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Generic skills in Physics

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ABSTRACT

When University students enrol in Physics courses, they are usually more aware of the “physics” content than of the generic skills that they learn along the way. By contrast, employers are often more interested in the students’ generic skills. During the past year, we have aimed to increase staff awareness of generic skills through workshops and discussions, and through a greater emphasis on generic skills in unit outlines and assessment tasks. We thereby aimed to improve the students’ awareness of this component of their education.

KEYWORDS

Generic skills, Physics teaching.

INTRODUCTION

Generic skills are undoubtedly valuable to a graduate seeking employment (DETYA, 1999) and Physics departments have frequently promoted a Physics degree as providing excellent training in analysis, practical skills and problem solving for careers other than physics (Ripin, 2001). However the understanding of the term generic skills varies between disciplines (despite the term “generic”). Like most Australian universities, Macquarie University expects a specific list of generic skills (Macquarie University Teaching and Learning Plan, 2001) to be developed for its students, but these need to be interpreted and adapted to suit each discipline. In addition, teaching staff need to adapt their teaching to promote generic skills relevant to the discipline, without compromising the discipline-specific content. This usually includes appropriate assessment tasks that test mastery of discipline content as well as skills (Ramsden, 1992) since students are strongly motivated by the assessment weighting of various tasks. We have noticed, however, that individual students are often unaware of the purpose of specific assessment exercises in the development of their generic skills, and are also ignorant of the value that employers place upon these skills (B/HERT 1995). Over the past year, we have attempted to improve the collective awareness of generic skills in university physics teaching for both Physics teaching staff and students.

APPROACH

Our approach was first to define the generic skills relevant to our discipline, and then to identify how these were fostered across the unit offerings of the department. This provided a basis for our promotion of generic skills to students in individual units.

After discussions at a department meeting of what constituted generic skills, informed by a guest speaker (Dr Sharon Fraser, Centre for Professional Development, Macquarie University) the Physics Department began with a workshop (held on the afternoon of Conception Day 2001) to identify collectively the skills that are most valued by us as Physicists, within the context of the University's more general skills list. This list was reviewed and refined, with additional detail on each skill. The discussion that ensued in the first workshop helped to clarify our collective understanding of the terms used, and indeed our views on Physics generic skills were surprisingly unanimous. Using our list of Physics generic skills, the lecturers concerned with individual units identified the skills emphasised or developed in each unit, and these results were collated to gain an overall view of the skills development and progression that was expected of our students. Each of the units already included assessment tasks and other activities to promote generic skills development in a Physics context, although the purpose of these has not always been made sufficiently explicit for the students.

We promoted both the concept of generic skills, and our specific list of skills, to our students via websites, posters, specific descriptions in unit outlines and more generic-skills-oriented assessment tasks. In a final workshop, we discussed a variety of approaches to generic skills teaching and assessment and identified some areas with potential for increased skills development. Third year students and staff were surveyed to evaluate the success of the program to date, but we expect to see further gains as teaching strategies evolve further.

GENERIC SKILLS APPROPRIATE FOR PHYSICS

We developed the following list of generic skills that are important for our students in Physics. Of course, no unit attempts to cover every aspect of skills development, but over the range of 22 undergraduate (100-300 level) units that we offer, each of these skills is fostered and developed.

Essential skills

- Reading, analysis and understanding of written material (*ranging from technical to descriptive text*)
- Research, analysis and synthesis (*to source information and synthesise a structure or central concept from a body of data*)
- Advanced numerical and quantitative skills (*facility with mathematical questions, translation of problem into mathematical tasks, solve or analyse numerical and graphical information, interpret numerical, graphical and analytic information in a physics context*)
- Information technology (*ability to source information, produce documents, seminar or other materials in a suitable format, using spreadsheets, word processors, web search, math analysis software, library databases, understanding algorithms, programming languages*)

Presentation skills

- Writing (*to convey ideas clearly, concisely, logically at a suitable technical level for technical or general documents*)
- Oral (*to present confidently and clearly a technical topic to a technical or general audience*)

Physics-specific skills

- Advanced and broadly based problem solving (*analysis of problem, breakdown into sections, verbal, mathematical, graphical formulation of problem and physical interpretation of solution*)
- Experimental skills (*instrumentation and measurement skills, ability to analyse the results of a measurement with conceptual understanding*)
- Awareness of safe working practice (*safety of experimenters and protection of equipment*)

Personal skills

- Self-awareness, knowledge of own abilities, strengths, weaknesses, self-discipline and motivation, independent learning skills
- Time management, meeting deadlines
- Teamwork and cooperative learning skills (*to cooperate with one or more other people to achieve a goal, to manage the efforts of each and report effectively on individual progress to the group, leadership, to motivate and manage a successful outcome, to build networks*)
- Creative thinking (*lateral thinking in problem solving, presentations with flair, innovation, inspiration*)

Other issues

- Awareness of scientific approach (*model building, concept of “truth”*)
- Ethical issues
- Influence of Physics on history and society

All 22 undergraduate (100-300 level) units offered in Physics, Astronomy and Astrophysics, and Optoelectronics at Macquarie University, were reviewed against this list of generic skills. The skills fostered within each unit have been identified, with details of assessment strategies or other approaches used. We have noted a number of patterns in the generic skills development within natural progressions of units, such as the 100, 200 and 300 level Physics laboratories for example, or 200 and 300 level Optoelectronics. The “curriculum map” of generic skills will be used in the future as we progressively improve our teaching approaches in specific units and across our degree structure. It has already had a considerable benefit in promoting staff to reflect on the specific skills that are promoted in each unit and to consider alternative teaching strategies and assessment tasks. A particularly valuable outcome has been to enable more specific references to generic skills in the Unit outlines distributed to students at the beginning of each semester.

Of course, the teaching of generic skills has been a feature of our Physics units over a long period. We have, in particular, collectively focussed on some skills, such as technical writing, modelling and problem solving, that we have identified as being particularly important (or particularly in need of improvement) for our students. The development of students' skills in modelling and problem solving is the goal of a recently introduced unit, Scientific modelling, PHYS 220, which has been successful in attracting students and in improving the students' scientific modelling skills. An ongoing project developing and documenting the teaching of technical report writing to first year physics students is described in another paper in this conference (Freeman & Jones, 2002).

OUTCOMES

After we identified the key generic skills fostered in our units, we promoted these skills to our students by listing them on the Physics teaching website and targeting skills development in individual unit outlines. We also developed a poster "What else do you learn when you study Physics?" (professionally designed by Tony Dwyer of the Centre for Flexible Learning). This poster is displayed on the Physics teaching website (www.physics.mq.edu.au), and on noticeboards in the Physics Teaching Laboratories.

Towards the end of the project, we surveyed the Physics teaching staff on their awareness of generic skills and Third year students on their perception of individual improvement in generic skills. The results of the surveys are shown in Tables 1 and 2. The promotion of generic skills teaching to Physics staff this year has resulted in a greater awareness of generic skills in the University context for most staff, which was judged valuable by most staff. While not all staff plan to increase the generic skills component in their units, this is partly because they judge that they already offer appropriate skills. Some staff consider that they need to promote these skills to their students more strongly. The students' awareness of generic skills is not judged by staff to have increased so much, and there is scope for improvement in this regard. A more systematic survey of students across the levels and units that we offer is desirable to understand this issue in more detail.

Table 1. Survey of Physics staff 2002 (9 staff, 8 responses)

Results are listed as numbers of replies.

Question	Strongly agree	Moderately agree	Uncertain / neutral	Moderately disagree	Strongly disagree
My awareness of generic skills in University teaching has increased this year	6	1	1	-	-
I found the workshops on generic skills in physics valuable	3	4	1	-	-
I would like more information on generic skills		4	4	-	-
My students are more aware of generic skills this year		5	3	-	-
I incorporate generic skills in assessment tasks currently	1	5	3	-	-
I plan to increase the generic skills component of my units	1	4	2	1	-

A survey of third year Optoelectronics students showed an awareness of generic skills, although in this case, we were seeking to establish whether the students believed that their skills had improved. The results are shown in Table 2. While the students clearly identify that they have improved in some skills, including their ability to think critically, to work with others and to solve new problems, their responses on researching information, discussion and presentation, and writing skills offer considerable scope for improvement. A more detailed survey of students' awareness of generic skills across the discipline is desirable.

Table 2. A survey of Third year Optoelectronics students 2002 (14 students, 10 responses). Results are listed as numbers of replies.

Questions	Strongly agree	Moderately agree	Uncertain / neutral	Moderately disagree	Strongly disagree
I developed useful skills in researching information	1	2	5	1	1
Working in labs improved my ability to work with others	1	7	2	-	-
I improved my ability to think critically	3	6	1	-	-
I improved my ability to work independently	2	7	1	-	-
I improved my discussion and presentation skills	2	4	4	-	-
I improved my writing skills	1	4	4	1	-
I improved my ability to solve new problems	2	7	1	-	-

CONCLUSIONS

The Physics department has long been aware of the value of equipping its graduates with a range of generic skills in addition to more specific Physics knowledge and experience. While this has not always been made explicit for students in the past, our development of a list of generic skills that we value in Physics, and related discussions, have improved the awareness of generic skills in University teaching among Physics staff. This has led in turn to the promotion of these skills in unit outlines, and other measures to increase the awareness of generic skills among students. There is scope for further work in this project, for example, in surveying students across levels and units on their awareness of generic skills in Physics.

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