 500 people have visited the web site. Between then and mid September another 100 have visited it.

Each of the parts of the kit is described in some detail below.

A **Keyword (or Concept) Search** can be made to explore the resources by selecting a number of chosen keywords or phrases relevant to thermal physics. This may be done across a wide range by using the keyword such as *heat*, or across a more restricted area by using a keyword such as *Stirling Engine*.

A **Concept Map** provides a similar function to the Keyword Search. However it prompts the user to visualise links between different concepts in the subject.

**Resource Questions** are provided for use in lectures, tutorials or even assessment purposes. These questions are different from the normal questions found in text books as they are more qualitative and seek to develop a greater understanding in the students of the concept addressed.

A facility to **Browse** through the collection of demonstrations to see what types of experiments are available. Users who know the type of demonstration they are looking for may use this facility to explore a demonstration directly.

Descriptions of **demonstrations** form the core of the kit. These include a list of the apparatus together with a photograph or diagram of the apparatus. There are sections which list the concepts and phenomena involved and the physics behind them. Advice is given on how to use the demonstration. Everyday examples of the phenomena involved are also given.

**Submissions** from others are encouraged. A web form is included to encourage submission of ideas based on prediction, observation and explanation. This also sets the scene for a further development of the kit (based on the 97/98 CAUT application) as a student resource.

In a version of the kit available only for University of Sydney students, a **Student Question form** was added in 1996. This form allows students to ask questions based on material on the web or delivered directly during the course. This is intended to provide support for the students and also to be an ongoing method of evaluation of the resources.

**CD Demonstrations** from a collection called "The Video Encyclopedia of Physics Demonstrations" are included. These serve as a useful resource for users who do not have access to the equipment for particular demonstrations. However we do not recommend the use of video presentations to save time; generally it is better to reduce the "talk and chalk" time and spend time on prediction, observation and class explanation.

Those **Videos and Films** available in the School of Physics are referenced and can be examined.

The commercial **Software** package *Gassim* (kinetic theory of gases simulation) is listed at the site. A link to the software clearing house, UniServe, is also provided.

**Power Point** slides which were used when lecturing a 12 times 1 hour lecture course will be included (some of these are already in place).

**Publications** covering material relevant to the demonstrations will be included in the near future. Some links already exist for particular demonstrations. This is in addition to a large, annotated list of relevant references to published physics education papers in thermal physics.

It is planned to add a **Teachers' Guide** to explain the relevance of the questions and demonstrations and how likely student responses might be interpreted.

### 3. How the kit differed from what was originally envisaged

The original application implied that the kit would be in print format. The audience for the kit was threefold:

- physics instructors at our own university;
- physics instructors at other universities;
- instructors at this and other universities who may be interested in how the ideas in this resource kit could be applied to their disciplines.

As the work progressed it was decided that the kit would be easier to access by its anticipated audience if it were placed on the Internet. This was done.

Other differences included:

- Dr Fekete lectured thermal physics in semester 2 to trial the resources;
- we used two third year students and the Talented Students' Project group to develop demonstrations;
- little contribution was asked for from the Reference Group, in particular those members who were not directly involved in First Year teaching in the School of Physics; this was principally due to the absence of the Project Leaders during much of the project.

#### **4. How the project led to practical advances in teaching and learning in the School of Physics**

In the course of the project key concepts in thermal physics were identified, a review was made of existing thermal physics demonstrations, these demonstrations were modified and sets of questions were developed to encourage students to develop "deep learning" strategies using interactive techniques.

In 1995, one of the three parallel classes for the first year thermal physics course made use of this work. In 1996 this was extended to two of the classes.

#### **5. How the output integrated successfully into the department and the field of study**

All available evidence indicates that the output can integrate successfully. There is evidence that it stimulates students interest and leads to improved performance. Several other academics have shown interest in using these methods.

An important difficulty that may be encountered with the approach we developed is the need to spend more time in teasing out demonstrations and questions in the class situation. This means a decrease in the amount of content in the lecture-room.

It is hard to wean colleagues away from accustomed teaching styles, especially in these times of increasing teaching loads. Nevertheless, one of the co-lecturers from 1995 has modified his teaching style for his 1996 courses (*Fields and Flow* and *Thermal Physics*), based on the work he saw being carried out on the trialling of the kit in 1995. He has used many of the resources of the kit.

#### **6. How the output is useful for others teaching thermal physics**

Our own experience and the interest shown by some, both within and outside our academic environment, show that there are quite a few who will make use of the output of this project.

There is a facility in the web site for external input. The authors plan to monitor this input and it is expected that much of it will be incorporated into the permanent material in the site. This should further increase the usefulness of the output.

#### **7. The monitoring and evaluation of the project**

The lecture course given in conjunction with the project development was evaluated by:

- 2 quizzes (pre and post lecture course);
- individual pre-course interviews for each of 3 groups of 10 students (from the 3 different lecture groups); post-course interviews with almost all of these students;  
NB. The second quiz and interviews have not been comprehensively evaluated at this stage. It is anticipated that this evaluation will commence towards the end of 1996.
- examination performance: in a traditional examination, that did not evaluate the objectives of the kit, students did no better or worse than their peers;

- student appraisal of the lecture course: a standard School-wide questionnaire asked students, inter alia, to respond on a 1 to 5 scale to the question "the set of lectures is good" [5 = good]; students rated the lectures based around the kit materials as 4.0, the parallel lectures as 3.3 and 3.5;
- sustained attendance throughout the lecture course: 55 of the 90 students in the class were present on the final day; in other courses for the same student group in the second semester 24 students attended the electromagnetism course and 26 the quantum physics course through to the final lecture.

## **8. Plans for further dissemination of information about the project throughout higher education**

The work of the project has been presented at three conferences spanning physics and science education. Two papers are being completed and will be submitted for publication in physics or science education journals. We also plan to give some material for electronic publication to Uniserve\*Science the Software Clearing House for the Sciences in conjunction with the Higher Educational Services of DEET.

When the current thermal physics web pages have progressed a little further, Dr Fekete plans to use an e-mail exploder (a set of multiple email address files) to email all other Physics Departments in Australia to bring this resource to their attention. He also intends to submit the kit to the various search engines on the Web. Experience shows that people are more likely to find a resource based on a keyword if the resource is submitted to search engines than if the search engines are left to find the resource for themselves.

## **9. Demonstration of support from University of Sydney (School of Physics) for the implementation of the project outcomes**

The School of Physics was impressed by the work done by Dr Fekete in 1995. Since the School wished to encourage the further development of the work involved in the project and to further improve student learning, Dr Fekete was re-employed for 1996 so that he could again deliver the thermal physics course. The School of Physics has supported further development of these methods to cover other parts of the introductory physics classes (CAUT grant application for 1997-1998 by Dr Fekete).

## **8. Personnel Outcomes**

If others worked with you on the project please indicate this. It is important for CAUT to know how many people participated in work supported by the National Teaching Development Grants. If participation differs from your original proposal, please let us know what the changes were.

Some questions which should be addressed are:

- how many partners worked on the project?
  - how many members were in your reference group?
  - how many students were involved?
  - what other personnel assistance did you use?
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**Two positions were funded** under the CAUT grant.

The first (level B: 3 days per week for 6 months) was to give teaching and administrative relief for Dr McInnes. Since Dr McInnes took early retirement, the money was used to pay for administrative relief for Dr Paul Walker. **Dr Nagarajan** was appointed to this position. She was not involved in the project. The second (level B: 3 days per week for 12 months) was to be used to employ a person for the design and development of demonstration equipment and resource questions together with written materials (for interviews and quizzes), interviewing of students, delivery of lectures and evaluation of the kit. **Dr Pal Fekete** was appointed to this position. It transpired that he played a major role in the project and, after mid-1995, took full responsibility for it. He assisted Dr McInnes in the writing of the Final Report.

**The grant was awarded to Dr McInnes and Dr Walker.** As a result of major career changes in 1994 and 1995, both played much reduced roles in the execution of the grant.

**Dr McInnes** took an early retirement from the University of Sydney at the end of August 1994. He then worked as a Visiting Professor with Professor Lillian McDermott's Physics Education Group at University of Washington, Seattle. After returning to Sydney he continued as Honorary Associate Professor and has contributed in minor ways to the project. He wrote the Final Report.

After overseeing the project until August 1995, **Dr Walker** took leave of absence in order to work at University College, London and, being offered a position there in 1996, resigned from this University.

The **Reference Group** included local and external physicists and educators.

All **nine** of these played a role in the setting up of the project.

Several of them - **Ms Henderson**, an honours student, **Ms Hemming**, a research student, and **Dr Crawford**, an academic in the Faculty of Education, - contributed to detailed preparatory work in 1994.

One of the consequences of the absence of the principle investigators from the detailed work of the project was a failure to consult with all members of the Reference Group during 1995. Nevertheless, several of the Group did play a part. **Mr Sefton**, now, like Dr McInnes, an Honorary appointment, helped in discussion of the physics and was responsible for compiling the annotated list of physics and education papers in thermal physics. **Mrs Millar** and **Mr Cooper**, who are both heavily involved in the organising and teaching of First Year Physics, were, from time to time, involved in discussions with Dr Fekete on the development of the demonstration, questions and assessments.

In hindsight, it is felt that more use could and should have been made of the Reference Group members. Dr Fekete has attempted to address this in his 97/98 application by confining his choice of members to those who will be directly involved in teaching those first year physics courses which are to be part of the project.

A **larger number of students** played an important role in the project.

Dr Fekete's **lecture class of about 90 students** were well aware of the project. Their attitude during class to the use of the materials and the POE process was monitored by Dr Fekete. Their attitudes were further sought by a formal questionnaire and by ad hoc conversations. Their understanding was probed by two course assignments and a formal, rather traditional examination.

Similar information was taken from two parallel classes of slightly smaller size. These students did not spend the same amount of time watching and discussing lecture demonstrations.

**Three groups of ten students** (from the 3 different lecture groups) took part in individual pre-course interviews; almost all of these students returned for post-course interviews. These interviews were about an hour and a half in length and were all recorded on audio-tape. The interviews have not been comprehensively evaluated at this stage. It is anticipated that this evaluation will commence towards the end of 1996.

**Two third year students and a "Talented students Project" group of three students** worked with Dr Fekete to develop prototype versions of new demonstrations.

## 9. Networks

Indicate the expressions of interest that you have had in the project to date. If the development has been supported by additional resources (funds or in kind support) indicate the size and source of these resources. This is important information for CAUT to assess the impact of the work it supports.

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Three academics who have shown interest in our work have become associated with Dr Fekete in further developments on other parts of introductory physics. They are:

- **David Bailey**, formally of the University of Western Sydney, now of the King's High School;
- **Peter Logan**, University of Technology, Sydney;
- **Ian Moore**, Queensland University of Technology.

**Koichi Hirata** from Japan builds his own **Stirling Engines** and has donated one of his engines to the School Of Physics in exchange for more information of interactive teaching and the resources developed from the kit. His input helped shape some of the kit. Many others have shown interest in Stirling Engines which has been dealt with by adding a link from our web page to Koichi's web page.

**Brent H. Van Arsdell** from the American Stirling Company has also shown interest. Again, a web link has been made.

Some have shown interest in "The Video Encyclopedia of Physics Demonstrations". In response to various requests for more information, Dr Fekete has added the contact address, fax and phone number to our web site.

Several other web sites around the world have provided links to our web pages: for example, Thermal Connection at <http://www.kassos.com/~takinfo>.

We expect a continuing interaction with interested persons through the web pages.

**Peter Jarvis** from the University of Tasmania had been awarded a teaching grant from his Institution to develop material for the teaching of thermal physics. As a result of our conference presentation, he made contact with us. He is using some of the kit for his teaching and we are awaiting a report on his work.

**Dr Sharon Fraser**, employed by **Associate Professor Elizabeth Deane** of the University of Western Sydney under a DEET funded project, is evaluation the success of CAUT projects. After a discussion with Dr Fekete, she has started a preliminary investigation of the work done on our project.

Several academics in the School of Physics are showing interest in interactive teaching styles and have approached Dr Fekete for more information.

## 10. CAUT Activities

If you have any suggestions about how CAUT could enhance the status of teaching and foster teaching developments, please state them below. Comments may concern the philosophical basis of CAUT and its programs, or the mechanics of administering grants and all points between. As always, candour is welcomed.

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**CAUT should:**

- be more in the public eye;
- promote itself more.

**CAUT should:**

- tell the government and the universities that they should take teaching seriously;
- raise the awareness of the university community to the importance of work on teaching;
- do more to change the Australian attitude where teaching is tolerated as a poor second to research.

This shows up in distribution of resources and of rewards, such as appointment, tenure and promotion which, in universities in Australia, are principally based on research and not teaching .

**CAUT should:**

- address the problem of career paths for persons such as those employed under CAUT grants as short-term lecturers or research assistants;
- provide scholarships to appoint developers and researchers to work in education for larger periods of time, eg. as a Postdoctoral fellow on an ARC-like grant.

**CAUT should:**

- ensure that its projects are relevant to the wider university teaching community in Australia and internationally.

We are of the opinion that many CAUT projects are relevant to the host university only and are not useful to people at other universities.

**CAUT should:**

- extend grants to cover discipline-based education work as well as application of such research.

It appears that CAUT sees itself as a "culture-changing" operation supporting the "teacher-scholar" as opposed to the "research-scholar" **but** teaching developments need to be based on and supported by discipline based education research covering curriculum and teacher development. Exclusion of research activity as part of the CAUT grants could be counter productive.

**CAUT should:**

- fund larger projects.

One of us, Dr Walker's has received \$0.5million for a UK project he is working on.

**CAUT should:**

- include in its grants money for purchasing and building apparatus (or equivalent).

**CAUT should:**

- discover how many people UniSearch reaches. (Is it a well-intentioned black hole?)