Undergraduate Learning in Science Project

Working Paper 7

A survey of students' and supervisors' experiences of research projects in undergraduate science courses

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July 1996

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Abstract

The Undergraduate Learning In Science Project (ULISP) started at the University of Leeds in September 1994 (appendix 1). Project members include educational researchers, lecturing staff within various science departments and others with interests in teaching and learning at the undergraduate level. The aim of the project is to inform understanding of science teaching and learning at the undergraduate level, through a variety of research activities.

The Research Project Study was a two year ULISP research investigation into final year undergraduates' experiences during project work. The results of this research study are reported in ULISP working papers 2 to 8 (appendix 2).

This paper presents results from a survey of students (n=128) and a survey of supervisors (n=43). These surveys followed the detailed interviews of students and supervisors described in working papers 2 to 6. The surveys were designed to check whether findings arising from our case studies (12 students and their supervisors) were valid across the entire student and supervisor population in the science departments involved in the study.

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Contents

Summary

The Undergraduate Learning in Science Project (ULISP) was set up in September 1994 as a collaboration between the School of Education and four science departments at the University of Leeds (Appendix 1). As part of the ULISP research programme we are investigating undergraduate learning during final year projects. This report is one of a series of working papers giving details of this study (Appendix 2).

This working paper describes the results arising from a written questionnaire survey of students' and supervisors' experiences during project work. The surveys were designed to check whether findings arising from our original case studies were valid across the entire student and supervisor population in the science departments involved in the study.

Presented below is a short summary of the main findings described in this report. Further details are given in the relevant sections of this paper.

Section 4 - The curriculum aims of project work

4a The key aim of undergraduate research projects as identified by supervisors is to give students an authentic experience of scientific research. Students value this experience which gives them additional motivation towards project work.

4b Projects help students to develop their general abilities within a scientific context. This is one reason for giving all students the opportunity to become involved in project work.

4c Students learn about the methods and culture of science through project work. The development of subject matter knowledge is not seen as important.

4d Projects help students to decide whether or not to continue with PhD/MSc studies. Project experience is more likely to encourage students towards PhD/MSc courses rather than away from them.

4e Most supervisors feel that ideally all students should be given the opportunity to do project work.

Section 5 - Types of project suitable for undergraduate work

5a A majority of students are doing original research as part of their undergraduate project work. The originality of project work is a major source of motivation for many students.

5b A majority of supervisors feel that projects should involve original research. Such work is recognised as a source of motivation for both students and supervisors.

5c Seven percent of students whose projects were intended to give scientific results failed to get any results at all. A much higher proportion of students are concerned about getting no results. This concern is probably linked to students' images of assessment, their conceptions of scientific results and their images of the process of scientific research (particularly time scale).

5d The working environment of projects is recognised as an important factor by many supervisors and students. However, our data does not support the idea that students who work alone are more likely to have a negative project experience.

5e The vast majority of students would rather do projects than a more traditional practical course.

Section 6 - The organisation of projects in departments.

6a The vast majority of students are happy with the project allocated to them, with 63% of students in our sample being allocated their first choice project.

6b A minority of students and supervisors are satisfied with the content of the departmental project booklet.

6c There was a strong view that details of skills covered and project working environment should be included in the project booklet.

6d Student visits to potential supervisors are seen as valuable by the majority of students and supervisors.

6e Students would value the opportunity to discuss project work with students who had just completed an undergraduate project.

6f The opportunity to discuss the reading of published research papers would be valued by both students and supervisors.

6g Both students and supervisors would value opportunities to give students confidence in interacting with lecturing staff.

6h A significant proportion of students are only vaguely aware of how projects are assessed during the final three weeks of project work.

6i A large majority of supervisors felt that students should be informed about the criteria used to assess project work. The most popular way of doing this was to show students the departmental assessment sheets.

6j Virtually all supervisors felt that projects can be awarded a first class mark even if they do not yield scientific results. However, some reservations were raised about how such an ideal can be achieved in practice.

6k A majority of supervisors felt that they should be heavily involved in the assessment of the projects that they supervise - largely because only they can know the details of the project and the student's experience.

Section 7 - The supervision of project work

7a PhD students and postdoctoral researchers are the major source of supervision for 40% of our student sample. Such supervision is highly valued.

7b The nature of the student-supervisor relationship has a major impact on students' experiences of project work - either positively or negatively.

7c One in five of the students in our sample reported experiences which provide evidence of a poor student-supervisor relationship.

7d One third of students reported evidence of miscommunication between student and supervisor.

7e Discussions between student and supervisor tend to neglect personal issues such as whether or not the student is performing well or how the student feels about project work.

7f Half of our student sample reported that they hardly ever (or never) discussed broader scientific and technological issues relating to their project.

7g Two thirds of our supervisor sample were satisfied that they had been able to provide effective supervision to all of their project students.

7h The most common constraints on the supervisors' ability to provide ideal supervision are lack of time and lack of effort and persistence from students.

7i Nearly one third of students felt that their supervisor was difficult to get hold of.

Section 8 - Workload and time management

8a A majority of students work longer hours on their project than is allocated to project work in the final year curriculum.

8b Nearly 3/4 of our student sample felt that their other module work had suffered because of the amount of time that they had spent on project work..

8c Over half of our student sample felt that there had been pressure from those involved in their supervision to spend longer hours on project work than is allocated in the final year curriculum.

8d Fewer than half of our student sample reported discussing workload and time management issues with their supervisor.

8e Nearly half of our student sample were dissatisfied with their final report. Of these 2/3 felt that this was the result of problems with workload and time management.

Section 9 - Students' attitudes to project work

9a In our sample 3 out of 4 students found their project 'really interesting'. A third of students found their project 'the best part of the course so far'.

9b One in eight students had 'a dreadful time' on their project.

9c Eight out of ten students found their project 'the most demanding piece of work that I have done so far on this course'.

9d Lack of good results was by far the most common source of disappointment for students.

9e The most common motivator for students was the desire to get a good mark (assessment driven).

9f Control over the nature of their supervision was a key source of advice given by students to students about to start their project work.

9g Careful time management was by far the major piece of advice offered by students, accounting for one third of all responses.

9h Working in real science research on a subject that interests and challenges you was an important source of motivation for students.

1 Introduction

1.1 Research projects in the undergraduate course

In the UK virtually all science degree courses require students to complete a long-term, independent project in their final year. For the students this is a unique part of the course. These projects give students the opportunity to gain an insight into what scientific activity is really like. Such insights are rarely gained during lecture, tutorial and teaching laboratory work. Many final year science projects involve original research, with a small number being published in science research journals.

Project work is very demanding for students. They must plan their time effectively, familiarise themselves with relevant research publications and establish a working relationship with their supervisor and other people associated with their project. There is a great deal to learn. Furthermore, these demands are very different from those associated with successfully following a lecture course or completing a laboratory practical. Students need to establish a new mode of working. In working paper 1 we describe student learning during project work as an apprenticeship. Students have much to gain from working on a 'real' scientific problem under the close supervision of an expert scientist.

Undergraduate projects are also a demanding part of the undergraduate curriculum for those lecturers who act as supervisors to individual students. Lecturers have a number of demands on their time - research, administration and teaching. It is rarely possible for the supervisor to be available for students at all times. Furthermore, project supervision involves establishing a positive relationship with students - something that is not often required in other parts of the undergraduate curriculum. This puts additional demands on the supervisor and the student.

1.2 The Research Project Study

The Research Project Study started as a longitudinal, case study analysis of student and supervisor experiences during project work. Twelve students and their supervisors were involved in this study. Full details of design and methodology are given in working paper 2. These case studies generated a number of findings and associated recommendations (working papers 3, 4 and 6). Following from these case study findings we decided to survey all of the students and supervisors in the science departments involved in the Research Project Study. This purpose of this questionnaire survey was to check whether the findings arising from the case study work were valid across the entire student and supervisor population.

1.3 The purpose of this working paper

This paper summarises the key findings following from our questionnaire survey. Most of the issues raised are discussed extensively in the discussion section of

working papers 3, 4 and 6. It is not our aim to revisit these issues in detail in this paper. Rather we wish to present empirical evidence which helps to identify those issues raised in earlier papers which are valid across the whole student/supervisor population.

We have presented details of student and supervisor surveys side by side. This enables us to make cross-comparisons and in particular to focus on those issues where students and supervisors may be in disagreement (many questions given to students and supervisors are identical).

Survey data is presented in eight sections, similar to those used in earlier working papers. At the end of each section is a brief summary of the key findings. These are the same as those presented in the Summary section at the beginning of this paper.

2 The design, implementation and analysis of the surveys

2.1 Design of the surveys

2.1.1 General considerations

The main purpose of the surveys is validation at the population level of findings following from the twelve case studies of undergraduate projects. These are reported in working papers 3 to 6 and follow largely from qualitative analysis of the interview data (the design of the case studies is discussed in working paper 2). These findings, and questions following from them, were used to define the range of issues addressed in the pair of surveys. However, it was not possible to validate all of the findings in the previous working papers. Many depend on a detailed understanding of the context of individual projects, which can not effectively be gathered by survey. Others require an understanding of the differing perspectives held by student and supervisor on a single project. Since we are unable to match surveys from student-supervisor pairs, these issues were not included. Finally, due to their complexity and context-dependence, questions about participants' images of science did not form part of our surveys.

Most of the questions in our surveys give participants a choice of possible responses. Participants are asked to tick either one or several boxes (or a position on a scale) to indicate their position. It is notoriously difficult for survey designers to anticipate all of the potential responses to an appropriate degree of complexity. This often results in survey questions whose categories are either too vague or do not exhaust the range of possibilities. However, our interview data proved very effective in helping us to provide respondents with a meaningful set of possible choices. Piloting of both surveys helped to improve the range of responses available. Furthermore, to allow for additional responses most questions allowed an open textual response in an 'other' category. Some questions also asked respondents to explain their answer.

The surveys have only a limited number of 'open response' questions. These take a great deal of time for participants to complete and are also time-consuming to analyse. Since our surveys followed from extensive interview data most questions could be presented in closed response form (i.e. tick boxes). This allowed us to cover a wide range of issues whilst ensuring that the surveys took no longer than 20 minutes for participants to complete.

2.1.2 Design of the survey for students

Our starting point for this survey was working paper 4 which reports on students' experiences of project work as discussed through interviews and described in their journals. Using these findings, eight broad areas were identified which could be included in the survey: details about the student, details about the project, the administration of projects, supervision, student's general experiences, projects in the undergraduate curriculum, projects and science and other miscellaneous issues. During a ULISP workshop session lecturers were asked to write down questions which they felt could be included under each of these

headings. These were then used, together with insights from researchers, to produce a draft version of the survey for students. This was then piloted with students. A single copy of the draft was sent to each department for feedback from supervisors. In addition a series of meetings was arranged with final year students from each department. Students were offered a sandwich lunch as an incentive/reward. In all 15 students piloted the survey. Piloting sessions started off with students completing the survey. This was then followed by an open discussion about survey questions which they felt needed revision or extension. This piloting resulted in extensive revision of the survey, during which the content was reduced by one third. This was achieved by reducing the number of open response questions and removing questions which students felt were ambiguous or which researchers felt did not give useful data.

2.1.3 Design of the survey for supervisors

An initial draft was prepared drawing upon the findings and questions identified in working paper 3 of this series which reports on detailed interviews held with 12 supervisors of undergraduate projects. This was then piloted during a ULISP workshop. The twelve participants (lecturers and colleagues involved in staff development) completed the survey and then gave feedback during an open session. Following from this session the survey was revised and a final copy was produced.

2.2 Implementation of the surveys

2.2.1 The student survey

Final year students were given the survey within a few weeks of them having completed and handed in their project, but before they were aware of the mark awarded to their project (except in the case of earth science students who had handed in their projects 3 months earlier and had recently been told their project marks). Our intention was to give every final year student in each of the four participating departments the chance to complete the survey (a target population of approximately 240 students). As an incentive every student returning a survey was entered for a prize draw for a bottle of champagne (one draw for each department). Organisational constraints meant that the surveys were distributed in different ways within each department. In most cases the students were introduced to the survey by a researcher from the School of Education.

In the Department of Biochemistry & Molecular Biology students were given a copy of the survey at the end of a lecture and then asked to return the survey at the start of their next lecture one hour later.

In the Department of Chemistry copies of the survey were distributed by the departmental undergraduate office. Students then returned these to their supervisor, who forwarded them to a single departmental co-ordinator.

In the Department of Genetics copies of the survey were distributed during a final year session where students were about to give presentations about their project to their peers. These were then returned to a single departmental co-ordinator.

In the Department of Earth Sciences surveys were distributed at the end of a 'communication skills' session. Students were asked to put completed surveys in a collecting box placed in the departmental office. Returned surveys were collected 4 days later.

Table 2.1 and figure 2.1 give details of the numbers of students sampled and the percentage of returned surveys for each department. Overall we received completed surveys from over half of the student population in the departments involved. This leaves the possibility that our student sample may be skewed towards a certain population type. However, our analysis in terms of gender, ability and project type seems to indicate that our sample is broadly characteristic of the whole student body.

2.2.2 The survey of supervisors

All staff involved in undergraduate project supervision from the four participating departments were sent a copy of the survey by internal mail (a total population of approximately 91 members of staff). Included with each survey was a letter from the head of department encouraging supervisors to complete and return the survey. Again in each department supervisors returning a survey were entered into a prize draw for a bottle of champagne. Table 2.2 and figure 2.2 give details of the numbers of supervisors sampled and the percentage of returned surveys for each department. Overall 47% of the supervisors completed and returned the survey.

Department	Approx. population	Number given the survey	Number of returns	% response	Approx. % population capture
BIOC	80	63	46	73	58
CHEM	70	70	41	59	59
EARS	50	42	26	62	52
GENE	40	40	15	38	38
TOTAL	**240**	**215**	**128**	**60**	**53**

Table 2.1 Implementation of the student survey

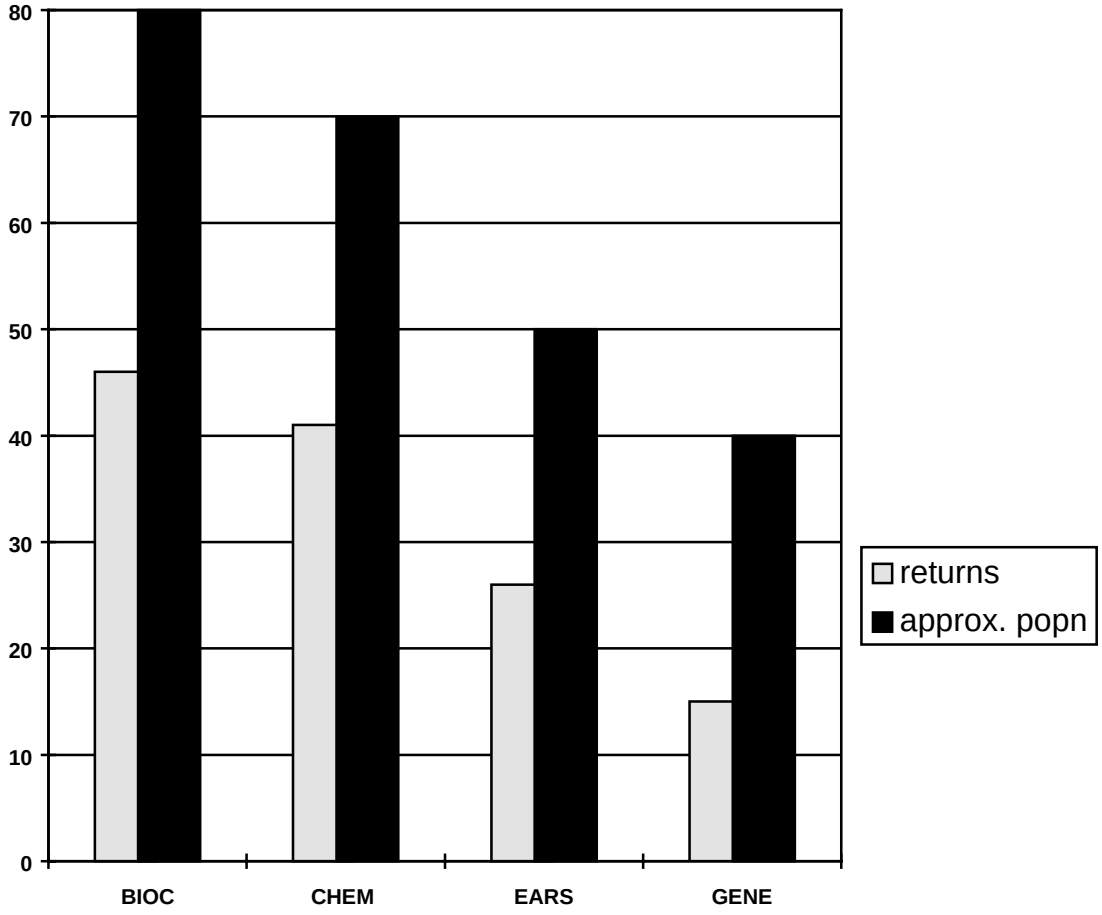


Figure 2.1 Responses to the student survey

Department	Approx. population	Number of returns	% response
BIOC	38	18	47
CHEM	25	14	56
EARS	15	4	27
GENE	13	7	54
TOTAL	**91**	**43**	**47**

Table 2.2 Implementation of the supervisor survey

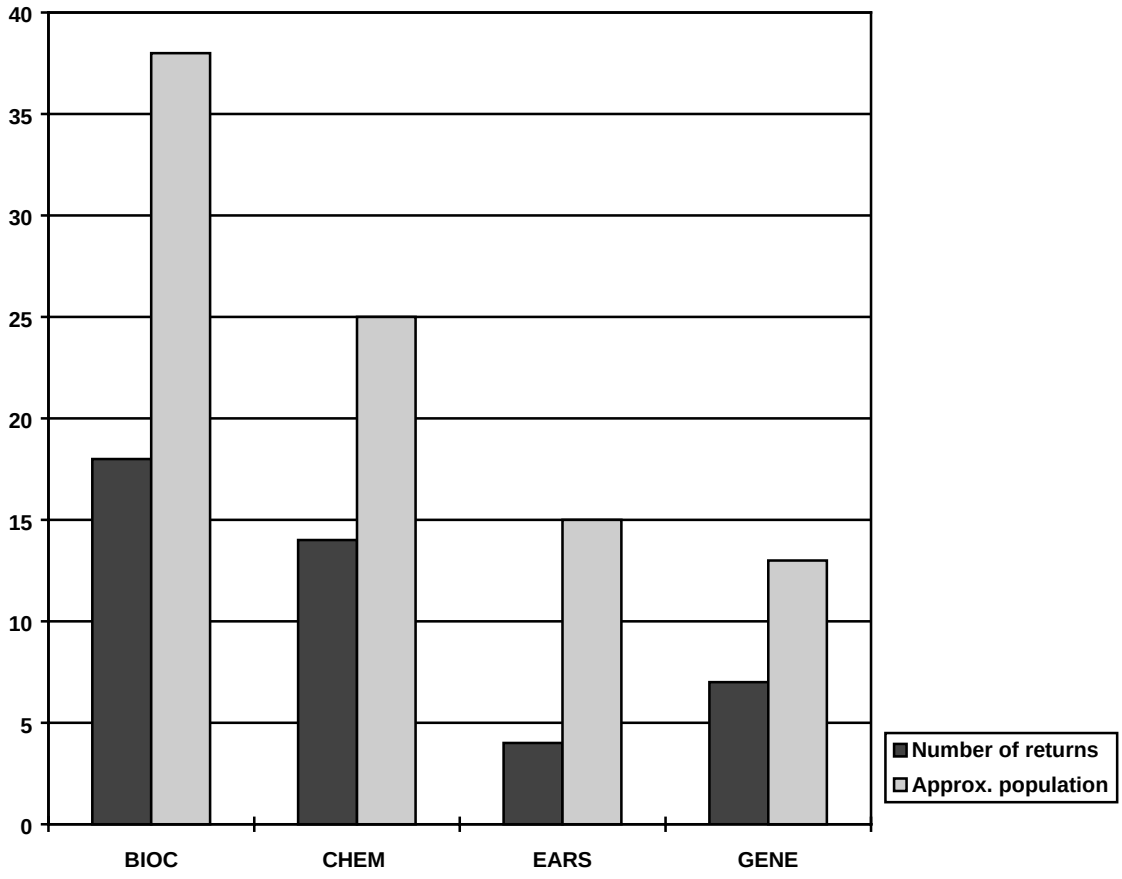


Figure 2.2 Responses to the supervisor survey

2.3 Analysis of the data

The surveys provide data of two types: answers to closed response questions and open response questions. Most closed response questions were coded directly from the survey. In this paper we present these results in the form of tables and/or graphs to indicate the range and distribution of responses chosen by participants. In most cases responses indicated as 'other' followed by an open response are presented as such with some description of the kinds of issues raised. In a few cases 'other' responses are recoded in terms of the response categories presented in the survey question, where this seems appropriate. For each question a coding category 'missing/unusable' was generated. The SPSS package was used to store the codes and to allow further analysis.

Open response questions were coded by a researcher. This involved reading through at least 40% of the responses to a single question and generating a trial coding scheme which captured the key features emerging from the responses. This trial coding scheme was then applied to all of the responses, leading to

(usually small) modifications. The resulting distribution of codes can then be presented in graphical format. Occasionally quotes from the open responses are used to illustrate individual codes.

3 Details of the sample

In the previous section we presented information about survey response rates across departments. In this section we will give further details about the student and supervisor samples. Our aim is to show that our samples are broadly representative of the whole student/supervisor body in the four departments involved in the study.

3.1 The students

All of the students in our sample were in their final year of undergraduate study. In section 2 (figure 2.1) we described the home departments of the students in our sample. Table 3.1 gives details of the degree schemes followed by these students. This shows that a significant proportion of genetics and biochemistry students followed degrees associated with medicine. This is reflected in the career intentions described later. Four students were also involved in a joint degree involving biochemistry and genetics. Seven students in our sample had completed a year of work experience during their course.

Degree scheme	Frequency
Biochemistry	33
Biochemistry with medicine	7
Chemistry	41
Genetics	7
Genetics with medicine	5
Earth sciences	27
Biochemistry with genetics	4
Other	4

Table 3.1 Degree scheme followed by student sample

An analysis of our sample by gender shows that 36% of the total sample is female. However, the gender balance varies significantly between departments (Table 3.2), with the biological sciences showing a much greater proportion of females than the physical sciences. This trend in our sample reflects the national trend. Recent results for England show that 60% of graduates in the biological sciences are women, whilst the corresponding figure for the physical sciences is 36%[1].

[1] Department for Education and Employment press release 188/95, 31st August 1995.

Department	% of females in sample
Biochemistry	43
Chemistry	24
Earth Sciences	27
Genetics	64

Table 3.2 Percentage of females in sample by department

Table 3.3 shows the age distribution for our sample. 83% of the sample are aged between 20 and 22 years. Again, this reflects the national trend for entry into HE in the UK.

Age range	Frequency
20	23
21	57
22	26
23	9
24-30	10
31+	2

Table 3.3 Age distribution for the student sample

Figure 3.1 gives details of the expected and actual grades for our sample. Only earth sciences students had been informed of their project grades at the time of survey completion. Students from the remaining departments were asked to state their *expected* grade. Of those who stated a grade, 16% expected (or attained) a first class project and 25% a 2:2 or 3rd. This compares with 19% of biochemistry graduates achieving a first class degree and 34% a 2:2 or 3rd, in 1995. This crude analysis indicates that our sample includes students from the whole ability range.

Details of career intentions are given in figure 3.2. Of those stating a career intention, 63% wished to continue with science research/development either on a PhD/MSc or in industrial research and development. This compares with 65% of Leeds University biochemistry graduates in 1995 continuing with further study or entering employment in research and development[2]. The 17% of students wishing to enter a career in medicine reflects the number of students in our sample following degrees associated with medicine (Table 3.1).

[2] From World Wide Web Home Page at http://www.leeds.ac.uk/bmb/courses/page10.htm

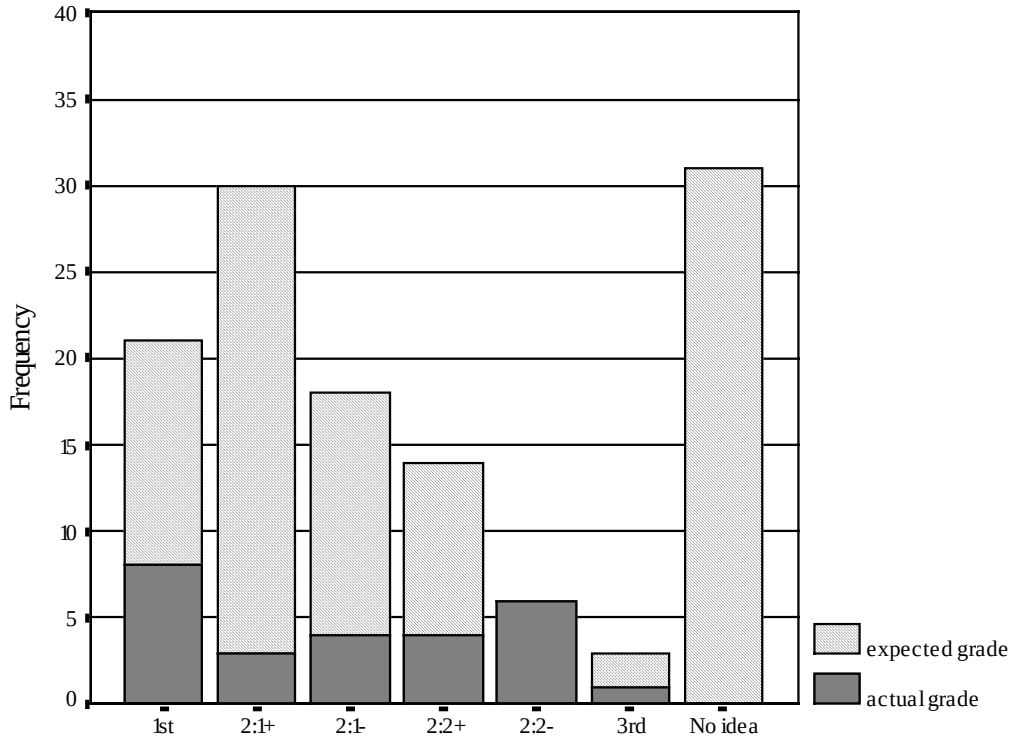


Figure 3.1 Expected and actual grades for sample

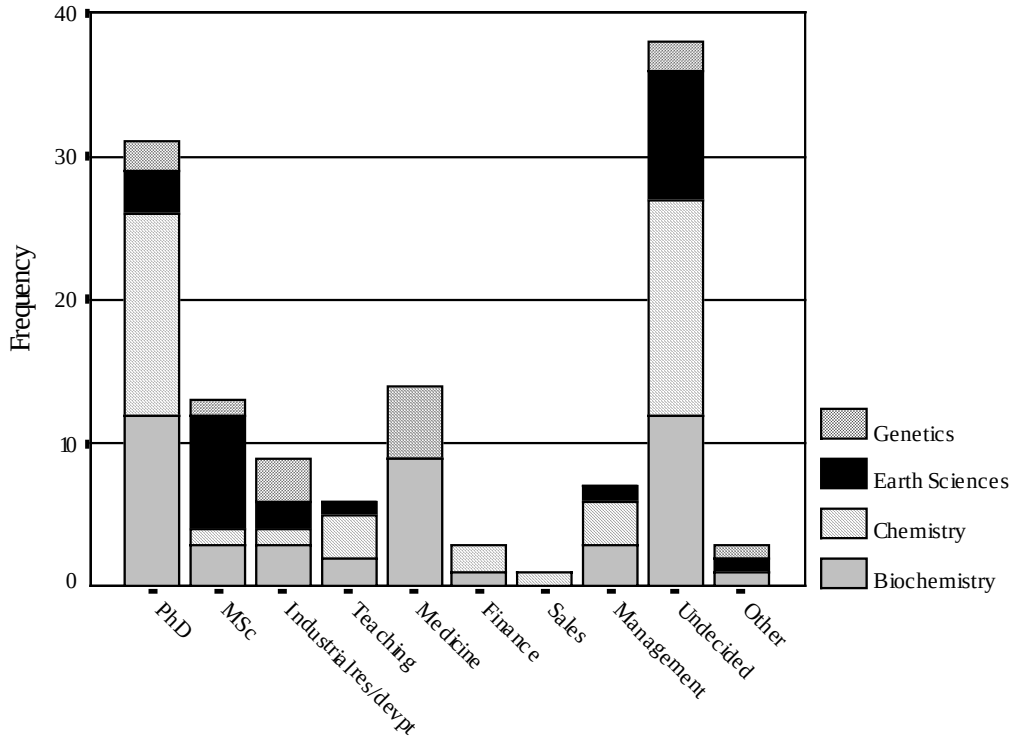


Figure 3.2 Career intentions of student sample

3.2 The projects

All students (except those from earth sciences) start project work in October - the beginning of their final year. Students work on their project whilst also attending lecture courses and tutorials. Project work typically accounts for one third of the final year assessment (see working paper 3 for more details) and project reports must be completed by April. Students from earth sciences do field-based projects involving a 6 week period of field work during the summer followed by analysis of data and preparation of the final report in the first term of their final year.

Figure 3.3 gives details of the types of project work undertaken by the students in our sample. A majority (63%) of the projects involve experimental work in a laboratory. The remaining projects include field work (mainly earth sciences students), modelling (mainly chemistry) and library-based work (mainly biochemistry). Modelling projects are those in which students are using existing theoretical models (or perhaps generating their own) to account for measured values in a dataset. Such projects usually involve extensive use of a computer. Library-based projects include literature reviews or document analysis, usually without any experimental analysis.

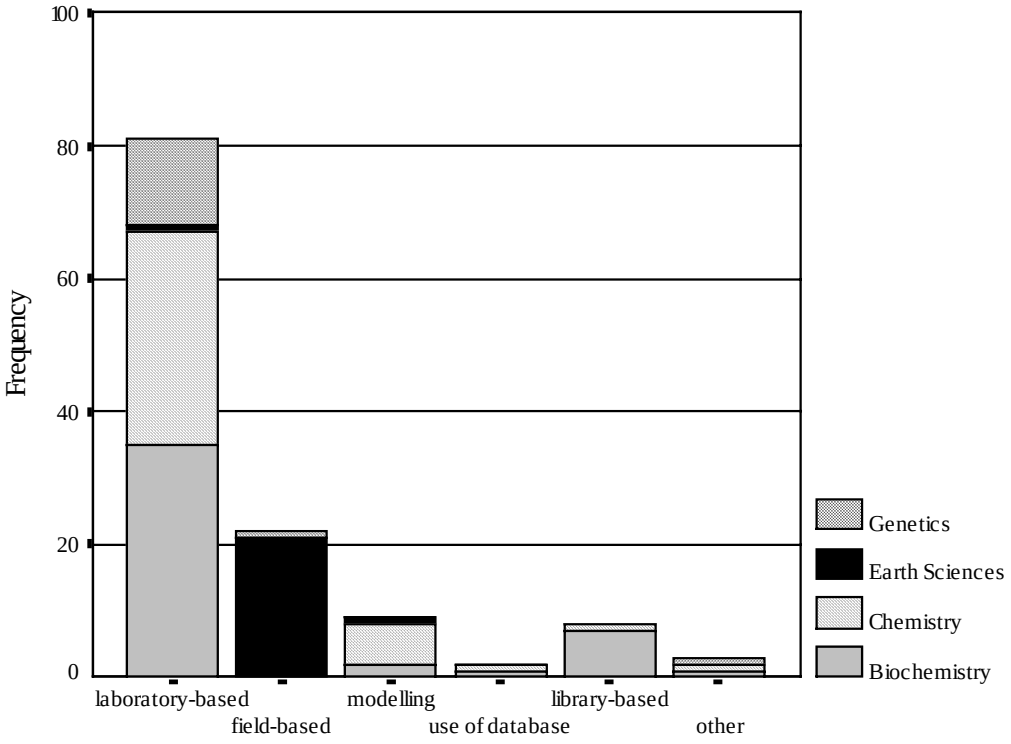


Figure 3.3 Project types followed by our student sample

3.3 The supervisors

Figure 2.2 and table 2.2 gave details of the home departments for the 43 supervisors in our sample. The small numbers (n=4 in one department) mean that

in general we are unable to make inter-department analyses as we can for the student sample (where we have n>14 for each department).

The percentage of male supervisors is 91% of the sample.

Figure 3.4 shows the projects supervised during 1995/96 by our supervisor sample. Comparison with figure 3.3 (projects followed by students) shows that the project types experienced by our student and supervisor sample are broadly similar.

Finally, supervisors were asked about the number of years that they had been an undergraduate project supervisor, and the number of projects that they had supervised over this time. This gives some measure of the experience of our sample. Overall, the 43 supervisors had supervised approximately 1000 projects between them. 56% of the sample had supervised more than 20 projects, and 20% more than 40 projects. This represents a great deal of expertise.

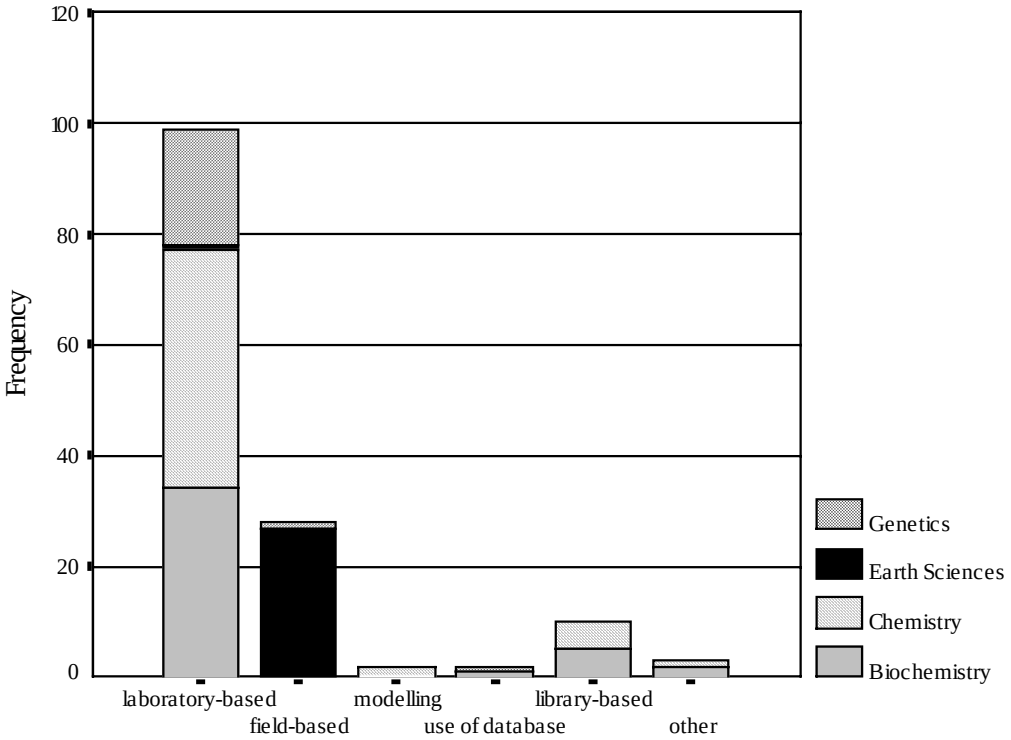


Figure 3.4 Project types supervised by our supervisor sample

4 The aim of projects in the undergraduate curriculum

4.1 Issues raised during interviews with students and supervisors

Working papers 3 and 4 of this series report on discussions with supervisors and students concerning the aims of undergraduate project work. The range of aims identified are summarised below.

Science-related aims:

- projects provide training for a future career in science
- projects help students to decide about a career in science research
- projects can contribute to scientific progress
- projects can support the research effort of individual departments

General aims:

- projects enable students to develop their general skills including time management, library skills and giving presentations
- to get a good mark (students only)

During the interviews it was felt that the *main* emphasis for supervisors was on science-related aims. It was also clear that supervisors felt that projects were a *unique* opportunity for students to gain an insight into scientific research. The main aims identified by students seemed to vary a great deal, with some students keen to experience 'real' scientific research, and others content merely to get a good mark.

4.2 Results from the surveys

Question 4 in the supervisor survey explicitly addressed the purposes of undergraduate projects. A list of 13 purposes were given and supervisors expressed their opinion using a scale ranging from 5 (very important) to 1 (not important). Table 4.1 shows the statements ranked according to the mean score. The table also shows whether statements refer to science-related aims (SCI) or general aims (GEN). However, this distinction does not imply that general aims are of no relevance to science, merely that such aims apply to a broader range of contexts than those aims labelled as science-related.

The aims ranked first and second are both strongly science-related. Indeed 63% of our sample felt that 'giving students an insight into what science research is really like' was 'very important = 5'. This supports the strong impression gained during interviews that projects are about introducing students to 'real' research.

Rank	Project aim	Statement letter	Mean score	SCI/GEN
1	Projects help students to develop a critical attitude when working with data or scientific models	F	4.55	SCI
2	Projects give students an insight into what science research is really like.	A	4.44	SCI
3	Projects give students the chance to think for themselves and use their own initiative	J	4.37	GEN
4	Projects enable students to decide whether they wish to enter a career in science research	C	4.14	SCI
5	Projects encourage students to improve their planning and time management skills	M	3.98	GEN
6	Projects give students the chance to investigate a single area of science in greater depth	K	3.70	SCI
7	Projects enable students to apply their scientific knowledge to an original scientific problem	E	3.69	SCI
8	Projects give students the opportunity to develop expertise with instrumentation and practical techniques associated with the discipline	G	3.63	SCI
8	Projects provide training for a future career in scientific research	B	3.63	SCI
10	Projects provide students with a piece of work which will be useful to show to potential future employers	L	3.53	GEN
11	Projects help students to develop their understanding of subject matter knowledge presented in lectures	H	3.21	SCI
12	Projects give students the chance to be in control of a piece of undergraduate course work	I	3.05	GEN
13	Projects give students the chance to contribute to the development of scientific knowledge	D	2.56	SCI

Table 4.1 Supervisors' opinions concerning the aims of undergraduate project work

However, of the 4 general aims included in the list, two appear in the top five aims - students thinking for themselves and time management. This is strong support for the case that projects fulfil *both* scientific and general aims, and as such can be seen to benefit all students, and not just those who intend to pursue a career in science research. Indeed question 6 in the supervisor survey addressed the issue of whether *all* students should be given the opportunity to do a research project - 71% of our sample felt that *ideally* all students should be able to do projects. One of the main reasons given in support was that 'students develop general skills during project work: independence, critical thinking and originality'. An additional reason offered by two supervisors was that 'projects

give a unique learning experience not found elsewhere in the undergraduate course'. Responses to this question are further explored in section 5.2.3.

It is significant that 'developing an understanding of subject matter knowledge' is ranked 11th by supervisors. As discussed in working paper 3 (section 2.1.2) projects give students insights into the nature of scientific knowledge, the methods of science and the culture of science. These issues go beyond the subject matter knowledge which dominates in lecture courses.

Students were not explicitly asked about the aims of project work. However their open responses to question 23 give an indication of what they are looking for from project work. This question asked students to describe one thing which had increased their motivation towards project work. Detailed results are presented in section 9.2 of this paper. By far the most popular motivator was 'the desire to get a good mark'. This is reasonable given that project work can account for up to 33% of the students final year mark. The third most popular motivator was 'working in real science research'. This shows that the supervisors' emphasis on 'real' research as a project aim is well placed.

Students were also asked whether their experiences of project work had influenced their inclination towards a future PhD or MSc course (question 22). 63% of students stated that project work *had* influenced their thoughts about a future PhD/MSc. Of these, 60% said that they were more likely to consider doing a PhD/MSc after their experience of project work. This certainly supports the assertion by supervisors during interviews (and through statement C in table 4.1) that projects enable students to decide whether or not to continue with scientific research.

4.3 Summary

Our analysis of survey data relating to project aims has given support to the following assertions:

4a The key aim of undergraduate research projects as identified by supervisors is to give students an authentic experience of scientific research. Students value this experience which gives them additional motivation towards project work.

4b Projects help students to develop their general abilities within a scientific context. This is one reason for giving all students the opportunity to become involved in project work.

4c Students learn about the methods and culture of science through project work. The development of subject matter knowledge is not seen as important.

4d Projects help students to decide whether or not to continue with PhD/MSc studies. Project experience is more likely to encourage students towards PhD/MSc courses rather than away from them.

4e Most supervisors feel that ideally all students should be given the opportunity to do project work.

5 Types of project suitable for undergraduate work

5.1 Issues raised during interviews with students and supervisors

The twelve case studies followed during the Research Project Study demonstrated the diversity of projects available to undergraduate students. In working paper 3 (section 3.4) we described six features of projects which can be used to characterise this diversity. Three of the most important features identified were the extent to which the project involves an *original research* question, whether the project yields *scientific results* (as opposed to no results being forthcoming) and the project *working environment* (e.g. whether the student worked in isolation or within an active research group).

Students tended to prefer projects which pursued original research questions. Such projects were seen as exciting, with the possibility of contributing to the development of new scientific knowledge. Supervisors also tended to prefer such projects, but there were some notable exceptions. Students were very concerned about getting results - largely because these were seen as influencing the final project assessment. The desire for results and the preference for original research are to some extent conflicting requirements of project work. Original research runs the risk of yielding no (or very few) results.

The significance of project working environment came from discussions with students. Many found the chance to work within an active research laboratory extremely rewarding. Others enjoyed the chance to work alone, with the chance to control and plan their own work programme. The significance of working environment is relevant to our discussion of learning as apprenticeship, where students learn by working under the guidance of expert researchers (working paper 1, section 3).

5.2 Results from the surveys

The types of projects followed by students and supervised by lecturers in our sample are shown in figures 3.3 and 3.4. In each case over 60% of the projects are laboratory based, with virtually all projects in earth sciences being field-based. However, within each of these categories there are a variety of project types as defined by originality, results outcome and working environment.

5.2.1 Original research and getting results

Students were asked to what extent their project involved original research. Their responses are shown in figure 5.1. Only 11% of students stated that their project involved no original research, whilst 41% described their project as ‘involving research which had the potential to give original research findings’. Thus, the majority of students in our sample were doing authentic research. The

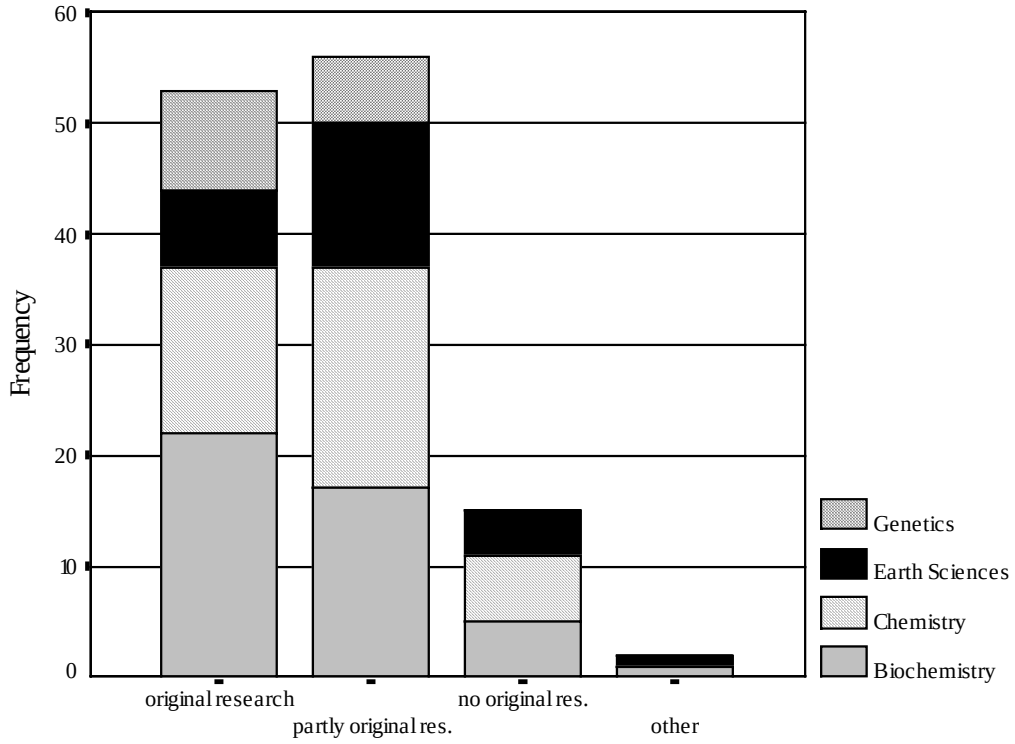


Figure 5.1 The extent to which projects involve original research

Key

The table below gives the full text of the statements used in the survey.

Original research:	My project involved research which had the potential to give original research findings
Partly original research	My project involved investigating areas covered already but with a small amount of original research
No original research	My project involved no original research

significance of this is evident in students' responses to question 23: 'describe one thing which increased your motivation towards project work'. The third most popular category (after 'desire for a good mark' and 'making progress') was 'working in real science research' (see section 9.2).

Supervisors were asked to indicate how important they felt it was that student projects involve original research questions. Results are shown in figure 5.2 - 62% chose 4 or 5 indicating that they felt it was important that projects involve original research. Supervisors were also asked to explain their response. Results are presented in table 5.1. The most popular positive responses describe how

original research can motivate students (as confirmed above) *and supervisors*. The most common negative response was the caution that it is extremely difficult to devise original research projects which are likely to provide results.

Our survey data show that concern about obtaining scientific results is a major feature of the student experience. Responses to question 24 show that by far the biggest disappointment for students is 'lack of good results' (see section 9.2). Responses to question 23 show that 'getting results or making progress' is a major source of motivation for students (see section 9.2). The issue of results was explored in question 7 of the student survey. Students were asked to indicate whether their project yielded scientific results, and if so whether these were original scientific results or replications of previous work. Figure 5.3 summarises the responses. Significantly 12 of the projects gave 'original results which will be included in a research publication'. Only 13 projects gave no results, with five of these being projects which do not lead to 'scientific results' (e.g. library-based projects).

It is often assumed that projects which involve original research are less likely to yield results than 'teaching' projects which involve no original research. Table 5.2 shows a cross-tabulation of whether projects involve original research, and whether they achieve scientific results. Library-based projects, those classed as 'other' in figure 3.3 (project type) and 'missing' responses have been excluded. All of the projects classed as 'no original research' gave scientific results. This supports the idea that 'teaching projects' can be designed to guarantee results. Of those projects involving all or part original research 8% (8 projects) gave no results at all. Thus, our survey suggests that those students doing projects which involve original research work have a 90% chance of achieving *some* results, a 68% chance of achieving some *original* scientific results and a 10% chance of achieving results which will be *included in a research publication*.

However, despite results which indicate that students have a good chance of achieving some original results, responses to our attitudinal questions (concerning motivation and disappointments) still show that getting results is a major concern. A key reason for this is the belief amongst many students that without scientific results it is difficult to get a good mark (section 6.3). Furthermore, although 90% of our sample did get some results, these results may not have been forthcoming until the very end of the project, and as a result of hard work (perhaps even over work - section 8.1). Thus, many students may still spend most of their project

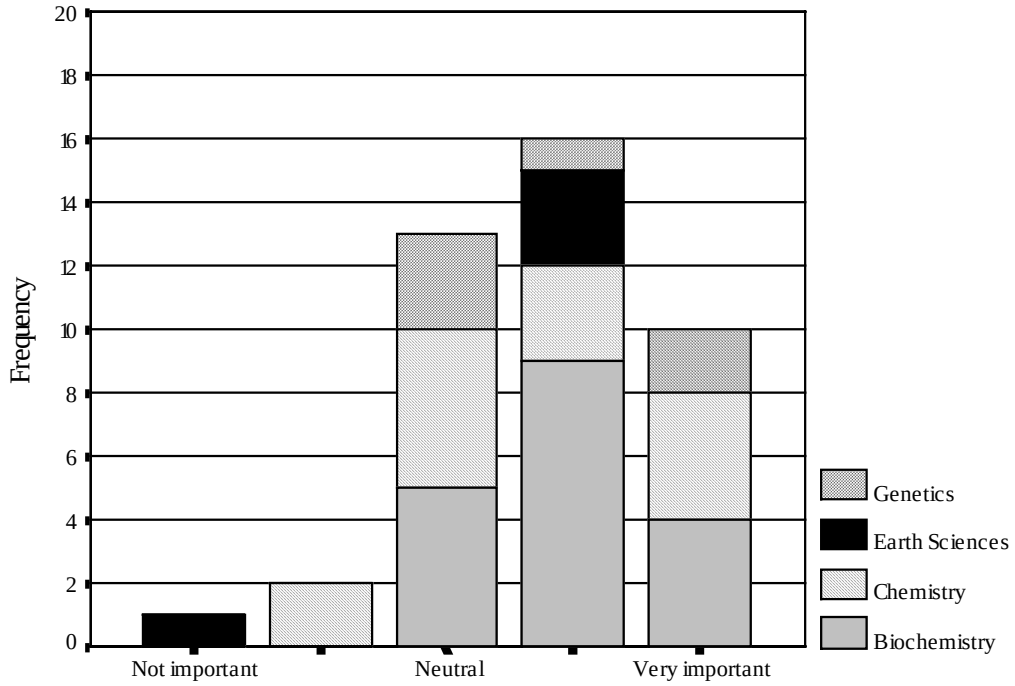


Figure 5.2 Do supervisors feel that projects should involve original research?

		Frequency
	Positive responses:	
A	So that students see that there is a point to their work - motivation	9
B	So that supervisors feel motivated and can gain something from undergraduate project work	4
C	So that students get an authentic image of scientific research	3
D	So that students get a feel for the key research questions of the discipline	1
E	So that students experience the uncertainty of original research	2
F	So that students experience the thinking behind good research	3
G	So that students see 'science in the making'	1
H	So that students are challenged	2
I	So that students have the opportunity to get something published	2
	Negative responses	
J	It is difficult to provide projects that could give original results	6
K	Original projects may not give any results	4
L	Poor students will struggle with original research projects	2
M	Lack of results may lead to a student not getting the opportunity to acquire a variety of skills from their project	1
N	Lack of results may lead to students losing confidence	2

Table 5.1 Supervisors' reasons why projects should/should not involve original research

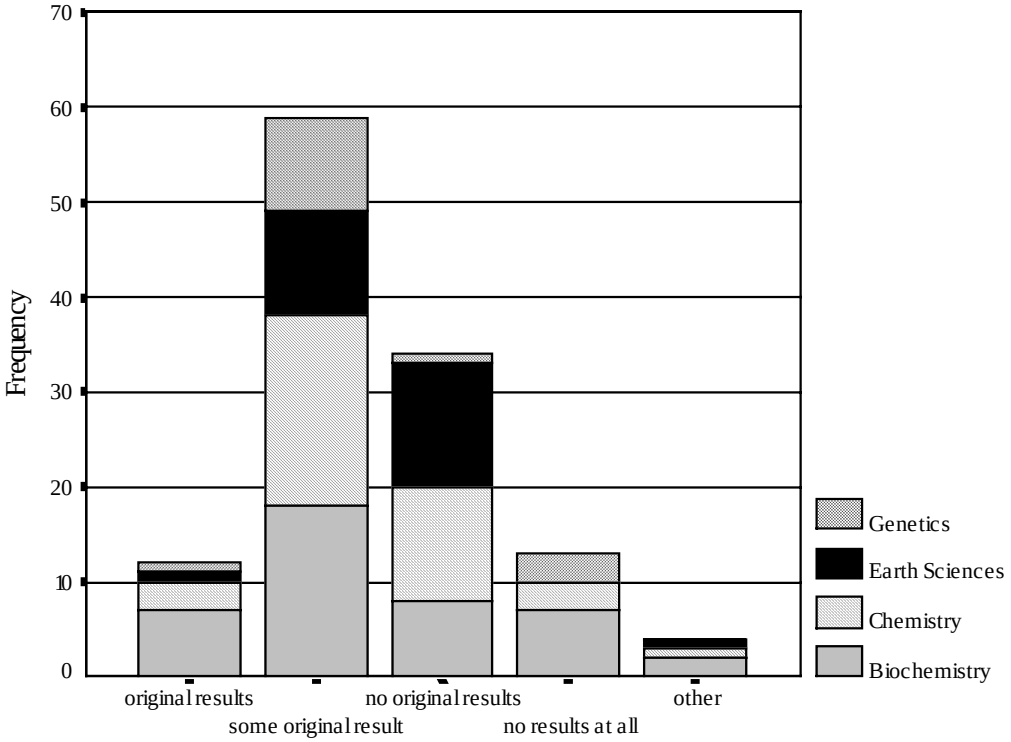


Figure 5.3 Scientific results from student projects

Key

The table below gives the full text of the statements used in the survey.

Original results	Original research results which will be included in a research publication
Some original results	Some original research results
No original results	No original results but some results which corroborate previous work
No results at all	No results

	Results outcome (figure 5.3)					
Project involved: (figure 5.1)	original results	some original results	no original results	no results at all	other	**Totals**
original research	11	29	6	2	0	**48**
partly original research	1	26	15	6	2	**50**
no original research	0	2	7	0	0	**9**
other	0	0	1	0	0	**1**
Totals	**12**	**57**	**29**	**8**	**2**	**108**

Table 5.2 Relationship between amount of original research and success in achieving scientific results.

concerned about getting results. Finally, as discussed in working paper 3 section 3.4, students' conceptions of 'result' can be very different from that of the experienced research scientist. For some students, getting a result means answering the original research question. However, lecturers are aware that good results can take a long time to achieve. Furthermore, a research study which sets out to pursue one research question may evolve in response to events to pursue new questions. The issue of students' perceptions of scientific research and the influence these have on their expectations of, and reactions to, undergraduate research is examined in working paper 5 of this series.

5.2.2 Working environment

Students were asked to describe the working environment in which most of their project took place. Responses are summarised in figure 5.4. The majority (53%) involved work within a research laboratory. However, 28% of our student sample reported doing most of their project work alone (in a laboratory, in the library, at home or in a computer room). Following from our discussion of 'learning as apprenticeship' (working paper 1), it might be inferred that students who work alone on their project are more likely to have a negative project experience. A cross-tabulation between those students who reported having 'a dreadful time on my project' in response to question 25 (14 students - see section 9.2), and whether students worked alone (34 students) shows that 5 of the 14 students reporting a dreadful time had worked alone. This is not significantly different from the expected number of such cases (= 4) if there were no linkage between working environment and having 'a dreadful time'. What is probably more important is matching each student to a working environment *appropriate to them*. Some students prefer to work alone, and will have the motivation and enthusiasm to benefit from this experience.

Further evidence that working environment is considered as an important feature of project work is given in students and supervisors' opinions about the sort of

information that should be included in the project booklet for students. As described in section 6.1.2 there was a strong feeling that this booklet should give students information about the working environment of projects. Furthermore, some supervisors felt that visits to potential supervisors were important because they gave students then chance to learn more about the project working environment (section 6.1.3).

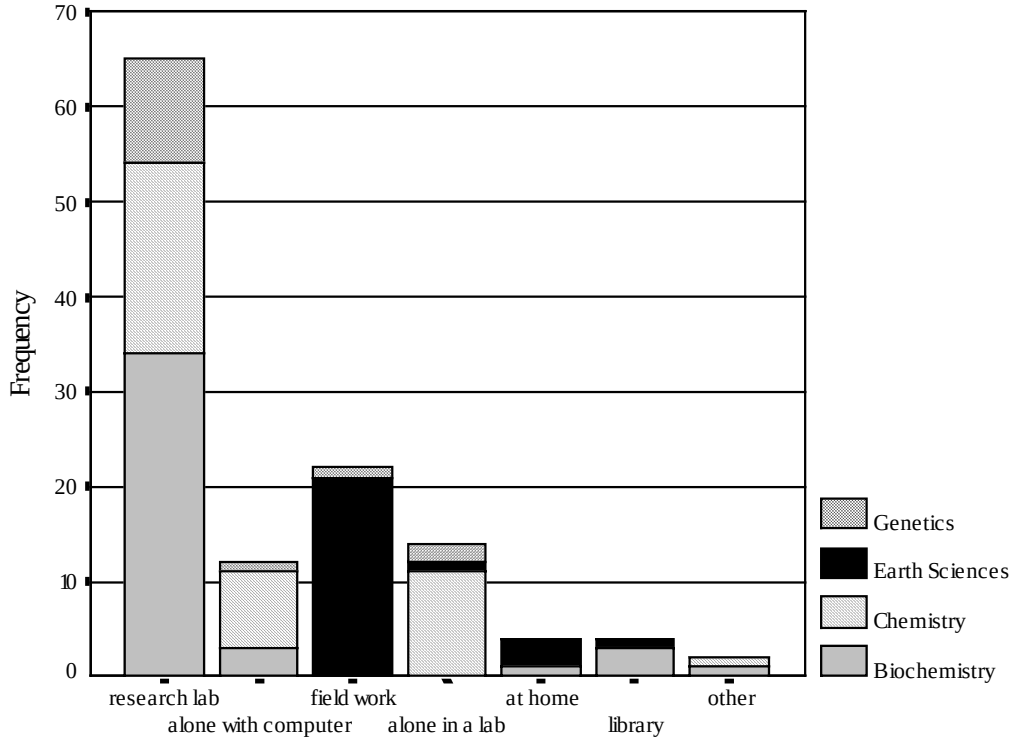


Figure 5.4 Student project working environments

5.2.3 Should all students do project work?

Students were asked whether they would have preferred a series of final year laboratory or field classes similar to those held in the second year instead of project work - 89% said they would prefer project work. Of the 14 students who said work similar to the second year would have been better reasons given included the fact that projects are too specialised, too likely to fail and too unstructured.

Pressure on lecturers' time and financial considerations have forced many departments to consider restricting projects to a proportion of their final year students. Question 6 asked supervisors whether they felt that *ideally* all students should be given the chance to do project work - 71% agreed whilst 29% felt that projects should be restricted to a proportion of the students population. Supervisors were asked to explain their answers. Table 5.3 summarises the categories of response.

All students should do projects:	**Frequency**
All students should get an insight into 'real' scientific research during their degree	6
Many 'poor' students excel at project work	6
Students develop general skills during project work: independence, critical thinking, originality	4
Projects are a unique learning experience not found elsewhere in the course	2
It is not possible to pre-select who will do well at project work	2
Equality of opportunity	2

A proportion of students should do projects:	
Offer projects only to the most able students (academically or in terms of practical skills)	9
Projects are too expensive to be offered to all students	7
Projects are too time consuming/staff intensive to be offered to all	6
Offer projects only to those who are enthusiastic about project work	4
Offer projects only to those students who intend to enter a science-based career	4
Offer projects only to those with a high potential for the subject	1
Other	2

Table 5.3 Supervisors' reasoning concerning whether all students should do project work

One of the main reasons given for allowing all students to do project work was that students previously considered as 'poor' are often able to shine in their project work:

> *"In my experience student performance on course work is not an indication of how well they will perform on project work."*

However, table 5.3 shows that many supervisors feel that projects are time consuming and expensive and should be restricted to the most academically able. The following comment is typical of such views:

> *"I have seen many students make a mediocre attempt at their projects. Supervision involves an enormous expenditure of my time. I feel that there are many students who would benefit more from a traditional practical course."*

5.3 Summary

Reported below is a summary of findings relating to project type.

5a A majority of students are doing original research as part of their undergraduate project work. The originality of project work is a major source of motivation for many students.

5b A majority of supervisors feel that projects should involve original research. Such work is recognised as a source of motivation for both students and supervisors.

5c Seven percent of students whose projects were intended to give scientific results failed to get any results at all. A much higher proportion of students are concerned about getting no results. This concern is probably linked to students' images of assessment, their conceptions of scientific results and their images of the process of scientific research (particularly time scale).

5d The working environment of projects is recognised as an important factor by many supervisors and students. However, our data does not support the idea that students who work alone are more likely to have a negative project experience.

5e The vast majority of students would rather do projects than a more traditional practical course.

6 The organisation of projects in departments

6.1 The process of allocating projects to students

In each department the module manager must allocate a research project to every student. The process usually starts with each student's list of choices. Each student compiles their list on the basis of the information available in the departmental project booklet. This gives a limited amount of information about every available project. Students may also gain additional information about projects by visiting individual supervisors. Further details are given in section 4 of working paper 3. In this section we will examine survey responses concerning the three features of project allocation - students' choices, project booklet and supervisor visits.

6.1.1 Student's choices and their final project allocation

Students were asked what position their project was on their original list of preferences. Their responses are given in figure 6.1. The chart shows that 63% of students were allocated their first choice project. However, 18% of students were given projects which were not on their list of preferences. Students were also asked whether they were happy with the project finally allocated to them - 90% of students said that they were. Of the 13 students who were unhappy with their allocation, 9 were given a project not on their original preference list. The most common reason for being unhappy with their project allocation was that the project was not in a subject area that they were interested in. One student stated that given the popularity of certain *supervisors* it was inevitable that some students would be disappointed.

6.1.2 The project booklet

The project booklet contains information about available projects and is intended to help students make appropriate choices. Questions 11 (to students) and 8 (to supervisors) used a 5-point scale (strongly disagree=1, strongly agree=5) to probe attitudes towards the 5 statements reproduced in table 6.1. The question to students asked them to state whether there should be *more* of each statement in the project booklet. The question to supervisors asked what should be included in an *ideal* project booklet.

Figure 6.2 shows the mean scores for each statement for both the student and supervisor responses. Results for statement E show that supervisors are slightly happier than students with the current content of the project booklet. However, only 41% of supervisors and 30% of students felt that the current booklet was satisfactory (i.e. strongly agree or agree with statement E).

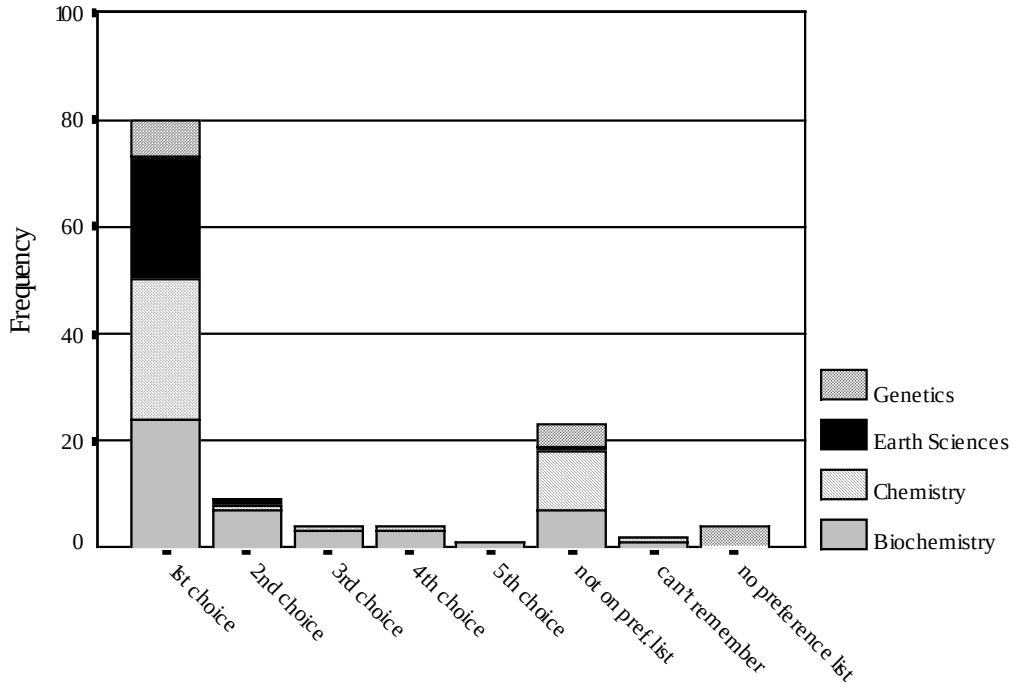


Figure 6.1 Place of students' final choices of project on their original list of preferences

A	It should give more details about the **scientific content** of each project
B	It should say more about the **environment** in which the project will take place (e.g. alone, in a research laboratory with other researchers or with other undergraduate project students)
C	It should say more about the sort of skills that each student is likely to acquire during the project
D	It should make it clear whether it is possible to get results easily from the project or whether it may be harder because the project is original research
E	At the moment it provides the right information to guide students in choosing projects

Table 6.1 Statements about the Project Booklet used in the student and supervisor survey

Statement	Supervisors	Students
A	4.16	3.70
B	3.70	3.55
C	4.00	3.91
D	2.84	3.46
E	3.32	2.92

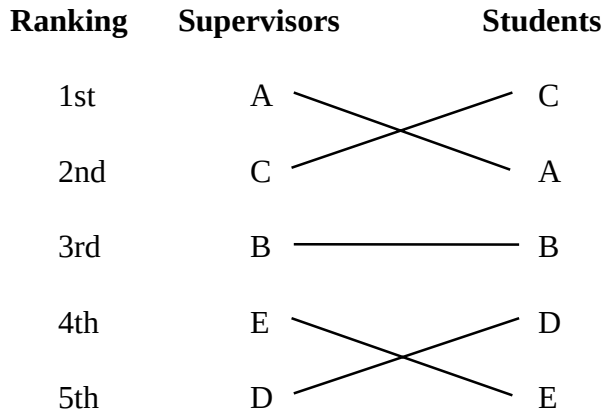


Figure 6.2 Comparison of student and supervisor responses concerning the content of the project booklet

Statements B, C and D refer to the inclusion of details about working environment, skills and 'the chance of getting results' respectively. All of these were largely absent from the project booklets actually given to these students. Figure 6.2 shows that the most popular of these for both students and supervisors was C (skills) followed by B (working environment) and D ('the chance of getting results').

The desire for more information about skills probably reflects current concern about the explicit inclusion of skills in undergraduate courses. In many departments students are already encouraged to think about their own skills development. The interest in details about working environment reflects our earlier discussion about this important feature of project work (section 5.2.2).

Statement D was felt to be the least important for inclusion in the project booklet (though it was more popular amongst students). This probably reflects the feeling that it is extremely difficult to predict in advance whether or not a project will yield results. However, one student added the following comment which describes the kind of statement that could be included in the project booklet:

> *"give an idea of whether the project involves progressive accumulation of data etc. or a remote chance of finding something"*
> *(student's underlining)*

Given the number of projects on offer in each department, it is unlikely that the project booklet could include all of the information discussed here for every project. However, the strong desire for information on skills and project environment seem to suggest that their limited inclusion would be welcomed by both students and staff. However, figure 6.2 also shows that such information should be provided alongside information about the scientific content of each project (statement A).

6.1.3 Visits to potential supervisors

Supervisors were asked whether their department suggests that students should visit potential supervisors before completing their list of project choices - 93% of supervisors responded positively (question 9). Supervisors were also asked (question 10) to indicate on a scale from 1 (not very useful) to 5 (very useful) how useful they felt that such visits were - 91% of supervisors felt that visits were either very useful or useful (mean score = 4.51). Students were asked the same question (question 10): 67% felt that visits were either very useful or useful (mean score = 3.74). Thus, visits are seen to be of value by the vast majority of supervisors and a majority of students.

Supervisors were asked to expand on their answer to question 10. This resulted in 55 statements about visits - 46 of which were positive. Table 6.2 lists the categories of statement in rank order. The most common positive statement is that visits will enable students find out whether they could get on with the supervisor:

> *"Students need to have a good rapport with their supervisor and to find out whether student and supervisor are "on the same wavelength" about the nature and aims of the project."*

Other common positive statements refer to learning more about the project - particularly the working environment and things which are not in the project booklet.

One of the most common negative statements was that students do not bother to make visits. In fact, of our student sample 23% made no visits to potential supervisors. In many cases this was because students were unable to make visits - e.g. due to being abroad or on work placement. Another negative statement was that visits tend to focus on the personality of the supervisor:

> *"[Visits] can be very useful but many students do not bother to take the opportunity. Many other students don't really take it all in - they are mainly influenced by the personality/enthusiasm of the potential supervisor."*

However, despite these reservations, visits seem to be strongly favoured by supervisors, with the best visits being used to discuss the science of the project,

the supervisor and the working environment. Students who do not make visits may be more likely to be allocated an unsuitable project. However a cross-tabulation between whether students made visits (42 did not) and a measure of the success of the student-supervisor relationship (see section 7.2 - 26 had a 'poor' relationship) does not provide strong empirical support for this assertion. Of the 26 students who had a poor supervisor relationship, 6 had not visited supervisors. This compares with an expected number of 5 students, if there was no link between making visits and success of relationship.

Positive statements	**Total**
Students can meet the supervisor - will they be able to get on?	11
Learn more about the project - in general	8
Learn more about the project - than is possible from the project booklet	8
Learn more about the project - the working environment	5
Supervisor can help to steer the student to a suitable project	3
Students can ask questions	2
Students can get up to date with any changes to project details	2
Learn more about the project - the sort of activities involved	1
Learn more about the project - whether it interests them	1
Learn more about the project - what support will be available	1
Supervisor can learn about prospective students	1
Other	3

Negative statements:	
Many students don't bother to make any visits	3
Students misuse the visit by basing their choice on the personality of the supervisors	3
Visits are time-consuming for supervisors	1
Visits are ineffective	1
Students can't visit all supervisors	1

Table 6.2 Supervisors' statements concerning student visits to potential supervisors

6.2 Preparing students for project work through the undergraduate curriculum

Interviews with students during the twelve case studies (see working paper 4 section 7.1) indicated that many students felt very unprepared for the demands of project work. These students also suggested a variety of things that could have been done earlier in their undergraduate course which would have made them more prepared. Suggestions included discussions with students who had just completed their undergraduate projects, and mini-projects in the first two years.

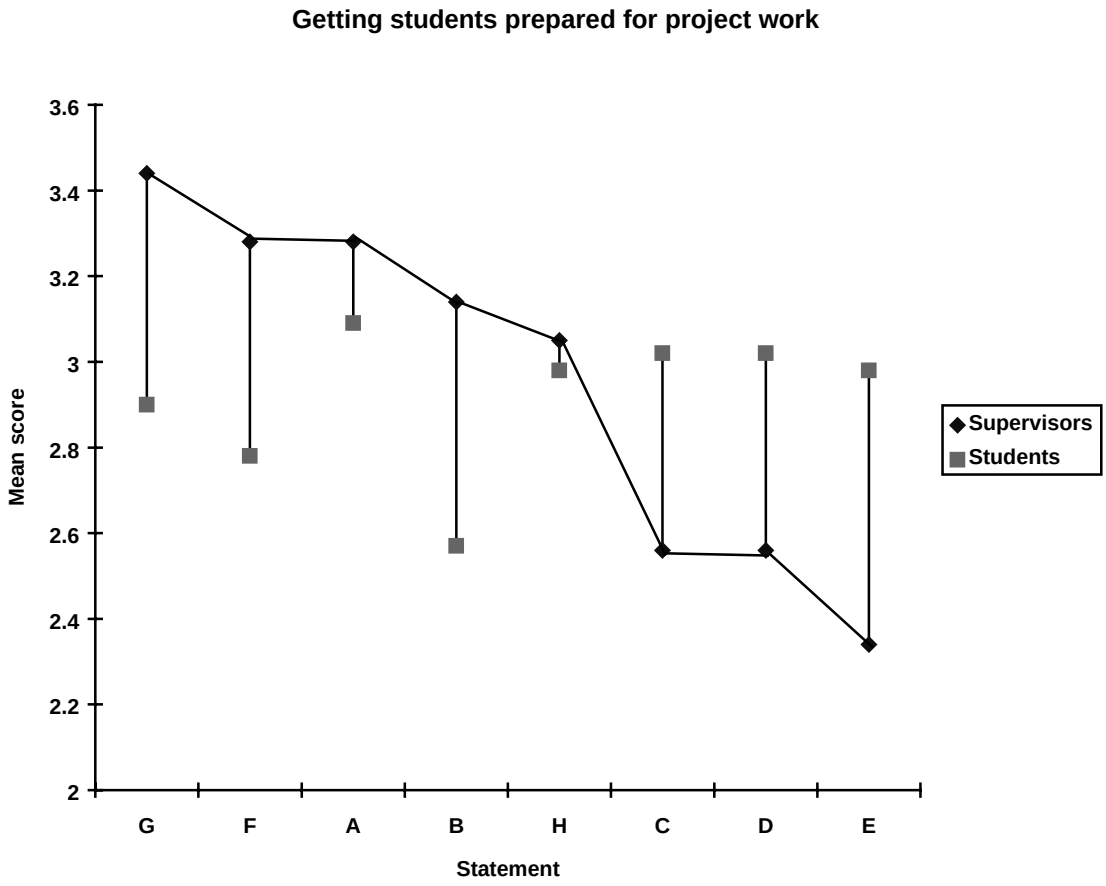
Sections of the survey for students and supervisors were designed to explore these issues across the whole student/supervisor population.

Question 27 (student survey) and 7 (supervisor survey) asked respondents to consider which aspects of an undergraduate curriculum could help to prepare students for project work. Respondents were given 8 statements A to H and asked to indicate their preference on a four-point scale running from very useful (=4) to no use at all (=1). The statements A to H are given in table 6.3. Figure 6.3 gives the mean scores for each category for both students and supervisors. This figure also shows the statements ranked in popularity for both students and supervisors.

A	Practice at reading papers published in research journals
B	Tutorials where students need to prepare a literature review
C	Mini-projects in the first two years
D	Activities which give students the chance to talk with students who have just completed their research projects
E	Tutorials where students discuss how to get started on open-ended project work
F	Opportunities to develop writing skills
G	Activities where students have the opportunity to work on their own initiative
H	Activities where students gain confidence in interacting with lecturing staff

Table 6.3 Statements concerning how students could be prepared for project work

Figure 6.3 shows that there are significant differences between student and supervisor responses. Statements D and E - referring to the explicit discussion of project work with more experienced students or in tutorials - are both ranked much higher by students than by supervisors. Clearly many students feel that such discussion about ‘how to go about project work’ would be beneficial. In fact 85% of students said either D or E would be useful (a score of 3 or 4). However, supervisors may have reservations about how this could be organised, within a busy curriculum.



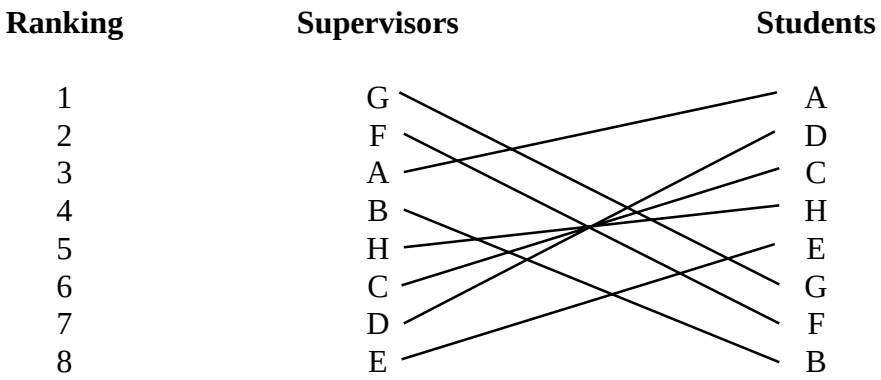


Figure 6.3 How can students be better prepared for project work - responses from students and supervisors

In contrast statements B and F - referring to preparing a literature review and writing skills - are both ranked higher by supervisors than by students. It may be that students feel that they already have opportunities to practice these things earlier in the course. However, statement A - practice at reading published research papers - scored highly for both students and supervisors. This reflects the suggestion from some interviewees that they had initially struggled to cope with the level, structure and style of research papers.

Statement G - students working on their own initiative - scored rather low for students whilst being the most highly ranked statement amongst supervisors. This may reflect the wish amongst many supervisors that students were more able to work creatively and independently. However, given what is at stake for the student (particularly in terms of assessment) it may be that students are less willing to be expected to take control of aspects of their own learning - particularly during project work.

Statement H - gaining confidence in interacting with staff - scored fairly high for both students and supervisors. This may reflect an awareness that the nature of the student-supervisor relationship is a key ingredient in successful project work. However, our survey can give no indication of how such an aim can be achieved.

6.3 The assessment of projects

Our twelve case studies showed that assessment is a major concern for students. This has been confirmed by our survey data - the single most significant motivator for students is ‘the desire for a good mark’ (section 9.2). Our case study data also identified the distinction between assessment methods (e.g. vivas, project reports) and assessment criteria (e.g. has the student shown initiative?) as being of significance (see working paper 4 section 6). Students were also concerned about whether a project which did not yield results could be awarded a first class mark. Several survey questions were designed to probe these issues - particularly with supervisors.

Questions 16 and 17 of the student survey asked about students’ awareness of how their projects would be assessed both at the beginning and towards end of their project work. The questions used a scale running from 4 (very well aware) to 1 (not aware at all). Results are shown in figure 6.4.

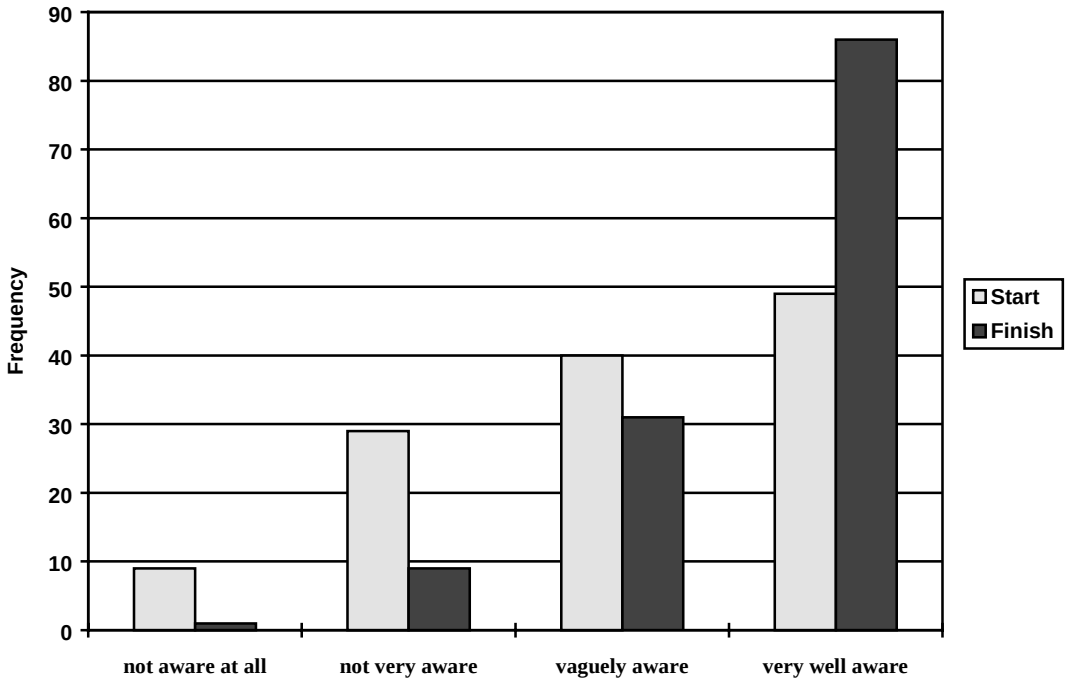


Figure 6.4 Students' awareness of how their projects would be assessed

There is a significant shift to increasing awareness from that at the beginning of the project to that at the end. This is unsurprising given the fact that most students do not discuss project assessment with their supervisors until project work is well underway. What is of concern is that within the last three weeks of project work 32% of students are 'vaguely aware' or less about how their project will be assessed.

Question 16 of the supervisor survey addressed the issue of how students could be better informed about the assessment procedure - focusing particularly on the assessment criteria - 85% of supervisors felt that students should be informed of the assessment criteria. Supervisors were also asked to explain their answer. The categories of response are given in table 6.4.

	Frequency
A) Students will know what is expected of them	21
B) Openness is a good thing	5
C) Helps students to realise that not getting results isn't a major problem	2
D) Students will gain confidence and motivation if they know what they are getting marks for	2
E) It is hard to make criteria explicit	1
F) Making criteria too detailed will mean they aren't applicable to the wide range of project types	4
G) Other	7

Table 6.4 Supervisors' views about advantages/disadvantages of informing students of the assessment criteria

The most common advantage identified by supervisors is that students will know what is expected of them:

> *"The criteria should be those to identify the makings of a good scientist. If the students are able to look for those qualities within themselves, they may be able to identify and develop such qualities."*

The main disadvantage identified was that it is extremely difficult to identify meaningful criteria applicable to all project types:

> *"My answer depends on what is meant by details. Students need to be told what skills are being assessed and how, but as projects differ widely very detailed criteria may not be widely applicable."*

Those supervisors who felt that students should be told the assessment criteria were also asked *how* this could be done. Supervisors were given four possible methods and asked to indicate which they felt could be effective. The results are given in table 6.5.

	Frequency
By giving students a copy of the departmental assessment sheets	24
Discussion of project assessment during a final year tutorial	19
By holding a mock assessment interview between the student and the project supervisor in the middle of the project	10
By showing students completed mark schemes for project reports submitted in previous years	7

[35 supervisors answered this question]

Table 6.5 Supervisors responses concerning ways in which students can be informed of departmental assessment criteria

The table shows that 69% of respondents felt that students should be shown the departmental assessment sheets as used by assessors.

A particularly strong issue for some students during the case study interviews was whether projects which do not get results can be awarded a first class mark. One student stated his view very forcibly:

> *"To get a first I think things might have to go right, you'd get good results to start off with (...) and start doing other things and you're actually thinking about it yourself (...) I'd say that is unfair but I think that's how it happens."*
> *(3D83-84)*

Supervisors were asked in the survey whether they felt that first class marks can be awarded to projects which do not yield scientific results. All but one supervisor stated that it was possible under their assessment system. In explaining their answer most supervisors stated that marks are not given for results. A typical response is given below:

> *"A student MUST not (and never) be penalised for the failure of a project to work according to expectations. It is the attitude and endeavour, motivation and perseverance, etc. plus intellectual ability, initiative, etc. that should be assessed."*

Other assessment criteria mentioned were understanding of the science, effort, presentation (oral and written) and problem solving skills. However, one supervisor raised a reservation similar to that of student D quoted above:

> *"However, it is all the more difficult to present a report when there are few results from lab work. It is also very difficult to assess such a report (which may be little more than background and literature survey) against projects which include extensive results and discussion. The onus is on supervisors to ensure, as far as possible, some prospect of success."*

Even though supervisors overwhelmingly feel that students should not be penalised if, through no fault of their own, they get no/few results, such projects are difficult to compare with 'successful' projects,. Furthermore, students are dubious about whether this is possible in practice.

An important feature of assessment which takes into account the difficulties a student may have faced in trying to achieve scientific results is the input of the student's supervisor. Supervisors were asked to indicate on a 4-point scale the extent to which individual supervisors should be involved in the assessment of the projects which they supervised (question 14) - 67% of respondents felt that supervisors should be heavily involved (=3) or involved in the entire assessment procedure (=4). Supervisors were also asked to explain their answer. Table 6.6 gives the categories of response ranked according to frequency. The most common feature in support of supervisor involvement was their knowledge of the student and the project - particularly how hard they worked, the difficulties they faced and the amount of input coming from the student rather than the supervisor. However, there was a strong feeling that moderation is important and that in many cases the nature of the student-supervisor relationship may influence a supervisor's assessment of their student:

> *"Supervisors are the closest member of staff to the project/student and as such know most about the difficulty of the project, competence of the student. As such he/she should have some assessment input. However because of this closeness there is the possibility of bias (in both directions)."*

	Frequency
Supervisor is ideally placed and knows the student and their project	17
There needs to be a moderation procedure to ensure uniformity of assessment across the student group	12
Supervisor is aware of how hard the student worked - their attitude to work	7
Supervisor knows how much came from the student and how much from the supervisor	6
Supervisor is aware of the difficulties that were faced on individual projects	6
Supervisor- student relationship can influence the supervisor assessment (positively or negatively) and make it difficult for them to be objective	6
Other	6
Supervisor can comment on technical/specialist aspects of the project	3

Table 6.6 Supervisors' responses concerning the extent of their involvement in the assessment of projects which they supervise

6.4 Summary

Our student and supervisor sample identified the following issues related to the organisation of projects in departments.

6a The vast majority of students are happy with the project allocated to them, with 63% of students in our sample being allocated their first choice project.

6b A minority of students and supervisors are satisfied with the content of the departmental project booklet.

6c There was a strong view that details of skills covered and project working environment should be included in the project booklet.

6d Student visits to potential supervisors are seen as valuable by the majority of students and supervisors.

6e Students would value the opportunity to discuss project work with students who had just completed an undergraduate project.

6f The opportunity to discuss the reading of published research papers would be valued by both students and supervisors.

6g Both students and supervisors would value opportunities to give students confidence in interacting with lecturing staff.

6h A significant proportion of students are only vaguely aware of how projects are assessed during the final three weeks of project work.

6i A large majority of supervisors felt that students should be informed about the criteria used to assess project work. The most popular way of doing this was to show students the departmental assessment sheets.

6j Virtually all supervisors felt that projects can be awarded a first class mark even if they do not yield scientific results. However, some reservation were raised about how such an ideal can be achieved in practice.

6k A majority of supervisors felt that they should be heavily involved in the assessment of the projects that they supervise - largely because only they can know the details of the project and the student's experience.

7 The supervision of projects

Interviews with both students and supervisors during the case study interviews focused very much on the supervision of projects. Issues of importance included the role of PhD students and postdoctoral researchers, the nature of the student-supervisor relationship, what students and supervisors talked about and constraints on the project supervisor which inevitably limit their ability to provide ideal supervision. Questions in both surveys were designed to address these issues across the whole population, in the four science departments involved in the study.

The student survey included 4 questions covering supervision issues. Question 12 asked students to indicate the people involved in their supervision - lecturers, PhD students, postdoctoral researchers and technicians. Question 13 presented each student with 12 statements about supervision and asked them to indicate their agreement with each on a scale from 1 to 5. Statements included both positive and negative experiences of supervision. Question 14 asked students to describe the best aspect of the supervision they received, in open format. These were read by researchers and then coded into categories of response. Finally, question 15 probed the students' experiences of talking with their supervisor - focusing on the content of this talk. Students were presented with 7 examples of things which they may have talked about and asked to indicate on a four-point scale the extent to which these actually reflected their experiences of talking with their supervisor.

Supervisors were asked 3 questions about supervision. Question 11 was similar to question 15 of the student survey - probing the issues talked about during supervision sessions. Question 12 asked supervisors to indicate on a five-point scale whether they were satisfied that they had provided their students with effective supervision. Finally, question 13 tried to identify the constraints on supervisors which may limit the extent to which they are able to provide effective supervision.

7.1 The role of PhD students and postdoctoral researchers in the supervision of undergraduate project students?

Of the students in our sample 40% stated that PhD students and/or postdoctoral researchers were 'heavily involved' in their supervision. Furthermore, figure 7.1 shows that 40% of our sample stated that a PhD student or postdoctoral researcher was *more involved* in their supervision than the lecturer assigned to them as supervisor.

The categories of students' responses to question 14 (what was the best aspect of the supervision that you received) are shown in figure 7.2. The fourth most common category (across the whole student sample) is for those responses in which PhD students and postdoctoral researchers were mentioned explicitly. This indicates that students value the supervision they receive from PhD students and

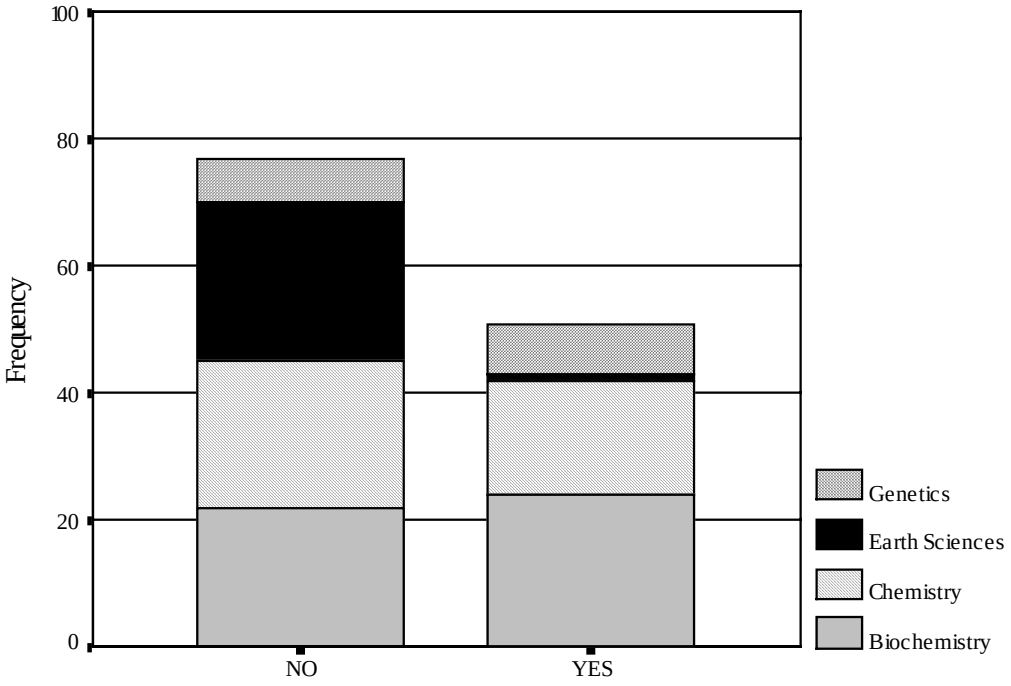


Figure 7.1 Cases where PhD or postdocs were more involved in the supervision of projects than the assigned supervisor

postdoctoral researchers, and that such involvement should be encouraged (see working paper 4 section 4.3).

7.2 The student - supervisor relationship

Figure 7.2 also shows that by far the most common 'best aspect' of the supervision which students received was 'a positive and friendly relationship'. Other 'best aspects' in figure 7.2 relating to relationship issues are 'providing motivation, confidence and encouragement' (2nd), 'showing interest/enthusiasm' (5th) and 'willing/happy to spend time with me' (7th). This strongly supports the finding from case study data that the student - supervisor relationship has a big impact on the student experience.

The converse of the assertion above is that poor student - supervisor relationships can have a negative impact. Table 7.1 lists those statements presented to students in question 13 which are related to the nature of the student - supervisor relationship.

Statement	
D	I found my supervisor very easy to talk to
F	My supervisor praised me when I did well
I	My supervisor was good at motivating me to do well
K	I dreaded going to see my supervisor
L	My supervisor saw me as a burden on his/her time

Table 7.1 Statements presented to students which refer to the student - supervisor relationship

Analysis of students' responses to these statements on a scale of 5 (strongly agree) to 1 (strongly disagree) shows that 20% of students either disagree with D or agree with K or L. This can be seen as an estimate of the proportion of students whose student - supervisor relationship could be classed as 'poor'. These students (26 in all) represent 1 in 5 of our student sample. As a complimentary test of a 'good' student - supervisor relationship 68% of students agreed with statements F or I.

In section 9.2 we discuss details of students' overall feelings towards their project work. There it is shown that 14 out of 113 respondents stated that they had 'a dreadful time' on their project. Of these, 7 students were included in our sample of students whose student - supervisor relationship could be characterised as 'poor'. This compares with an expected number of 3 students out of the 14, if there was no link between the nature of the student - supervisor relationship and the students overall feeling towards their project. This provides further support for the assertion that the student - supervisor relationship has a major impact on the student experience of project work.

7.3 The content of student-supervisor discussions

Question 13 also asked students to indicate their agreement with the two statements shown in table 7.2.

Statement	
C	My supervisor overestimated what I could do during my project
E	My supervisor was aware of my feelings about the project

Table 7.2 Statements presented to students which refer to degree of communication between student and supervisor

In our sample 36% of students either agreed with C (26%) or disagreed with E (18%). This can be taken as a measure of the extent of *miscommunication* between student and supervisor. In this section we will examine the content of discussion between the student and their supervisor.

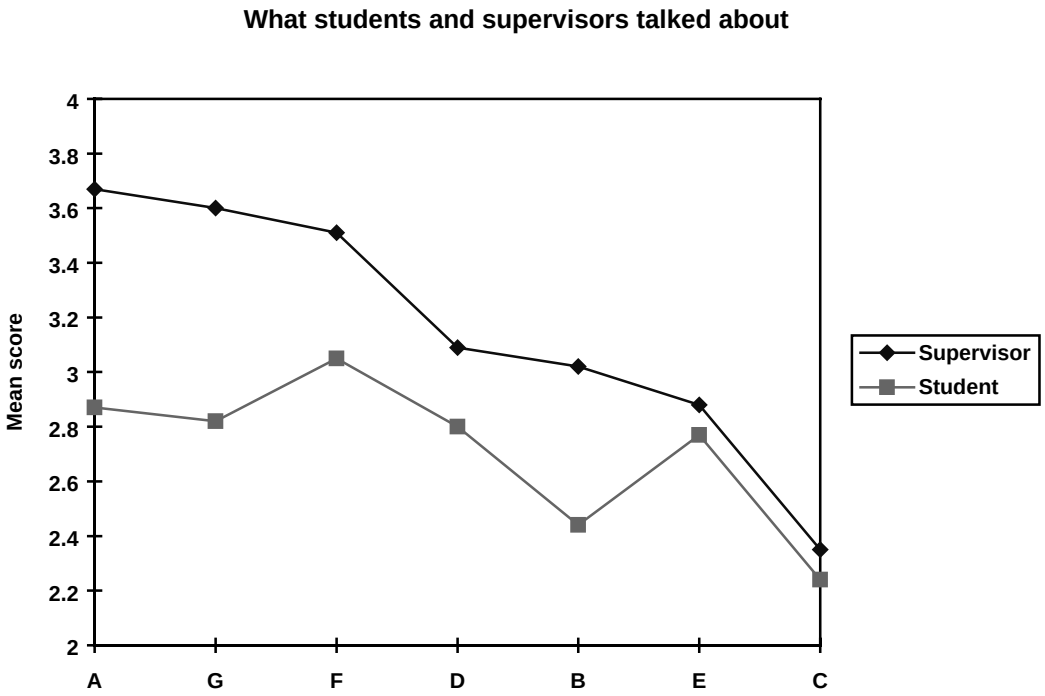
Students and supervisors were asked about the content of their discussions in questions 15 and 11 respectively. Table 7.3 lists the seven statements which they were asked to grade on a four-point scale running from 'we talked about this a lot of the time' (4) to 'we never talked about this' (1).

Figure 7.3 gives a graph of the mean scores given by students and supervisors for each of these statements, together with statements ranked according to mean score. The mean score can be interpreted as a quantitative measure of the amount of time students or supervisors felt that they spent on discussions about each statement.

The statements can be grouped into three areas of discussion. Statements A and G focus on the *scientific* aspects of the project - results and technical issues. Statements D, E and F focus on issues *personal to the student* - especially the student's evaluation of their own performance. Finally, statements B and C focus on the student's *broader view* of their project - knowledge about other scientific and technological work related to their area of research.

Statement	
A	Interpretation of the results from the student's project
B	Scientific work by other researchers which was related to the student's project
C	Potential applications (technological, medical...) of the student's project
D	How the student felt about their project work so far
E	Whether or not the student was doing well on the project
F	What the student thought they should do next on the project
G	Technical advice about how the student could overcome problems on the project

Table 7.3 Statements describing the content of discussions between students and supervisors



Key: 4 = 'we talked about this a lot of the time'
2 = 'we hardly ever talked about this'

Ranking	Supervisors	Students
1st	A	F
2nd	G	A
3rd	F	G
4th	D	D
5th	B	E
6th	E	B
7th	C	C

Figure 7.3 Supervisors' and students' descriptions of what they talked about during supervision sessions

Broadly speaking figure 7.3 shows that students and supervisors spend most of their discussion time on scientific issues. The next most common area of discussion is about issues personal to the student. In fact 30% of students stated that they hardly ever (or never) talked about whether or not they were doing well on their project (statement E). The issue of self-evaluation was identified as being of crucial importance during our case study interviews (working paper 4 section 7.2). Our survey results seem to show that this issue is underrepresented during student-supervisor discussions.

The student's broader view of their project is the issue covered least during student-supervisor discussions. Indeed 49% of students stated that they hardly ever (or never) talked about scientific work by other researchers which was

related to their project (statement B). Again the development of a 'broader view' of their project was identified during interviews as being an important part of the student's learning (working paper 4 section 8.2).

Although it seems reasonable to assume that most discussion will focus on scientific and technical issues relating directly to the project, it may be important for supervisors and students to be aware that there are other important areas which could be covered during discussions. Whilst those students who have the opportunity to interact with PhD students or postdoctoral researchers may be able to discuss broader scientific and more personal issues with them, many students will rely entirely on their assigned supervisor for discussion about such issues.

Finally, figure 7.3 also shows that although students and supervisors responses give similar rankings for statements A to G, students report that they felt they spent less time discussing these issues than that recalled by supervisors (as evidenced by the lower mean scores given by students). This may indicate that students would have preferred more discussion time overall. The next section examines the constraints on supervisors which often act to limit the amount of time that they are able to spend in discussion with their students.

7.4 Constraints and limitations on what supervisors can offer

When asked whether they were satisfied that they had been able to offer effective supervision to their project students, 7% of our sample (3 supervisors) indicated that they were dissatisfied, and 26% were either neutral or dissatisfied. This represents a small but significant minority of supervisors who felt that their students had not received effective supervision.

All supervisors were asked to indicate which of the statements A to F in table 7.4 were reasons which prevented them from providing *ideal* supervision for their students. The table lists the statements in rank order.

Statement		Number of supervisors agreeing (N=43)
A	Insufficient time available for discussion with students due to other commitments within the university	34
B	Difficulties because a student rarely came to see me	20
C	Feeling unwilling to spend time with a student who was not putting in the required time on the project	13
D	Having too many undergraduate project students to supervise at one time	10
E	Being away from the university at important times during student projects	6
F	Being unable to establish a positive personal relationship with a student	4

Table 7.4 Factors which prevented supervisors from providing ideal supervision

In our sample 79% of supervisors felt that they had insufficient time to provide ideal supervision owing to other commitments. This inevitably puts a severe strain on supervisors and students. Significantly only 23% of our sample felt that they had too many students to supervise (the average number of students per supervisor was 3.3).

Statements B and C described constraints originating from the nature of the students being supervised - 49% of supervisor agreed one or other (or both) of these applied to their experiences of supervision during that year. One supervisor added the following comment:

> *"[It is] difficult to supervise effectively a student who hardly turns up."*

The nature of the student is largely beyond the supervisor's control. However, many students find it difficult to arrange meetings with busy supervisors. Responses to question 13 show that 29% of students felt that their supervisor was difficult to get hold of (i.e. agreeing or strongly agreeing with this statement). Some realise that persistence is required. Responses given as advice to future project students (question 28 - section 9.2) include 'make the most of the supervision available', 'be persistent when asking for help' and 'select a

supervisor who will be available to you'. Many students do not have the confidence to repeatedly approach busy supervisors.

Only 7% (4 supervisors) of our sample stated that the nature of the student-supervisor relationship was a problem. This contrasts with the 20% of students who were characterised in section 7.2 as having a poor student-supervisor relationship. This may be further evidence of the potential for miscommunication between students and their supervisors.

7.5 Summary

7a PhD students and postdoctoral researchers are the major source of supervision for 40% of our student sample. Such supervision is highly valued.

7b The nature of the student-supervisor relationship has a major impact on students' experiences of project work - either positively or negatively.

7c One in five of the students in our sample reported experiences which provide evidence of a poor student-supervisor relationship.

7d One third of students reported evidence of miscommunication between student and supervisor.

7e Discussions between student and supervisor tend to neglect personal issues such as whether or not the student is performing well or how the student feels about project work.

7f Half of our student sample reported that they hardly ever (or never) discussed broader scientific and technological issues relating to their project.

7g Two thirds of our supervisor sample were satisfied that they had been able to provide effective supervision to all of their project students.

7h The most common constraints on the supervisors' ability to provide ideal supervision are lack of time and lack of effort and persistence from students.

7i Nearly one third of students felt that their supervisor was difficult to get hold of.

8 Workload and time management

During the second and third interviews of the case studies many students identified workload and time management as a major concern. Many students seemed to be working far longer hours on project work than was timetabled for them in the curriculum. Other module work was often neglected in order to spend more time on project work. The completion of the final report was a source of considerable stress and worry for some students. The student survey included questions designed to follow these issues up with a wider sample.

8.1 Student workload

Question 18 presented students with 6 statements about workload and time management. These are shown in table 8.1. Students were asked to indicate on a four-point scale the extent to which each described their own experience (4=very true, 1=not true). The statements are near verbatim extracts taken from the interviews with students.

A	I had a good idea of the amount of time my department expected me to spend on my project
B	I was able to work for a fixed number of hours each week on my project
C	I worked longer hours on my project than I was supposed to because I wanted to get better scientific results
D	I felt that people associated with my project expected me to work longer hours on the project than I was supposed to
E	My other module work suffered because of the amount of time that I spent on my project
F	My supervisor used to talk to me about how I was managing my workload

Table 8.1 Statements presented to students concerning their experiences of workload

One of the most important questions is whether or not students spend longer hours on their project than they are supposed to. Students' responses to statement C show that 57% of students felt that is was 'mostly true' or 'very true' that they worked longer hours than they were supposed to because they wanted better scientific results. Only 21% said that this was 'not true'. This indicates widespread over work on projects. One of the consequences of this over work is indicated by the students' responses to statement E presented in figure 8.1 - 72% of students felt that it was at least partly true that their other module work had suffered because of the amount of time that they had spent on project work.

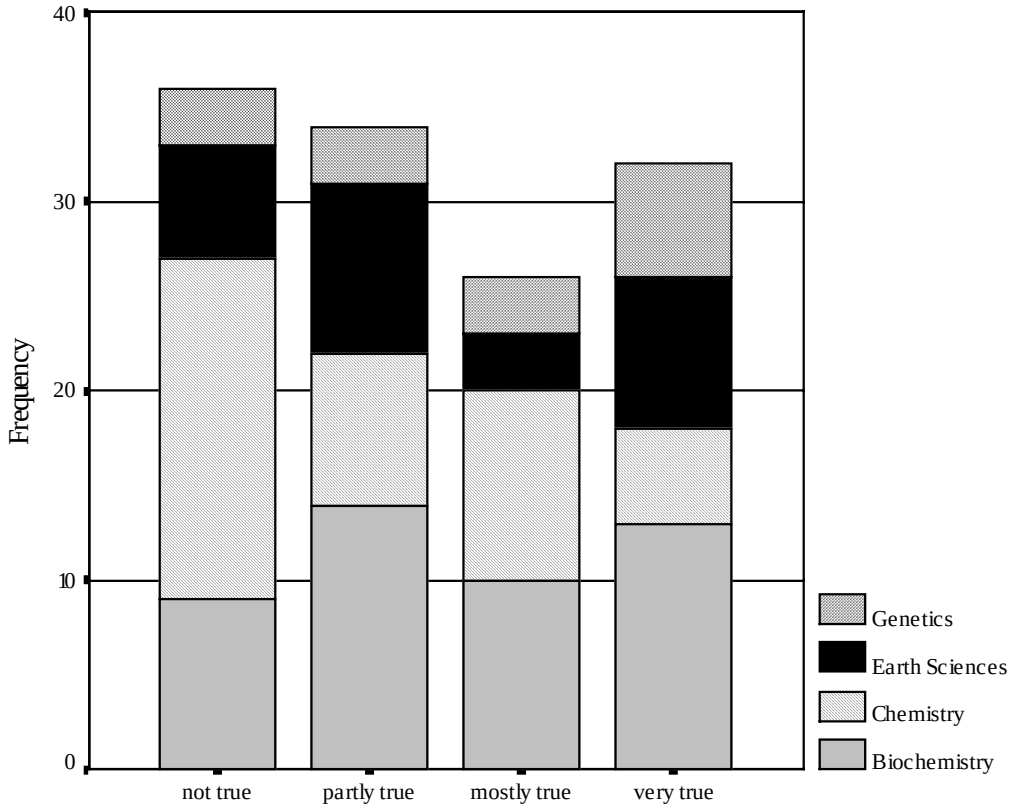


Figure 8.1 Students' responses to the statement 'my other module work suffered because of the amount of time that I spent on my project'

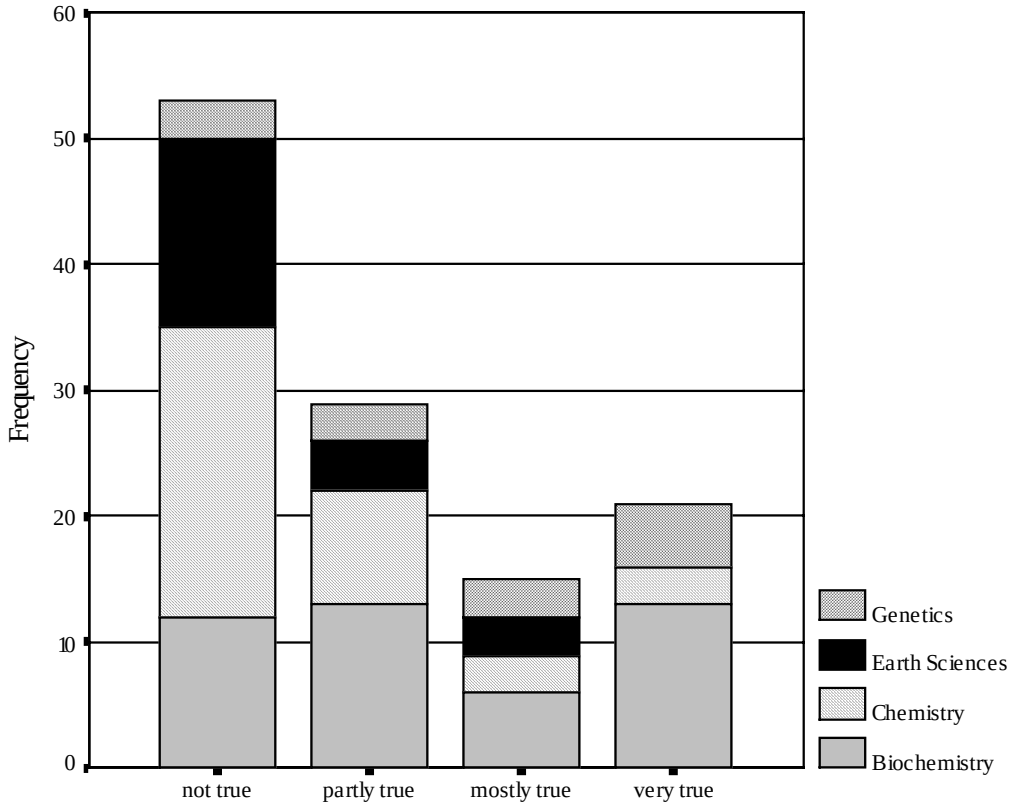


Figure 8.2 Students' responses to the statement 'I felt that people associated with my project expected me to work longer hours than I was supposed to'

Why do students over work on projects? One of the key reasons is indicated in statement C - the desire for results (see section 5.2.1). Responses to statement A show that 67% of students feel that it is 'very true' or 'mostly true' that they were aware of the amount of time they were expected to work on their projects. Hence most students are conscious that they are over working. Figure 8.2 shows the extent to which students felt that people associated with their project expected them to over work (statement D) - 55% of students felt that this was at least partly true. This confirms the statements from some students during interviews that they felt pressure (often from PhD students or postdoctoral researchers) to work 'normal researcher' hours rather than the (smaller) amount of time assigned for undergraduate project work (see working paper 4 section 5).

Finally, students' responses to statement F show that 60% of students felt that it was 'not true' that their supervisor talked to them about managing workload. This may represent a missed opportunity for students to be encouraged to manage their time appropriately. Whilst appropriate time management may inevitably mean over work at certain times on their project, it should not lead students to neglect other module work, or cause them undue stress and anxiety because they have insufficient time to prepare their final report.

8.2 Completing the final project report

Question 19 focused on the students' experiences of completing their final report. Students were asked whether or not they were satisfied that this was their best effort, and what issues may have caused them difficulties in completing their final report. Figure 8.3 shows the proportion of students who felt that they had spent enough time on their final report to be satisfied that it was their best effort. Overall 43% of students felt that their final report was not their best effort.

Table 8.2 lists the statements offered to the 43% of students who felt dissatisfied with their final report. These are ranked according to the number of students agreeing with each statement. Statements reflect reasons given by students during the case study interviews.

The top two reasons for students struggling to produce a good final report are related to time management. A rather surprising result is that half of the students who were dissatisfied with their final report felt that adequate access to a computer had been a constraint. Other reasons given by students included illness, lack of motivation and a clash of deadlines with the start of exams.

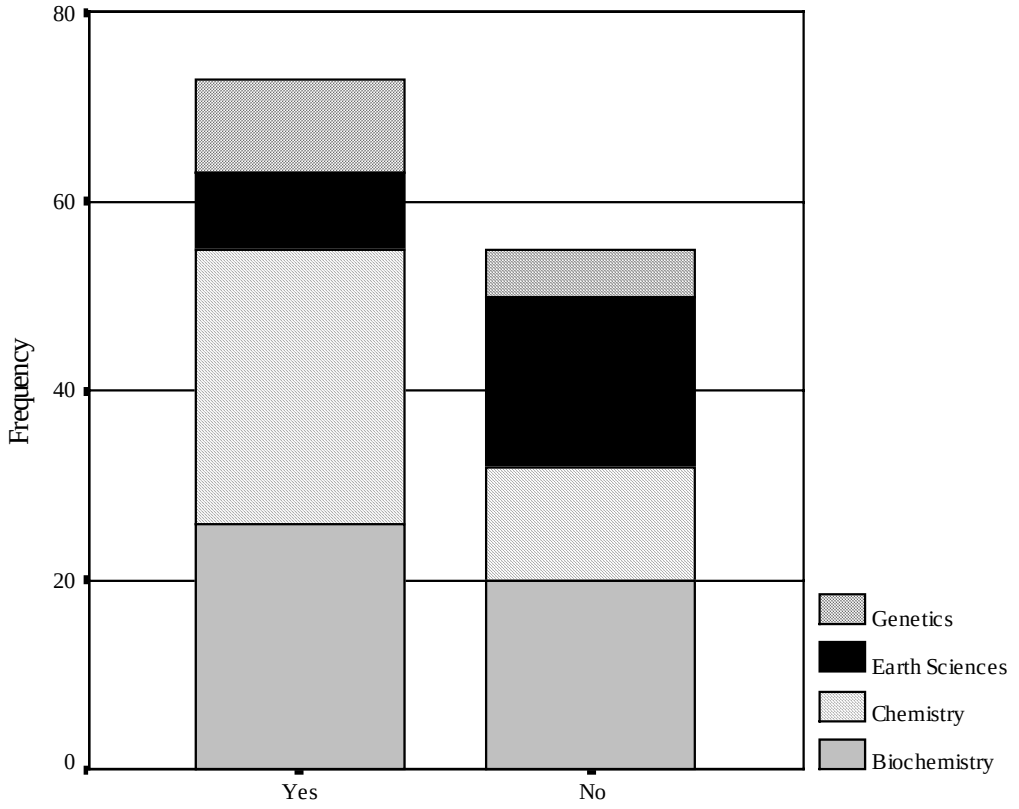


Figure 8.3 Students' responses to the question: 'do you feel that you spent enough time on your report to be satisfied that it was your best effort?'

		Number of students agreeing (N~51)
A	I didn't realise how long the final report would take	32
B	It was my own fault for not managing my time properly	31
C	It needed to be word-processed and I found it very difficult to find access to a computer	24
D	I spent so much time trying to get data that I ended up with not enough time for the final report	13

Table 8.2 Reasons given by students for not producing a final report which they were happy with

8.3 Summary

8a A majority of students work longer hours on their project than is allocated to project work in the final year curriculum.

8b Nearly 3/4 of our student sample felt that their other module work had suffered because of the amount of time that they had spent on project work..

8c Over half of our student sample felt that there had been pressure from those involved in their supervision to spend longer hours on project work than is allocated in the final year curriculum.

8d Fewer than half of our student sample reported discussing workload and time management issues with their supervisor.

8e Nearly half of our student sample were dissatisfied with their final report. Of these 2/3 felt that this was the result of problems with workload and time management.

9 Students' attitudes to project work

Following from the case study interviews with students working paper 4 identified a number of 'attitudinal' issues which had an impact on the student experience. These include:

- the student's ability to realistically evaluate their own performance
- the student's motivation
- the student's sense of control over, and ownership of, their project

Many of the survey questions to students were designed to probe these issues further.

9.1 Students' overall feelings

Question 25 was an attempt to access the students' 'overall feelings' about project work. The question gave students 8 statements about project work - positive and negative - and asked which statements applied to them. Table 9.1 lists these statement together with the percentage of students who ticked yes rather than no for each statement.

		Yes responses (%)
A	The best part of the course so far - I really enjoyed it	32
B	I found the project really interesting	70
C	I enjoyed it a lot	51
D	I enjoyed some aspects of project work	87
E	It is the most demanding piece of work that I have done so far on this course	79
F	I could have done a lot better if I had worked harder	26
G	I had a dreadful time on my project	12

Table 9.1 Students' overall feelings about project work

Nearly 3 out of every 4 students found their project 'really interesting' and half of our student sample enjoyed project work 'a lot'. A third of students felt that project work was the best part of the course so far.

By contrast 1 in 8 students had a dreadful time on their project. It appears that students' overall feelings about project work vary a great deal with the majority finding it a very positive experience, but a significant minority having a very difficult time. This may reflect the fact that 8 out of 10 students felt that project work was 'the most demanding piece of work that I have done so far on this course'. For some students - those perhaps suffering from poor supervision, poor motivation or bad luck - the demands of project work prove to be too much.

9.2 Students' motivation, disappointments and advice to future undergraduate project students

In this section we will summarise the students' responses to the following three open questions:

- Give details of **one** thing which increased your motivation towards your work on the project (question 23 - figure 9.1)
- Give details of your **one** major disappointment about project work (question 24 - figure 9.2)
- Now that you have completed your project what advice would you give to students who are about to begin their projects? (question 28 - figure 9.3)

The categories of response identified by researchers in the students' textual replies to these questions are presented in figures 9.1, 9.2 and 9.3. Taken together these questions identify a group of four *Key Issues* relating to the students attitude towards project work. These are summarised in table 9.2, together with representative categories which appear in figures 9.1 - 9.3.

Results	The desire for results, getting results, making progress, lack of good results, the desire to do a good job, desire to answer the original research question, desire for a good mark.
Supervision	Being motivated by supervisors, poor supervision, being persistent with supervisors, supervisors being accessible.
Time management	The desire to get it finished, spending too much time on the project, spreading the workload over the whole project, planning use of time very carefully.
Project type	Working in real science research, interest in the scientific content.

Table 9.2 Key Issues relating to students' attitudes towards project work

Results

Lack of good results was by far the most common source of disappointment for students (1st in figure 9.2). Nine students stated that their major disappointment was not answering the original research question (5th in figure 9.2). Furthermore, figure 9.1 shows that 'getting results' (2nd) and 'the desire for results' (5th) were common sources of student motivation. As discussed in section 5.2.1, for many students there is a close link between getting results and getting a good mark for their project work. Given the importance of getting a good mark for student motivation (1st in figure 9.1) lack of results is even more likely to concern students.

Supervision
The nature of supervision features strongly in students' open responses - particularly the student-supervisor relationship (see section 7.2). Advice offered by students includes: making the most of supervision, selecting a helpful/interested supervisor, being persistent when asking supervisors for help, visiting potential supervisors and selecting a supervisor who will be available to help you (5th, 8th, 11th, 13th and 15th in figure 9.3). Those involved in supervision were also identified as the major source of motivation by some students (7th in figure 9.1). Finally, poor supervision and support was identified as a very common source of major disappointment (2nd in figure 9.2).

Time management
Our discussion of workload and time management in section 8 is reflected in the students' responses. Nowhere is this more evident than in students' advice to future undergraduate project students (figure 9.3). The first four categories all relate to issues of time management and workload. These represent 36% of all responses to this question. Students also identified not managing time effectively and spending too much time on the project as major sources of disappointment (6th and 8th in figure 9.2). A further common source of disappointment (3rd in figure 9.2) was the fact that projects are not given enough time in the final year curriculum.

Project type
Working in real science research and interest in the scientific content were seen as major sources of student motivation (3rd and 4th in figure 9.1). Not finding the project challenging or interesting were also sources of major disappointment for some students (11th and 12th in figure 9.2). Furthermore, a key piece of advice given by students was to choose a project which you are interested in (6th in figure 9.3).

9.3 Summary

9a In our sample 3 out of 4 students found their project 'really interesting'. A third of students found their project 'the best part of the course so far'.

9b One in eight students had 'a dreadful time' on their project.

9c Eight out of ten students found their project 'the most demanding piece of work that I have done so far on this course'.

9d Lack of good results was by far the most common source of disappointment for students.

9e The most common motivator for students was the desire to get a good mark (assessment driven).

9f Control over the nature of their supervision was a key source of advice given by students to students about to start their project work.

9g Careful time management was by far the major piece of advice offered by students, accounting for one third of all responses.

9h Working in real science research on a subject that interests and challenges you was an important source of motivation for students.

Appendix 1 The Undergraduate Learning in Science Project

The Undergraduate Learning in Science Project (ULISP) was set up in September 1994 as a collaboration between the departments of Biochemistry & Molecular Biology, Chemistry, Earth Sciences, Education and Genetics. It is funded by these departments together with money from the Academic Development Fund at the University of Leeds.

The aim of the project is to inform understanding of science learning at the undergraduate level. These insights will be used to improve undergraduate learning through the development and evaluation of new teaching approaches. The project has a particular interest in undergraduates' images of the actual practice of science and how these influence (and follow from) their experiences in learning science.

Departments Currently Involved

Department	Contact
Biochemistry and Molecular Biology	Dr. E Wood
Chemistry	Prof S Scott, Prof M Pilling
Earth Sciences	Prof J Cann, Dr. J Francis
Genetics	Dr. A Radford
School of Education	Dr. J Ryder, Dr. J Leach,

Further Information

If you would like further details concerning the Undergraduate Learning in Science Project then please contact Jim Ryder at the address below.

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Appendix 2 The ULISP Working Papers

As part of the dissemination of research findings to ULISP participants and others interested in teaching and learning of undergraduate science, a series of working papers has been prepared. Details of these are given below.

1 A perspective on undergraduate teaching and learning in the sciences

This paper sets out the perspective which participants in the Undergraduate Learning in Science Project have developed towards the broad range of issues associated with undergraduate teaching and learning in the sciences. The paper draws upon discussions within ULISP and is informed by the studies that ULISP participants have been involved in.

2 The Research Project Study: Design and Methodology

Focusing on the Research Project Study this paper gives an account of the design of the study. It also includes the reasons for designing the study in this way and the limitations and strengths of the data obtained.

3 Final year projects in undergraduate science courses

This paper gives an account of the role of projects and how they have been implemented in departments as discussed in the interviews with supervisors. The paper covers the suitability of projects for undergraduate work, the allocation of projects to students, supervision of students and assessment of projects.

4 Undergraduate science research projects: The student experience

This paper focuses on students' views and experiences of projects. Using interview data and entries in personal diaries a variety of issues are addressed from the student's perspective.

5 Undergraduate research projects and students' views of the nature of science

This working paper focuses on the students' views of science and science research as discussed in the interviews.. What themes are evident in the students understanding of science? In our sample of students how do views of these themes develop in time? For particular students how do their views of science develop through the research project?

6 Case studies of science students doing undergraduate research projects

Several detailed case studies from the Research Project Study are used to highlight particular features concerning research projects in the undergraduate curriculum. These can be used as a teaching resource for use in tutorials with second year students.

7 A survey of students' and supervisors' experiences of research projects in undergraduate science courses

Following from the 12 case studies reported in working papers 2 to 6 a survey was designed and administered to students (N~250) and supervisors (N~120) at the University of Leeds. Results and conclusions from this questionnaire survey are presented in this paper.

8 Implications and messages arising from the Research Project Study

This paper reflects on all of the work described above. It attempts to summarise the salient features and draw some implications of these findings for undergraduate teaching in the sciences.