INTRODUCTION TO SECTION 3

Teaching and learning within the physics classroom

Aim: To consider teaching and learning strategies within the physics classroom to explore methods of engaging young people with physics.

Contents: Report

Evaluation from the Co-ordinator of the Teaching and Learning Coaches (FEC)

Methodology: This report started by discussing the work by Hattie on what makes a good teacher. It acknowledged that there are many external factors outside of the control of the classroom, but once inside of the classroom, it was up to the teacher to make a difference. The Institute of Physics report: 'Girls in the Physics Classroom: a Teacher's Guide for Action' made a sound start for producing a questionnaire that could be developed with my students. The report provides practical advice for physics teachers for conducting surveys, mainly as a vehicle for learning more about students within the classroom and developing an empathy with students. The report itself is a guide for good teaching practice that can applied to anyone, irrespective of gender.

The report also contains discussion of a project, which was primarily to develop problem based learning. The project (Project Think!) was based upon developing resources that we tested with our students then shared the generic principles with teachers from other disciplines. For example, we developed a practical assignment that was based upon the testing of the elastic properties of carrier bags, in order to apply physics towards solving a real life problem. I then went on to develop resources on the physics behind incidents such as the Space Shuttle Disaster, or Chernobyl, containing a thinly disguised effort to develop students' written communication skills in the process. The original aim of the project was to develop material that applied subject-based knowledge to real life situations, mainly to engage the students and enable them to appreciate the relevance of their studies. Over the duration of the project, I adjusted my personal objectives towards developing materials that I believed would increase the students' abilities to achieve higher grades. The final part of this study considers the use of the Virtual Learning Environment as a mechanism for engaging students with learning outside of the classroom. This was later developed into an action research project which is discussed in Section 5 of the portfolio.

Conclusions: The main conclusion from the student survey was students may have preferred learning styles, but it is important to stretch and challenge students so that they develop a wide range of skills. The purpose of the surveys is to open up channels of communication and encourage students to reflect upon their learning. Project Think! encouraged a small team of teachers within the FEC to develop resources which could develop higher order thinking skills.

Dissemination of this study: When the initial Project Think was conducted, it was with the aims of collating the resources that we had prepared and sharing them with other teachers. Unfortunately this did not materialise as the facilitator suffered a series of health problems and then found new employment. Despite sending samples of my resources and then a copy of the final report to be reviewed, a written evaluation form was not completed by the organiser of the project. This study was reviewed within the FEC by the Co-ordinator of the teaching and learning coaches, who was also a lecturer on the teacher training programmes within the college. I have subsequently been asked to produce an abridged version of this project for publication in a college journal.

Teaching and Learning within the Physics Classroom

Marianne Hill

Introduction

This report will consider teaching and learning within the classroom, with particular interest in raising the achievement and aspirations of A level physics students. As teaching in the twenty first century adapts to meet the needs of the learners, do all learners have the same needs? As girls are under-represented in physics A level classes at the college, I am constantly reflecting upon my own classroom practice in order to ensure that girls, or any other minority group, do not feel marginalised within a classroom environment.

Part 1: The section will discuss the reasons why it is important to reflect upon classroom practice and continually develop as a teacher. It will draw upon some of the documents produced by the Institute of Physics, which have been produced to encourage physics teachers to strive for high standards in the classroom and promote the enjoyment of physics for all students.

Part 2: Students' preferred learning styles will be evaluated through the use of questionnaires. This will compare AS and A2 physics students' attitudes as well as evaluating any gender differences in learning styles.

Part 3: This section will report upon a college-based project (Project Think!) which was undertaken in 2008 to develop higher order thinking skills. My contribution towards the project was to develop problem-based learning activities that could engage students in the wider aspects of physics.

Part 4: This will explore systems and strategies to engage students, such as the use of Blackboard, blogs and wikis, as well as monitoring students using grade-centre and progress review plans. It will make particular reference to the Physics Action Project that I conducted with the Science Learning Centre (2009/10).

PART 1: Why do we need to reflect upon classroom practice?

In the report 'Teachers make a difference' (Hattie, 2003), it was suggested that whilst there are many factors that affect the educational achievement of young people, the single most important variable is the classroom teacher:

> 'We need to ensure that this greatest influence is optimised to have powerful and sensationally positive effects on the learner. Teachers can and usually do have positive effects, but they must have exceptional effects. We need to direct our attention to higher quality teaching, and higher expectations that students can meet appropriate challenges – and these occur once the classroom door is closed and not by reorganising which or how many students are behind those doors, by promoting different topics for these teachers to teach, or by bringing in more sticks to ensure they are following policy.'
>
> Hattie (2003, p.2)

A teacher has a powerful influence upon young people and, as can be seen from some of the responses to the student questionnaire in section two, teachers do make a difference. Whilst teachers are judged by quantitative measurements such as examination success rates, evaluating the percentage of high grades, the percentage of students who have achieved above their target grade and other such calculations, it is easy to become focussed upon working towards examination specifications. Some of the greatest effects that a teacher can have are to inspire young people, to create an enthusiasm for learning and give them the confidence and self-belief that they can achieve success.

Whether through the structured Continuous Professional Development which is organised by the institution itself, or embarking upon external training, it is important for classroom practitioners to keep abreast of new developments in their subject area, share ideas with teachers from other organisations and reflect upon their own classroom practice. As a physics teacher, I find that the Institute of Physics has been an excellent support at all times during my career. The educational strand of the IOP is superb, providing a range of services such as their Teaching Advanced Physics site which has teaching aids for a wide range of A level topics. The IOP is not, however, confined to providing content for teachers but provides a strong forum to encourage teachers to excel. The support and encouragement for practising physics teachers is tremendous, so there is no reason for a teacher to be merely satisfactory, teachers are encouraged to be excellent.

The Institute of Physics report '*Girls in the Physics Classroom: a Teacher's Guide for Action'* (2006) is an excellent starting point for exploring teaching and learning styles within the classroom, and encourages teachers to reflect upon not just what you teach, but how you teach. In the introduction, it outlines why the low proportion of girls who study physics A level is problematic since the qualification is a gateway to a variety of careers that can ultimately contribute to the 'financial and intellectual wealth of the country' (p.1). The report is not confined, however towards the teaching of girls, as it provides a supporting platform to consider one's own teaching practice that can be beneficial for all learners within the classroom. The main purpose of the document is to critically reflect upon one's own practice to place the learners at the heart of the teaching. This report found that the key influences upon students' attitudes towards physics are:

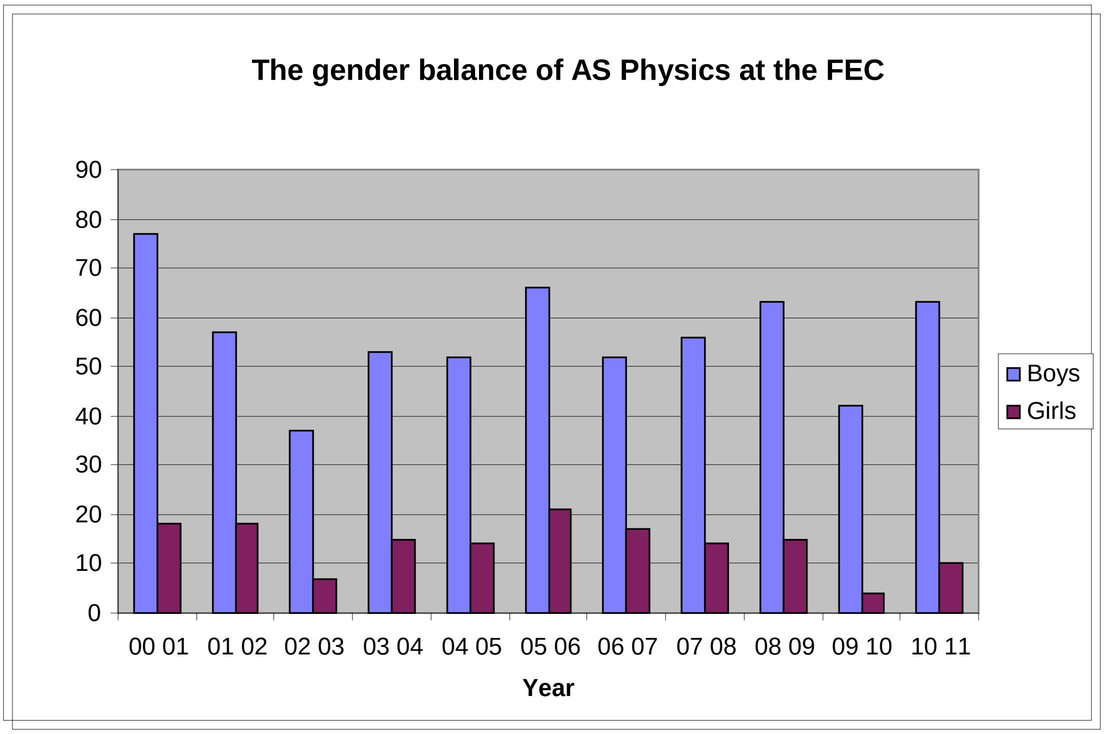
1) Self-concept and how they value or engage with the subject.
2) Views of physics based upon their experiences at school
3) The support provided by their teachers

(p.1)

As can be seen from the chart below, the number of girls who study AS physics at the FEC is very low indeed. Whilst there are a range of external reasons for students making decisions about subjects, it is my role as the classroom teacher to make sure that I reach out to all students, irrespective of gender or other differences and make my teaching as accessible as possible. When devising strategies to engage students with physics in the classroom, it is important to stress: 'Any interventions that make assumptions about all girls and all boys will have little chance of succeeding and may well have unintended negative impacts.' (Murphy and Whitelegg, 2006, p.12)

It is also important to stress in any discussion about gender that the differences are trends rather than factors that are attributable to all members of that group. (Murphy and Whitelegg, 2006, p.1)

Chart 1: The gender balance of AS Physics students at the FEC (2000 to 2010)



The section of the report that considers 'Lessons from Research' provides practical advice and strategies that teachers can explore in a school or college environment. This provided a strong basis to reflect, consider and re-evaluate my own classroom practice and teaching methods. It is important to stress that whilst the suggestions are a guide to exploring practical strategies within the classroom, the aim is to improve the learning experience of all students, with girls as an important subset. This section makes a number of suggestions, but the three most relevant are:

a) How do girls perceive they are doing within the physics class?
b) How do girls perceive physics compared to other sciences?

c) Do girls think that physics lacks relevance to their current and future lives? (p.11)

It suggests that teachers devise their own questionnaires and samples are provided in the appendix of the document. I have designed a range of student surveys throughout my career as I have found that as well as obtaining quantitative data on a wide range of topics and issues, it initiates dialogue between the learner and the teacher. Students become more open about their feelings and the teacher learns more about the strengths, weaknesses, anxieties and apprehensions of individuals within the group. I support the idea of using surveys as a means to continually reflect and reappraise one's own teaching. Care needs to be taken at all times to ensure that students take surveys seriously and answer honestly. The results of a student survey that I conducted with my AS and A2 physics students (June 09) are discussed later within this section.

The second section of the 'Lessons from Research' discusses curriculum issues, particularly how relevance is important to engage students in the learning process. It claims that girls are more likely than boys to require a social context in which activities are set. The AQA specification (introduced 2008) for A level physics includes an integral component to the course called 'How Science Works', which emphasises the human aspect of science by 'recognises the contribution scientists have made to their own disciplines and to the wider world' (AQA, 2009).

Obviously the suggestions quoted in the report are designed to encourage teachers to think about the questions, but I fundamentally believe that there are no topics that are more difficult for girls than boys. There may be topics that might appeal more to boys or girls due to the content, but this does not translate into levels of difficulty. Having conducted an evaluation into examination performance, using data from 2004 to 2010, I have found that there are no particular topics where examination performance between girls and boys shows any strong differences.

Section three of the Lessons from Research deals with 'the teacher perspective' and claims that 'students value strong leadership, friendliness and understanding in their teachers but they are more likely to experience these qualities in subjects other than science or maths' (p.16). It discusses issues such as the amount of teacher attention given to boys and girls, and states that there is evidence to suggest that teachers have lower expectations of girls in physics.

The document suggests that teachers reflect upon the learning environment in order to make sure that it is a comfortable place for students, whether boys or girls, to work. We are very fortunate in having excellent, well-equipped laboratories at the College. The environment is crucial and as Jane Butler Kahle explained in her research, the teachers who made their rooms visually stimulating were most likely to encourage girls in science. She found that it was 'the energy, creativity and initiative of the individual teacher' that created good learning environments. (Kahle, 1985 p.52)

School or college laboratories can often seem to be sterile and inhospitable places, so it is important to make the learning environment more comfortable for the students. By displaying colourful posters, a selection of students' work and a selection of physics toys (cars, balancing toys, elastic toys and a crane) can develop a sense of belonging for the students. I am constantly surprised by how much information students take in from the posters around the room. Therefore I try to put up information about women in physics and physics from different cultures, as well as news about forthcoming television programmes that may be relevant.

There has been a marked increase in students finding physics topics on the internet, for example with 'youtube', which is very popular with students, so the class wiki was initiated so that students could share there findings with the rest of the class. This initiative will be discussed later in this report.

PART 2: Students Preferred Learning Styles

Over the years, I have devised many surveys to determine the interests of students, but for the purpose of this research, I devised and conducted a survey in June 2009. During the academic year 2008/9, there were only eight students in my second year A level physics class. Due to this small number, I had the opportunity to discuss with students which learning styles they preferred, which they disliked, and more importantly, why they disliked certain activities. Rather than base conclusions upon individual interviews alone, I conducted the survey in order to quantify their preferred learning styles.

It must be stressed at this point that the aims of conducting surveys are to find out more about students, engage in meaningful dialogue with students about the learning process, and encourage students to reflect upon their educational journey. It is not with the intention of adapting teaching methods in order to please the students, but to understand where care must be taken within the classroom in order to overcome particular fears, anxieties or limitations. According to Brookfield: ‘Students who define their needs as never straying beyond comfortable ways of thinking, acting and learning are not always in the best position to judge what is in their own interests.’ (Brookfield, 1995, p.20) In order to ‘stretch and challenge’ young people, they must be encouraged to work beyond their ‘comfort zone’ and embrace new situations and ways of learning.

For this particular survey, the students could respond to the different questions according to the following terms; definitely, mostly, perhaps, maybe not or definitely not, ranging from the very positive to the very negative responses. The aim was to use wording that the students would feel comfortable using and be able to relate to, rather than more formal terms such as ‘excellent’ or ‘outstanding’.

To the first question of whether the A level physics course was as they had expected it, all eight of the students responded with either definitely or mostly, indicating that the students have not been surprised by the content or difficulty of the course. The survey then listed different types of activity, which the students could rate in the same way. The most significant factor was that even with only eight students, there were no activities where all of the students were unanimous.

The sections that were answered by every student to be within the positive region (i.e. definitely or mostly) were:

Practical work in a small group

Calculations working on your own

External visits (e.g. to universities)

Activities that included some responses in the negative region included:

Writing practical reports

Making presentations in small groups

Making individual presentations

When designing the questionnaire, I deliberately avoided using a point scale, as I have found from previous experience that students may sometimes confuse the scale, for example, whether it is an ascending or descending scale. After the students had completed the questionnaires, I then assigned a point system so that I could produce a more quantitative analysis. For this survey, I assigned: definitely = 5, mostly = 4, perhaps = 3, maybe not = 2 and definitely not = 1. Then the average point scores for each activity were calculated and ranked in order of the preferences of the group.

TABLE 1: Preferred classroom activity for A level physics students

Classroom activity	Average point score in survey
Calculations – working individually	4.6
Individual problem solving tasks	4.5
External visits	4.5
Practical work in small group	4.4
Calculations in a small group	4.4
Independent practical work	4.4
Writing up reports	4.1
Problem solving as a group	4.1
Making notes in class	4.1
Making posters/visual aids	3.9
Making presentations in a small group	3.8
Developing a class blog site	3.8
Visiting Speakers	3.6
Contributing to the class wiki	3.5
Making individual presentations	3.4
Producing power-point presentations (either individually or as part of a group)	3.1

Despite the small group, the students' preferred learning was individual, whether working on calculations or problem solving. This does not necessarily mean that it is their only way of learning, as the students could respond to all of the suggested activities in differing amounts. It was pleasing to note that students were providing considered responses to the questions, as there were no occasions where students were biased in the totally negative or positive regions.

According to 'Girls in the Physics Classroom: A Teacher's Guide for Action': 'Students' perceptions about tasks might offer you some ideas for alternative tasks and approaches that broaden their experience of physics and extend access to it' (IOP, 2006, p.16). The questionnaires help teachers to learn about students perceptions, but we would not use them to dictate or constrict our methods of teaching, more to help us develop and expand our learning strategies.

One pleasing aspect to this survey was that the responses were more positive than anticipated, with the only 'definitely not' responses being for the class wiki. This was a surprising response as all of the students had contributed towards producing material for the site. The range of responses from 3.1 to 4.6 is positively biased and indicates that the students were taking this survey seriously and giving well considered responses. The responses indicate that students are less comfortable asking or answering questions in front of the whole class, but the results are too close to draw this issue into deeper discussion.

The second part of the survey was designed to determine which qualities in a teacher are important to students (see Table 2 below). All eight of the students agreed unanimously that factors such as subject knowledge and enthusiasm were the most important factors. The only clear outcome of this part of the survey is that students want to be pushed and actually want the teacher to set homework, preferring a teacher who sets too much rather than too little work.

TABLE 2: Preferred Teacher Qualities for A level students

Teacher Qualities	Average point score
Subject knowledge	5.0
Enthusiasm for subject	5.0
Experience of teaching	4.8
Makes lessons interesting	4.8
Teachers who push you to work harder	4.8
Teachers who make an effort to get to know you	4.5
Industrial experience	4.4
Relating subject to students' interests	3.8
Teachers who set lots of homework	3.8
Teachers who set little homework	2.0

The third part of the survey was concerned with the perceptions of the students. For the questions:

1) Do you feel that you are doing well in physics?
All eight of the A2 students answered 'mostly'

2) Do you feel that your teacher values you?
All eight answered positively with four answering 'definitely' and four answering 'mostly'.

3) Is it important that you get along with your teacher?
All eight students answered positively with seven answering definitely and one with mostly.

This indicates that the students have a strong awareness of how they are doing in the subject (answering definitely to the first question may be over-confident!) and that the relationships between the students and teacher are strong for this group.

AS Survey

The same survey was given to my AS physics class and 16/17 students responded that the course was as they had expected, with only one student answering in the ‘perhaps’ column. The surprising aspect to the AS survey was that for the different types of activity, there were no activities that were either positively or negatively favoured by all members of the class. The AS analysis produced a more diverse response to the different learning styles than the second year A level students.

The three preferred activities were: calculations – working individually, practical work in a small group and problem solving as a group. The least favoured activities of the AS students were: making presentations, either in groups or individually, or contributing to the class wiki. It must be stressed again that there were no activities for the AS responses where there were clear positive or negative responses.

The most surprising response to the survey for both AS and A2 students is that for the wiki. In 2009, we created a wiki site for both AS and A2 physics on Blackboard (Interactive Learning Environment). We have been surprised by how students have responded positively by uploading their own material and sharing ideas with other students. When I questioned students to determine why the response in the survey had been rather negative, some students said that they thought the survey related to activities that they would like to participate in during class time. They thought the wiki was excellent for additional or extension work but they would not like to spend class time on this type of activity.

Analysing the second part of the survey for the AS students was slightly more problematic as some of the students missed out some of the questions. There were two responses to the teacher quality questions that were unanimously positive: subject knowledge and enthusiasm for the subject. To the third set of questions:

1) Do you feel that you are doing well in physics?
2) Do you feel that your teacher values you?
3) Is it important that you get along with your teacher?

There was a much more diverse range of answers and indicated that this cohort were far less confident, self-assured or comfortable in the classroom than the A2 students. As the A2 students had already achieved some measure of success in order to proceed to the second year of study, it could be that they were more confident of their own and the teacher's abilities.

An interesting comparative analysis can be extracted from the data to evaluate the responses provided by the female students. Taking part in this survey were four female AS students and two A2 students. Because of the small numbers involved, I was concerned that the girls answered truthfully and honestly, as there is always a worry when conducting such surveys that students write down what they think are the right answers rather than how they really feel, which would invalidate any efforts to obtain realistic data.

There were no particular activities where all of the girls were unanimous, the only response where there was a definite 'like' (either definitely or mostly) was in doing calculations on their own (average score of 4.5). Another positive response, which was slightly less popular than the previous task, was with making notes in class. This was quite different to the responses from the whole group surveys, indicating that this task was not popular with the boys. The girls were also positive about external visits and talks by speakers, whereas the whole group surveys indicated a spread of responses for these categories.

Both of the second year girls said that they definitely liked independent practical work, whereas the first year girls answered from perhaps to definitely not. The reason for this difference in attitudes could be that the second year girls have already succeeded at the AS course and having applied to university, are more mature and confident than the first year girls. It was interesting to see that the two second year girls answered positively towards making presentations in small groups, whereas the first year girls were all negative about this activity.

The girls' responses to the questions about homework were not as varied as the whole group responses, with the girls being in favour of teachers setting a lot of homework and also were more positive about the need to be pushed by their teachers. The responses to the third section did not show any significant differences for the girls or boys, indicating that all students agreed that it is important how they get along with a teacher.

The single most important fact that I have learned from conducting surveys with students is that all students are unique and that it is impossible to make any sweeping generalisations about preferred learning styles. It is important to incorporate a range of different activities in order to engage and interest students, as well as developing in the students a wide variety of skills. Conducting surveys and asking students what they like and how they feel about being in the classroom, makes the students feel valued and lets them know that you care about their progress. Providing a supportive, caring and enthusiastic environment where students can feel comfortable in trying a wide variety of styles is crucial, whereas restricting the types of activity or teaching to suit the students preferred learning styles is not what education is about.

PART 3: Project Think! (Problem based Learning)

It could be argued that physics is a subject that is founded upon problem-based learning. Unfortunately, due to the lack of necessary resources and the need to press through the specification at a rather rapid pace, the ambition to base all learning upon actual problem solving is not always practical or possible. ‘Project Think!’ was an initiative developed by a consultant from a local university to promote and encourage strategies to develop Higher Order Thinking Skills. Involvement in the project was voluntary, and as I was subject leader for AS Critical Thinking as well as A level Physics, I was eager to participate in the project.

There were three strands to Project Think!; Community of Enquiry, Peer Assessment and Problem Based Learning. I selected the latter option for the project that I wanted to develop with my physics students, mainly as physics is a practical subject and solving problems is integral to the entire course. Feedback from students consistently reveals that ‘problem solving’ is a type of activity that promotes learning within physics, particularly if it combines practical work and calculations.

For the AS physics coursework, we had to devise an extended practical activity where the students had to conduct a scientific investigation and produce a full report. These reports were assessed in the categories of planning, implementation, analysis and evaluation. For this assignment, we devised an investigation into the quality of supermarket carrier bags, which encouraged students to explore the elastic and plastic properties of carrier bags then suggest how simple modifications could be made to produce stronger bags (see Appendix 1). Feedback from students was very positive and indicated that having an open-ended investigation into a real life situation enabled students to develop their knowledge and understanding of the properties of materials to a much greater level.

The topic of carrier bags also carried social relevance as students were all conscious of the environmental and economic consequences of the use of plastic bags. Therefore discussion would develop on why one should re-use carrier bags and recycle materials. In the assignment brief, it stated that students should be able to present their findings to a supermarket manager, which provided a social context for the investigation. A second open-ended assignment was devised to explore ways of keeping coffee hot. Students were at first cautious about open ended activities, but enjoyed applying science to real life contexts.

Another strand that I developed was with correcting mistakes in problems. For this type of activity, a set of problems were produced and the students had to first of all complete the problems themselves, but they were then given a set of answers from an imaginary student and the students had to mark this piece of work. An example of this type of activity can be seen in Appendix 2. The task involved trying to find where the student had made the mistake, and this really highlighted to the students the importance of clarity in presentation, and enabling the teacher to follow a student's line of thought. The students found this task difficult at first and I pointed out that this was the problem every time that I marked their homework! The group became fully involved and actually wrote comments for the 'student' on how they could improve their work.

The third strand that I developed for Project Think was to develop physics in a wider context that of the classroom. Although not exactly real-life physics, I produced a series of activities based on the physics of Superheroes (sample in Appendix 3). There was also another series of activities based upon the physics of Films (sample in Appendix 4). Both of these units were entertaining and engaging for the students. Whilst some of the students asked the question: 'Will we be examined on this? the majority of the students appreciated the fun aspect of studying physics, particularly when we deconstructed misrepresentations of physics in film. For example, the invisible car featured in a James Bond film proved to be an interesting starter for the topic of refraction. A further package on the Physics of Fairgrounds was produced with a synoptic approach of bringing together different aspects of physics and showing how physics is related to the world outside of the classroom.

The fourth aspect of the project was to extend and develop real life situations such as the Challenger Space Shuttle Disaster and the Chernobyl Disaster (sample in Appendix 5). I developed two projects where students had to research into the background of the situation, assess how each disaster could have been prevented and produce a report. Whilst some of the students engaged whole-heartedly with these activities, I found that this was the least popular with my physics students. The students who were academically stronger could appreciate these initiatives, however some of the less confident students wanted to confine their studies to the specification and felt that they needed as much time as possible to master the skills for the examination.

In summary, the work conducted for Project Think! was successful to some extent as it demonstrated to students the wider contexts and applications of physics. Whilst the aim of the project was to develop higher order thinking skills, we already cover a range of activities within the course that develop these skills in a more examination focussed manner. Where this project proved to be successful was by drawing in the less academic students with some of the more real-life (Disasters) or entertaining (Superheroes) applications of physics. It was also useful for developing wider skills of the students such as teamwork, written communication and reading about the subject using a variety of sources. From a personal perspective, I have found that working on projects with teachers from different disciplines can be particularly inspiring, and that all initiatives that encourage critical reflection upon classroom practice can be worthwhile and meaningful.

Reflecting upon the needs of my students, I have found that one of the barriers to success is the inability to concentrate upon difficult problems for sustained periods. All too often, students will encounter difficult problems and then give up, losing interest the minute that they feel stretched. Many students have a short attention span and simply can not concentrate upon one specific task for more than a few minutes.

In the AS physics examinations, questions are confined largely to the recall and application of one single equation. However at A2 level, students need to recall, rearrange and manipulate different equations. The ability to concentrate, recall and apply knowledge from different aspects of the specification is crucial. The skill of thinking is not to be under-valued and time must be given to develop higher order thinking skills.

After the project ended, I continued to devise activities that would encourage students to maintain interest in challenging problems. One of these activities involved finding problems that would synthesise information from different parts of the specification and draw them together to solve one particularly difficult problem. I would only set the students one problem at a time, but warn them that these problems could take approximately fifteen minutes to solve. If students appeared to be struggling, I would give them a prepared clue card, encouraging them to keep going and not to give up on a problem (see Appendix Six for a sample of this type of activity). This activity encouraged the more able students to become more competitive and developed a strong determination for all students to solve the problems without the clue cards. Some of my A level colleagues have used this technique as they also feel that the main challenge with students in the transition from GCSE to A level is to develop the ability to think.

Ironically, the emphasis at training sessions is for teachers to devise a series of short, ‘hands-on’ activities that engage the students in learning. This is good for students who have low attention spans and need to be given constant stimuli in order to keep them on track. However, for A level students, this could be regarded as counter-productive, as we need to develop the skill of thinking and this involves concentration in order to acquire a complete understanding of difficult topics.

PART 4: Using the Virtual Learning Environment to engage and support students

All students have a network account and when they log on to the college computers, the Blackboard site appears on-screen. This site contains everything that a student may need whilst studying at the college[1], for example email facilities, targets, personal progress review plans, as well as a wide range of other information about the college, library resources and particular course information.

Grade Centre is a feature on Blackboard whereby teachers can upload student marks, which can then be viewed by the student, the teachers (instructors) of that subject and their line manager. The basic principle is that students can chart their progress, as well as teachers being able to quickly monitor a student's progress and identify any potential problems.

The Progress Review Plans (PRP's) have been designed so that students can input their information, whilst teachers can upload a report and SMART TARGETS. The teacher can comment on whether the student is above, on or below target. At the Assessment Boards, managers, course leaders and tutors can view the information and decide if any action ought to be taken about a particular student. PRP's are conducted three times per year and the Spring reports are sent out to parents. Students have shown a particular interest in uploading their own personal photographs and taking ownership of their personal area.

Physics Action Research Project

Having conducted an analysis of students' performance in the modular examinations, it was evident that the module which featured the greatest component of extended writing was the one in which the students performed least successfully.

[1] The Virtual Learning Environment changed from Blackboard to Moodle in January 2011

It became clear from the questionnaires that students preferred the calculations to the explanations, perhaps as the students who selected to study physics at A level had greater numerical rather than communication skills. This is, perhaps, a generalisation as the strongest students were good at all aspects of the curriculum, whereas the weaker students selected subjects that played to their strengths.

As the use of computers in education has increased dramatically over the past two decades, it seems that we increasingly ask students to word process documents. As the software incorporates spell check and grammar correctional facilities, we are taking away an essential responsibility from the individual for this process. Again, the stronger students may be more aware of the limitations of the computer but less able students trust that the computer will have corrected their work.

As dependence upon the computer increases, it could be argued that students' literacy skills are becoming weaker. When we recalled several students examination papers (2008), the quality of the written responses were very poor indeed. The papers revealed that many of the responses had been far too minimal, with many of the students not expressing the concepts with the clarity or powers of written expression that would satisfy an examiner.

The initial research that was conducted in the summer of 2008 was shared with the subsequent A2 physics class (2008/9) so that the students could understand the problem and learn from the findings of the research. Despite developing more discursive activities within the classroom and also for homework, a problem was emerging in that students simply did not like to write. I realised that by asking students to word process assignments, which was the common college policy at the time, this was masking the major problem in that the examination was hand written.

This fact made me stand back and critically reflect upon the value of what we were doing as teachers. Was it better to have good quality word processed documents from the students or to try to encourage students to write by hand? The students further explained that at GCSE, many of the tasks that were set for homework required one word answers, or phrases, but they were never expected to write more than a few lines. All of our partner schools currently follow the AQA specifications for Science, with most taking the core and additional science examinations, and some taking the separate sciences at GCSE.

A content analysis of the June 2008 physics GCSE (Higher) examination papers revealed that in Paper P1, there were 8 questions that required explanations, with 7 of these questions providing only four lines for the response and one question providing 7 lines for the answer. Paper P2 contained five explanation questions, with four of these having four lines and one having six lines for an answer. Paper P3 had seven explanation questions, with the required response ranging from three to ten lines.

If students choose to study Science (Core and Additional) then papers one and two of the each of the three sciences are taken. As the longest explanation questions are in the third paper P3, the students who have GCSE double science have less scientific knowledge as well as fewer opportunities to develop extended responses to the questions. Whilst I moved away from the policy of written assignments to be word processed, a move that was not popular with the students, I also wanted to encourage students to write more fluently.

Towards the end of the academic year 2008/09, a colleague developed a ‘blog’ page for his students on the college mathematics site. I was intrigued by the popularity of this site, which appealed to students of all abilities within the course. Using this initiative as an inspiration, I launched the physics wiki site for two of the three AS groups of students, with the objectives of:

a) To engage students with physics outside of the classroom.
b) To encourage students to create their own pages and research topics of interest.
c) To develop students’ written communication skills.

The project was formalised as an Action Research Project with the Science Learning Centre. The evaluation of the project resulted in a separate report which was then uploaded onto the Science Learning Centre research portal. Having conducted the project throughout 2009/2010, the students who were the most active participants in the project achieved good grades and progressed onto the second year of the course. The success (pass) rate increased as well as the number of students who are considering the study of physics at university.

To summarise, the use of the VLE can play a very important role with the engagement of students, as well as encouraging them to write about their learning process.

Conclusion

This report has presented an overview of some of the teaching and learning strategies that have been developed to improve the experiences of our students. It is important as a practicing teacher to critically reflect, develop and improve practice. The report considered why it is important to review classroom teaching, particularly if we want to encourage more girls to take up physics at A level or degree.

Student questionnaires provide an insight into how students learn within the classroom, but there is a strong difference between needs and wants, and the experienced teacher should realise this fact. It is important to create an inclusive and nurturing learning environment, but teachers must stretch and challenge students, particularly with the development of thinking skills.

Project Think! was a college-wide initiative developed to encourage students to develop higher order thinking skills. Participation in the project allowed me the opportunity to reflect upon my practice and develop a range of new materials and activities that would engage and encourage students within physics lessons. The use of the VLE is another mechanism that we can use to engage the students and (either directly or indirectly) develop skills and raise achievement.

Critically reflecting upon classroom practice is crucial for all teachers, but is particularly important for subjects where there is a problem in attracting students. We need to ensure that more young people study physics at A level and university, in order to provide scientists who can contribute towards the future industry and economy of the country. This will not be achieved without striving to improve all aspects of teaching within our schools and colleges.

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Appendices

The appendix includes sample activities devised as part of the Project Think initiative.

1) Investigation into the properties of carrier bags
2) Mistakes in problems
3) Physics of Superheroes
4) Physics in Films
5) The Space Shuttle Disaster
6) Higher Order Thinking Skills activity

APPENDIX 1

PHYSICS AS
Assessed Practical

After years of shopping at cheap supermarkets, the Physics team have become really fed up with the quality of carrier bags issued to them at the checkouts.

These bags are clearly not very substantial and frequently cut into the fingers when full of goods, before snapping just when you don't want them to!

Bearing in mind that the material used has both plastic and elastic properties, could you please:

(a) Investigate these complaints, looking specifically at the physical properties of the materials used in the different bags available.

(b) Suggest simple and economically viable modifications that may be made.

Please present a full report on your findings, using the main headings of

A) Planning
B) Implementing
C) Analysing
D) Evaluating

The first draft of this report should be handed in by **1st February using the usual method in the I.L.C. This will be marked and notes given on how to improve your mark.

APPENDIX 2

Correcting Mistakes in Problems

A student has handed in some homework on capacitors. The student has worked very hard, but are the problems right? For this task, you have to take on the role of the teacher, see if the student is answering the questions correctly and whether there are any mistakes (Yes, there are some deliberate mistakes!)

See if you can spot the problem this student is having. How would you explain to the student how to put this mistake right?

A charged capacitor of 100 μF is connected across the terminals of a resistor (100kΩ). When t = 0, V = 10 Volts.

a) Using the equation $V=V_0e^{-t/CR}$, find the reading on the voltmeter after 20s.

$V_0 = 10$
$t = 20s$
$C = 100\ \mu F$
$R = 100k\Omega$

$V = 10\ e^{-20/0.01}$
$V= 10\ e^{-2000}$
$\underline{V= 0}$

Is this the correct answer? If not, can you trace the error?

b) Find the reading on the voltmeter after 5 seconds have elapsed.

$V = V_0e^{-t/CR}$
$V =10\ e^{-5/10}$
$V = 10\ e^{-0.5}$
$\underline{V = 16.49V}$

***Why is it obvious that this is the wrong answer?

***Where has the student gone wrong?

***What advice would you give to this student to ensure they do not make the same mistakes again?

APPENDIX 3

The Physics of Spider-Man

In the original comic strip, Peter Parker is bitten by a radioactive spider. He develops the ability to cling to walls, a sixth sense (spider-sense) that alerts him to danger, perfect balance and equilibrium, as well as superhuman speed and agility. In the film, Peter Parker is bitten by a genetically altered spider and then develops the additional property of the ability to produce webs.

Spider silk is an extremely strong material with interesting physical properties.

Fibre	Density (g/cm^3)	Modulus of Elasticity (Gpa)
Spider silk	1.3	10
Nylon	1.1	5
Kevlar	1.4	130
Steel	7.8	200

QUESTIONS

1) Assume Spiderman is 75kg – what is his weight in Newtons?
2) Using the formula for Young's modulus $E = Fl/Ax$, find out what the area must be for the 'spidersilk' if it is to be 40m long, and extend 5 m when he swings from it.
3) What would be the radius of the 'spidersilk'?
4) What would be the mass of this fibre?
5) Compare these values to those which Nylon
6) If Spiderman can eject fibre of diameter 1cm, what would be the extension if he ejected 50m of spidersilk?

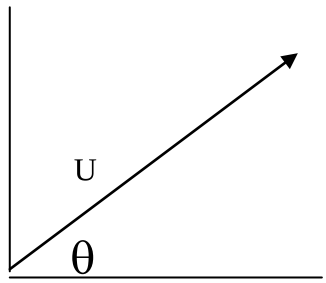
SPEED

One of the most famous scenes in the film shows the bus jumping across a gap in an elevated freeway-to-freeway ramp while still under construction. Both sides of the gap are at identical heights, making it impossible that the jump would work in real life.

According to the "Making of..." feature that accompanied the DVD release, the stunt used a ramp and really did traverse fifty feet in the air. To handle the sudden jolt on landing, the stunt bus had no passengers aboard and the driver was wearing a shock-absorbing harness.

Let's look at the physics behind this stunt!

Suppose the bus is driven up a ramp which is inclined at θ to the horizontal



The vertical component of the velocity = ________________________

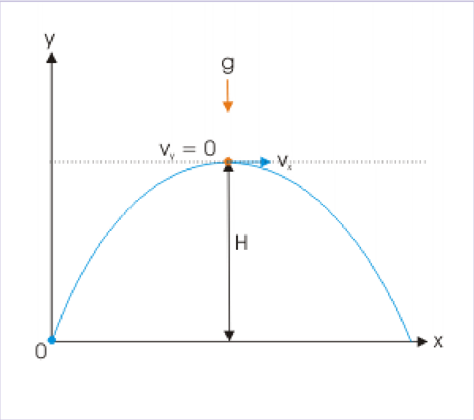
The horizontal component of the velocity =________________________

For the vertical motion, we need to use the equations of motion.

Initial vertical component of velocity

= ____________________________

Final velocity (as it reaches maximum height) = _________



Time to reach maximum height = t = T/2 Now use v = u +at to obtain an expression with u,θ, g and t.

_______________________________ (1)

The horizontal velocity is constant, so the horizontal distance R, can be connected to the time by velocity= distance/time

____ (2)

When you have done this, substitute this into the first equation above so that you have an expression which includes the terms: θ, R, g and u but not T.
(3)

You can simplify equation 3 (if you study A level mathematics!) to show that the range, R, of the bus is given by the expression $R = u^2 \sin\theta / g$

In the film, the bus has to drive at over 50 miles per hour. Convert this into m/s

____

The bus travels a horizontal distance of 50 feet through the air. Convert 50 feet into metres

____

Using these values, do the calculation and find the angle of the ramp necessary for the stunt to work!

APPENDIX 5

Space Shuttle Challenger disaster

The **Space Shuttle *Challenger* disaster** occurred in the United States, over the Atlantic Ocean, off the coast of central Florida, at 11:39 a.m. on January 28, 1986.

The **Space Shuttle *Challenger*** disintegrated 73 seconds into its flight after an O-ring seal in its right solid rocket booster failed at liftoff.

The shuttle was destroyed and all seven crew members were killed.

The crew compartment and many other vehicle fragments were eventually recovered from the ocean floor after a lengthy search and recovery operation.

A committee has been set up to re-investigate the disaster

For this committee, we need:

1) **A scientist to provide an outline of what happened and place the situation in historical context.**
2) **A physicist to report back on the Rogers Commission Report and what were its findings.**
3) **A physicist to explain the mechanical properties of O-rings.**
4) **An engineer to explain how the O-rings worked in the shuttle**
5) **A physicist to explain the pre-flight problems encountered by Challenger for that particular flight**
6) **Who was Roger Boisjoly's role in the matter?**

7) **What was Richard Feynman's role in the matter?**

Once the committee has heard from the consultants, we need to evaluate safety measures to prevent such disasters from happening again.

Your task

1) **You will be given your topic and you need to research around your area.**

2) **Make a powerpoint presentation and sufficient hand outs for the rest of the group.**

3) **You will be expected to explain your topic to the rest of the group – do it in a professional manner, introducing yourself, explaining your role and speaking clearly.**

4) **The task is within the context of a physics lesson, so we are interested in the <u>physics</u> of what happened.**

5) **When everyone has made their presentations, we will have to discuss the contributions of the consultants (peer assessment!)**

6) **The next task in to work in groups and draw up recommendations for safety – you can prepare for this in advance.**

Why are we doing this?

By working collaboratively, we can examine the incident by research and look at what happened in a broader and more meaningful manner.

By doing the lesson this way, we can demonstrate a wider range of learning skills such as individual research, communication skills (oral and written), evaluation and synthesis of the information and the ability to draw conclusions. Trust me, you will learn more by doing it this way than by taking notes!!!!

APPENDIX 6

Higher Order Thinking Skills Question

This problem has been produced to make you think more deeply about a situation, develop your ability to analyse information and synthesise different aspects of the course.

Problem

An oil drop in air between two metal plates falls with uniform velocity of $0.4 mms^{-1}$ when both plates are earthed.

When a p.d of 6900V is maintained between the plates, separated by a distance of 1.3×10^{-2} m, the drop remains at rest.

If the resistance to motion is given by the equation $F = krv$, where r is the radius of the drop, v is the velocity and k is a constant, calculate:

a) the radius of the drop
b) the charge on the drop.

Density of oil = 0.9×10^{3} kg m^{-3}.
$K = 6\,\pi \times 1.8 \times 10^{-5}$ Pa.s

THINK!

What information has been given to you and how can you use it?

This problem involves the synthesis of several equations from different physics modules.

To answer this questions you will need: Patience
Perseverance
Sustained Concentration

CLUE CARDS

CLUE 1 **Upward force = downward force**	**CLUE 1** **Upward force = downward force**	**CLUE 1** **Upward force = downward force**	**CLUE 1** **Upward force = downward force**
CLUE 2 **Mg = krv**	**CLUE 2** **Mg = krv**	**CLUE 2** **Mg = krv**	**CLUE 2** **Mg = krv**
CLUE 3 **D= m/V** $V = 4/3\ \pi\ r^3$	**CLUE 3** **D= m/V** $V = 4/3\ \pi\ r^3$	**CLUE 3** **D= m/V** $V = 4/3\ \pi\ r^3$	**CLUE 3** **D= m/V** $V = 4/3\ \pi\ r^3$
CLUE 3 **E = V/D = F/Q**	**CLUE 3** **E = V/D= F/Q**	**CLUE 3** **E = V/D= F/Q**	**CLUE 3** **E = V/D = F/Q**
CLUE 3 **E = V/D= F/Q**	**CLUE 3** **E = V/D= F/Q**	**CLUE 3** **E = V/D= F/Q**	**CLUE 3** **E = V/D= F/Q**

Report Evaluation Form

REPORT:

Teaching and Learning within the Physics Classroom

Reviewer:

Co-ordinator of the Teaching and Learning Coaches/
Lecturer in Education at the FEC

Comments on the report:

A very interesting insight into the teaching of Physics within the college. The report deals with a number of issues related to making physics ‘real’ for students whether they be male or female. The report analyses questionnaires that have been carried out with the students which look very closely at how best they learn. Which the teacher has used to great effect**.**

Are there things that could be added or removed to improve it?

With reference to the surveys that were carried out, there could be more emphasis on the research process itself, i.e. references made to issues of reliability and validity of the data achieved.

In what way could the contents of this report influence the wider profession?

With regards to the suggestion about making the problem solving relevant to the wider world and everyday experiences of students, from the report this appears to be a very engaging aspect of the teaching.

Also with regard to how examinations are carried out i.e. at present hand written within 90 minutes to 2 hours. This is pertinent to current debate initiated by the outgoing chief executive of Ofqual Isabel Nisbet (26/02/11 BBC)

Signature:

Supplied