

EDUC6000 Project Report:

**Integrating Physics and
Physiotherapy in a First-year
Introductory Course.**

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Chapter 1

Introduction

This report is intended to give a detailed account of the action learning project I have undertaken while teaching a physics course for first-year physiotherapy students during semester 2, 2001. Perhaps the most significant outcome of this project is the evolution of my conception of the teaching and learning process, assisted in no small degree by my interactions by challenging and supportive discussions with my peers and mentors in the GCED program. I shall give my reflections on this process as a conclusion, but the main focus will be on the project itself.

To begin with, the background to the course I teach will be discussed, and the rationale behind the educational intervention will be established in this context. The outcomes of the project and implications for future improvements will then be discussed. Since the action learning process will continue if I teach the course again in second semester this year, the data collected to date and the conclusions I have drawn should be considered as interim results, to be further developed and refined in the future.

Chapter 2

Context

During second semester, 2001, I taught the physics component of PHYS1160 (Physics and Physiotherapy). Although the majority of students are high achievers (OP 1 and OP 2) from secondary schools, for many, this subject is their first exposure to physics. Therefore, helping these students in particular to develop an understanding of relevant concepts in physics is my focus. At the same time, students who are already familiar with physics (about one third of the class), need to be given the opportunity to extend their understanding of physics, especially in contexts where they will use these ideas, both later in their course, and as practitioners.

2.1 The Course

In its current incarnation, PHYS1160 is an amalgamation of the previous one-unit physics course (PH127) with sections of previous 1st and 3rd year physiotherapy courses dealing with manipulative therapy, and electrotherapy, respectively. This forms a two-unit course, with 45% of the teaching time, and 40% of assessment assigned to the physics component. This rearrangement has necessitated a reduction in lecture contact time by about 30%, so students will need to do a greater proportion of their learning outside the scheduled contact times. This is a particularly important point, since the course is still required to cover the same concepts, even though some of the content areas have been reduced in scope.

Since therapeutic applications are discussed soon after the related physics, the current structure is likely to help students learn to apply physical reasoning in context. However, little pre-planned integration of the physics and physiotherapy components was possible, so there is considerable danger that students may be confused by topics being approached from two very differ-

ent perspectives (with associated differences in terminology). Happily, the physiotherapy lecturers have indicated that they do have the time to discuss these issues ahead of the 2002 offering of the course.

Specific problems which occurred during the 2001 course included the use of different conventions, and confusing use of terminology. An example of the first is that physiotherapy texts tend to use the convention that clockwise torques are positive, whereas physics texts use the opposite convention to be consistent with the usual method of specifying angles counter-clockwise from the positive x-axis. Although the two conventions give the same results, and I pointed this out to students, this did still generate some confusion. Nevertheless, once students grasped the concept of torque (as opposed to a routine method for solving numerical problems), they could accept that the conventions were completely interchangeable.

The misuse of terminology is a much greater concern, and is prevalent in all physiotherapy texts I have browsed, and therefore makes its way into lectures as well. Particularly problematic are the use of *inertia* interchangeably for *momentum* in mechanics, the description of high-frequency electric fields as “electrostatic”, and the use of “intensity” to describe voltage and current in electrical therapy as well as the technically correct usage in discussing ultrasound.

Even though I tried to point out as many of these discrepancies as possible, when a small group of students was surveyed at the end of the course on the degree repetition between the physics and physiotherapy components, those who noticed some repetition found the terminology confusing. However, a number of students did not notice any repetition (although there certainly was substantial overlap in parts), and this may indicate that the use of terminology differed sufficiently that they did not realise that the same ideas were being discussed.

2.2 The Students

Aside from this issue of integration and coherence between the two components of the course, a major difficulty to overcome is students’ negative perceptions of physics. In an informal survey, only two of the 110 enrolled indicated that they would have taken the physics component by choice, even if it were “strongly recommended”. This suggests that the very thought of physics makes many of them uncomfortable, so some effort needs to be made to help the students become more at ease, without reducing their opportunities for learning.

As stated earlier, most of the students are high-achievers from secondary

school, but there is also a large proportion (about 20%) who enter the programme as either mature age students, or by “upgrading” after the first year of another degree. A small number are international students, so a high level of proficiency in English cannot be assumed. Finally, about 70% of the class is female, which needs to be carefully considered in teaching a field which has historically been male-dominated.

A preliminary survey showed that almost all students had a high school background in mathematics, while less than half have previously done any physics. Although this means that most are competent at basic algebraic manipulation, very few are confident, and still fewer seem able to use mathematics as a meaningful tool for solving problems. Part of the survey contained brief conceptual physics questions, which showed that even those with physics background did not have a good grasp of the concepts.

2.3 Wider Issues

Although my focus was on this course, I also used the opportunity to consider the more general problem of encouraging students with little physics or mathematics background to learn concepts in physics effectively. This is seen as a widespread difficulty in physics courses, both those provided as service courses for students majoring in other areas, and in mainstream physics.

A particular problem with traditional introductory physics courses is an emphasis on developing proficiency in numerical problem solving, rather than developing an understanding of concepts. Not only is this approach unhelpful for those students who lack confidence with mathematics, but those students who achieve well in such courses often do not develop an understanding of physics, but merely mechanical ability, since this is what is assessed.

As with all first-year physics courses at UQ, the previous physics for physiotherapy course was based on numerical problem solving, with this forming the majority of the assessment, coupled with a number of conceptual multiple choice questions. It seems that moving the emphasis from this type of learning towards conceptual understanding and the deeper reasoning process would be likely to improve the students outcomes from this course, and if so, would indicate that the use of this approach should be considered more widely.

2.4 Experience with the previous course

During 1999, and particularly 2000, I was involved in tutoring students in the previous physics for physiotherapy course. Generally, my responsibility was helping those who believed they were not progressing adequately, but I did have some interaction with other students. Those who were having difficulty generally complained of their inability to use mathematics, and not knowing “what formula to use” to solve problems. Therefore, it seems that those students who struggled with the course often did so because of lack of mathematics background, not necessarily because they found the physics difficult to understand. Indeed, one student whom I worked with for a considerable period of time seemed to have a very good grasp of the ideas, but was unable to perform algebraic manipulations accurately.

Early in second semester 2001, I received informal comments from a number of students whom I had tutored in the 2000 cohort. One student believed that she would not have passed the course if it weren't for her high school physics knowledge, while another who had not done physics at high school, but who achieved well in the course indicated that she “didn't remember anything” from the physics course, and that it was “a waste of time”.

An action learning project undertaken by the lecturer in 1998 [Thomas 1999] significantly improved the course during that year, and for succeeding years. Although formal complaints from students (which had been a regular occurrence previously) ceased, the comments above indicate that there was scope for significant improvement of the outcomes from the course.

Chapter 3

Review of Literature

Although there is a large body of research dealing with the teaching of “mainstream” physics courses, there is little which deals directly with the problem of teaching physics to students as a component of their studies in another discipline. However, a number of useful points can be extracted from the above research, the most recurrent of which is the need for students to be engaged during learning activities, instead of merely listening to a lecture-style presentation [Redish 1994, Hake 1998, Johnston and Millar 2000]. Even so, these “interactive engagement” methods do not seem to be able to help all students [Johnston and Millar 2000], perhaps because only a limited range of these techniques is usually implemented for any one class.

3.1 Active Learning or Action Learning?

Certainly, it appears that encouraging student interaction with both teachers and their peers is a step in the right direction. However, this focus on “what the student does” equates with a “Theory 2” conception of teaching [Ramsden 1992: 113], where the teacher designs activities for students without significant cooperation with the learners. In the higher level “Theory 3” formulation, teaching and learning become “two sides of a coin”, so that the “curriculum will need to contain different ways of encouraging students to learn and different sequences of material” [Ramsden 1992: 116]. Therefore, to effectively reach as many students as possible, a continuous process of change, based upon reflection on recent (and past) experience, is needed. This process of action learning is advocated as best practice in the tertiary education setting.

In considering the design of a curriculum, the way in which student learn needs to be carefully considered. A number of respected thinkers in education

seem to agree that the social-constructivist model of learning is the most effective way of conceptualising learning [Butler and Dall’Alba 2001a]. This suggests that students learn best when interacting in a group with peers, as well as with the more experienced “teacher”. The theoretical basis for the positive effects of group learning is discussed in more detail in module 3 of the GCEd [Butler and Dall’Alba 2001b]. The suggestion that explaining ideas to someone else within a group is of advantage to both agrees with my experience in tutoring students - it is also interesting to see how often they come up with a more elegant or direct way of expressing what I have been trying to teach them. This can often help me refine my own understanding of the ideas.

3.2 Relevance through learning in Context

As well as a variety of learning activities, students become more motivated if they approach the learning in a familiar context. Whitelegg and Parry [1999] discuss the advantages of teaching physics in context, both by applying previous knowledge to real life situations, and by initially learning physics through analysing these situations. Although the latter option has obvious advantages for student perceptions of the relevance of a course, it is pointed out that there is an inherent danger that students will be unable to generalise their knowledge outside the context in which it was initially learned.

Another advantage of learning in context, is that the objectives of the course are almost automatically better aligned with what students are likely to want to achieve. If they find that the work they are required to do links into their field of interest, they will engage with the material at a deeper level, instead of merely memorising what is required. This process of deeper conceptual learning must be re-enforced by appropriate forms of assessment so that “constructive alignment” [Biggs 1999] is achieved within the course.

Donaghy and Morss [2000] discuss the value of reflective practice in the teaching of physiotherapy, especially in relation to the process of clinical decision making. Whilst the scope of this physics course cannot encompass training students in reflection, the critical evaluation of various treatments and their associated safety issues through applying physics concepts in these contexts should permit students to engage in more effective reflection later in their careers.

3.3 Assessment - defining the curriculum

According to Ramsden, assessment is the students' primary focus: "the assessment always defines the actual curriculum" [Ramsden 1992: 187]. The best way to encourage students to engage with the relevant content or processes is to design the assessment to address these goals. Biggs [1999] suggests that the design of assessment tasks will define the nature of other teaching and learning activities (TLAs). If the assessment is carefully chosen, the remainder of the TLAs (lectures, tutorials etc.) need to be aligned to meet the goals of the assessment programme, making the design of these other activities more focused than if they were designed independently of the assessment tasks.

The value of designing assessment tasks to encourage student learning is discussed by Gibbs [1999]. Among other useful points, he suggests that using assessment throughout a course keeps students working on a regular basis, and therefore improves their learning. Continuous assessment should also allow students to receive regular feedback on their progress.

In the example of a mechanical engineering course, a random sample of students' assignments was marked. As well as reducing the marking load, this ensured that students had to maintain the quality of their work over all of the assignments, since a single weak assignment could lead to the loss of a large proportion of their marks.

An in depth discussion of many issues including the effect assessment has on students learning is given in Rowntree [1987]. Of his proposals for improving the effectiveness of assessment [Rowntree 1987: 241-243], the most relevant ones to my situation recommend considering a wider range of assessment options and choosing those which "elicit qualities of the type being sought" as well as avoiding those whose sole purpose is grading. A final piece of sage advice which should be heeded by all physics educators, is that although different assessors may not agree on the worth of a student's work, one should "resist, nevertheless the temptation to concentrate on qualities and abilities that are more routinely measurable and less likely to provoke disagreement among assessors", since these are likely to be less influential in the student's development.

As well as the direct effect of assessment on student learning, the value and validity of the information which can be garnered from various forms of assessment differs widely. Walsh et al [1992] and Bowden et al [1992] evaluate students' understanding of basic concepts in physics, and show that many forms of incomplete conceptual understanding would not be detected by some traditional forms of assessment, including multiple choice and numerical problems. This suggests the need for a move towards essay and other

written work as a means of better ascertaining the level of understanding attained by each student. As well as having greater validity for assigning marks, the key advantage is that students can receive feedback on how they misunderstand topics, not merely that they misunderstand. Furthermore, having to explain their reasoning is likely to elicit a higher quality of learning.

In particular, it is important that assessment is conceptualised in a way which maximises its value to both lecturer and students. This is represented by the “Culture of Assessment” as discussed in Module 4 of the GCEd [Butler and Dall’Alba 2001c]. Of particular relevance to my thinking of assessment are the following statements [*ibid*]:

1. “The aim is to document each student’s thinking process.”
2. “Assessment is considered to be an episode in learning.”
3. “Each individual’s response reveals data about that learner and can be used to design instruction.”

Taken together these suggest that effective forms of assessment should lead to the desired learning outcomes, as well as producing a record of the student’s performance and thought process which can then be used by the instructor to develop the course.

3.4 Previous work in the same context.

Finally, some of the issues of teaching physics to physiotherapy students are dealt with in a study analysing improvements made to the previous “physics for physiotherapy” course, PH127, in 1998 [Thomas 1999]. The focus of this study was on improving student perception of the relevance of the physics course to their future studies and careers. Some of the improvements, such as smaller group tutorials (30-35 students) and the use of examples from physiotherapy in lectures, have continued in the intervening years, and will remain for this year’s course. However, the portfolio workbook (which focused on definitions of physics terminology) introduced in 1998, that had the greatest effect of any of the changes, has since become optional due to constraints on the time available for marking.

The positive effect of portfolio type assessment documented in this study suggests that developing this type of assessment in a form which is reasonably economical in marking time would be a sensible way to progress. However, the idea of definitions of individual physics concepts (even though if they involve identifying an application to physiotherapy) does not have as great a potential educational value as would the use of these concepts in the analysis of situations and treatments commonly encountered in physiotherapy.

Chapter 4

Intervention

4.1 Delimiting the problem

Since student effort tends to be directed towards assessment, I chose to concentrate on altering the methods of assessment so that work on assessable tasks constituted the major part of the learning objectives for the physics component of the course. While this necessitated redesigning the lecture sessions, I focused on analysing the effect of the assessment intervention to make this action learning project more manageable. A brief discussion of issues arising from the lecture sessions and the ways in which these could be more effectively used in future will be given as a possible future direction for improvement in chapter 6.

4.2 Assignments

The major part of my intervention was a workbook consisting of 10 short assignments. As well as asking students to explain physics concepts (either directly, or indirectly in discussing the assignment question), these related directly to physiotherapy applications or clinical situations. Not only does this embed the learning of physics in the context in which students will later have to use it, but it should help them appreciate the value and relevance of an understanding of physics to their future careers. To allow students to receive feedback on this part of their work, the first five questions were marked and returned near the middle of semester. A preliminary version of the second set of five questions was given to students at the beginning of semester, but students were made aware that these could be adjusted in response to any issues arising from the first set.

Each set of five questions constituted 25% of the student's marks for the

physics component. One of each set of five was marked at random, and this formed the bulk of the mark, with a smaller contribution for overall quality of the other four responses. For more details on the marking scheme and criteria, please refer to the assignment handout in Appendix A.

This marking scheme should encourage students to spend comparatively more time on those areas they understand least, so that they are sure of achieving good marks. An additional side effect is a reduction in my marking load, which meant that I was able to give higher quality feedback on the question chosen for marking, as well as brief comments (without having to justify a mark) on the remainder.

Some tutorial time was allocated to discussing workbook questions to encourage students to work in groups, and this generally had the desired effect, although many students seemed reluctant to collaborate, possibly due to their competitive nature.

Although most of the workbook questions could be answered in part using mathematical reasoning, they could be answered equally well without any direct need for mathematics. This was to accommodate for those students with a poor mathematics background, who could not cope with learning both the physics concepts and the related mathematics in the limited timeframe of a single semester. I was confirmed in this decision by comments from the subject coordinator that practicing physiotherapists “have no real need for maths”. Furthermore, student responses to the questions seldom contained a significant proportion of mathematical working.

The questions cover the main topics of the course, and since I will later discuss which questions drew the best responses from students, Table 1 lists, in brief form, the physics topic/s and context of each question. Of particular interest in the analysis will be questions 7 and 8. The former required students to decide between two opposing viewpoints in the form of web based articles on magnetic therapy, and the latter requires an understanding of electromagnetic induction, a topic which generally causes students great difficulty.

4.3 Tutorials

As well as this major intervention, weekly tutorial questions formed 25% of the assessment for the physics component of the course. These were designed to encourage students to put effort into physics continuously, and thereby help them develop a deeper understanding. The questions focused on important, but specific, topics which were insufficiently broad to be encompassed by the workbook assignment questions. These were marked by the four tu-

Table 1: Topic and context for each workbook question

	Topic/s	Physio/clinical context
1	heat flow, temperature	ultrasound, patient body temperature
2	force, tension	traction
3	torque, equilibrium	lifting with back bent/straight
4	sound, waves	ultrasound
5	electric field	effect on living tissue
6	electrical circuits	nerve stimulation therapy
7	magnetic field	permanent magnets (alternative medicine)
8	oscillating E & M fields	Short-wave diathermy
9	interference	“Interferential” (addition of 2 AC currents)
10	Light, photons	Comparison of forms of phototherapy

tors (including myself), and returned the following week. This quick feedback allowed serious misunderstandings to be remedied at an early stage, as well as giving students continuous feedback on their progress through the course. The beginning of each tutorial session was used to discuss any common mistakes, since even those students who did not obviously make a mistake are likely to have similar misconceptions. A sample of tutorial assignment questions is given in Appendix B.

For the purpose of assigning grades, the mean of the best 10 of the 12 tutorials completed by each student was taken. Since students reasoning processes should develop throughout the course, and the purpose of these tutorials is to encourage learning, if a student shows continual improvement throughout semester, their mark would be weighted towards the later work. However, in practice, this provision was unnecessary, as students performed fairly consistently throughout the semester, perhaps because the earlier tutorials covered more simple topics or required fewer steps to formulate a rational answer.

The other use of tutorial sessions was to solve some relevant numerical examples with the support of tutors, so that the mathematics would be less threatening. Furthermore, having weekly discussions with all tutors allowed me to evaluate what students had grasped well, and which areas were proving particularly difficult. I could then use my reflections on any differences between the topic areas, and the way I had approached them in lectures to modify the way future lectures were presented.

4.4 Examination

The remaining 25% of assessment in the physics component was part of the end-of-semester examination. As a way of determining how well they had linked the physics concepts with physiotherapy, I asked the following question on the examination:

“Choose a physics concept and use it to explain the effect of a physiotherapy treatment on a patient. Include a brief description of the physics concept. Possible choices of concept may include, but are not limited to, electromagnetic induction, electric field, torque, tension, energy, or waves. Your response should be about three (3) paragraphs in length.”

Students were expected to spend approximately 25 minutes completing this question. It was designed to evaluate whether or not students have developed the understanding which the workbook assignments were supposed to encourage, and allowed a scope for choice of topic, so I could use students' choice of topic as feedback on which areas they best understood. I decided that making students aware of the type of assessment early in semester was one way to discourage plagiarism or cheating in the assignment work, since the assignment then had the additional function of exam preparation. The other reason for retaining some assessment in the final exam is to prolong the students' learning beyond the end of classes.

Chapter 5

Project Evaluation

To help evaluate the effectiveness of the intervention, data were collected using a range of techniques, and from a number of different sources during the semester. As well as providing data for the summative evaluation in this chapter, this was also used to adjust aspects of the intervention as the semester progressed, consistent with the notion of an action learning cycle.

5.1 Data Collection and Analysis

To help in planning for the course, students were surveyed at the end of first semester to determine their educational background in physics and mathematics, as well as their current understanding of the concepts of energy, heat and temperature which are central to the course (the survey form is included as Appendix C). In written questions to assess their current understanding, students were asked to rate their confidence in their answer. As well as assisting in the design of assessment and lecture sessions, this information can be used to analyse the correlation of student performance with their prior education and knowledge.

Throughout the semester, students were encouraged to give free-form written feedback at any time, with some time set aside in lectures for more guided feedback in weeks 2 and 7. Since this form of feedback did not elicit sufficiently focused responses for use in analysing the effect of the intervention, students were asked to complete questionnaires on the effect of the assessment items on their learning soon after the first set of workbook questions was completed. This form is included as appendix D. The themes emerging from this student feedback can be used to determine how successful they believe the intervention has been in helping them learn the physics relevant to their profession.

Another way of measuring how well students have learned from the intervention is to analyse their performance on the assessment tasks. The focus was on determining how well they understood the concepts underlying the workbook and tutorial questions, and monitoring any changes in the sophistication of their reasoning processes throughout the semester. To compare with these data, student performance in the end-of-semester examination was also analysed.

The perspective of staff was recorded through my own reflective diary, as well as by having the tutors keep a similar diary as part of their tutor training for the semester. Few issues arose from the tutors diaries, but those that did were used to adjust the intervention and respond to students needs throughout the semester. The diaries also form a record of the effects of the intervention from the teachers perspective. Finally, comments on any broader effects of the intervention on student's approach to the physiotherapy component of the course were sought from the physiotherapy lecturers involved, only one of whom (the most heavily involved) responded.

The methods of data collection are summarised in Table 2. This breadth of data allows hypotheses based on one method of data collection to be checked with other, independent, data sources. The different perspectives also give a wider base from which to draw constructive ideas for the future.

Table 2: Summary of Data Collection Methods

Method of Data Collection	Focus
Preliminary survey	Students' background (planning)
Assessment/workload survey	Students' perception of assessment
Free-form feedback	Timely feedback on important issues
Performance on assessment	Effect of intervention on learning
Tutor diaries	Perspective of teaching staff
My Personal Diary	Short-term action learning cycles
Comments from Physiotherapy Lecturers	Broader effects of intervention

5.2 Preliminary Survey

The main purpose of this survey was to determine what academic background students had in physics and mathematics. They were asked to (optionally) provide their name so I would be able to determine what effect prior experience in these areas had on their results. Of 86 surveys collected (the total class numbers at this stage were 110), 77 provided their names, which is suf-

ficient to allow meaningful analysis of the influence of background knowledge on their progress.

Of the 86 respondents, more than half (51) had taken physics at high school, and all but two had done either Maths B or an equivalent. The general ability of students to handle algebraic manipulation was tested in one of the written questions, and although very few students indicated that they were confident of their answer, all but 10 performed the manipulation successfully. Nevertheless, the lack of confidence probably indicates that students are not comfortable using mathematics, and would find applying it to solving numerical physics problems difficult. Removing mathematics from the assessable work for the course should thus have made students more comfortable, as well as allowing them to concentrate on understanding concepts.

In the remaining written questions on physics concepts, some students were able to quote textbook definitions of energy and heat, but very few showed any depth of understanding, especially of the difference between heat and temperature (most responses indicated that they believed the two were the same thing, although temperature was often described as “quantitative”). Describing energy is difficult, even for most physics graduates, so that question may not have been a good way to elicit information about students’ understanding, but some did demonstrate that they were aware of conservation laws and a variety of forms of energy.

As should probably have been anticipated, the majority of responses to the conceptual physics questions were very poor, and involved a number of the more common misconceptions (e.g. temperature is measure of the “amount of heat” in an object). However, I was particularly disappointed to see lack of understanding demonstrated by the student (at least seven) who had previously taken the first-level biological physics course. These students had since entered the physiotherapy programme by upgrading, so they must have performed well to gain entry. This indicates that the biological physics course is not developing conceptual understanding effectively, and again helps to justify a move away from the traditional assessment methods.

The final section asked students what forms of assessment they would prefer. The favoured types (in order of preference) were: short answer exam, individual (as opposed to group) assignments, and tutorial questions. The weighting of the examination in the physics component was quite small, but otherwise these preferences matched well with my intended intervention. A number of students suggested multi-choice exams, probably because they are practiced at taking these, but this option was intentionally left off the form, since I believe this form of assessment is inappropriate to evaluate, or encourage the development of, conceptual understanding.

5.3 Student Perspectives on Assessment

In the open feedback I requested from students in the second week, I suggested that they could, among other things, indicate what was helping them learn. At that early stage, it was surprising to find 15 of the 73 respondents mention the value of tutorial questions for their learning. Even though the workbook assignments were not due for another seven weeks, two of the students also identified these as assisting them to learn, although a number of others complained about the marking scheme and workload.

Near the end of semester, students were asked to complete another freeform feedback during one of the tutorial sessions. Since there were other assessment pressures on them at the time, there were only 28 respondents. Specifically, the students were asked to write advice to next year's class including suggestions on how to study, and what to concentrate on. A number of the comments (12 and 16, respectively) mention that the tutorial questions and workbook questions are important, with 10 suggesting that doing the workbook questions was a good way to learn, and 8 saying the same for tutorials. Other suggestions for study included working in groups (6 students), concentrating on the concepts which are directly relevant to physiotherapy (6 students), and thinking during lectures (4). Although there were no negative opinions voiced about the workbook or tutorial questions, the stimulus students were asked to consider was not designed to elicit these.

5.4 Workload

Students were asked to hand in a survey on the amount of time they spent on various activities related to the physics course with their first set of workbook assignments. This survey (see appendix D) also included a section for students to rate the effect of some of these activities on their learning, and a final section for more general comments. From the class of 105, I received 58 responses to this survey.

The results of the workload question are shown in Table 3. Since the physics component is essentially equivalent to a 1-unit course, students would be expected to do about 6 hours per week of total work, including the three contact hours. In planning the assessment activities, I decided that the workbook should take about 2 hours per week, and tutorial questions 1 hour per week. Obviously, on average, the students have exceeded these estimates: only slightly in the case of the tutorials (1.2 hours), but by a larger margin for the workbook questions (2.7 hours), although I would be surprised if most of the claims of more than 5 hours were valid.

The “total” column includes time spent on textbook questions and readings, which I felt would form a minor part of students learning. However, the total (5.2 hours) does show that some students also spent time on this (on average, 1.3 hours per week). Although the textbook should be a useful resource for answering workbook and tutorial questions, I suspect that the emphasis some students placed on it was due to the perception that the examination would consist of numerical questions. This view persisted among a number of students until I provided them with examples of exam questions, even though I had explained the nature of the assessment to them a number of times. In future years, students should be given examples of the exam format as early as possible.

Table 3: Results of Workload Survey

Time	Total	Workbook	Tutorial
< 1 <i>h</i>	2	6	13
< 2 <i>h</i>	7	13	30
< 3 <i>h</i>	3	19	12
< 5 <i>h</i>	21	11	3
< 10 <i>h</i>	19	9	
more than 10 <i>h</i>	6		
Mean	5.2	2.7	1.2

Students’ rating of the learning benefit gained from a number of activities is shown in Table 4. The rating scale is shown at the bottom.

Although the results of this rating is difficult to interpret in an absolute sense, the relative usefulness of various activities can be gauged. In particular, the workbook and tutorial questions rank highest, albeit closely followed by lecture sessions. Tutorial sessions and readings/textbook problems rate lowest, although these are still within one standard deviation of the highest rating. This suggests that different activities benefit individual students differently. One possible hypothesis which might explain this data is that students are more focused when working on assessable items, and so learn more effectively from these.

Finally, in the comments section, the primary issues raised were the ambiguity of some workbook questions, and the view that the workload was excessive for the relatively small weighting of these questions. Certainly, it would have been sensible to give students more definite guidance on the earlier questions, and gradually make the later questions more open. In terms of the disproportionately small weighting for the workload, I feel that many

Table 4: Student Ratings of Educational Benefit of Various Activities

Activity	Mean Rating	Standard Deviation
Workbook	3.8	0.8
Tutorial Problems	3.6	0.8
Tutorial Sessions	3.1	0.9
Readings	3.2	1.0
Lectures	3.5	0.7
Rating Scale	1 = Detrimental	
	2 = No Benefit	
	3 = Some Benefit	
	4 = Beneficial	
	5 = Great Benefit	

students tried to overachieve by writing significantly more than was suggested in the guidelines provided, so these may need to be enforced more strictly in future. Nevertheless, students in previous years spent a lot of time working on marginally relevant mathematical problems, most of which were not assessed, so the directed effort on workbook questions seems much more productive use of this time. However, this feedback does indicate that the workload needs to be carefully considered for next year.

5.5 Opinion of Assessment

As well as the formal requests for feedback from the entire class discussed above, I also received a number of unsolicited email and verbal comments, and surveyed a small group of students who attended an “extra” tutorial at the end of semester.

The focus of the small group survey was mainly on how well the two components of the course were integrated. Generally these students were happy with the integration, and especially with the relevance of most of the physics component, but did point out that the use of terminology was often confusing and contradictory between the two. Their suggestions for irrelevant material in the physics component generally involved the mathematical content, with the consensus being that equations should be avoided if possible. However, the entire group agreed that all of the topic areas covered were relevant.

As part of this survey, I requested students to identify positive aspects of the course, and possible improvements. The positive aspects identified included the use of continual assessment, and the workbook in particular,

although they did feel that the workload for this was somewhat too high. The suggested improvements were focused mainly on reducing mathematics content in lectures and tutorials, and the redesign of the latter to incorporate discussion of ideas with minimal time spent working through numerical problems. Given that mathematics was not required in a great deal of the assessment, this makes sense, but the discussion of ideas will require tutors who are comfortable explaining physics in the context of physiotherapy. This could be accomplished by discussing the relevant ideas with tutors each week, and redeveloping the tutorial questions to focus on ideas rather than mathematics.

Unsurprisingly most of the unsolicited feedback was positive, although there are comments on workload and ambiguity of questions in the following selection:

“Assignments are too much work, but very interesting.”

“As for the assessment - excellent! I like the workbook questions because I think I am actually going to learn something about physics.”

“Reword the workbook questions to avoid ambiguity.”

The generally positive tenor of other comments received suggests that the idea of continuous assessment, and the workbook assignments in particular were perceived by students to be useful for their learning, and reasonably enjoyable. However, I will need to consider giving more specific direction in future questions, as well as finding ways to reduce the perceived workload.

Finally, from the comments on TEDI teacher evaluation confirmed the opinions that mathematics content should be further reduced, and a number of students noted that they were particularly pleased with the feedback given on their work - the quality of which would be compromised without both the tutorials and assignment work.

5.6 Performance on Assessment Items

The plot in Figure 1 shows the marks for both the physics and physiotherapy components of the course, as well as the overall result (solid line), as a fraction of the maximum possible score on each - in order of increasing total score. As would be expected if the two components were inter-related, there is a generally trend that students who achieve higher results in the physics component also perform well in the physiotherapy section, although the correlation is not very strong.

Interestingly, students generally performed significantly better on the physics component than physiotherapy component. I believe this may be due to the physiotherapy assessment occurring only during the final exami-

nation period (comprised of a practical exam, and a theory exam of which the physics exam component forms part). In contrast, the continuous assessment used in the physics component allowed students to respond to feedback on their work, and the assignment format has significantly more relaxed time-constraints than examinations. It is therefore not surprising that students performed better on the physics component, and I believe that the lower stress and more directed effort spent on assignments means that the high marks also reflect students development of good conceptual understanding of the topics covered.

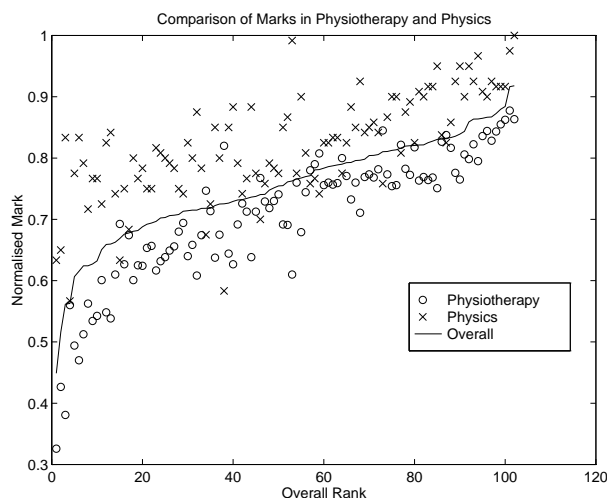


Figure 1: Comparison of Overall marks in Physiotherapy and Physics Components.

In marking each set of workbook questions, I tried to identify which question of the five had elicited the best response, with attention especially to the chain of logical reasoning presented. The plots in figures 2 and 3 show the frequency with which a particular question was a student's best of the five. In the first set (figure 2), question one predominantly attracted good responses, followed by fairly even distributions between questions 2,3 and 4. The smallest number of high quality responses was received for question 5.

The reason for worse performance on question five is that it relied on material covered quite close to the due date, and was on a topic (electric fields) which students found comparatively difficult to grasp. Not only this, but many found the wording ambiguous. Although I had hoped for students to approach it from a general perspective, the introduction of the concept of alternating electric fields in the physiotherapy component of the course occurred earlier than I had anticipated, so many students tried to relate the

question to this directly - doing so was particularly difficult, since the physics required had not yet been covered. Nevertheless, most students did manage to piece together a logical answer, and the interaction these difficulties engendered between students was extremely productive. Although unintended, the end result of this, aside from a degree of stress for both myself and students while we negotiated a sensible solution, was greater openness to collaboration and discussion, especially among the student group. While this was not one of my major aims for the course, and the process could doubtless have been better designed, the end result was certainly positive.

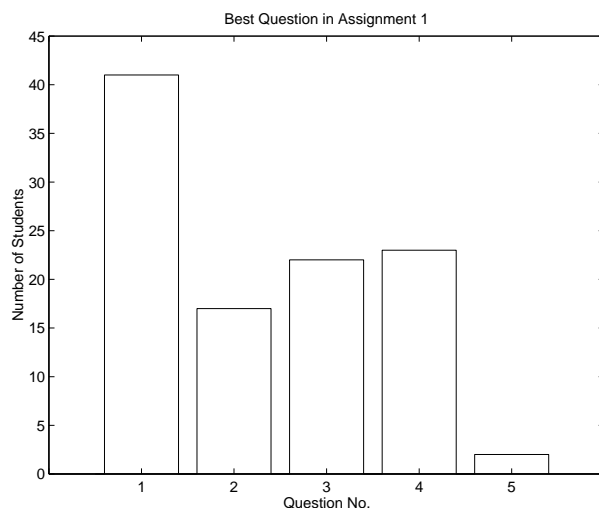


Figure 2: Question on which student performed best in assignment 1.

In the second set of questions (figure 3), a qualitatively similar situation occurs, with students performing better on question nine, on the topic of shortwave diathermy, beats and interference of waves. This had also been covered in a tutorial assignment, and the applications was discussed in detail in the physiotherapy component of the course, so the large number of high quality responses on this question is understandable.

Again, the final question elicited the least quality answers. This time, I believe that this was mostly due to time constraints, since students had other assessment due, and the final examinations were approaching. Those students who spent the time to produce a complete and detailed answer to this question performed well, so I do not believe the lower quality of response was due to any ambiguity or intrinsic difficulty in the question itself.

Although most students performed better on other questions than on eight (shortwave diathermy/ electromagnetic induction), almost all students explained the physics in reasonable detail, although occasionally missing one

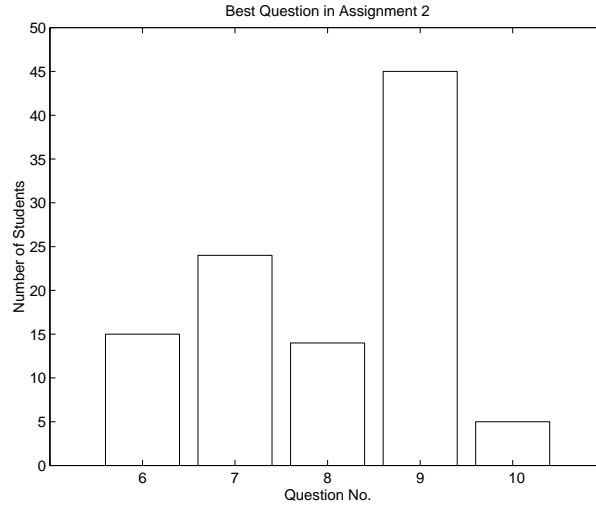


Figure 3: Question on which student performed best in assignment 2.

or more steps in the logical reasoning. Nonetheless, this was a positive result for such a difficult topic area.

Finally, the number of good performances on question seven is also worthy of note. In this, students were asked to decide whether therapy based of static magnetic fields was clinically effective based on two opposing web-based articles. Only three of the 103 students who completed this piece of assessment were taken in by the “unscientific” arguments presented by one of the articles.

Figure 4 shows the students choice of topic on the examination question. As discussed earlier, this allowed scope to choose almost any relevant topic to write on, but required students to explain the effect of a treatment on a patient using physics. The most popular choice was interference of waves, and I will return to this presently. The other choices are headed by electromagnetic induction, which was a sensible choice since this is easy to relate to physiotherapy, even if the concept is somewhat difficult to explain. The remaining topics are evenly spread between electric field, waves (in the context of ultrasound) and electromagnetic radiation, each of which was a reasonable choice and is closely related to at least one physiotherapy modality.

The popular choice of interference, on the other hand, is not a good choice, since the link between it and the modality of “interferential” therapy is complex, and requires discussion of electrical properties of nerves and voltage etc. Although most students who chose this topic did explain the physics adequately, only five of the 29 correctly explained the link to therapy. This choice of topic highlights to me the power of hints relating to assessment,

since I had suggested that an understanding of interference would be useful (this was intended to refer to the tutorial questions on this topic, and its relative importance in the physiotherapy component of the course). Perhaps these students were among those who performed well on the interference question in the workbook, and this also helped motivate their choice.

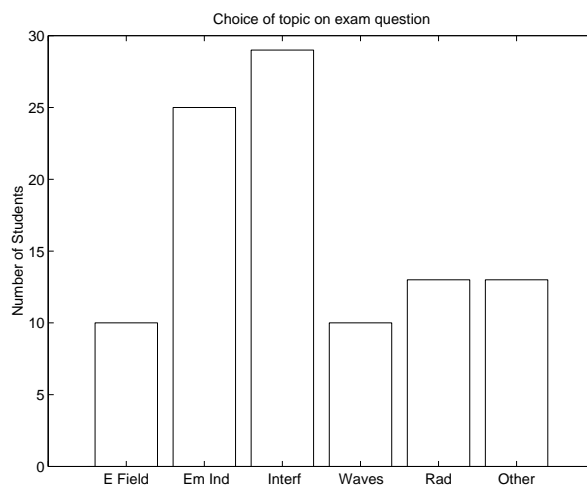


Figure 4: Choice of topic for exam question.

To round out this analysis of assessment performance, it is very interesting to compare performance of students with and without a high school physics background (Figure 5) on the various pieces of assessment. What is immediately striking from this is that the distribution of marks for those students without a physics background is very similar, and only very marginally lower than that of students with this background on all assessment except the final exam. In this, students without high school physics show many fewer high scores (of 9 and 10), and a number of fails at 5 or below. Although there are also two marks of 5 among those students with prior physics background (these two may not have achieved well in high school physics, but this cannot easily be verified), this does suggest that the time pressure or other stresses of an examination noticeably disadvantaged those students who lacked the background in physics. To check this hypothesis, the marks on other assessment items of those students who achieved 5 or less were examined. In the first assignment, these students were among the worst performers, and they were slightly behind on early tutorials. In contrast, their performance on the second assignment was above average, although their later tutorial marks still showed occasional lapses. I believe that this indicates that these students had improved their comprehension of physics throughout the semester, but had not yet internalised this sufficiently to perform well under pressure.

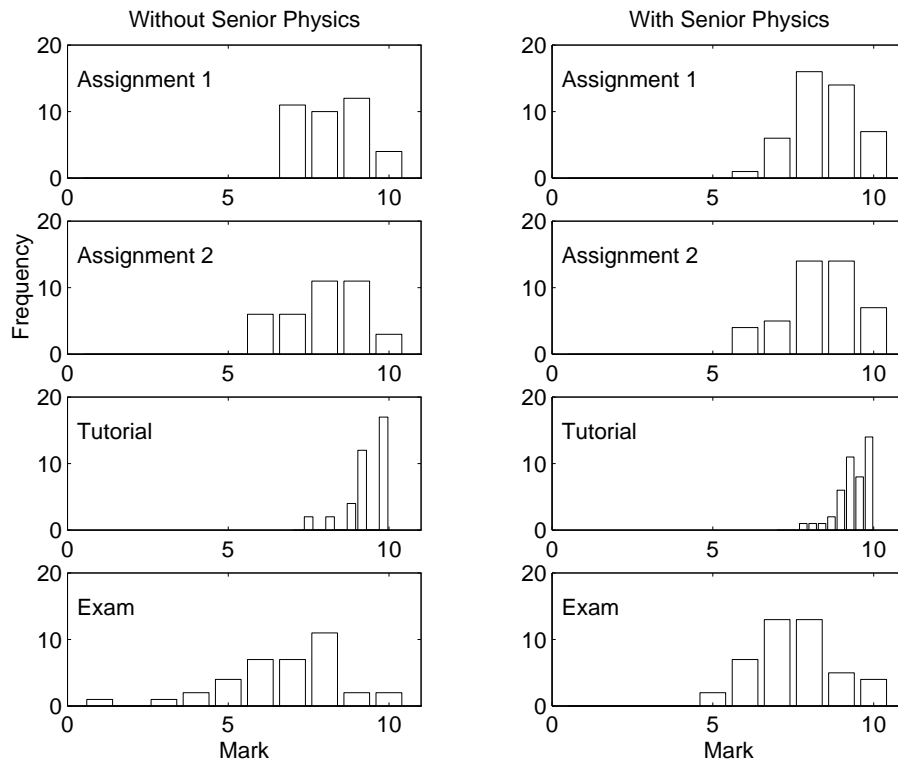


Figure 5: Comparison of Marks for students with and without a high school physics background.

Although I would like to retain some assessment in the examination in future, as motivation for students not to cheat on the assignments, these data do indicate that the weighting of examination-style assessment should be small if the result is to reward students for their development throughout the subject without bias towards those who have prior knowledge.

5.7 Other Perspectives

To complement information obtained from students, the results of the changes to the course need to be considered from other perspectives. Perhaps the most important of these are my own impressions of the overall running of the course, based on comments recorded throughout in my personal diary.

In the early weeks, I concentrated mainly on thinking about lecture sessions, since this course was my first experience of this situation, and a number of problems needed to be solved. Most prevalent in my early comments are issues related to the excessive content of the course, dictated to some extent

by the curriculum document (or rather, list of topic areas) I had been given to teach. I could hardly fit what I thought was needed in the time available, so it was not with too much surprise that students' comments on the 2nd week feedback generally reflected a lack of comprehension and anxiety about the pace of the course. In response to this and my own reflections, I decided to model the lectures around the workbook and tutorial questions which I had designed. This led to much more focused, and obviously relevant lecture sessions, although some required topics did not relate adequately to assessment - these I suspect worked worst of all, since I was no longer comfortable with their relevance. Thus, the assessment topics also influenced design of the remainder of the course, although the alignment between various activities needs to be further refined in future.

Having been through this process, I was quite satisfied with the design of the workbook and tutorial questions, but it did take significant effort in lecture discussions for students to accept the rationale behind these, and especially the marking scheme. Once they accepted these, progress was reasonably smooth, and I was especially impressed by the consistently high quality of responses in my tutorial group. Other tutors mentioned similar impressions, although all of the other groups had difficulty on some topics. This difference may be due to the tutorial allocation process where I suggested students sign up for certain tutorial groups if they were worried about mathematics, since two of the tutors had extensive experience teaching introductory mathematics courses. This may have meant that those students who were most confident signed up for my group.

My impression of the assignment work was that students often put in excessive effort (some assignments were as much as ten times the recommended word limit), but almost all managed to piece together a coherent argument, and demonstrated good understanding of the concepts, although there was a number of lapses in technical details such as the use of units and confusion of terminology (e.g. weight / mass). Overall, the assignments were handled significantly better than I had anticipated, based on my experience in tutoring students in the previous year's course.

Perhaps the greatest change I observed was in those students who came to request assistance with the work. Previously, students who requested help were interested almost solely in algebraic difficulties, whereas I now found myself discussing ideas and how or why various physiotherapy modalities affect a patient with this year's students. Given that the only background I have in physiotherapy comes from preparing this course, this was often challenging, but I found it stimulating rather than threatening. This was especially the case since most students were interested in comprehending the ideas rather than having me tell them "the answer" (again a focus of students

in past years - perhaps due to the multichoice assessment).

One of the tutors noted in their diary that they found students were asking questions and being involved in tutorials more readily than in their prior experience. I feel this is a positive change, probably in part due to the lower emphasis on mathematics, so that discussion of ideas also occurs in tutorials: given student feedback I think that a more definite move in this direction for tutorials is justified.

Another, albeit unrelated, point which was consistently noted by all tutors was the small number of students attending tutorials on the assignment due dates. This suggests that some students left these until rather late, as opposed to working on them consistently throughout. I may have to consider carefully whether to try to further encourage continuous work on these assignments, or whether this is really the individual student's responsibility.

The comments received from the main physiotherapy lecturer with regard to her impressions of the physics component were very positive. In particular, in terms of exam performance, she "was very pleased with how the students answered the question on beat frequency." This may reflect the effect of my hint to students that this was an important area to understand, as well as the students' familiarity with these ideas from tutorial and workbook questions. Students also performed well on the shortwave diathermy question, reflecting the way this was reinforced by the workbook.

In general, she was very pleased with students overall performance, especially when compared to an accelerated course run for second and third year students in the previous semester. The one area in which students did particularly badly, although this is apparently not unique to this group, was ultraviolet therapy. Since there was only one lecture session designated for coverage of the entire electromagnetic spectrum and properties of light etc., I did not cover the physics of this in depth. It may be worth considering placing more emphasis on this in future, or designing a workbook question around ultraviolet therapy directly, either in addition to, or as a substitute for question 10, which was on phototherapy in general.

Finally, although this is not directly relevant to my intervention, I received feedback from one student as follows:

"... you always look for ways to improve your teaching."

While this doesn't necessarily indicate that I have succeeded in improving the intervention during the semester, it does show that students are aware of my willingness to consider any suggestions. Coming just after the mid-semester holiday break, this also reminded me of the importance of the action learning cycle in managing change.

Chapter 6

Future Directions

The feedback received from students and my own reflections on the effectiveness of this educational intervention suggest a number of possibilities for future improvements. In particular, I will focus on the development of the workbook and tutorial assignments, and more effective ways to use lecture sessions.

One logical progression suggested during learning set discussions, was the possibility of moving entirely to a problem based learning format. I believe this would have great merit if the entire physiotherapy programme, or a large part of it, were PBL based, but with the current structure I consider that this would disadvantage those students who lack high school physics background. Those who have previously done physics would be able to find the necessary information reasonably efficiently, but without prior knowledge, students need some active support system to give them a base from which to extend their understanding. The current format seems to achieve this goal reasonably well, although I believe that a focus on improving the targeting of the current course, and better alignment between lecture and tutorial sessions and the learning objectives would be useful.

6.1 Development of Assignments and Marking Procedure

For the workbook assignments to be viable in the long term, the current marking load needs to be reduced, while still maintaining the quality of feedback to the students. There are two possible ways of attacking this problems, either I should mark just one question per student, and give general feedback on the remainder by providing example answers, or the assignments could be completed in groups of four or five students. The latter has the advantage

that I could give specific feedback as necessary on all topics covered, whereas the former solution means that I may miss common problems in responses to some questions. However, organising successful group work is difficult and time-consuming, but the advantages of this approach were already apparent from the *ad hoc* collaboration which occurred between students. Thus, a more formal emphasis on group work is likely to have benefits for students learning, and would be a good direction to pursue in future.

In terms of the workbook assignments themselves, the early questions need to give students more direction so that they use their time efficiently, with the scope for freedom of thought gradually increasing towards the later questions. This would allow students to become comfortable with the assignment and group work process initially, then require them to develop their critical reasoning skills later in the semester when they are (hopefully) more comfortable with approaching physics, and have some background knowledge to fall back on.

In terms of the complaints about excessive workload, moving to group work should reduce this somewhat, but I would also like to relate the questions better to other work the students are concurrently studying. Although the second half of the course (electromagnetism) fits well with the physiotherapy section, the mechanics discussed at the beginning could be linked to orthopaedics and other areas of study. This would require a significant amount of research on my part, but if this link could be formed in the workbook questions, it may also help in overcoming some of the current difficulties experienced by the physiotherapy students with the self-directed learning module in orthopaedics (a large proportion of this year's class was required to sit a supplementary examination for this section).

6.2 Improving tutorial sessions

Although the tutorial assignments were generally well received by students, much of the feedback on the tutorial sessions themselves, and on the remaining tutorial questions, was quite negative. Specifically, students suggested that the emphasis on mathematical solutions during tutorials, and on the mathematical problems was not helping them to learn. Indeed, a number of students to whom I spoke recommended having more of the conceptual style questions asked in the marked tutorial assignment instead of those based on mathematics. They found the conceptual questions interesting, and were disappointed with the “boring” material covered in tutorials.

On the other hand, a significant proportion of students (around 25%) do like the mathematical questions, and I suspect these students do learn from

attempting them. However, I feel that, in future, tutorials should mainly concentrate on conceptual discussions and the use of estimation (rather than in-depth mathematics) for determining the order of magnitude of effects, since the numbers in most problems are chosen arbitrarily within some sensible range anyway. I also intend to include a short list of numerical problems from the text for those students who find these helpful.

Finally, to help students get started on the workbook assignments, and to let them develop their own outline of the important concepts covered during the course, some of the early tutorials will ask students to identify the concepts relevant for all of the workbook questions. A list of concepts for each question can then be compiled in each tutorial group so that students have a list of ideas to refer to when they attempt each question.

6.3 Effective learning in lecture sessions

Since my focus for this project was on assessment, I spent only a comparatively small proportion of the time thinking about lectures. From discussions arising during the GCEd, and my personal experience of sitting in lectures, I knew that I needed to move away from the traditional lecture format, especially since I had a two-hour lecture block to deal with. In general I tried to introduce demonstrations where these were appropriate, at times asking for members of the class to participate. I also alternated between using overheads, discussing side-issues without visual aids, and drawing diagrams and/or performing mathematical manipulations on the board. Early in the semester, I also tried to design activities for students to perform in pairs, but the response to these was not as good as I had anticipated, possibly because I had not designed them carefully enough, so I ceased using these after about the fourth week.

The one great advantage I found to doing work on the board was that it slowed my presentation down so that most students could keep pace, whereas, even with a conscious effort, I tended to move too quickly when talking to prepared overhead slides.

In feedback received from students, the main issue relevant to lectures was that they thought my use of mathematics was excessive, given that they didn't really need to know it, as evidenced by the following representative statement:

“If we don't need to know the mathematics, remove it completely!”

From results of the TEDI survey, and comments on these, students seemed to feel that this rendered explanations unclear to them. I also felt that many students were not concentrating, and found that even important (and simple)

administrative information was not retained by some students.

Although I did not continue with small group activities during this course, I feel these are essential in the future. Obviously I will need to think carefully about how to manage these to achieve maximum benefit for the students. Otherwise, the positive comments on lectures given by students focused on the value of demonstrations, and the use of graphs/diagrams (although not all found graphs useful). Therefore, I would like to introduce more demonstrations to lectures where possible, and try to find ones which can involve the entire class. I only managed to think of one of these, which was involved in the explanation of torque, but most students indicated that they found this valuable, and I was also pleased with the way in which they answered the related tutorial and workbook questions.

Finally, I noted that whilst students did not concentrate well in the lecture situation in general, they were particularly attentive when I was discussing anything related to assessment, and also when we discussed how the physiotherapy treatments worked. Again this would indicate that I should try to extract the physics through discussion of the physiotherapy treatment. Although this is likely to be a difficult process, if it means students are more attentive and learn more in lectures the effort will have been worthwhile.

Chapter 7

Reflections

The action learning process I engaged whilst teaching the PHYS1160 course has impacted greatly on both my views of teaching, and the way in which I approach it. In particular, my view that effective learning only occurs when there is interaction between the lecturer and students and in particular between students themselves has strengthened significantly. My experience with the failure of the traditional lecture format to communicate ideas to students has led to an increased focus on what happens during contact sessions, and the reflective process allowed me to keep my focus mainly on this, rather than on technical issues of content and presentation, throughout the semester. Aside from this development in my understanding of the role of a teacher, I have come to a better understanding of my own learning processes.

Although this project is itself only part of an action learning cycle which will continue when I lecture the course again in second semester this year, every week I reflected on what had happened in lectures and tutorials for that week in order to decide how to alter my approach to these sessions in the following week. Thus, there were many small action learning loops within the project, and, especially in tutorials, I would seek feedback from students to adjust the way these were run even within a single session.

As well as being an effective way to respond quickly to feedback, the action learning process helped in managing the changes that were part of my intervention. In particular, it gave me the confidence to accept the initial negative feedback from many students, and respond to this by repeatedly explaining the rationale behind the changes, and giving students suggestions for dealing with these. Without the reflection involved, I may have been tempted to reduce the scope of the changes as an easy alternative, and although this would have been “safer”, it would also have limited the positive outcomes.

Perhaps the area in which continual reflection benefited me most was in

maintaining focus on the broader issues rather than technicalities. Since I was looking at the teaching and learning process, rather than my performance in lectures, this reduced the stress I felt during lecture sessions, and also allowed me to accept the negative feedback from some students in a constructive way. As well as making the lecture environment less threatening, the feeling of responsibility for, and control over the learning process in which students would engage meant that I became absorbed in trying to improve this as much as possible, and led me to become increasingly enthusiastic and involved with the students over the course of the semester.

Overall, this action learning project has increased my confidence in students ability to learn even the most difficult concepts, if they are given the motivation and opportunity in a low-pressure environment. On a personal level, I am now more comfortable seeking and receiving feedback from students (and others), and am able to use this in a constructive sense via reflection to modify my own understanding and beliefs.

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Appendix A

PHYS1160 Workbook

PHYS1160 Physics Workbook Assignments

Purpose:

These questions are designed to help develop your understanding of principles of physics which are important in physiotherapy. They should assist you to see the relevance of these aspects of physics to your future profession. Furthermore, if you work consistently throughout the semester and revise your responses as you progress, your work on these questions will constitute a major part of your learning in the physics component of the course, as well as allowing you to better understand the physiotherapy component.

Guidelines for Submission:

- Approximately 300 – 500 words per question.
- Essay format is preferred, but responses may also be in point form, make use of equations, etc.
- Use of diagrams and/or graphs is encouraged.
- Explanations should be written in clear English.
- Handwritten responses are acceptable, but illegible work will not be considered in awarding marks.

Due Dates:

Questions 1-5: September 13
Questions 6-10: October 31

Collaboration:

You are encouraged to share your ideas with the members of your tutorial group. You should also seek feedback on ways to improve your responses from within this group, and from the rest of your peers. Group discussion is likely to be one of the most valuable learning experiences you have. However, the responses you submit for assessment must be your own, and use of the work of others (including texts) should be acknowledged in an appropriate fashion.

Feedback:

Your feedback on the educational worth of these questions is needed to help improve the course as it progresses. Constructive criticism of how appropriate the questions are to the aims of the course and any suggestions for improvement are particularly valuable. I will readily accept verbal comments, written feedback (to your tutor or myself), or contact via email: rayner@physics.uq.edu.au
The versions of questions 6-10 are preliminary, and may be altered in response to feedback. Final versions will be made available by September 14.

Marking Criteria:

Mark	Criteria
7	Outstanding response incorporating independent research which may include relevant material and/or concepts not directly covered in the course. Criteria for a 6 must also be met.
6	Response demonstrates a good level of conceptual understanding by generalising from specific examples or exploring interrelationships between concepts. Reasoning is clear and consistent throughout. Conclusions are evaluated in relation to their significance and limitations.
5	Response demonstrates a good level of understanding of relevant concepts. Reasoning is clear and consistent throughout. Conclusions are evaluated in relation to their significance and limitations.
4	Response demonstrates an adequate understanding of directly relevant concepts. Reasoning is good, but may lack consistency. Some attempt is made to evaluate conclusions.
3	Response demonstrates an adequate understanding of most, but not all directly relevant concepts. Reasoning may lack consistency. Some attempt is made to evaluate conclusions.
2	Response does not demonstrate significant understanding. Reasoning is unclear. Solution is incomplete.
1	Response does not demonstrate significant understanding. Reasoning is very unclear or irrelevant. Solution is incomplete
0	Sketchy or unreasoned response.

Note: Where a response does not meet all of the criteria for a mark, the next lower mark will be awarded.

Questions:

If you wish, you may write your own replacement question for one or more of those below. If you do so, your question must be approved by the lecturer, and should be on a similar topic to the question being replaced.

1. A metal spoon and a styrofoam[®] cup are left for a long time to ensure that they come to equilibrium with room temperature. When you first pick up the spoon it feels cold, whereas the cup may feel slightly warm. Explain this apparent paradox. If you are applying ultrasound to a patient and they say it feels warm, does this necessarily mean the temperature of the area being treated is above body temperature. Why, or why not?
2. In a traction device, masses are suspended from pulleys with ropes to support or extend a limb. Estimate the minimum and maximum masses that would be used in such an application. What sets these limitations, and are there any safety considerations associated with the maximum value?

3. Discuss why bending your back when lifting a heavy object is more dangerous than bending your knees.
4. Explain why an applying gel or similar substance is used to couple an ultrasound head to a patient. Why are different frequencies used for therapeutic and imaging applications? Are there any limitations on what regions of the body can be effectively treated with ultrasound?
5. What are the possible effects of applying an electric field to the human body via insulated capacitor plates? Is there a limitation on the magnitude of electric field strength which is safe to apply?
6. In High Voltage Stimulation therapy, a patient's limb forms part of an electrical circuit. Where does most electrical heating occur? What effect of High Voltage Stimulation causes the greatest therapeutic benefit?
7. Some companies offer therapeutic products based on permanent magnets (Bioflex™ etc.). Can these be effectively used in physiotherapy? You may find the following articles of use in your response:

Magnetic and Electromagnetic Therapy, David W. Ramey, The Scientific Review of Alternative Medicine, Spring 1998, Prometheus Books.
Available from: <http://www.hcrc.org/contrib/ramey/magnet.html>

A few short articles at <http://www.nutriteam.com/articles.html>

8. Shortwave diathermy can be administered to a patient either via capacitor plates or an induction coil. How do the mechanisms of heat generation in the patient differ in the two techniques?
9. Describe the phenomenon of interference. Use this to explain why, and in what circumstances, interferential treatment has advantages over other forms of electrotherapy.
10. Compare and contrast the likely effects of the different forms of phototherapy (Infrared, Laser, UV etc.) with reference to photon energy and intensity of radiation. Also comment on any safety issues involved in the application of these modalities.

Appendix B

Sample Tutorial Questions

Sample Tutorial Questions

1. How many blades of grass are there in the Great Court?

2. (a) Why do you lunge forward when your car suddenly comes to a halt?
(b) Why does whip-lash commonly occur in car accidents?
(c) Why are you pressed backward against the seat when the car suddenly accelerates? In your explanation of these, refer to the most appropriate one of Newton's three laws of motion.

3. Sit-ups are more difficult to do with your hands placed behind your head instead of on your stomach. Explain why this is with the aid of a diagram.

4. A course of ultrasound treatment seems to assist healing of muscle tissue near the skin, but is not having the same beneficial effect on deeper tissue. Explain how you might alter the treatment to have greater effect on the deep tissue.

5. Some ionic drugs are transferred to the body through the skin by a process called iontophoresis. Explain how this process helps the drug ions to migrate through the skin, and comment on any issues related to the charge of these ions.

Appendix C

Preparatory Survey

PHYS1160 (Physics Component): Preparatory Survey

To help adjust the course to meet your individual needs, it would be useful to know your name. However, if providing your name is likely to influence your answers to the survey, leave the line blank.

Name: _____

School Background

Please tick which (if any) of the following you studied at high-school:

- Maths B
- Maths C
- Physics

Year of Completion of Senior (or equivalent): _____

School: _____

Written Questions These are designed to help me gauge your current understanding. I am more interested in how you approach the question than the “correctness” of your the answer.

1. What does the term "energy" mean in a scientific context?

How confident are you of your answer? (Indicate with an "x")

Very Low _____ Very High

2. Rearrange the following formula to give x (show working):

$$C = \frac{A}{x^2} + 3$$

Confidence: Very Low _____ Very High

3. What is the difference between "heat" and "temperature"?

Confidence: Very Low _____ Very High

Assessment:

Indicate which methods of assessment you would prefer by assigning a weighting to each of the following.

Method	Weighting (%)
Short Answer Exam	_____
Problem Solving Exam	_____
Essay Exam	_____
Individual Assignment(s)	_____
Group Assignment	_____
Weekly Tutorial Questions	_____
Oral Presentation	_____
Other (Please specify)	

General Comments:

Please add any other comments or thoughts you feel may be useful. These may include your concerns about the difficulty of the subject, topic areas you would find particularly interesting, timing of assessment, etc.

Thank you for your effort in completing this survey.

If you wish to give further comments, please email me at rayner@physics.uq.edu.au

Anton.

Place completed surveys in the assignment box opposite the Student Unit office on level 3, Therapies Building.

Appendix D

Survey on Study Workload and Assessment

PHYS1160 Physics Workbook and Tutorial Survey I

Name (optional): _____

Have you done: Senior physics (or equivalent)? Yes / No

Senior maths B or C (or equivalent)? Yes / No

1. On average, how many hours per week have you spent:

a) Preparing answers to workbook questions? _____

b) Working on tutorial problems? _____

c) On readings and textbook questions? _____

d) Doing other activities related to physics? _____

2. Rate the effect on your learning of the following activities using the scale:

- 1 Detrimental
- 2 Not beneficial
- 3 Of some benefit
- 4 Beneficial
- 5 Of great benefit

a) Preparing answers to workbook questions _____

b) Working on tutorial problems _____

c) Readings and Textbook Questions _____

d) Tutorial Sessions _____

e) Lecture Sessions _____

3. Do you have any general comments on the difficulty of the course or the assessment workload? Any suggestions for improving workbook questions 6-10?