Students' Reactions to Undergraduate Science

Higher Education Learning Project (Physics)
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INDIVIDUAL STUDY IN UNDERGRADUATE SCIENCE

SMALL GROUP TEACHING IN UNDERGRADUATE SCIENCE

PRACTICAL WORK IN UNDERGRADUATE SCIENCE

STUDENTS' REACTIONS TO UNDERGRADUATE SCIENCE

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General preface

The Higher Education Learning Project is a working alliance of teachers in higher education, initially of physicists. We began in 1972 with a group drawn from the Universities of Birmingham, Surrey and Sussex; Birkbeck College, Chelsea College and Royal Holloway College in the University of London; and from Liverpool Polytechnic. Over the next four years we were joined by teachers from a considerable number of other Universities and Colleges.

The activities of the project fell into four areas:

Individual Study: experimenting with, and looking into the value of methods of teaching which placed less reliance on the lecture.

Tutorial Teaching: investigating the problems of small group teaching in science, and trying out new materials for tutors to use.

Laboratory Teaching: investigating the problems of laboratory work, and the advantages and difficulties of a variety of kinds of innovation.

Motivation: a large scale study, interviewing students at many universities, with a view to understanding better the problems of learning as they see them.

Many departments of physics helped in the work of the project. We are grateful to the Department of Physics, University of Birmingham, for providing facilities for Barbara Hodgson; to Chelsea College for facilities for the co-ordinator, the project secretary, Martin Harrap and Dietrich Brandt; to the Institute for Educational Technology, University of Surrey, for providing facilities for Will Bridge and for releasing Sid O'Connell part-time; to the School of Mathematical and Physical Sciences, University of Sussex, for releasing Peter Unsworth part time; and to the Physics Department, Liverpool Polytechnic, for releasing Roy Lawrence part time.

Much of the work of the project has been done by people who

gave freely of their time, without reward. The project is particularly grateful to Lewis Elton, who organized the individual study activities of the project, and to Joan Bliss who developed the motivation interview, trained physicists in interviewing, and organized the whole study.

The project owes its thanks to the very many teachers, in a large number of departments, who involved themselves in the work. Their names appear in the publications with which they were particularly associated. We are also grateful to the many students who have talked to us, and who have been at the receiving end of various innovations.

We also wish to thank the Director and Trustees of the Nuffield Foundation for their support; and the members of the Advisory Committee, notably the chairman Dr Gavin, for their continued advice and help.

Finally, everyone concerned in the project is in debt to Paul Black. He played a major role in initiating the project, acted in all but name as joint coordinator, and gave generously of his time, energy and insight to every aspect of its work.

We began as a group of physicists, but it was never our intention to concern ourselves solely with problems of teaching physics. We have had useful discussions with teachers in a number of other scientific disciplines, and this experience is the basis for the belief that these books will interest many besides physicists. Nothing would please us more than to have made some contribution to the discussion of teaching problems in the academic community at large.

Jon Ogborn
Coordinator

Preface to this volume

The study reported in this volume was undertaken in parallel with the other work of the project (described in the other volumes), in the hope of understanding better what makes physics students tick.

As a cooperative venture, it owes much in its conception, design, and execution to the many discussion we had with others in the project, and to their willingness to help in the undertaking. We are particularly indebted to the team of interviewers, named on the title page, who together with us traveled from university to university talking to students. We are even more indebted to the students who so willingly consented to be interviewed, for the forthrightness, freshness, and clarity of what they had to say. Much of the book is really theirs, not ours. We are also grateful to the many teachers in various universities who helped to arrange the interviews, and to their departments for welcoming us so warmly. In addition to the places named in chapter 1, we are grateful to staff in the physics departments at Chelsea College and at Royal Holloway College for arranging some of the pilot interviews.

We thank the interviewing team in addition for their aid in checking transcripts and categorizing material from transcripts, adding in this connection the name of Sandy Grassie. We most particularly thank Paul Black for his very substantial contributions, to the analysis, to checking the coding of material, and to discussing and criticizing ideas for and draft chapters of the book, and we thank him personally, for his patience, insight, and unfailing good sense.

Finally, we thank those who made it possible for us to work together, the director and trustees of the Nuffield Foundation, and also our consultative committee, particularly Professor Burge, Professor Chambers, Professor Frazer, and Malcolm Parlett, who joined a sub-committee which gave us much-needed advice and criticism.

Joan Bliss
Jon Ogborn

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1. What kind of study?

1.1 FEELINGS ABOUT WORK

This is a book about students and their work.

The work of learning can mean many things. It can mean deep absorption in ideas, intellectual excitement, a growing feeling of power and knowledge. But it can also mean an endless struggle with the incomprehensible, a grind of turning in work which is instantly torn to pieces, the mindless copying of notes from a blackboard.

Learning, then, is a puzzling mixture of good and bad; of spontaneous enthusiasm on the one hand, and of being forcibly done good to on the other.

Teaching, too, has its opposite faces. It can mean sharing one's own passion for a subject, seeing others grow in that subject until they too begin to add to it, or it can mean the pleasure of helping someone to grasp an idea and make it his own. But it can also mean lecturing to an audience that seems neither to care nor to understand, toiling through tedious problems with students who still can't do them, or tearing oneself away from research at a critical moment to suffer boredom in the first year laboratory.

So teaching is also a puzzling mixture. It matters for one's subject, for one's self respect, and for one's pleasure in the job, whether teaching goes over well. At the same time, one is inclined to feel that the subject does after all exist, and that it is simply the student's job to get on and learn it, like it or not.

All this makes it hard to know how students react, and to decide which reactions matter. Teachers talk a good deal about how students are likely to react: to a new course, to lecture notes, to new experiments, and so on. Will they like them? Ought they to like them? Will they work harder or not?

Such talk is practical; its aim is to decide what to do. But the reasons people give are varied and conflicting. Some think

students are all the same. Some look to background, habits, or personality. Others look to that magic ingredient, 'motivation'.

Nobody would deny that some students work hard and others do not, but to attribute the difference to differences in 'motivation' is to come dangerously near to arguing in a circle. 'Motivation' is, after all, just an imagined quantity of whatever it is that makes people try hard. Naming it does not say what it is, nor does it make it real.

Personally, each one of us does have some idea why we worked hard on some occasions and not on others. Nor are our motives hidden from those who know us. One explains how an idea went on nagging at one, until slowly its deep importance became clear, and it was hard for a time to think of anything else. Or one describes how a deadline drew nearer and nearer, with other urgent matters always getting in the way, until finally getting the job done was more important than anything else, even though it meant working half through the night.

Husbands, wives, or close friends know one's motives better still. They know them from the multitude of telling details they hear about. It is they who hear of the paper accepted without a change, or of the one where the referee patently didn't understand what it was all about. They are told about the idiot on the committee who not only made the whole proposition sound like his own idea, but put it over so badly that it got shelved, so that now all the spadework has got to start again. They get told that evening how one suddenly realized what was wrong with the low temperature system, changed just one part, and had it working at once after weeks of failure.

It is such talk, immediate and concrete, which is the most revealing. A question like, 'What makes you work hard?' is difficult to answer, but a question like, 'Tell me about a time when you found yourself really working hard', makes more sense. At the same time, the reply to it contains at least a part of the answer to the first question.

We thought that to ask students such questions, about concrete events and why they had seemed important, would be reasonable. We felt that the questioner could reasonably expect to make sense of the answers, and that if he could not, the questions to ask in order to do so would come fairly naturally. He could ask about feelings, and hope for a clear answer, because the feelings would be real ones attached to real events. Indeed, the natural response to some difficult question about how one in general reacts to some type of situation is to give examples.

For these reasons, we decided to try to get at the general through the particular; at the abstract through the concrete; at what students meant through examples.

Students will talk about work. When we asked them to do so, they told us things like:

> 'If you had a question, he would always try his best, and if he couldn't answer it, he would go away and ask somebody, and tell you the next week. All the time you felt he was trying. If you couldn't answer a question, he was almost willing you to get the answer...Then he would say, "I'm going to show you my research", and take you off to look at it...You see what he is actually doing, and why he knows what he does - why he is very good at maths and bad at thermodynamics, or rather that he doesn't remember some of it because he just never uses it. You see what makes him tick.
>
> '... when you do get down to work at some problems, you feel great when you get something right - you really do. I mean, you understand some physics...I suppose it is just putting maths to something, and finding it works -finding that the expression actually predicts something physical. I think, "Great'. This is what actually happens", and feel that I am understanding the world much better... It is getting nearer to an ultimate knowledge of how the world works - though we will never know how it works -but it is still marvelous to think that we do know something about things which are smaller than us, and things which are bigger than us, and things we can't see.

These are parts of stories extracted from the interviews upon which this book is based. We felt that things like this were close enough to actual experience to make sense, and that from them one might reasonably hope to get a better understanding of how and why students react as they do to a variety of events.

The study reported here began from a feeling amongst the teachers involved in the project that they needed and wanted such an understanding. Their reasons, like those of other teachers, were practical. Some were interested in new ways of teaching; all were concerned about their teaching. All felt it important to know more about how to get students interested and involved in whatever they were being taught. They had found it hard to guess how students would react, and hard to understand some of the reactions they could see.

In short, teachers in the project felt a need to know what

made students tick, in relation to actual concrete teaching situations. Without that understanding, the best laid plans were apt to go astray, and to be hard to correct when they did.

1.2 NATURE AND SCOPE OF THE STUDY

It seemed to us to follow from these thoughts that we should plan a study in which we asked students to tell us stories; stories of how they had reacted to actual events in learning science at the university. We believed that such stories, rich in concrete detail, would be telling and informative.

Each student was asked to tell of a time when he or she had felt particularly good or particularly bad, about anything at all to do with learning at the university. We asked what happened, why it mattered, how they felt, and what sort of effects there were. Approaching the students. as collectors of stories, we tried to ask questions which would make their stories come alive.

The idea of talking to students in this way was borrowed from a study of motivation in industrial work by an industrial psychologist, Herzberg. He had adapted the idea of asking about such 'critical incidents' from Flanagan's studies of factors of importance in the content or performance of a job. The method and the results obtained from it have been criticized (see the annotated bibliography at the end of the book). We borrowed, however, only the main idea for the interview, developing our own detailed interview, and our own form of analysis. Nor did we seek to test or replicate the kind of results Herzberg got. On balance, this kind of investigation seemed to us to have more virtues and fewer faults than others we could have used.

We aimed to talk to 120 students in ten representative physics departments, taking four in each year in each place. In the event we obtained and transcribed a total of 115 recorded interviews.

The departments were chosen to represent a variety of kinds of university, with one polytechnic included as well. They included small and large, old and new, urban and rural. Some had a technological bias, others not. It is hard to determine what would be a fair sample, but we believe them to be reasonably representative. They were the physics departments at:

Bath	Leeds
Birmingham	Liverpool Polytechnic
Bristol	Nottingham

Southampton	Warwick
Sussex	York

The students were selected by staff in the departments concerned. We asked, as well as for equal numbers from each year, for the sample to cover the ability range and to balance numbers of men and women appropriately. We decided, because we wanted to know about the normal run of students, to ask for any who were certain to fail because of their special difficulties to be excluded. For the same reason, we also excluded those who were certain to do brilliantly whatever happened. Thus the sample ranges from those who would quite possibly get first class degrees to those who were thought likely to get third class degrees. (To check the spread we asked staff for guesses at students' likely degree classes, and asked the students the same.) Within all these constraints, we asked for the students to be chosen at random.

The table below shows the distribution of students amongst first, second, and final years, in the various departments. The departments are identified by randomly assigned code letters.

Department	First year	Second year	Final year	Totals
A	4	4	4	12
B	4	3	4	11
C	3	6	2	11
D	2	5	4	11
E	4	5	3	12
F	4	3	1	8
G	2	1	9	12
H	4	6	4	14
I	4	4	4	12
J	4	4	4	12
Totals	35	4'1	39	115

In total, the three years are roughly evenly represented. The departures from the quotas in departments F and G were caused by local difficulties, and need to be borne in mind in interpreting data, especially on final year students. Other data on the balance of the sample will be considered where it is relevant to the interpretation of results.

PILOT STUDIES AND INTERVIEW TRAINING

To begin with, we were not confident that students would be able to recall and tell stories of times when learning was very good and very bad. The first step was to interview half a dozen recent graduates. We found them ready and willing to talk, and their stories seemed interesting, though it was difficult to get concrete details and real expressions of feeling.

We felt that the results justified a pilot study, so we next arranged to interview twenty first year and twenty third year physics students in four different physics departments.

During these pilot interviews, the interview itself was developed and refined. We began to find the questions to ask so as to elicit more of what happened and of how the student felt about it. We found that asking for a third story, after asking for one good and one bad one, often produced the most interesting story of all; the one that had been in the student's mind all along, perhaps.

The pilot interviews were transcribed, and we attempted to analyze their content along conventional lines, breaking up the content into small pieces and trying to classify these chunks. Finding that this led to missing much of importance in the stories, especially the connections between events, we developed the alternative and rather more novel method of analysis described later in the book. This new analysis tried to capture much more of the content and structure of each story, but still in a way which allowed one to be compared with another.

For the main study, a team of interviewers was needed. We felt it essential that, if the work was to reflect the interests and concern of physicists, they should play an important part in the interviewing. Interviewing, however, is a difficult art that needs to be learned. The value of the study would depend wholly on the quality of the interviews; on whether the interviewer could create the right atmosphere, ask questions which let the student say what he wanted to say, and not ask leading questions which told the student what he was 'supposed' to say.

Accordingly, the interview team of physicists and others first spent two days doing trial interviews which were video-taped and discussed. The actual interviews were conducted in teams of two, one of whom was an experienced interviewer, who sat in on the initial interviews of the other, intervening if necessary. Where, despite these precautions, it was clear from the transcript that the interviewer had, for example, suggested to the student what to say, that material was not used.

1.3 WHAT HAS PSYCHOLOGY TO OFFER?

Physicists are not noted for their trust in psychologists. And it surely is hard to deny that there is a wide gap between the way ordinary practical people think about the problems of everyday events of importance and what they see going on in them, and the way a psychologist might approach or see those problems. Further, if one does try to link the two, asking perhaps if 'extroverted' students do better in tutorials, the question seems not to do justice to all the obvious real life complications, and any answer is hard to apply to an actual instance.

In a sense, what we have tried to get by asking students to tell stories falls somewhere in the middle of this gap. They are talking about real events and immediate reactions, as instances of the kind of things that have mattered to them. But, the clearer the story and the more vivid the detail, the easier it is to compare the different kinds of thing which are going on under the surface. It is, for example, not hard to say that one student's story is more about achievement while another's is more about feeling safe, even when neither would have put it in that general way. A single such label will rarely do, of course. So, for example, one might say that the first story quoted in section 1. 1 was about responding to the teacher's willingness to help and to the fact that he seemed to care, while the second is about achieving understanding and the sense of power in the way abstract ideas really do work.

Clearly, though, at least some such ways of looking at what students are saying do come from ideas about why people might react as they do. It is therefore necessary to see what these ideas might have to offer. This, however, is not the place for any serious or extended account of what psychological approaches might be relevant. The discussion which follows is intended only to indicate how the present study is related to such work. Readers who wish to go further may care to consult the annotated bibliography at the end of the book, which contains both background reading and references to immediately relevant studies.

There are two main ways of thinking about people's reactions. One way looks at each person as an individual, with a personal history, and looks to the way his history has shaped him to explain, at least in part, how he reacts to some events. The other way attempts to take a few categories within which to place a number of people, and tries to look at differences in the behavior of those placed in different categories.

The individual approach embraces many schools, in some conflict with one another. To them however, and especially to

those linked with the name of Freud, are owed most of the' terms and ideas in current use. Where these ideas help in describing and understanding stories, we have used them. But in no sense did the interviews probe the personal history of the student, in such a way as to attempt to discover the deeper sources of his reactions, were that even possible.

The categorizing approach may be exemplified by the work of Eysenck. He, as have many others, asks people standardized questions in a questionnaire, the questions being selected so that the patterns of answers to a whole battery of them indicate the strength or weakness of particular traits in a person. So, for instance, the question,

'Do you often do things on the spur of the moment?'

is one of many used to detect a tendency to extroversion, whilst,

'Are you easily hurt when people find fault with you or your work ?'

is one about how stable the person is. The approach is obviously open to objection, but the difficulty is to see how to do better. Many have tried; few have succeeded.

Various people have taken these standard tests and have used them to try to find out what kinds of people do what kinds of things. One study of this kind by Wankowski, for example, suggests that it is the stable introverts amongst students who adapt well to university life and do well in the end.

A study of this kind did not seem to answer our needs. Results would too much concern types of students, and bear too little on actual teaching or learning events. Our interest was in what went on and in understanding how it affected people.

Besides these two approaches to personality and its effects on how a person reacts, there is a whole other area concerned with how people affect one another; with questions about authority or about mutual support. Again, where we could, we borrowed ideas from this field, so as not to ignore such matters as whether a student's story had an important element of having to fit in with rules, or of setting his own rules and standards.

We decided, then, to talk to students, using what insights we could glean from elsewhere to interpret what they said. We were impressed by the interest and illumination offered by others who had followed this path. Notable amongst them is the work of Perry on the intellectual development of university students, of Parlett and Miller on the influence of examinations, of Madge on art students, and of Zinberg on chemistry students.

We felt that such a study could deal in matters of immediate practical concern; with problems as seen by students and teachers. No less important, we found from previous work and from our own initial attempts, that what students said had a value and interest of its own, apart from any analysis or interpretation. When, for example, a student says:

> 'He started off, and he did it well. He gave an historical background, showing where thermodynamics came into it. He talked about it - he didn't immediately start off writing formulae, and giving you an unreal sense of, "Well, here are the formulae; learn them; they do something but I'll tell you about that later." He told us what they did; he explained what thermodynamics was about, why it had come about, which is quite fascinating. Then he started to go from the basic concepts, and the people who developed it...he was explaining it in human terms. ...That is what physics is about; it's a process of thought, and this is the way he was putting it across.'

the story itself has an impact. The impact, and the insight it gives, will differ from person to person, and is perhaps the more valuable for that. Even those who reject it can get something from asking why they reject it. As important, then, as any analysis in this book, are the stories themselves. No analysis can capture everything they have to offer.

1.4 SAMPLES FROM INTERVIEWS

This chapter concludes with two extracts from interviews. At this point they may help the reader to get a clearer idea of the sort of material we have collected, and the way in which it was collected. Such a view of the data ought to inform a critical reading of the book.

The extracts will be used later in the book, to illustrate in the next chapter the nature of the interview and some of the problems associated with it, and after that, the way in which the interview material has been coded and analyzed.

1.4.1 FIRST SAMPLE

The first. extract is from an interview with a girl in her first year at a size able and well-established provincial university. She said that she hoped for an upper second class degree; staff

estimated a lower second. The extract begins after she has told a first story about an incident which made her feel bad.

I Well, perhaps you could cast your mind back now and think of something nice - something you felt particularly good about when you were learning something. Any situation at all... ?

S I think the time when you feel that you've most achieved something is when you hand a piece of written work in...problems, and get good marks for them.

I Can you think of a particular incident when that happened ?

S Well, for my tutor I had to do three exam questions for practice, and I got good marks in all of them. You felt, you know, that you really understood what you were going on about once you had had to write it down in essay form. And it helps with the learning, actually having to write it down.

I Well, can you remember the one that you felt was the most satisfying?

S Oh yes...It was about the wave and particle properties of electrons and light.

I How long did it take you to do?

S Oh, it took a lot of work. I had about three text books out, and about five hours I think in writing it up. And I got a good mark for it - I was generally very pleased about that.

I What were you pleased about? Were you pleased about the mark, or the reaction of the tutor or yourself; what was good about it?

S Well, I felt that I really understood what I was writing down. And it wasn't just copying it out of the books, because I had to prepare the essay as well. And the tutor praised me for it - said it was very good, that it was first class honors. I just felt very pleased about it.

I That's nice. What I was trying to get at is - well, you can have all sorts of good feelings; if somebody told you you'd won the pools you'd feel good but very elated, while if you went out and had a good meal you'd feel good again, but this time nicely satisfied.

S I feel virtuous, I suppose, because I've actually done something right for a change.

I Is there any other way you could describe the way you felt good?

S I felt elated, I suppose, It's just because you have done something well for a change.

I For a change ?
S For a change, yes.
I What made you say that?
S Well, I don't generally get all that good marks. I'm not particularly thorough with my work, I suppose. I do it as quickly as possible most of the time.
I But in this particular situation?
S I decided to get down to it and try and prepare it well.
I Why was that?
S I don't know - we generally have problems to do, and they're not very interesting - we just fiddle about with numbers - but this was an essay we had to write. I think I prefer writing essays to doing problems.
I Writing essays ?
S Exam questions, things like that.
I Why is that?
S I don't know, I feel you can get down more in an essay.
I Why is writing essays more satisfying, do you think?
S Well, it takes longer; it looks better; you can read it back to yourself. With problems you just have to fit the numbers in, and you know what the answer is going to be because you can look it up. It's just a question of fiddling until you get the answer. There's about five of us back in the Hall who generally do our problems together, but you can't really do essays together, so you know it's your own product.
I And how does that make you feel?
S Virtuous:
I Does writing the essay and getting good marks and all the rest of it have any effect on your work at all? On the way you feel about university work or life ?
S I shouldn't think so.
I When you come out from the tutor or when you get the essay back, does it have any... ?
S Ah: Well, you do think then, "Oh, this is good. I shall keep this up and work hard all the time". But then you feel fed up again and just let it drop, and get back into your old ways.
I So the effect, does it or doesn't it last?
S It doesn't last. Just a day or two.

1.4.2 SECOND SAMPLE

The second extract is from an interview with a second year man at the same university. He hoped for some kind of second class degree, but feared that he might not be able to stay on the honors course. Staff estimated a lower second class for him. This was his first story.

I ... is there any time when you did feel particularly strongly about learning? Good or bad?

S The sort of lecturer who's like a magician bringing his formulae out of a hat. That tends to annoy me a bit, but you don't feel like standing up in the lecture theatre and telling the lecturer what you think of him.

I Can you give me an example of this? Can you describe it?

S Well, our thermal physics lecturer this year was particularly bad as far as I was concerned. I read through his notes before the exams, and quite honestly they were rubbish in some places. Kinetic theory he got wrong... which worried me a bit. He asked a question on it in the exam which tended to annoy me even more.

I I can understand that. What I'd like you to do is to try to paint me a picture of what it was like. Try and take me back. We want to find out what it was like when he was giving a lecture. What it was that made you feel bad about it. Just imagine now that I'm walking in with you, and you are describing it to me now.

S I should say confusion. You sat there: you've understood the little recap from last week, which has had time to sink in...Then he'll just write a formula and say, "I'm not going to prove this". The formula will appear, and then three sides of board later, you'll just have had a chance to copy up what he's been writing. You've just about managed to get your breath again. You go back and look at what he's done, and it just makes absolutely no sense at all. And then you spend the remaining half-hour of the lecture trying to keep up with what he's doing at the time, and going back and trying to see if you can understand the work he did before, because what he did then you need now. You're sort of getting yourself tied in knots progressively.

I Yes.

S Generally in the end not understanding the end result because of some confusion which started off at the beginning. Which in this case he wasn't prepared to

sort out

I Not prepared to sort out?

S Well, someone would ask a question, and he'd ramble on for five minutes. He'd think he'd explained it. But you don't ask twice because...you know what the answer will be...he'll say the same thing the second time. You then end up that little bit more confused, because you thought you might have understood a little bit of it, but what he explains means that you haven't actually understood any of it.

I Can you tell me what it feels like to be sitting in a lecture when it's like that?

S Worrying.

I Worrying? Can you explain that a bit?

S Well, to a certain extent before revision for this last exam, I began to wonder a bit whether I did understand physics any more - had I sort of reached the limits of my intelligence? Is physics no longer understandable? But the revision I did proved it wasn't.

I Yes. What I'm trying to get at is the feeling in those sort of lectures.

S Frustration.

I Frustration?

S Not being able to understand what he's on about, which is possibly going to form some part of an exam.

I If when you came out of the lecture there were some friends around, and it had got you annoyed, what would be the sort of things you'd say about it? You know, if you could really express the feelings deep down inside. If there was a chance of saying what you really felt?

S Well, you sort of saunter out and make comments like, "He gets worse", or, "It's not worth going...I wish he'd recommended a book because then I could use that instead of him.

(Here there was an aside about another course)

I Could I ask you what were your emotional feelings about the whole thing? If you can describe them?

S Well, worried to a certain extent, that it was just me not understanding it - that I'd fail all the exams and not be here next year. And, to some extent, the possibility of it being that I no longer understood physics, rather than that the physics wasn't being explained properly.

I I see.

S Because, no matter how much people say that they

also didn't understand it, you do tend to think that you understood it less than they did...

I What else do you think about yourself?

S Well, it would be nice to think that I could succeed. Sometimes it tends to put you off a little bit when you don't understand a bit. Sometimes even tutorials don't explain it. The tutor's field is solid state, so sets of examples you get until the exams are solid state, solid state, solid state. "Can we have some relativity please?' Next week - solid state. Sometimes points you don't understand in lectures don't get cleared up.

I What is the general feeling that leaves inside you, would you say ?

S Well, towards the exams, panic. But at other times a little bit of frustration, mainly. Wishing that you could understand it. It would be nice to be able to fail and think, "Well at least I understood it - it's just that I couldn't remember it". Rather than, "Well I didn't understand a word of it".

(Another aside here about difficulty of other courses)

I You said you got worried and wondered about yourself. Did those feelings have any effect on the rest of work?

S I think to a certain extent they tend to build up, and get a bit blown up out of proportion, so you tend to give up rather than just plod on.

I Give up?

S You think, "Well, it's been a good life while it lasted, but I've come to the end of my understanding now. It was a nice idea to be able to do the second year at university; it's a shame I couldn't manage the third". But you manage to pull yourself together before the exams, and hopefully that's not too late.

1.5 EVIDENCE OF WHAT ?

The last story is clearly no basis for judging the lecturer. The student may indeed be reaching the limits of his understanding, and the lecturer may have done a good job in putting the ideas over.

For the same reason, the first story is not a sufficient basis for judging the system described to be a good one. What both stories tell is how these things seemed to the student, not how

things really were.

What, then, can such stories offer? At the simplest level, one may dismiss one such case as the last, but it would be cause for concern if there were many. Or again, if several students independently say how valuable they found it to feel that their essay work was really their own, that might influence a department's view of the role of essays.

The detail of such stories may count for something. If the consequence of a difficult course is a nagging sense of self-doubt about whether one can cope with physics at all, knowing that might influence the way tutors talk to weaker students. Again, that the first student regards what seems to have been a fairly modest effort as a major successful enterprise could influence staff's ideas about setting work and about reacting to work done.

In all of this, any link between the evidence from the stories of how things seemed to students, and action as a. result, is an indirect one. The evidence is just one of the many things that might go into the melting pot of judgement. It ought not to determine that judgement, but it ought to inform it. For, at the end of the day, decisions about teaching are based on taking some view or other. (The students are lazy and need sanctions, or they are insecure and need help - which view will one take?)

In taking such views, people have always taken into account what they think students think. We hope that this book will add to, and clarify some of, those ideas.

2. The interview

2.1 WHAT KIND OF INTERVIEW?

This chapter explains the design of the interview, and some of its problems.

Once we had decided that the interview was to find out about students' reactions by getting them to tell stories and by getting them to explain what the events described had meant to them, it was necessary to devise an interview suited to this purpose.

What the student would have to say was necessarily unpredictable. To have prepared and asked a fixed schedule of questions would have been to have made many assumptions about what kind of things were important to students. Indeed, the point of the interview was to find out something about just this. It was therefore essential that the student shaped the interview; that the questions did not direct his thoughts and feelings into paths they would not naturally follow.

On the other hand, we did not merely wish to hear anything the student might care to say. We wanted the interview to probe what happened and what he felt about it so as to make these things as clear as possible.

In addition, it was essential to try to ensure that the student felt able to talk freely, and to talk about matters of some intimate concern to him. The material would only have value if the student really talked about something that mattered to him, and did so without too much concealment.

Equally, interviewers had to learn to follow and probe the student's thoughts, and not to impose their own ideas about what might be important on him.

All this meant that the interview had to try to achieve the following goals:

to obtain the student's confidence, and show that he was being taken seriously.

to make him feel comfortable and relaxed; able to talk freely about quite private matters with a person who was necessarily a stranger.

to elicit details of actual events of real importance to him, including at least one 'good' and one 'bad' story.

to use those concrete details to try to understand how and why the events had been important; what the student had felt and what effects they had had.

to lead the student to say what he wanted to say of his own accord, and to avoid his saying what he might think was expected.

2.2 STRUCTURE OF THE INTERVIEW

The interview procedure is described here, together with reasons for having chosen the form we did. From the description, the reader may be able to see for himself how the material discussed in the book was obtained. It would also be possible (given training) for others to repeat similar interviews.

The first contact with the student was a letter, reproduced at the end of the chapter, from ourselves asking the student to take part. This first personal contact from outside was intended to show him that the interviews were important to us, that they were not an operation internal to his university, and to encourage him to cooperate. None refused to be interviewed, though in ten or so cases in two universities, some were unexpectedly not available and were replaced ad hoc.

On arrival, the interviewer looked after such important small details as the arrangement of chairs (using chairs of similar size placed comfortably on the corner of a table, for example). Arrangements such as chairs confronting one another across a desk were avoided.

INTRODUCTORY PHASE

The interview began with an introductory chat from the interviewer, for which he was provided with examples of appropriate things to say:

> 'I'm not quite sure how clear a picture you got from our letter of what these interviews are about (pause for reply) Anyway, I work with HELP - it's a project sponsored by the Nuffield Foundation - maybe you've heard of them? (pause for reply). Well, they sponsored a lot of projects

for school chemistry, physics, biology and so on - maybe you did one of those courses or have heard of them? (pause for reply). Well, in this project we are trying to think about new ways of teaching physics and perhaps other subjects at university. Of course, we talk with university teachers, and they have all sorts of ideas about why students do or don't learn. But of course we need to talk to students too, and we thought we would ask them about times when learning felt good, and times when they felt it was bad. Both sides of the picture (pause for any comment). I dare say you can imagine that things often look different from the teacher's point of view and from the student's? R's a fairly large study with us visiting ten or so universities all round the country talking to students in each year. We hope that when we get enough stories about times when learning felt good arid when it felt bad for all these students, we will be able to see some picture emerging.

This seemingly rambling, repetitive introduction served, in our view, several essential purposes. It was deliberately designed to encourage the student to comment and so to begin talking. It deliberately mentioned the aim of the interview more than once, because we found in pilot interviews that the idea took time to sink in. It deliberately mentioned the Nuffield Foundation and the scale of the study so as to try to make the student feel part of something important. It deliberately emphasized the importance to us of the student's point of view. Last, and not least, it provided a time in which little was demanded of a probably nervous student, so that he could get used to the interviewer and the situation.

Interviewers were free to depart from the words suggested, but were required to make what they said satisfy these conditions.

INITIATING THE INTERVIEW PROPER

Next, the interview began with the interviewer-

explaining that the interview would be confidential, and asking permission to record it (this was never refused).

asking the student's name (used thereafter); his year of birth; his year of study; his main and subsidiary subjects.

requesting the student to make some guess at the final class of degree he thought he might get.

Then, the nature of the interview was again explained, in

some such form of words as:

> 'We are collectors of stories, you might say. I'm interested in hearing about what it's like to be a student learning physics, and I'm particularly interested in hearing stories about times, situations, events, when you felt very good when you were learning something, or working at something in physics, and times when you felt especially bad.
>
> It doesn't matter how you say things - say them any way
> you want. So if the words don't come easily, don't worry. We want your impressions, as they seem to you.
>
> The stories could be about any kind of situation at all -lectures, labs, tutorials, working on your own, working with other people, seminars, examinations- anything that you do at university. It might have happened in a few minutes, or lasted two weeks, or spread over a term.
>
> Of course everyone is always talking about things with their friends - this was good, that was bad. But it's often rather hazy, so what we want are stories of actual times when you felt particularly good or bad - what really happened. So do you think you could cast your mind back and think of a story, good or bad? It doesn't matter at all which you start with.'

Again, interviewers were free to use other words as suited them, but had to include all the essential features. They had to repeat the description of a story, to tell the student to say it in his own way, to list all the situations that might be involved so that students were not guided towards or away from 'any of them, and to say that the first story could be either good or bad as the student chose.

The point of providing such forms of words was to help 'the interviewers find ways of saying things that were at once clear but not too formidably expressed. It was very easy for the adult interviewer to put the student off by appearing, in the way he spoke, to expect a very fluent and analytical reply.

ELICITING DETAILS

Naturally, to begin with, many students were both hesitant and tended to talk in general terms. To help them to get talking, the interviewer first concentrated on concrete details, and in this way also brought the student back from generalities. To

encourage the student to tell a particular story, questions like the following were asked.

> 'Can we go back to the beginning, and can you tell me the sort of thing that happened, so that I can get a clear sort of picture of what it was like?'
>
> 'Can you give me an example of what you mean, of things that happened which as it were show what you mean?'
>
> 'Can you describe a particular lecture (or whatever the student had mentioned), and tell me what it was like? Can you take me back? How it started, what went on?'

To encourage further details, we went on asking questions such as:

> 'I want you to try and put me in your shoes, so that I can see what happened. '
>
> 'Can you paint a picture of it for me so that I can see it as you did at the time ?'

To help the student to talk, it was important for the interviewer to take the blame for not yet understanding:

> 'I can't quite see it yet - I can't imagine it'
>
> 'Can you say that again - I didn't catch it properly?'

(this last question being used to get more detail, not because the interviewer did not hear).

Other useful techniques included repeating what the student had just said, and leaving gaps for him to fill, such as 'So you were ... ?' This part of the interview continued until the interviewer felt that he had a clear account of some events, in sufficient detail for him to be able to make sense of what the student felt about them. Often, of course, the feelings began to show through the events.

In the first sample story, section 1.4.1, the stage of eliciting details is relatively brief (lines 1 to 25) because the student soon mentions a feeling (Free 25) which is then pursued. More detail is elicited later (lines 47 to 66). Lines 9 and 17 illustrate the interviewer asking for particular .instances. In the second sample interview," section 1.4.2, the 'give an example' question (line 7) and the 'paint me a picture' question (lines 16 to 22) produce a good deal of concrete detail and feeling. The interviewer persists

(line 43) because a new detail emerges. In this interview, the break between the first stage of eliciting detail and the second stage of eliciting feelings is fairly clear (line 52).

ELICITING FEELINGS

Given a concrete story, the interviewer then asked what the student had felt, using clues picked up earlier. Questions suggested were:

> 'What did you feel about that/in there/after that?'
>
> 'What did that mean to you?' 'Why was that important to you?' Why did that matter to you?'

Often, the student spoke more of what he thought than of what he felt; of how he might reasonably have reacted rather than of how he did react. It then became necessary to ask such things as:

> 'What were the sort of emotional feelings you had?' 'What did you feel inside you then?'
>
> 'If you could have said then what you were feeling, what might you have told him/a friend?'

Another way of getting at clearer feelings was to draw a parallel, talking about different feelings in another context: a good meal, winning the pools, losing some money, getting lost.

As before, the interviewer continued questioning until he felt that the student had said all he could. Given one feeling, he would ask if it could be explained in another way, and if there was any different feeling. Repeating the word the student had used was an effective way of getting him to say more about what he had felt.

Examples can be seen in the sample interviews. In the first sample, the feeling of 'being pleased' is followed up (lines 26 to 28) and a new feeling drawn out ('virtuous') by drawing a parallel (lines' 35 to 40). In the second sample, the feeling is first explored without much pressure (line 55, line 65), and then asked about by asking what the student might have said at the time (lines 69 to 74). Finding it difficult, the interviewer tried again with 'emotional feelings' (line 79) and was rewarded with something rather deeper than had previously emerged. The samples illustrate the difficulty of eliciting expressions of feelings without accidentally telling the student what to say.

EFFECTS

At the end of each story, the interviewer asked if the events and feelings described had had effects on other work, or on feelings in general:

'Did that affect the rest of your work in any way?'

'Was there a difference after that in how you felt about other things?'

'What did you feel about other work after that?'

SECOND STORY

Having elicited details, feelings, and if possible any effects for the first story, a second story was asked for. If the first had been about events where the student felt good, the student was now asked for ones where he had felt bad, and vice-versa. He was reminded that the story could be about anything, so as to avoid getting artificial pairs of good and bad stories about the same kind of situation.

The interview then followed the same course as before, with details, feelings, and effects being drawn out in the same way.

The first sample story, section 1.4.1, is such a second story.

OPTIONAL THIRD STORY

We found in the pilot interviews that a number of very good, clear, and deeply felt stories emerged if, having said that the interview was now over, the interviewer asked if perhaps any other events had popped into the student's mind during it.

This optional third story could be about good or bad events. If one was offered, the questioning routine was again followed.

ENDING THE INTERVIEW

To conclude, the interviewer thanked the student, and asked if the interview had been as he had expected. A good proportion said not, and that they had expected to be asked what they thought of lectures, labs, tutorials, and so on. But most felt that they had said what they would have said in that case.

An interesting number, when thanked, themselves thanked the interviewer, saying that it had been good to talk to someone-who was interested in what they thought and felt.

2.3 PROBLEMS OF THE INTERVIEW

Interviewing is a difficult art, which the physics teachers amongst the interviewing team found took some learning. Indeed, Piaget was perhaps not far from the mark when he wrote:

> '... at least a year of daily practice is necessary before passing beyond the inevitable stage of a beginner. It is so hard not to talk too much when questioning...It is so hard not to be suggestive. And, above all, it is so hard to find the middle course between systematization due to preconceived ideas, and incoherence due to the absence of any directing hypothesis. '

We did not have a year, and not all the interviewers felt that they had overcome all the problems. Indeed, even the most experienced made mistakes from time to time. It is worth illustrating some of the mistakes, and some further techniques, from the two sample interviews in section 1.4.

The interviewer has to learn to be pleasantly receptive, in words, intonation, and expression. What the student says must be accepted, without either welcoming it so much that he thinks that that must be what the interviewer is really after, nor so coolly that he is put off. So, in the first sample (line 35), the interviewer says, 'That's nice' when the student has said she was pleased, before pressing for anything more precise. In the second sample; (line 16), after the student has mentioned a number of different issues all very briefly, the interviewer says, 'I can understand that', before asking for a clearer picture. It would have been so easy, especially in the second case, to have said something like, 'Well, but can't you tell me... ?'.

One way to be receptive, and get more detail, is to repeat what the student has just said, in an inquiring way (first sample lines 47 and 62; second sample lines 43 and 55).

The interviewer is not, however, a piece of blotting paper. He has constantly to look for germs of what might be something important. In the first sample, the student says that she had done well 'for a change'; the interviewer (line 46) decides that there may be something there worth probing, and follows up a first inquiry with, 'What made you say that?'. All the time, a good interviewer is trying to understand what the student may mean; forming hypotheses about what it might be; and testing those hypotheses. This does not mean, however, asking questions like, 'Do you mean that... ?' It does mean trying to find out what the student might want to say.

Necessary as it is to try to guess what the student is getting at and follow it up, this opens the interviewer to the likelihood of putting words into the student's mouth. Suggestion, direct or indirect, is one of the hardest things to avoid.

For example, the physicist-interviewer is prone to be interested, for professional reasons, in the exact difficulty presented by, say, a set of equations, and to assume that the student sees it in the same way. The trouble is that people kindly and willingly invent reasons for almost anything one asks them, whether or not those things matter to them. For example, in the second sample, at about line 28, the interviewer might have interrupted to ask if it was the speed or the complexity that mattered. The student might have taken the bait and spoken at length about the speed with which the lecturer had written, taking it that this must be the kind of thing the interviewer was after.

It is even easier to interpret feelings and so direct the student along some line he would not have chosen. In the first sample, the interviewer must have been tempted at line 76 to ask something like, 'So you feel it belongs to you?', which might have taken the student away from describing how virtuous she felt.

Indirect suggestion is even harder to avoid. In the first sample, it is the interviewer, not the student, who introduces the word 'satisfying' (lines 18 and 67). Something like 'feels better' would have been less leading. Had the student later said that she found the work very satisfying, it would have been impossible to know whether she had felt it or had simply picked up the idea.

One of the hardest problems in designing the interview was to find ways of talking about possible feelings without being suggestive. Sometimes the device of talking about feelings one might have in a totally different situation did not work. Notice how the word 'elated', introduced by the interviewer in the first sample (line 38) about winning the pools, pops up at line 45 as what the student says she felt.

The interviewer must be prepared to feel a fool, asking the same question several times (first sample, lines 79, 84, and 90). In this case, without the repetition, 'I shouldn't think so' would have been all one had got about the effects. It is also easy to ask questions which are too complicated and clever, so that the student feels put down. So, in the-second sample. (line 55) the question is, 'Worrying? Can you explain that a bit?' and not, say, 'What exactly was it about the lecturer or his behavior that gave you concern?' , which asks more than most people

could answer and puts it in a rather formidable way.

Many of these problems mean that one gets less out of the student than one might have. In extreme cases, the resulting story is too thin in detail, so that it was impossible on reading the transcript to form any clear idea of what the student meant. Such stories, which were few, were not used. Other of the problems, notably suggestion, mean that the transcript is misleading; that the student says things he would not have said of his own accord. We have looked very carefully for such things in the transcripts, and have avoided using material where it seems to have occurred.

To set against all these problems, it is important to add that the interviewing team were very struck by the openness, thoughtfulness, and depth of feeling shown by those they interviewed. All felt that they had learned a good deal, and had had their eyes opened to a number of matters which, despite their teaching experience, had not previously been clear to them. Other physics teachers in the project, shown the transcripts, felt sure that the material they were looking at was genuine and rang true. Such a feeling cannot be quantified, but it was an important condition to be met before it could be worth going on to analyze the material produced by the interviews.

LETTER INVITING STUDENTS TO TAKE PART

I am writing to invite you to help us in a part of the work of H.E.L.P. This project is looking at various ways of improving the teaching of physics in higher education, so as to make it more interesting and more worthwhile, both for students and teachers.

Naturally, we want to know as much as possible about what students think and feel about their work, so we are engaged in a series of interviews with students. I am writing to ask you to take part in one of these interviews. They usually last about half an hour and will simply be a discussion between yourself and one of the members of the project, about occasions you remember when you felt particularly strongly – both good and bad – about your work. We have so far found that what students have told us is very useful and illuminating, and I hope that you will be willing to help us add to our picture of how students react.

The interview will be completely confidential and no information which could identify you with what you say will be given to anybody. We are visiting quite a number of universities and colleges, so as to get as broad a view as possible, and so that the results reflect the impressions of a variety of students in a variety of circumstances.

The arrangements at... are being made for us by..., who will, if you are willing to be interviewed, arrange a suitable time and place with you. There is no need, therefore, to reply to this letter. Should you prefer not to be interviewed, would you please tell..., who will find a substitute.

I hope that you will feel able to help us. We look forward to meeting you and hearing about your experiences.

3. Analyzing the interviews

3.1 NATURE OF THE ANALYSIS

The struggle to find a useful and workable way of analyzing the interviews began as soon as transcribed pilot interviews came from the typist. In the end, we devised our own method, which is described in this chapter.

The fundamental problem is to reduce the stories the students told to a form in which one can look for similarities and differences, without trivializing what they contain. It would be easy enough to label stories 'good' and 'bad', or as about lectures, labs, and so on, but that would be to miss most of the interesting and valuable information. Equally, it would be possible to try to form general impressions from the interviews themselves, but that would be both unreliable and likely to miss all but the obvious, because one would be having to cope with too much information.

We wanted a way of analyzing the material which would satisfy the following criteria:

It must be reliable: different readers should reach the same analysis.

It must be faithful to the data: the analysis should reflect what is there in students' stories, and not force them into any arbitrary mould.

It must be relevant to the concerns of the investigation: the terms of the analysis should bear upon understanding why students react to various kinds of learning as they do.

It must strike a balance between naivety and complexity. An analysis which is too simple will miss much of importance, since, as the Practitioner already knows, these are not simple matters. One which is too complex, so that no interview has features in common with any other, will leave all the questions as baffling, and all the evidence as anecdotal, as they presently are for most of us.

It must accommodate a variety of different, sometimes over

-lapping points of view. For example, one wants to be able to look at such things as different kinds of feelings, different situations in which they occur, different kinds of action of teachers and students, and so on.

In devising a method, we borrowed from linguists, who also have to handle the problem of analyzing things people say. The idea we borrowed is currently controversial amongst linguists (see the annotated bibliography at the end of the book) but we felt that it had important merits for our purpose. We thought that it would help us to meet the above criteria better than any other way we could think of.

The way we have tried to handle the analysis of the interviews is described in brief outline below. Later sections then discuss the ideas behind the analysis, and the stages in which it is carried out, in greater detail.

The first idea was that we should accept one simple and obvious fact: that what ought to be analyzed was what the stories had to say. That is, we had somehow to get out of each story the essence of what it was about; to extract what 'one would tell someone else was there. And that 'someone else' needed to be another teacher, so that what was further analyzed would be of interest to the right audience.

What is involved in such a notion can be checked by looking at the sample stories in section 1.4. A paragraph or two might catch what is there in each, which would have something to say to a teacher. One or two words would be too little.

Obviously, though, just how one says what one thinks is there in a story will vary from day to day. Also, going through many stories, new insights will open up which would have altered the accounts of previous stories. We therefore tried to find how to give each story a standardized account, close enough to what one wanted to say was in it to be satisfying, but using fixed terms so that the standard accounts could be compared with one another in a reliable way.

Thus the first stage in analyzing a story is to write down and agree with others what is the essence of it. This is then translated into a standard form, until one feels that one has caught in the standard form all that really matters in the first, commonsense, version.

Of course, in developing the method, the things available to be used in the standardized summaries of the stories had to be added to, and refined and defined.

To do anything about the first idea meant having a large number of component parts of stories forming a variety of patterns. So a second idea was needed, for some way of keeping all these components under control. The second idea was to organize them in linked groups of various kinds.

Obviously, feelings and actions for example, could be grouped separately. But this did not go far enough. The feelings taken from the stories were of very different kinds, and it was clearly going to be important to be able to say what kind of feeling a student had expressed. Actions were even harder to cope with, because they were both more diverse in kind, and could also involve different people (the student solving a problem is not at all the same thing as the teacher solving it, for example).

One could imagine building up a story-kit of potential parts of stories, something like a phrase book, and drawing on that for constructing standard coded stories to summarize those in the interviews. But that leaves unsolved the problem of describing such component parts in any more general way, so as to be able to look, not at what particular actions, thoughts, and feelings went together, but at what types of actions, thoughts, and feelings had connections with one another.

We found our solution in a device borrowed from linguists, of building a kind of map or network of the features which could characterize the various components of stories. Thus something like 'giving praise' (important in the sample in 1.4.1) appears at a place in the network which identifies it, not only as a potential action of a teacher, but as one to do, amongst other things, with interactions between people. The job of the network is to give every part of a story labels of this or of other kinds, so that each part can be seen as more than just itself, but as an instance of one of several general types.

In this way, we could hope to look at the stories from a whole variety of points of view, all chosen to be of some interest to a teacher who is concerned with what students might think or feel, why, and in what circumstances. At the same time, the analysis could stay close to the immediate realities of each story, throwing away as little as possible of the information .in it. The stories could both be represented as the essence of what they had to say, in coded form, and also be put together in groups having important features in common.

3.2 CODING STORIES

We shall now show how the two sample stories in section 1.4 are coded. For the moment, the words used in the codes may be read as having their everyday meaning. Section 3.3, however, will show that this can be misleading, and will indicate how meaning is attached to the various pieces of code using the networks of features mentioned before.

Consider the first sample story (1.4.1) and what one might tell somebody about it. As a first shot, one might say that the story concerns writing an essay, about which the student felt very pleased, because she felt she had achieved something and because she was told it was very good.

This brief account consists of answers to three questions:

What situation does the story concern?

What did the student feel?

Why did the student have those feelings?

All the stories are first looked at in this simple way. We took as a basic criterion of acceptability that the interviewer must have got out enough detail for there to be clear answers to these three questions. Stories for which nothing definite could be put down in answer to one or more were not coded.

The account of the story just given is, however, a little thin. The person being told about it might reasonably ask such things as whether this was just one particular essay or was meant as a typical instance of essay writing, as whether the student was pleased more by the work itself or by the praise it was given (or the mark), or as why it was an essay and not something else that gave pleasure. The interview does not contain answers to every possible such question, but it does contain answers to some of them.

So one might elaborate, looking at the interview, and say about the situation that it was work done on her own, and that it was one particular essay. On inspection, the feelings too are a little more complex than just pleasure. There is pleasure in the work itself (see lines 65 to 75), but the student is also pleased with herself, feeling, as she says, 'virtuous'; glad to have made a successful effort (lines 41 to 55). She felt that she had done something (lines 54 to 72) and that it was her own (lines 73 to 76), feeling both a sense of achievement and a sense of possession.

Looking at the reasons for these feelings, the pleasure and sense of achievement seem to arise from the coming together of having worked hard (in her view) on preparing the essay, of understanding the ideas involved because of that work, of having been told it was very good and having been given a good mark, and of having done well for a change. The feeling that it was her own work, though, is tied more closely to her having done it alone without help.

If this is an acceptable account of the story, neither leaving out too much significant detail nor reading too much into it, it is ready to be put in coded form. Our coded version of this story is:

```
STORY CONCERNS/INDIVIDUAL LEARNING PARTICULAR THAT IS WRITING
ESSAY/
WHEN (I FELT PLEASURE AND PLEASED-WITH-MYSELF AND I-HAVE-
        DONE-IT)
    BECAUSE (I DID A LOT OF PREPARATION)
    SO (I UNDERSTOOD IDEAS)
    ALSO (TEACHER PRAISED ME)
    ALSO(TEACHER GAVE ME GOOD MARK)
    ALSO (I DID WELL WHICH IS UNUSUAL)
ALSO WHEN (I FELT IT-WAS-MY-WORK)
    BECAUSE (I WAS WORKING INDEPENDENTLY)
```

All the coded stories have a fixed outline structure, within which the details vary, consisting of answers to the three questions just discussed for the first sample story, about the situation, about the feelings, and about reasons for feelings. Correspondingly, the codes contain in the same sequence lines beginning:

```
STORY CONCERNS...

WHEN (I FELT...

    BECAUSE (...
```

The first two lines normally have a simple structure. The third line, of reasons, is usually complex, consisting of a number of parallel or interdependent items. Code lines consist of events or states of affairs such as (I UNDERSTOOD IDEAS),with links between them shown by terms such as BECAUSE, SO, ALSO. The coding rules are such as to produce a kind of telegraphic version of the story, which can be read fairly naturally.

To illustrate how different stories fit within this fixed format, we shall now show how the second sample story (1.4.2) is coded.

The second story is about lectures, and its first line of coding is:

STORY CONCERNS/LECTURE TYPICAL ABOUT THERMAL PHYSICS/

The choice of TYPICAL in place of PARTICULAR indicates that the events described typify or exemplify things which happened more than just once, as is the case in the second story but not in the first, where the importance of the events surrounding the essay seems more to lie in their special, particular nature. Both these first code lines use devices like THAT IS and ABOUT to let the coder give more details (slashes mark the scope of the extra items).

Respectively, then, the two first lines of coding say that one story is about a special event that happened when the student was working alone, in fact doing an essay, and that the other is about things which happened in lectures which were in fact on thermal physics, and which catch something general about those lectures.

The second line of coding always begins WHEN (I FELT and continues with one or more feelings. Often, the terms used for feelings are words used frequently by different students, rather than more psychologically oriented terms such as 'aggressive'. This makes it easier to pick out the feelings closest to those expressed in any one interview, and helps to reduce the degree of interpretation which is required. (The next section shows how these feelings are organized in groups in networks so that they do not remain merely the uninterpreted words of students.)

Reading the second sample story, we thought that the main feelings attached to the whole sequence of events were that the student felt confused and frustrated, and that he would rather go off and do something else (here reading a book) instead of going to the lectures. He also seemed to us to feel some doubts about his own ability, to feel put off the work, and to have worried about it. These feelings, though, like the feeling of owning her work in the first story, were tied to identifiable causes of their own. In such cases, these feelings are coded separately, together with their causes.

Thus the second line of code for the second story reads:

WHEN (I FELT CONFUSION AND FRUSTRATION AND/I-WOULD-PREFER-
SOMETHING-ELSE THAT IS READING A BOOK/)

The third line, usually followed by a sequence of further related lines, always begins BECAUSE and continues with the

events or states of affairs which are the reasons given for the feelings they follow.

Dependence amongst these reasons is indicated by indenting. Thus, returning for the moment to the code for the first sample story, there are four reasons all at the same level (preparation, praise, good mark, and doing well), while the first reason has a consequence of its own (understanding). The term ALSO is used to indicate that the next thing has the same status as the last at the same level, and so here means ALSO BECAUSE.

In the same way, the return to the top level of indentation at the end of the code indicates that the new feeling (that it was her own work) belongs like the previous feelings to the whole story, and not just to some later part of it. The new feeling then has its own reason (working independently) coded after it.

This complexity of structure is needed in order to give a reasonable account of the stories without interpreting them too much. In some, a mixture of events produces a mixture of feelings, while in others, identifiable reactions have identifiable causes. In many stories, there is a mixture of both.

The full coding of the second story illustrates how the codes can be used to represent a structure which is not identical with that of the first story. The code we gave it is:

```
STORY CONCERNS/LECTURE TYPICAL ABOUT THERMAL PHYSICS/
WHEN (I FELT CONFUSION AND FRUSTRATION AND/I-WOULD-PREFER-
        SOMETHING-ELSE THAT IS READING A BOOK/)
    BECAUSE (TEACHER DID NOT INSPIRE CONFIDENCE)
        BECAUSE (TEACHER MADE MISTAKES)
        ALSO (TEACHER'S PACE TOO FAST)
        ALSO (TEACHER'S EXPLANATIONS MADE NO SENSE)
        ALSO (TEACHER'S ANSWERS NOT CLEAR)
            SO (I GOT TIED IN KNOTS)
ALSO WHEN (I FELT SELF DOUBT AND PUT OFF)
    BECAUSE (I COULD NOT UNDERSTAND)
ALSO WHEN (I FELT WORRY)
    BECAUSE (SUBJECT IMPORTANT FOR EXAMS)
```

If it seems to read more harshly than the first, it is important to remember that it reflects, not how things were, but how the student said they seemed to him to be. The code does not say that the teacher actually made mistakes or that he in fact was not clear, but that the student thought this to be so. The same, of course, is true of the 'good' stories.

The commonsense account of what is in the second story, which lies behind this code, might run somewhat as follows. In some thermal physics lectures the student felt confused and

turned off, because he did not have confidence in the lecturer.

Looking more carefully at the pattern of reasons for feelings, it seems that it is an overall lack of confidence which causes the feeling of frustration and confusion (lines 23 to 37; 64 to 68), and the feeling that something else, perhaps a book, would have been better (lines 75 to 78). It had several causes: mistakes (lines 10 to 15); pace (lines 24 to 30); and not trusting getting answers (lines 44 to 50). Because he could not understand, he also began to doubt his own ability, and worried a good deal, especially because of the need to understand for examinations (lines 55 to 60; 81 to 86).

Clearly, reducing and coding the interview material involves interpreting it. The coder has to judge whether a feeling is clearly present or not, and what to call it. He has to disentangle reasons and decide how genuine they are. These things inevitably emerge slowly, if at all, through the whole course of an interview, and the clarity with which they emerge depends on the skill of the interviewer. Often, even with the best interviewers, one is faced with things that are unclear, not least because they are unclear to the student himself.

Such problems are unavoidable. At the least, the analysis should avoid more than the minimum of interpretation. However, what comes out of the analysis may be relatively insensitive to some differences of interpretation. The way in which we have tried to reduce the difficulties depends on the other part of the analysis, using networks of features, and will therefore be tackled after that has been described.

3.3 NETWORKS

The job of the networks described here is two-fold: to store in an organized way the possible items that can go into coded stories, and to give each item a label (normally complex) which says what kind of thing it is and what part it plays in the story.

The full set of networks (actually, one large interconnected network) which we developed and used is given in an appendix. Here, we shall try to explain what they are, how they were arrived at, and how they were used. The examples are also intended to illustrate the more important of the features in them which we have used in the discussion of results in later parts of the book.

To illustrate how the networks might help to classify

and organize parts of stories, we shall first use as an example the problem of dealing with the feelings or reactions to be found in the stories. Many other examples could be chosen (things done by teachers, things done by students, attributes of people or of situations, and so on), but this example is both important and reasonably tractable.

Looking through the interviews, one readily collects a very long list of feelings expressed. A small part of such a list would include:

relief
reassurance
relaxation
bewilderment
confusion
anxiety
pleasure
contentment
fed-up
elation
despair
achievement
frustration
defeat
re cognition
lack of recognition
importance of oneself
foolishness
inferiority
self -confidence
self-doubt

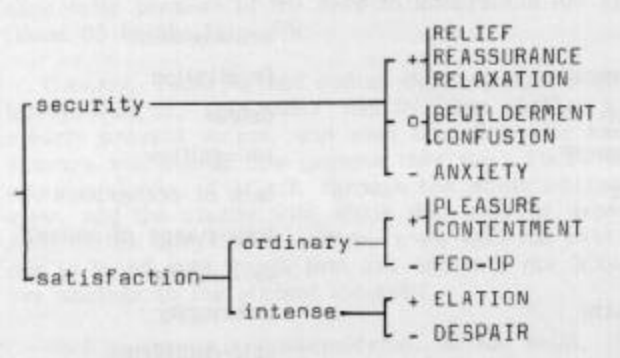
Despair rather than elation is the feeling induced by the complexity of even this brief list. The feelings in it are varied, and yet some clearly bear some relation to others. While some, such as elation and despair are more or less opposed pairs, other similarities and differences, such as those between elation and relief, are much harder to capture while no less significant.

Faced with such lists, whether of feelings or of other things, we try to find ways of collecting them in groups. So for example, in the list above, we distinguish the first six from the rest by saying that they have in some way to do with security. That is, relief, reassurance, and relaxation are positive feelings of security, while anxiety is a definite feeling of insecurity. In between come bewilderment and confusion, as expressions of lack of security.

Of course such a grouping is open to doubt. It gains some substance when compared with other groupings. Thus the next five feelings do have a different character, better caught by saying that they have to do with satisfaction rather than with security. Pleasure and contentment contrast with being fed-up

as positive and negative kinds of satisfaction. So too do elation and despair, but now the feeling is more intense than before.

It will already have struck the reader that keeping such groupings and sub-groupings in mind is difficult, so that a compact and expressive notation for representing them would be useful. The notation we use is one developed by linguists and sociologists for representing the similarly complex and inter-related features of language and of social situations. The groupings mentioned above we represent in the form:



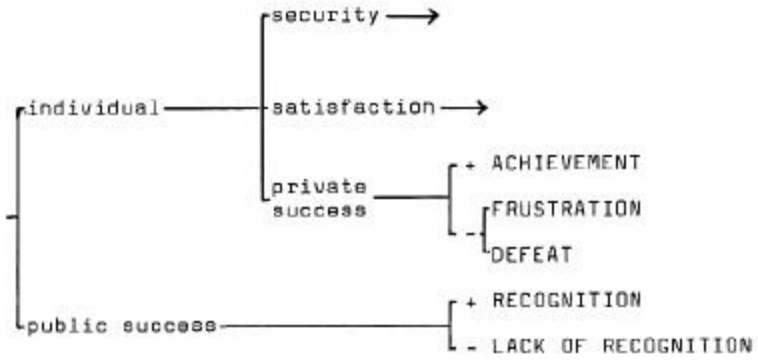
Here, the representation is a simple tree diagram, in which a vertical bar indicates a choice of one out of several options. Items which can be fed into coded stories are given in capitals, the other items being higher level descriptive features.

Whether or not the grouping is a good one is obviously open to question. While this matter will be taken up in the later discussion of the problems of the analysis, the kind of issue that can arise can be illustrated by continuing with the example of classifying feelings.

Further feelings from the list, of achievement, frustration, defeat, and recognition or lack of recognition, could all be grouped under success of some kind, positive or negative. But the interviews do not lend support to such a grouping, in that the emphasis in the last two is very much on the other person who does or does not acknowledge success, while the emphasis in the first three is much closer to that given to the feelings described before, namely being much more private, personal, and individual. Nor is this surprising: a physics student has some pretty objective criteria to judge some kinds of success -either the problem comes out or it does not, for example.

This led us to group the features used above, security and

satisfaction, together with private kinds of success, as all having to do with feelings of an individual nature, and to distinguish all of them from feelings to do with public success. The following diagram shows how these distinctions are added to those in the previous diagram (detailed features of the first diagram being omitted for clarity).

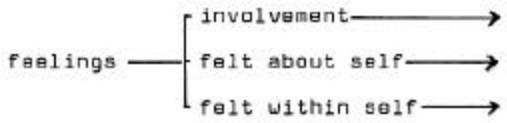


The feelings to do with security and satisfaction also being individual, we now have a more general grouping of such feelings. Assembling items into more and more general groups can continue in this way.

As an example of identifying a yet more general feature, consider the difference between all the feelings so far collected in groups, and the last few on the list (importance, foolishness, inferiority, sell-confidence, and sell-doubt). These last ones are all things the student feels about himself as a person, whereas the former ones are all things the student feels within himself, not about himself.

Looking at yet more feelings, we identified one more general feature of groups of feelings at this last level, namely feelings having to do with involvement. They include interest (involvement in a subject) and respect (involvement with a person), for example.

This gives, as the broadest set of distinctions amongst feelings:



There is thus one large network of features of feelings, with the feature 'felt within self' leading to the distinctions described so far, and the other two features leading to similar divisions and subdivisions.

This rather extensive example is not intended to convince the reader of the subtlety of our thoughts about feelings. It is simply an example, in one of several important areas, of how we have set about classifying material from the interviews.

One virtue of such a classifying network is that it gives each item in it a label which says what type of thing it is. For example, if the coded story says that the student felt relief, this feeling gets the label 'feeling within self - individual - security -positive'. In comparing stories, we then use such labels to pick out stories which have things in common at varying levels of generality. This makes it possible to ask such questions as whether first year students often express feelings to do with security as opposed to, say, satisfaction, or (one level higher) whether feelings the student has about himself are important in or not in different circumstances.

Clearly the value of any such further analysis depends on the value of the various distinctions which have been introduced in classifying items. We shall discuss this and other such problems later.

Besides classifying, we use networks for a second job, that of saying what role various things are playing in stories. It is important, for instance, to know which reasons for feelings are things about a teacher, and which are things about the student. Similarly, it is important to know which are things somebody did, and which are circumstances or states of affairs. It is valuable to distinguish cases where a requirement is imposed on the student from those where he sets his own standard of work. These of course, are only a few of the features describing the part played in a story by one piece of it, about which one might want to record information.

As an example of this second use of the networks, we now describe how they are used to generate and label such parts of stories as

(I FELT PLEASURE)
(TEACHER PRAISED ME)
(SUBJECT IMPORTANT FOR EXAMS)

in which something happened, someone did something, or something or other happened to be the case. Looking back at the two

examples of coded stories, the reader will be able to see that they are built out of such clauses, each clause enclosed in brackets. The clauses are connected together by links such as WHEN and BECAUSE. In writing the coded versions of stories, these clauses are produced by using a network as a kind of sentence generator, which at the same time says what kind of clause has been generated. This device is useful because the different kinds of clause will clearly contain different kinds of items, so that it becomes easier to store, classify, and retrieve the very many disparate possible ingredients of stories.

How, though, could any kind of order be imposed on even the few but varied clauses in the two examples? Worse, how can any order be useful rather than arbitrary, containing information which can later be used to cast light on questions about reactions to learning?

After many false starts, we found a way which seemed fairly natural and informative. Of each clause, we first ask two parallel questions:

Who or what is it about?

What kind of thing is being said?

The answer to the first will either be a person-the student himself, a teacher, other students, or occasionally others in general-or if not a person will be some situation or thing, such as work, a topic in physics, or an experiment.

It proved fairly easy to collect. together all these possible topics of clauses, and to organize them in groups in the way explained above. In coding, the fact that an item is the topic of a clause is indicated simply by putting it first, so that the clause naturally reads as if that is what it is about.

The very many different kinds of thing that could be said - all the answers to the second question - were more difficult to deal with.

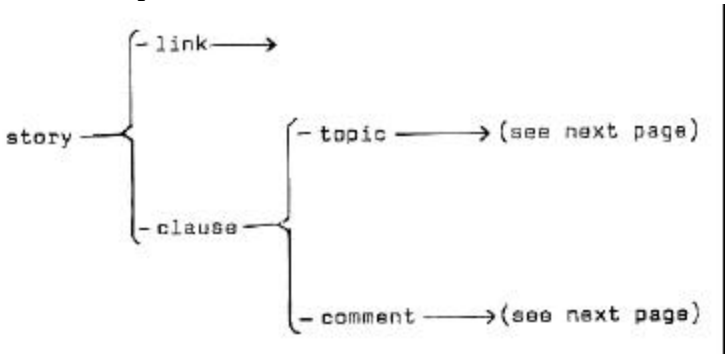
First, we divided them into processes and states of affairs; that is, into things which happened, and things which were the case. Thus the student feeling pleased, and the teacher giving a good mark would go into the category of processes, the first being private and internal, the second being public and external. By contrast, the subject being important for exams would count as a state of affairs.

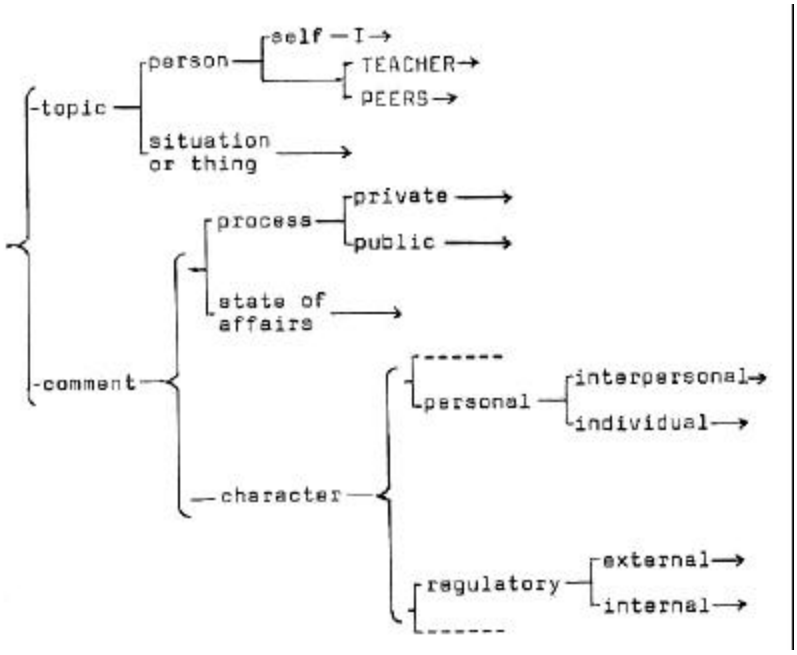
This, however, was not enough to provide natural and useful groupings. The nature of processes varied with the topic, so

that things which the student did or which happened to him were very different to things the teacher did, but even within these groupings there were large variations of type. It proved useful to introduce some further features to describe the character of a clause, which we then used to help sort out processes and states of affairs into convenient groups.

One such feature, which may or may not be present, is the extent to which the clause has a personal character. The teacher giving praise has it, as does the teacher making mistakes, the first being interpersonal and the second being personal but individual. The subject being important for exams does not have a personal character, but does have another feature we found it useful to use, namely that of having to do with regulating behavior - with control, influence, or pressure. This instance is a case of external regulation (rules would be another) while something like the student making an effort we count as a case of internal regulation - of setting one's own standards.

All this, together with the way a story is made of clauses joined by linking items which say how one clause relates to the next, can be represented with one addition to the network notation. The addition is the brackets used in the diagram below, which say that all the features following a bracket coexist. Thus the bracket after 'story' says that a story consists of clauses and links, with any kind of link joining any kind of clause. (Formally, a small recursion loop - not shown here - is needed to allow stories to be long chains of clauses and links.) Again, a clause consists of a topic (what it is about) and a comment (what is said about the topic) and, apart from restrictions introduced later, any kind of comment can go with any kind of topic. Arrows after a feature indicate that it leads to some further network of distinctions; the various possible links or topics, for example.

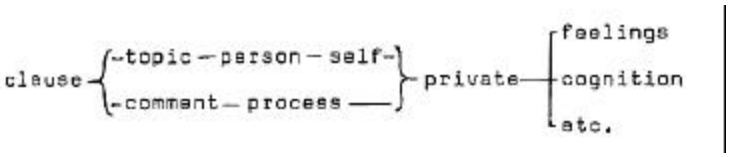




The broken-line options in the character network indicate that the absence of the features 'personal' and 'regulatory' has no consequences; only their presence is used later.

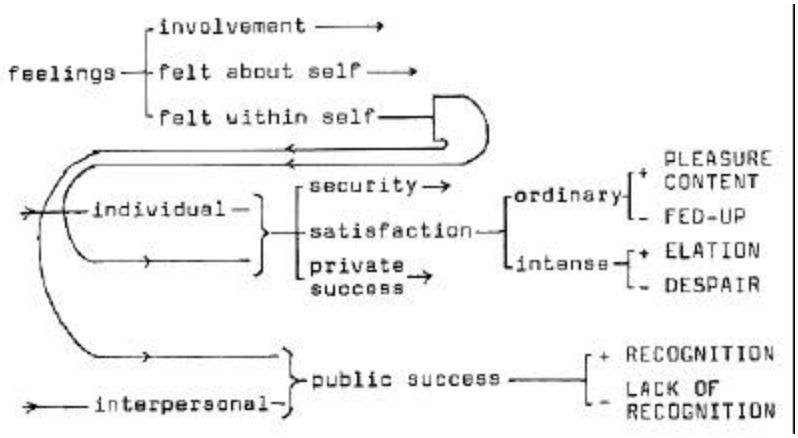
We now show how several examples of clauses, taken from the sample codes in section 3.2, fit into this scheme.

Consider first (I FELT PLEASURE) . It and all other clauses expressing feelings are necessarily about the topic 'I', the student himself. They are all also necessarily private things which happened, but there are other such things, like understanding ideas, which are not feelings. These and other necessary conditions are shown by a left-facing bracket entered from the relevant previous places in the network, after which possibilities branch out again, as shown below.



We then group feelings by further use of necessary conditions. 'Pleasure' was one of the feelings discussed previously, where it was distinguished (with others) as having an individual

character. This feature is taken, from the 'character' part of the network above, as an input condition defining a group of feelings. Other groups of feelings have other things, such as 'interpersonal', as necessary prior features. In this way, the network of feelings described before is joined to the general network which describes the nature of clauses. The diagram below, seen as a continuation of the one just before, shows how the clause saying that the student felt pleasure is fitted in the system, together with some of the nearby features.



The point of this seemingly cumbersome machinery is to provide a way of looking later at various aspects of the meaning of parts of stories. So, in the present instance, the student has an individual feeling of satisfaction within himself. Would such a feeling arise often from work done alone? Would it perhaps be the predominant kind of feeling, no matter what the circumstances? When will negative feelings of otherwise the same kind (being fed-up)arise, as compared with, say, interpersonal feelings like annoyance? These are the kind of questions we wanted to look at, and the machinery was designed to keep track of the relevant information.

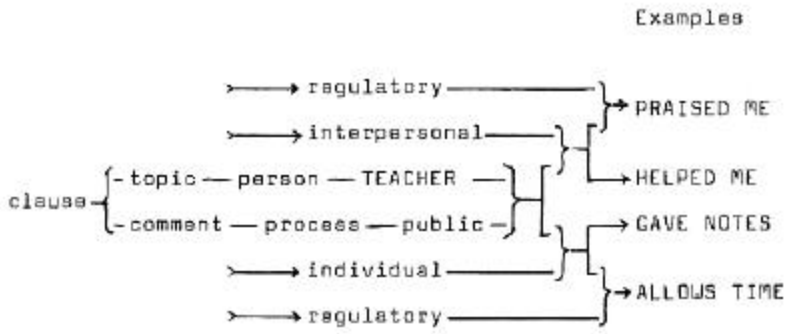
Consider next the clause (I UNDERSTOOD IDEAS). It too is about the student. Because it appears in a code as a reason, this is potentially useful information, as one might ask how many reasons have to do with the student himself, with the teacher, with the subject, and so on. The comment is also similar in being a private process (understanding), but differs from expressions of feeling in being described by the option 'cognition' as opposed to 'feelings'.

The comment is therefore in this case stored in a network

containing such cognitive processes as thinking, learning, seeing connections, and concentrating. Important parts of it are marked off by the feature 'internal regulatory', having to do with trying hard, going at his own pace, setting himself goals, and so on. In this way something like trying to understand is distinguished from simply understanding.

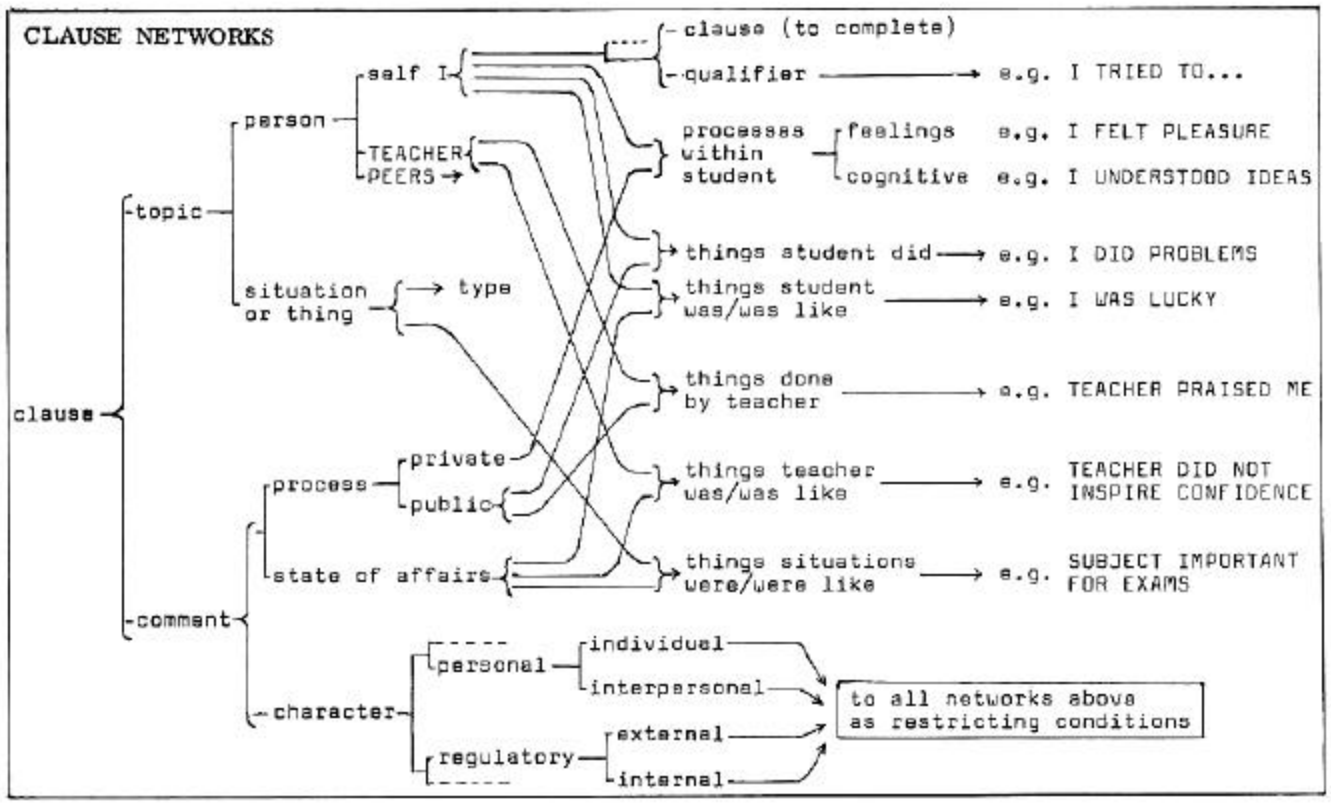
The same network handles things like (I GOT TIED IN KNOTS) distinguished from those above by having the feature 'coping' or 'not coping'. It is, of course, only because of the circumstantial detail in the interviews that it is possible to decide on such labels with any kind of confidence.

Consider now a very different kind of clause: (TEACHER PRAISED ME). This must belong to a whole collection of things which are about a teacher, and in which what is said is something that visibly happened. The diagram below shows these input conditions, and four groupings into different kinds of process, with examples of each. All are either something done by the teacher interacting with the student (interpersonal) or are something he did as himself alone (individual). Some but not all of both have a regulatory character; to do with influencing the student.



These examples may be enough to show how the features which describe what a clause is about, what kind of thing it says, and what character it has, are brought together in various ways to define a group or cluster of possible items all having something in common.

Groups other than those above include ones in which the clause is about the student or the teacher, but in which what is said describes some state of affairs (being enthusiastic, for example); and ones in which the clause is about some situation or thing (an experiment, perhaps) and what is said about it is again some state of affairs (that it was long, for instance).


CLAUSE NETWORKS
clause
topic
person
self I
TEACHER
PEERS
situation or thing
type
comment
process
private
public
state of affairs
character
personal
individual
interpersonal
regulatory
external
internal
clause (to complete)
qualifier
e.g. I TRIED TO...
processes within student
feelings
e.g. I FELT PLEASURE
cognitive
e.g. I UNDERSTOOD IDEAS
things student did
e.g. I DID PROBLEMS
things student was/was like
e.g. I WAS LUCKY
things done by teacher
e.g. TEACHER PRAISED ME
things teacher was/was like
e.g. TEACHER DID NOT INSPIRE CONFIDENCE
things situations were/were like
e.g. SUBJECT IMPORTANT FOR EXAMS
to all networks above as restricting conditions

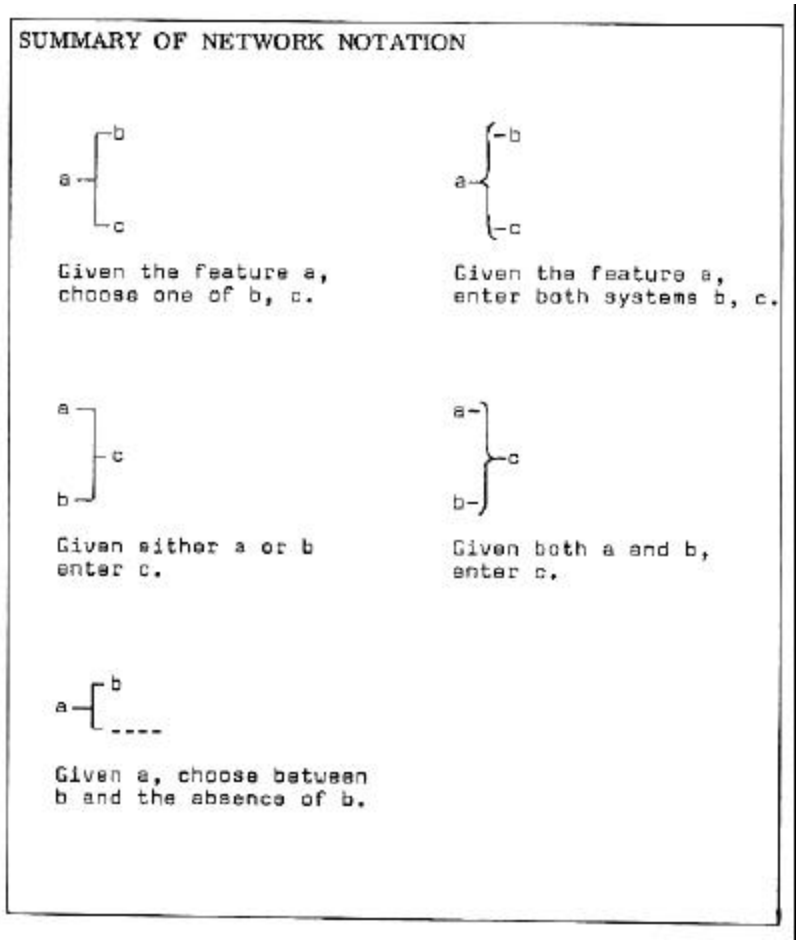
The network in the box on the previous page shows how the eight main networks describing different kinds of clauses are connected to the network of general features of clauses. (It is the combining connections shown here, and others like them, that make the system a network rather than a tree.)

As in the examples given before, the clause character features also feed into the networks describing clauses, helping to divide them into natural and convenient groups. For clarity, their detailed connections are not shown here, but are of the kind shown in the previous examples (things felt by the student, and things done by the teacher). They are given in the networks in the appendix, together with the contents of the various networks shown only in summary so far. The examples of coded clauses on the right of the diagram are typical of the contents of these networks.

To sum up, our way of analyzing the interviews is to put the essence of what we think each has to say into a standard coded form, rather like a telegram. The pieces of code have fixed meanings, given to them by the features of the place in the network where they are located. The network is such that these features combine in a variety of patterns, so that the potential meanings of pieces of code are flexible, though fixed. The various features allow us to look at the coded stories from a whole variety of points of view.

The next chapter discusses the problems this approach led us into, and this is not the place to expand upon them. At first sight, the system looks complicated beyond belief. In fact, however, we used it so as to keep things simple in a different sense. By using it, we can code stories in a way which is close to what they actually say, so that it is fairly easy to agree on a coding. But that means that each story will be a complex configuration of meanings, and it is a modest part of that which the network helps us to try to capture.

If the problem seems intangible and the solution complicated, it may help to remember that everyone thinks in much the same way in all the events of daily life. Thus when someone says, 'How are you?', he is without difficulty understood as asking a question, addressing someone else, making a greeting, and starting off some kind of exchange. This and any other event has significance at a whole variety of levels. In trying to make systematic the different kinds of significance which could be attached to what students told us in interviews, we are doing no more (indeed much less) than everybody does easily every day. Nothing less would begin to do justice to the richness and variety of what students had to say.



AUTHORS' NOTE

The complete descriptive network, presented in abridged form in the appendix, and the coded summaries of the stories, may be obtained from the authors on request.

4. Problems of the study

4.1 STUDYING PEOPLE

Human beings, the reader will not need to be told, are complicated and contrary, so that any study of their reactions is likely to generate more problems than it resolves. The present study is no exception.

One set of problems concerns the validity of the interviews. Will students tell a stranger anything worth knowing? Worse, will they not simply take the chance to offload a lot of grumbles about others, when they should blame themselves? Also, surely interviewers must have varied amongst themselves in tone and style, each getting rather different things from those they spoke to?

A second set of problems concerns the extraction of information from transcribed interviews. Do the words on the page accurately reflect the meaning? Does the student really mean everything he says - sometimes, does what he says mean anything much at all? Reading a meaning into what is said is inescapable, but how fair is the reading? What information is to be kept, and what discarded? How far will different people agree on what they get out of an interview transcript?

Behind these questions lies the larger question of what, if anything, is the picture derived from asking students about special times when learning was good or bad, a picture of? Is it a balanced picture of normal life, highlighted in detail, or is it an assembly of odd and unrepresentative moments?

Coming down to more detailed issues, there are many problems of handling the interview material. What criteria can there be for accepting or rejecting stories? Does rejection unbalance the sample? In codifying information from stories, how far can the terms in which the codifying is done be regarded as deriving from the material itself, and how far must it be regarded as having been imposed on it from outside? Who decides what goes into the analysis, ant} why?

Then, when material is safely codified, what aspects of it can be quantified? What does one choose to count? Are the things counted sufficiently alike to be counted? Are the numbers of things recorded more a product of the analyst's interest and attention than a product of the method itself? In any case, how far is it worth trying to quantify? Of some things, which happen often, it may be very valuable to know how often. There are also things which some think to happen often, and it may be useful to know if they do not. But there are some things about which the most important thing to know is that they can sometimes happen - that they are possible if not probable.

Lastly, how is all this to be interpreted? Here any such study is inevitably on a hiding to nothing. If the reader's own experience agrees with a conclusion, he will often feel that we went to much trouble to say the obvious. If not, he may suspect the conclusion to be wrong, perhaps with reason.

These are the issues we have tried to confront in this chapter. We also describe here the steps we took to minimize some of the dangers, checking the analysis in various ways. First, however, we discuss the problems of the interview material.

4.2 VALIDITY OF THE INTERVIEWS

At the outset, we shared the doubt as to whether the interviews would produce anything worth having; anything more than moans about the inevitable problems of studying science or expressions of pleasure about its obvious rewards.

Here we had the advantage both of working in a project consisting of university physics teachers, and of being able to use such people as interviewers. Before embarking on the main study, we showed the raw material from the forty pilot interviews (see 1.2) to about twenty people involved in the project, to decide whether it was worth going on. Their strong feeling was that it was, because they felt that the material offered useful and striking insights to them personally. They did not feel that the interviews had produced spurious and unreal data; rather, the transcripts struck them as real and telling. Only because this feeling existed did the study continue, as a part of the project, consuming resources that could have gone elsewhere.

Similarly, it is worth recording that the physicists who did the interviewing all agreed that they were hearing valuable and non-trivial things from students.

None of this is to claim that the interview approach has no defects: it has many. The alternatives, however, seemed to us to be worse for our purpose. To have constructed a questionnaire, for example, would have pre-empted what to ask, would almost certainly have secured less serious involvement than face to face talk, and would have made it impossible to explore the meaning to students of our questions and their answers. In an area so well mined with subtleties and confusions, that approach seemed to us even less valid.

Obviously, however, both in the interview itself and in later analysis of it, it was open to the students to pull the wool over our eyes. Indeed,' those with experience of talking to students will know how often this happens, and will doubt our ability to detect nonsense when we were told it.

It was for just this reason that the interview, as described in chapter 2, had the probing style it did. The interviewers did not accept everything at face value, but instead tested statements by returning to them and asking about them in several ways. Equally, in reading transcripts, we were alert for inconsistencies and contradictions. Because the interview was about concrete events, we could ask whether it was reasonable for a feeling described as arising out of events actually to do so. Because the interview took half an hour or so, it was quite difficult for a student who wanted to spin a yarn - and some did - to maintain it without betraying the fact in the detail of the story.

This does not mean, of course, that we were never deceived, but only that we were less often deceived than we might have been. Nor does it mean that students always spoke of what really mattered most to them. There are very natural restraints on what anyone will tell a stranger, and equally natural tendencies to talk about what one hopes will please the questioner, or will put one in a favorable light. Here it was particularly important that the interview was designed to put the student at ease as much as possible, and that the interviewer learnt not to react other than in a pleasantly neutral style to anything that was said. Despite all these very real reservations, the interviewers were all impressed by the seriousness of students' attitudes to the discussion, and were often taken aback by the intimacy of what they were told. It is not every day, for example, that one is told about the effect on work of having a pregnant girl friend at home whom one does not want to marry.

Finally, the restriction of the sample to the mainstream of students, excluding those with problems so bad that they were certain to fail, or whose abilities were such that their final

performance would predictably be very good indeed, contrived that some of the difficulties mentioned above were reduced. Unlike those whose job it is to talk to students who are in trouble so as to counsel them, we were not so often faced with what smelt of hard-luck stories or special pleading, because the situations under discussion and the relationship of interviewer to student gave less cause for it.

4.3 CONSISTENCY OF THE INTERVIEWS

There is no question but that the quality of the interviews was variable. The best interviewers were sometimes tired, and some were generally better than others. Faults included letting students ramble on without getting enough clarification; being impatient and moving on before allowing the student to get round to saying something difficult; and pursuing every detail beyond the point where it would be reasonable to think that there could be much more to say.

On the positive side, however, the interview was simple to learn so that all the interviewers were able to keep to the same format. Omissions of important parts of it were rare. Its general robustness is confirmed by the fact that only a small proportion of the stories told had to be rejected on grounds of lack of clarity or completeness (see section 4.4).

The method of analyzing the stories, of turning each into a coded summary of what it had to say, has the result that interviews which are less good, either in lack of clear detail or in a mass of repetition, tend to have briefer codes containing fewer items, and so have less weight in the final data. The main danger here is encoding too much in those interviews which go on at length, but here the use of network features affords some protection, since we did not encode over and over again details of stories which were mere variations on a theme having the same overall network: description. There is no way of estimating whether good and less good interviews were given the proper weight, but we did make every effort to ensure that the weighting was in the right direction.

That the interviewers differed in personality and style, and so very probably got different things out of students, can be seen as a strength or as a weakness. It has the virtue that the variety of issues emphasized is wider, and that there is less of the predelictions of one interviewer reflected in the results. It has the defect of adding a further uncontrolled source of variation to the data. Here we felt that the best

approach was a compromise. The experienced interviewer who had designed the interview and trained the others normally went on each visit, with one other interviewer, sat in on the first few conducted by the other, and herself conducted about half the interviews at each place. This gave us some consistency and some variety.

It was, of course, of particular importance to us that the interviews be conducted in part by, and be influenced in their form by, people with university teaching experience in science. They brought to the study a healthy skepticism and practicality.

4.4 PROBLEMS OF SELECTING STORIES

As explained in the previous chapter, a story was accepted and coded if it was quite clear what it was about, what the student had felt, and there were clear reasons for the feeling.

We began by dividing each interview into potential stories, simply by looking to see what different things were talked about. Usually this was simple, except in those cases where the student changed the subject suddenly or returned to one later. This yielded 307 potential stories from the 115 interviews.

Most passed the above tests and were coded. Some, however, were rejected or put on one side, as shown below.

'Good' events; clear feelings and reasons	129	
'Bad' events; clear feelings and reasons	142	
Total 'good' and 'bad' stories coded		271
Conflicting feelings, but clear, so coded	14	
Total of stories coded		285
'Good' stories, but unclear details	8	
'Bad' stories, but unclear details	5	
Vague mixture of 'good' and 'bad'	3	
Stories about non-science subjects	3	
Conflicting feelings, but unclear	3	
Total of stories not coded		22
Total potential stories		307

We set on one side the 14 stories involving conflicting feelings, and based the main analysis on the 271 stories about

decisively 'good' or 'bad' events. Despite their interest, the conflictual stories were, we felt, too few in number and too diverse for analysis. With the 22 rejected stories, there are 36, or 12%, of those identified in the transcripts which were not used for the main results of the book.

The overall rate of 2.7 stories per student (and the final rate of 2.35) did not solely arise from the invitation, mentioned in chapter 2, to tell an optional third story. Because we wanted each coded story to be about some one definite situation, it was sometimes necessary to divide what was for the student one set of events in more than one context, into two stories. So, for example, a story about a difficult lecture course and how a good deal of work alone had produced a very different reaction to the same topic, might be divided like this, though we of course kept a record of the connection. In addition, one or two students had several stories to tell, and we accepted and coded them if we thought they all had substance, though in such cases we were more than usually skeptical.

The combination of the rejection of some stories and the division of others led to the following distribution of numbers of students producing stories which were taken and coded:

Number of stories	First year	Second y ear	Final year	Total
1	0	2	3	5
2	21	22	17	60
3	10	14	17	41
4	3	3	2	8
5	0	0	I	1
	Total number of students			115
	Total number of stories			285

With 85% of coded stories coming from students who told two or three, it seems unlikely that the garrulous ones will have had any very marked effect on the results.

The process of selecting and rejecting stories did not introduce any marked bias between the various universities, with the number of stories coded ending up more or less in proportion to the number of students interviewed at each. Happily, the two departments (F and G, see section 1.2) in which the sample between the years was unbalanced did not produce any students who told more than three stories which were coded.

4.5 DIFFERENT EMPHASIS ON THE YEARS

Because we invited students in roughly equal numbers from each year to talk about events in any year they chose, it was certain that stories about the first year would outnumber those about others, and that stories about the second year would outnumber those about the third. The exact outcome, which was not the same for 'good' and 'bad' stories, can be found in the next chapter.

At the same time, the design ensured that the views of students in each year would be equally represented, and made it possible to look into whether views about a year might shift in retrospect. We could look, for instance, at whether first year feelings of insecurity were not so often recalled in the third year, or at changing views of hard toil.

On balance, we feel that the choice we made was reasonable, but it does have the consequence that data on the third year is a little scarce, so that inferences about that year are less secure and less complete than they might be.

4.6 PROBLEMS OF CHECKING CODES

Since the summaries of the stories in the interviews, in coded and standardized form, are what is taken for further analysis, it is important that they are as valid and reliable as possible. It is in producing them that decisions and interpretations are made, which necessarily have a subjective element.

The fact that the coded versions of the stories were complex made the problem at once harder and simpler. It was harder because it was difficult, perhaps impossible, to quantify the degree of agreement between different coders. It was easier because most disagreements were minor, leaving the main structure of the story unchanged. Typically, coders would agree about all but one or two lines out of ten or so when working independently. Perhaps more important, they could easily make minor adjustments to which both could agree.

The network features described in the previous chapter played an important part in making it easy to come to an agreement about codes. There could easily be disagreement about just which terms to select for a piece of code, but very often it turned out that the different terms had the same set of descriptive features attached to them, so that the difference had no effect when features of stories were later compared.

Some examples may illustrate the point. In the code for the first sample story in chapter 1 (1.4.1) given in chapter 3 (3.2), one code term for one of the feelings is 'pleased-with-myself'. Another coder might have picked the term 'proud', with equal justification. Both terms, however, are to be found together amongst other feelings all to do with positive feelings about oneself, so that analysis can continue with what the different choices have in common.

In the same case, different coders might represent the fact that the student thought she had done a lot of work, in different ways, but the codes they would choose would normally have in common all the essential features: that it was something done by the student; that it was done individually; and that it had seemed large in amount.

Where there were important differences, the network features made it easier to discuss and resolve them. So, for example in this story, one coder might have picked up the praise given by the teacher, and another the way the student thought she had done well, both to represent the same aspect of the story. The difference between them, at the level of network features, is that the first has picked on a positive inter-personal aspect, and one to do with influencing behavior, while the second has noted the student's feeling of success. In the present instance, the coders might agree that both are right, and include both, as in fact they are. If they did not, one might ask the other to point to the evidence in the interview for the importance of how the teacher reacted, or for the reality of the feeling of success.

We carried out a fairly extensive checking process of this kind.

Half the transcripts were checked against the recordings by interviewers, to test their accuracy and to see if the written record distorted meaning by not taking account of intonation. Relatively few problems turned up, so for the remainder we went back to the tapes only when the interpretation seemed doubtful.

In the initial phase of coding, when the networks of items to be used in writing codes were being built up, two coders worked together on a sample of 80 stories, developing the scheme and writing tentative codes. The coding items and the networks of features produced in-this way proved sufficiently stable and complete to be usable in coding the rest of the stories, with new items needed for the rest finding acceptable places in the system without any need to reorganize it.

One of us then coded all of the stories, recoding the previous 80. During this process checks were made on every story which presented difficulties, and also on a sample of those which did not, by one or two other people, as shown below.

	Number accepted	Number rejected	Total
Problematic stories checked:			
dubious stories	17	18	35
doubt about part	17	2	19
interpretation	48	2	50
Sample check:			
by one other coder	19 (15%)		19
by two other coders	23		23
Total checked	124 (43%)	22 (8%)	146

In the whole checking, 50% of codes were left unchanged. 40%. had minor changes, adding, omitting, or altering up to two lines of code. 10% suffered major changes, though even here the main outline of the code was normally unchanged.

4.7 PROBLEMS OF DEVELOPING AND USING NETWORKS

This is not the place for an account of the slow process. of developing the system of analysis itself, borrowing and adapting ideas from others and making up some of our own. It is important, however, to indicate how the descriptive features used later in the book in analyzing results were arrived at, because the value and significance of the analysis depends a good deal on them.

The main question is whether these descriptive features arose naturally from the interview material, or were imposed arbitrarily on it. How far are they natural descriptions of what students think, and how far are they what we think about what they think ?

Put in this sharp way, the question has no simple answer, except to say that everything is a reading of the data and not a carbon copy of it. But we did not approach the analysis of interviews with any fixed ideas about what we would find, or of what to look for. Indeed, typically a set of descriptive

features would go through ten or so preliminary versions before reaching a final form. Changes would be forced upon them because something of obvious 'importance in some story simply had no place, or was badly distorted by being assigned the only available description.

The test was always the same: did the available code items and the description the network gave them catch what seemed to be important about what students were saying?

Quite a lot was straightforward. The world of the stories was peopled by all the obvious people and events: the student himself, other students, the teacher, and lectures, practical work, revision, and so on.

What was said about them was not so easy to classify. Here we had sometimes to arrive at distinctions which reflected our own concerns, rather than anything said directly by students. So, for example, after some time we saw that we could usefully label all such things as wanting to work hard, trying hard, deciding for oneself, or choosing what to do, with a feature indicating that they all shared the property of a private decision by internal rules or standards, as opposed to being imposed by outside authority or just happening.

Is this an imposition on the data? In one sense, yes, since it brings together different things said by different students under a banner they might not themselves have chosen. In another sense, no, because our reading of the stories was that these things had all been important to students. in much the same way; that they did pick out for special mention those times when they were self-governing. Equally, they spoke (as we saw it) very differently and equally consistently of events where others made, or tried to make, them do things.

Is it a worthwhile 'imposition'? We thought it was, because of its likely relevance to understanding students' reactions.

Another example might be the description of things said of teachers. The variety was large: that they were clear, helpful, went slowly or quickly, were nice, amusing, or interesting, seemed interested in one or enthusiastic about the subject, and so on. In the end, one distinction we drew was between things reflecting on the teacher himself, as a person, and things just about his actions. At the same time, we had to divide both into things having to do with personal interaction (like being kind) and things without that ingredient (like being knowledgeable).

Clearly the value of some such distinctions could be

challenged. It is not obvious that things to do with the teacher as a person are importantly different, so far as students' reactions are concerned, from those to do with his actions. Nor is the distinction easy to maintain: where is being clear to be put? At the same time, it is common to talk of the importance of the teacher's personality, so we thought it right to make the networks able to record what might be traces of the effects of such a factor if it was indeed important.

All of this means that the main network features have the status of hypotheses about aspects of learning science which may turn out to matter. They are our hypotheses, not ones proposed by students in the interviews. But they are those aspects which we found we needed to give a satisfying account of all the interviews, and they do not include aspects not needed for this purpose. We did not, for instance, find that we needed features describing students' home backgrounds, significant though those might be, because there were no important parts of any story describing how home background had been a. major factor. (It was mentioned, of course, but not in a way needing a detailed set of distinctive features to differentiate one background from another.)

Inevitably, we may have missed important features, or have chosen bad ones. We tried to avoid this as far as we could by asking, of the code and its description in terms of network features for every story, if they gave a satisfying, complete, faithful, and defensible account of what was in the interview.

The extent to which different features could reliably be extracted and used in this way is limited by two things: the depth of detail in the interviews made our own ability to make and maintain discriminations. The first is mainly a product of the length and circumstances of the interview, which made it certain that most issues would be everyday ones, and not deep matters of personality, past history, and so on. This we do not regret: it seems to us useful to have an account of students' reactions in everyday, even though arguably superficial, terms.

The second is inevitable: no description, no set of features, can be better than the perceptions of its authors. It determines the point at which liner and finer distinctions were cut off. If we found that we could not agree reliably on whether a part of an interview should be described in one way or in another, that distinction had to be abandoned and a coarser one found. If we found that an existing grouping contained items we could and wanted to differentiate, suitable liner distinctions were added.

In this sense, the reliability of the descriptive features was

to some degree assured. We used only those that we could use. They were also those that we needed to use; those that the interview data seemed to us to demand. By staying close to the interviews, we tried to avoid reading too much into them, while getting out of them as much as we could mutually agree upon.

4.8 WHAT DO THE RESULTS MEAN?

What kind of information can such a study yield, and in what way ought it to be taken, even be acted upon?

One part of that judgement is to decide whether stories of incidents which were more or less critical, together offer any useful picture of the forces operating at most times. Such a decision is probably better made in the light of the sample material from interviews included in the book, than it is from argument. To the extent that they ring true as typical in some way, is there a case for regarding the results as potentially illuminating in any general sense.

This however leaves open the question whether the method taps all, or even any, of the real issues. One can always argue that something deeper or more general lies behind the surface. One can also argue that the surface does not reflect what really matters at all; that laziness of students is a better explanation than any derived from their own accounts of times when they did no work, for instance.

A way of evading these questions is simply to say that these are what you get when you ask students the questions we asked. That is at least true, but only by definition. It may still be a position worth taking, because the way students think about their experiences, even - or especially - when it is wrong-headed, is what anyone who wants to influence them has to take into account. The effect of telling them that they should review lecture notes will depend on whether they think that to be very hard, or unusual, or a consequence of poor lecturing, not on the view the teacher takes of the matter.

At the same time it is an evasion. To continue to act on the belief that most students are there for the degree, caring little whether they understand or not as long as they can knock out answers to standard questions, if there is solid evidence that many have a passion to understand, is not reasonable. It is not possible to teach without having some opinions about what students are like, and what they have to say about the matter ought to influence those opinions to some extent.

5. 'Good' and 'bad' stories

5.1 KINDS OF STORIES; KINDS OF STUDENTS

This chapter takes an overall look at the 271 'good' and 'bad' stories, and how they divide amongst different years, subject areas, and types of student. The raw data obtained by counting stories is given in tables at the end of the chapter, from which selected aspects have been picked out for display within the chapter.

Each story was classified as being about one of the following areas (using features employed for coding the first line of a coded story, beginning 'Story concerns... '):

Lectures: stories about a lecture, or about a lecture course.

Tutorials: stories about tutorial teaching, examples classes, or any small group work (except in a laboratory).

Laboratories: stories about any laboratory work except project work.

Projects: stories about any laboratory project, in any year and of any length.

Individual work: stories about essay writing, problem solving, private study, or revision for examinations.

Other: stories about examinations, systems of options, work outside university, etc.

Stories were also classified according to the year of the student, and the year the story was about. The small number of fourth year students were placed with third years, all as final year students. This gives six groups:

First year students talking about the first year.

Second year students talking about' the first year.

Final year students talking about the first year.

Second year students talking about the second year.

Final year students talking about the second year.

Final year students talking about the final year.

These can be collected into stories about each year, and stories told by students in each year, as required.

Table 5.1 at the end of the chapter shows numbers of stories by subject area and by years, using the above divisions. Table 5.3 shows how 'good' and 'bad' stories told by students in each year divided amongst the years they concerned.

Using estimates of degree performance from both teachers and students, we divided students into three roughly equal groups according to ability: 'stronger', weaker', and 'medium' (the last including four for whom the estimates differed very markedly). Table 5.2 shows the breakdown by ability within years. The moderate weighting towards stronger students in the second year and weaker students in the final year needs to be borne in mind in interpreting the results. The basis of the division is given with table 5.2.

Clearly the design of the study, which ensures that there will be roughly equal numbers of 'good' and 'bad' stories both overall, and from students in each year, makes it impossible from the data to form any estimate of the relative 'goodness' or 'badness' of students' overall experience, either as a whole or as reflected in stories from those in any one year.

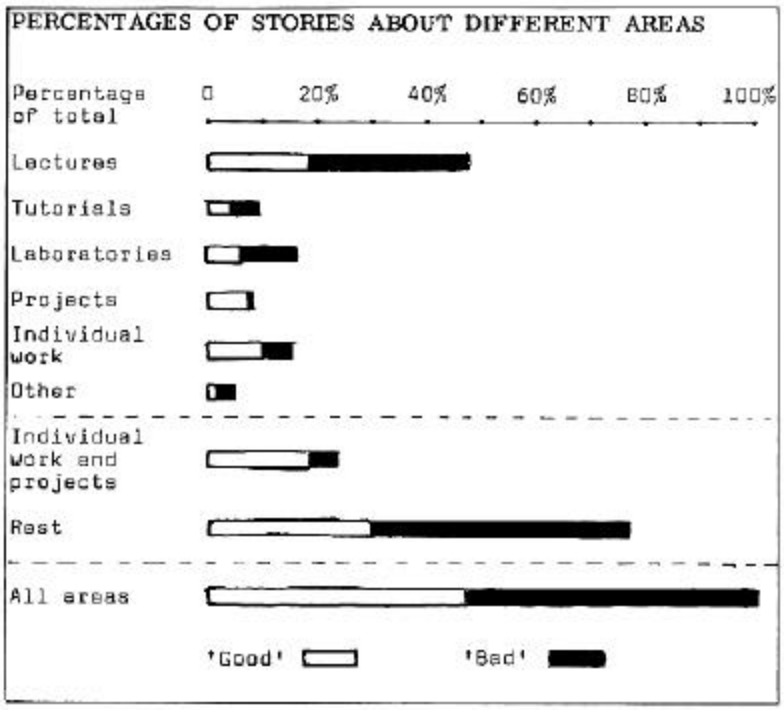
However, because they could choose to talk about any year, and about any subject, it is possible to ask whether there are trends towards greater numbers of stories, or a disproportion of 'good' and 'bad' stories, about any area or about any year.

Students were also free to tell stories in any order, so that one can see if first, second, or later stories divide equally or not amongst areas or years they concern, or between 'good' and 'bad' stories. The relevant data is given in tables 5.6 and 5.7.

Finally, students were free to talk about any topic, inspiring or depressing, easy or difficult. Section 5.8 discusses mentions of topics in stories about lectures, looking for any pattern.

5.2 WHAT AREAS WERE IMPORTANT?

A glance at table 5. I shows that stories about lectures were by far the most frequent, being nearly half of all stories, and that they divided about three to two in favor of 'bad' stories.



Laboratory work, or laboratory work taken together with projects, came next in order of frequency, followed by individual work and tutorials in that order.

Whether the relative frequency of stories about different areas is as one would expect depends upon what one would expect. The preponderance of lecture stories is not surprising for physics students, but is perhaps large out of proportion to the importance given to lectures by staff. If, almost half of the time when students are asked about learning they think of lectures, one is not altogether pleased.

The diagram above shows the percentages of stories, divided into 'good' and ,bad', for the various areas.

The low percentage of stories about tutorials is quite striking. It must disappoint those who see the tutorial as an important occasion on which teacher and student are in close personal contact doing valuable work which cannot be done in any other way. It perhaps indicates a certain realism amongst students: tutorials occupy perhaps an hour or two a week, and are seen

as having importance in proportion.

Laboratory work accounts for just less than a sixth of all stories, or, adding in projects, for almost a quarter. It is hard to decide whether the two together should seem half as important to students as lectures (as indicated by frequency of stories). Similarly, that work done alone should not come last will please those who darkly suspected that students never do such work, but not please so much those who regard it as the main time when things are really learned.

These initial reflections cannot be taken very far. It cannot be assumed without question that areas were made the subjects of stories in proportion to their importance or significance to students. The main hint is one that, to physics students, learning means lectures more than anything else, and that it does not very much mean talking to a tutor.

Before turning to more detailed analyses in pursuit of these ideas, we can also look at the proportions of 'good' and 'bad' stories.

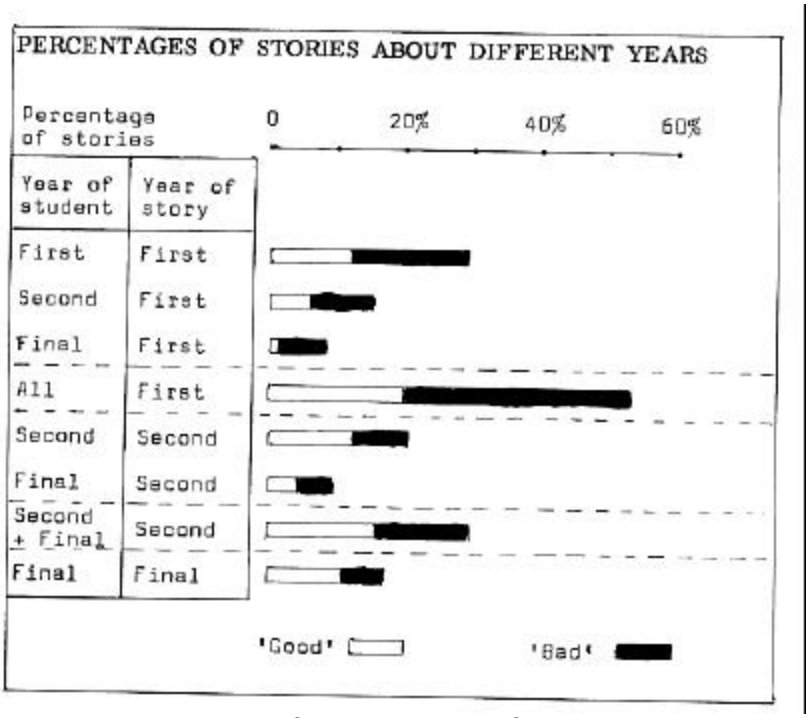
Nothing should be made of the overall excess of 'bad' stories over 'good' (142 to 129; 52% to 48%). It is not statistically significant, and if there is any effect, it probably arises from the way stories were subdivided for analysis. It does not indicate that optional later stories were mainly 'bad' (see table 5.6).

Perhaps the most notable feature of the data in the previous diagram is the difference between, on the one hand lectures, laboratories, tutorials, and other stories all with much the same excess of 'bad' stories over 'good' ones, and on the other hand, individual work and projects which both have an excess of 'good' over 'bad'.

In other words, it is those areas where students are doing things for themselves that are most productive of 'good' stories, and those where things are being thrown at them that they more often report as 'bad'. Laboratory work, which one might have hoped to find belonging to the first .pattern rather than to the second, does not seem to do so. Within the two patterns, the relative fractions of 'good' and 'bad' stories look to be fairly constant,

Looking at how proportions of 'good' and 'bad' stories vary from year to year shows a shift in favor of 'good' ones with time. About the first year as a whole, nearly two thirds of the stories are 'bad'; about the third year, more than two thirds are 'good', as may be seen from the totals at the foot of table

5.1, and from the diagram below derived from them.



The larger number of stories about the first year than about any other, and the smaller number of final year stories than second year stories arises because students were free to talk about any year. The next section looks at how differing memories of 'good' and 'bad' events have affected the numbers of stories told about each year.

On inspection of the above diagram, though, it appears that consistently earlier years are associated with more 'bad' events, and that, looking back, students in later years do not (as might have been hoped) take a more forgiving or less jaundiced view of those earlier years - rather the reverse.

Any such comparisons are of course relative. If one year, or one group of areas of work, is favored another will be disfavored in the data, since 'good' and 'bad' stories must total roughly equal numbers. Thus the first year might show up poorly either because it is inherently full of experiences

remembered as bad, or because the final year is seen as a very good experience, or both.

The grading with time is not automatic. The second year could have, but does not appear to have, shown up as a relative peak or trough. Those who suspect there to be a 'second year depression', as some do, can find no direct support for it here.

The preliminary reflections and interpretations offered here are only tentative guidelines for further analysis, not firm conclusions. The crude data needs much more critical examination before there is evidence that the differences suggested in fact exist, and are not likely to have arisen by chance.

Even should they exist, some such differences may have arisen from other factors, such as a preponderance of weaker or stronger students telling stories of one kind, whether biased towards 'good' or 'bad', towards one area such as lectures, or towards one time, such as the first year.

There will also be interactions. Is the shift towards 'good' stories with time produced by the extra stories about project work (itself seen mainly as 'good') to be expected in later years where projects are often concentrated, or does that not explain the whole shift?

These and other such questions occupy the following sections of the chapter. After that, later chapters take up what are in many ways more important matters, asking not so much whether one area of study or year seems 'better' than another, but why. For that purpose, the reactions of students and the reasons they give for them become important.

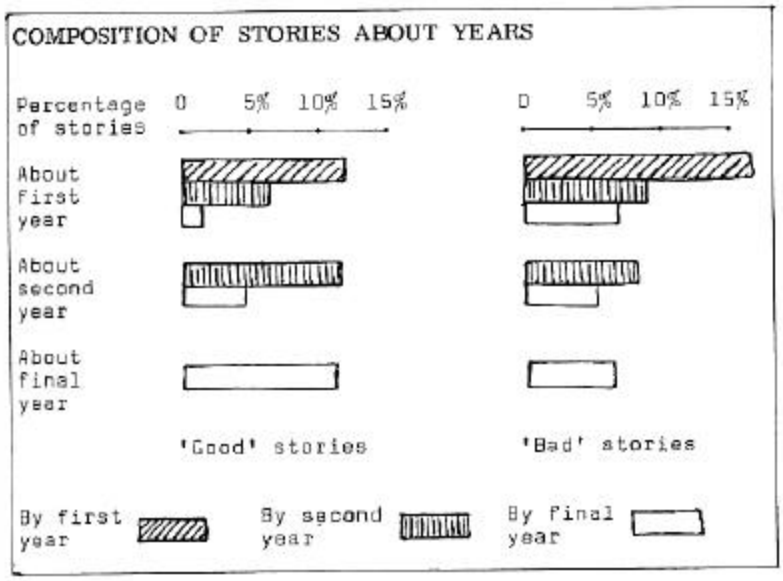
5.3 DIFFERENCES IN MEMORY

Do students remember more or less from previous years than from the current year? Is the memory different for 'good' and 'bad' events? How have such differences affected the numbers of stories of different types told by students?

Table 5.2 shows that, while 'bad' stories divide roughly equally between the available previous years and the current year as well for both second and final year students, 'good' stories are systematically less frequent from any earlier year. The diagram on the next page shows the size of the effect, and how it has affected the composition of stories told about each

y ear.

In general terms, the consequence is that twice as many 'good' stories about the first year are from first year students than from others, while 'bad' stories about that year come equally from first year students and others. In the second year the effect is again there, with more than twice as many stories being from second year students (as opposed to final year ones) in the case of 'good' stories, and less than twice as many for 'bad' ones.



It is not clear just what memory effects to expect on purely psychological grounds. Some would argue that the effect is that people tend to remember bad events in some circumstantial detail, while good events tend to become surrounded in a rather general halo of good feelings. (The misery of losing one's pocket money is recalled; the details of a good holiday are often blurred though the feeling remains strong.) Good events are not forgotten, but are remembered differently, so that an interview method of asking specifically for details of concrete events could produce a bias towards greater numbers of bad events from the past.

Only if one could estimate the size of any purely memory effect would it be possible to use the data to describe the

relative 'goodness' or 'badness' of various years, as seen through numbers of stories told. Later, however, we shall be able to look at feelings and reasons for them, for various years. Even so, the amount of forgetting to be explained away if one wants to maintain that the years do not differ is quite substantial. The number of 'good' stories about any year is never less than twice as many as those told by the same group about the previous year, and rises to three times. There is no evidence of any forgetting of 'bad' stories. Differences between 'good' and 'bad' in this respect are highly significant, with chi-square for the null hypothesis of no association between the three years and the two types of story being 13.4, significant at nearly the .001 level.

In our view, the data at this general level can best be interpreted as being quite inconsistent with any view that students' overall experience of learning physics at university worsens as the years progress, and as lending some support to a view that it may improve. It is not consistent, we think, with any view that students change their minds as time goes by so as to look more favorably on the past than they did at the time.

Further, whatever one thinks about the actual quality of the experiences at different times, it is difficult to escape the conclusion that, so far as recollections are concerned, things seem to students to be better now than they were last year, when they think about the matter at all. This in itself must be a part of the reality, for them, of the way they feel about work at any one time.

Some traces of the things discussed so far can be seen at work in the following extracts from interviews, which may also serve to enliven what must otherwise be an abstract argument. The first, from a third year student, illustrates the importance of immediacy so far as good events are concerned:

> '...the project this year is right on top of me at the moment, but is something I have enjoyed a lot...It has been six month's fairly constant work and a great deal of satisfaction, pleasure, and gaining knowledge - knowledge of things you needn't necessarily have to know for the project, but interest was generated and it carried on from there. It took us right out of the doctrine environment, and down to the workshop where there are a lot of very interesting people you hear about and don't come across... There was the challenge of getting it done, getting equipment, talking to people and trying to get things off them. And I got the impression people cared about what we were doing... one bloke in the Biology Department

(heard about it) and said, "Oh, that's good - I'd love to see that", and he came round to see it...You felt useful; you felt you were contributing something. If you are a student usually you work for yourself - you want a good degree and that is it - but if you go around thinking that the whole time it is not much fun. If you get away from that so the work is carrying on with its own momentum and you are having to push yourself, that's better, I think. '

The same student then looked back a year or two, remembering a lecture course which contrasted in several ways with what he had just said.

'...he hasn't got any presence, and everybody didn't want to go because we couldn't understand a word he was saying...his brain was working on a plane so different from ours. (How did you feel?) Well, you have got to concentrate - sit down and write all the notes out. Now, if he is not making any sense, you don't follow the pattern of the lecture, so you go from taking an interest and writing down what you think he said, to taking no interest and writing down what is on the board without applying any critical sense to it. After about five minutes of this your eyelids begin to close, and you just become like an automaton. You feel there are so many things you could be doing more profitably than sitting in here wasting your time. And you feel angry, because if the .lectures are bad it's not our fault, it's the department's fault. He is a very nice man actually -you couldn't dislike him, but you could think, what the hell are they playing at?

Both stories illustrate the point of the distinction, visible in the data, between working for oneself and having work put over at one. A story from another third year student suggests why it may be reasonable to put private study and revising for exams together with projects as sharing this feature. Again, his story is about recent events.

'... when everything was coming together, and all the courses were beginning to join up...The more they came together the more I learned and understood. It usually happens 3.fter the first time I've read through all my notes. And from then on, learning is a pleasure, because every new fact I read I can say, "Oh yes, I remember that from there" and things begin to slot into places, which helps my understanding. I can feel that now I'm a physicist, that I know what I'm talking about.

> Someone can ask me a question about physics and I can give them an answer...It's like you've dug a garden and dug up all the weeds and planted all the seeds - and one day you come round and they're all blooming. That's what it feels like - watching those flowers come up from nothing. Knowing that you've put in the work...that what you've been doing has had a potential and it's now being realized. It gives me confidence to continue. I feel that the work has been worthwhile, and that makes me work harder then - it pushes me on more and more because I know that I'm not wasting my time. It's an interest -it really develops.'

To conclude these examples, one from a second year student about first year laboratory work suggests some reasons which may sometimes lie behind its not being seen very differently from lectures and other teaching.

> 'The experiments cover a vast range of things...you quite often end up doing the experiment before you do the lecture course, so you're beating your way through this thing not understanding the slightest little bit of what you're doing... You felt it was something you had to do, and had to keep having to keep at it all the time. ...(the script) tells you virtually exactly what you should do - it's just a case of following instructions...you're working virtually completely in the dark...you've got no feel for the experiment and why it did what it did... You're just doing exactly what you're told just to get a set of results - to get the practical done - and nothing else. '

5.4 SIGNIFICANT VARIATIONS IN NUMBERS OF STORIES

Some of the variations in numbers of stories, 'good' and 'bad' or in total, looked at in section 5.2 could well have arisen by chance. Evidence that this is unlikely would make one take them more seriously.

Table 5.4 at the end of the chapter is derived from table 5.1. It shows where the proportions of 'good' and 'bad' stories in the various categories of table 5.1 depart markedly from the overall proportions.

It assumes that one may expect the overall ratio (129/142) of 'good' to 'bad' stories to obtain in each part of the table, unless there is good reason for a departure. So, for example,

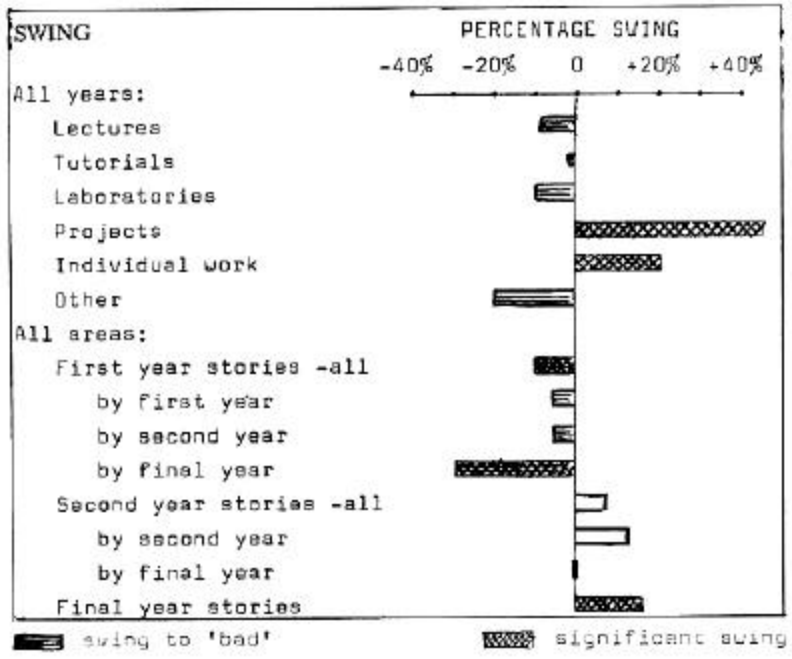
the first entry in table 5.1 shows 35 stories about lectures told by first year students, 15 'good' and 20 'bad'. Had the 35 stories divided in the ratio 129/142 there would have been 16.7 'good' stories and 18.3 'bad' ones.

There are fewer 'good' stories than expected if first year lecture stories follow the general pattern, and correspondingly more 'bad' stories. A measure of the tendency towards either is the number of stories which would have to swing from 'good' to 'bad' to give the expected proportions. Here the value is -1.7, the sign indicating the tendency for stories to be 'bad'. To compare swings it is convenient to express them as percentages of stories: in this instance, as 5% of the 35 stories told. Table 5.4 shows such swings for all cells in table 5.1 having more than ten stories.

Is such a swing statistically significant? Calculating the statistic chi-square from the observed and 'expected' frequencies:

$$\Sigma\,(f_{obs}-f_{exp})^2/f_{exp} = 1.72/16.7 + 1.72/18.3 = 0.3 \quad .$$

which is well below the value 3.8 at which chi-square is significant at the .05 level (for one degree of freedom). Cases where the swing is significant at the .05 level or better are underlined in table 5.4, and shown hatched in the diagram below.



The diagram on the previous page shows the overall swings for the different areas (all years) and for the different years (all areas).

By themselves, the swings against lectures, tutorials, laboratories, and other stories are none of them significant. Taken together, however, there is an average swing of -9% which is significant at the .05 level.

Another way of saying the same thing is that the division of stories into projects and individual learning on the one hand, and lectures, tutorials, laboratories, and the others on the other hand, gives stories which can not be regarded as coming from one uniform set with the same proportion of 'good' and 'bad' stories.

Within the two groups the variations are not significant, so it is best to regard them as behaving similarly.

Dividing stories by years, the first year stories are significantly 'bad' and the third, or the second or third taken together, are significantly 'good'. The second year is not significantly different from the average taken on its own.

The detail of table 5.4 shows that care needs to be taken in interpreting some of these differences.

The swing against first year stories as a whole is dominated by the large swing of final year stories about the first year (-30%). This itself largely arises from a disproportion of 'bad' stories about lectures by these students. And it must be recalled that final year students produced many more 'bad' than 'good' stories about the first year; an effect probably owing something to differences in memory. It must be remembered, however, that stories about the first year represent nearly half the total number, so dominating the averages and making it difficult to detect any significant swing.

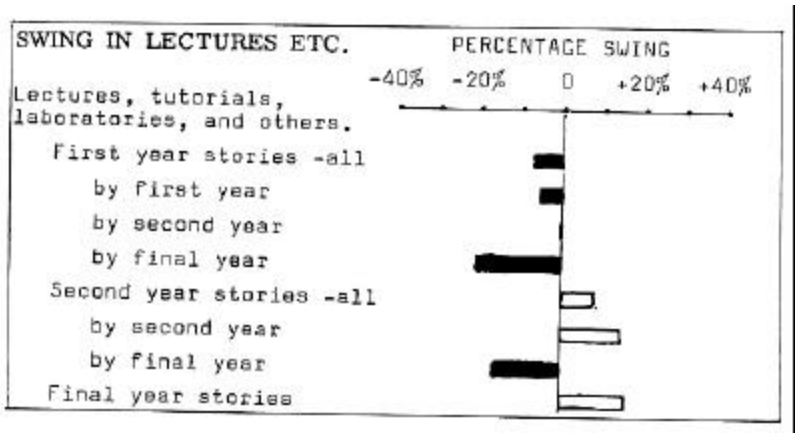
Similarly, the swing in favor of the final year is dominated by the 'good' stories about projects in that year, where they are to be expected.

The swing in favor of projects and individual work is not, however, produced entirely by project stories. Individual work shows a positive swing by itself, and one to which stories about all years contribute.

In view of the fact that lectures, laboratories, tutorials, and other stories behave differently from project and individual work

stories, it is clear that evidence about swings for any one year taking stories as a whole will tend to be reduced because of the opposite tendency in the two groups of kinds of story. Useful partial evidence about the differences between years could thus come from looking at the numbers of stories year by year in the two groups separately.

The result, for lectures, tutorials, laboratories, and others alone is shown in the diagram below. There is a change from a swing of -7% against the first year as a whole to swings of 7v/C and 14% in favor of the second and final years respectively. The variation with time is statistically significant, by a test of the null hypothesis that all these stories divide into "good' and 'bad' in the ratio 81/127, this being the way all the 208 stories in this group split.



We think it can be concluded that, at least in our sample of students, there was a shift of feeling, other than any due to project work or to more opportunity to work alone, which made work in lectures, laboratories, and tutorials seem rather better in the final year than in the first.

The pattern over the years of numbers of feelings about projects and individual work is much more constant, with 'good' stories consistently outnumbering 'bad' ones by three to one. There is a slight and not statistically significant shift from a smaller ratio in stories about the first year to a larger ratio for later years.

5.5 VARIATIONS IN RELATIVE IMPORTANCE

In section 5.2 we attempted to suggest some judgements about the relative importance overall of various areas, such as lectures and laboratories, on the basis of the total numbers of stories told about each. Because there can be nothing with which to compare them, except other experience or expectations, only personal judgement of their significance is possible.

It is, however, possible to look at the detail of table 5.1 and see if different areas seem to be more or less than usually important in different years, and table 5.5 gives data of this kind. For each Cell of table 5.1, we calculated an expected total number of stories, by sharing the total number of stories told by one group of students in the ratio of the total number of stories about the relevant area to the grand total of stories told. So for the first cell, lecture stories told by first year students, the 79 first year stories by first year students were shared in the ratio 128/271, since there are 128 lecture stories in all out of the grand total of 271 stories, giving an expected number of 37.3 stories. The actual number, 35, is less by 7%, so that there is a tendency for these stories to be less important than others in general. This particular deviation is not statistically significant.

Amongst the significant differences, there is a trend for stories about projects and individual work to become more important as one goes from the first to the final year, perhaps reflecting more opportunities for such work. Correspondingly, there is a trend for lectures, laboratories, tutorials, and other stories to become less important, but not a significant one.

One very striking deviation is the high importance given to laboratories in stories by first year students (+30%). The value for all first year stories is still positive (+19%) but does not attain statistical significance. Taking this together with the relative 'badness' of first year laboratory stories (table 5.4) there seems to us to be a case for regarding this as a critical area. It is explored in more detail later in the book.

In accord with what has previously been noted, there is also a high importance (+32%) for stories about first year lectures by final year students, running if anything counter to the importance given to first year lectures by the others. The nature and composition of the stories in this category needs special attention.

As before, it is necessary to emphasize the relative nature of such data. Within a fixed total number of stories, if more of one kind are present, there must be fewer of another kind.

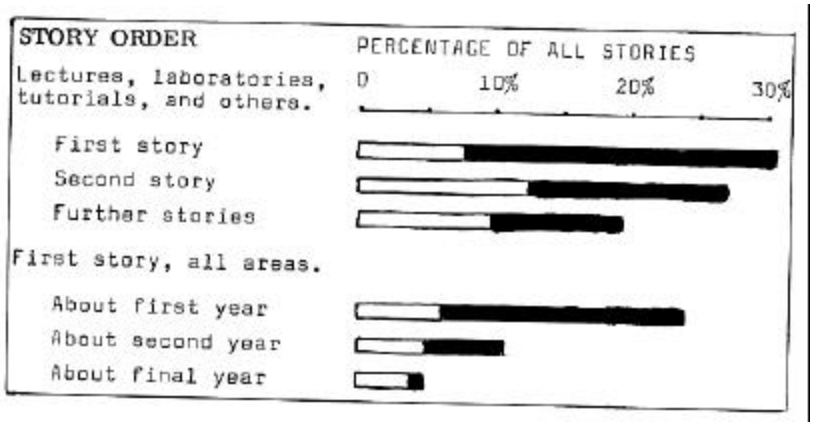
5.6 INFORMATION FROM STORY ORDER

The thing one thinks of first and the thing one thinks of after reflection when somebody asks a question, sometimes have a different character. We kept a record of the order in which stories were told, which is summarized in tables 5.6 and 5.7., and in this section look at differences between the things students talked about first, second, and later.

The first story has a strong overall tendency to be a 'bad' one, with the ratio 39/67 departing significantly from the overall ratio 129/142 of numbers of 'good' and 'bad' stories. This departure is due to a heavy predominance of 'bad' stories about lectures, laboratories, tutorials, and others: the ratio 21/62 of 'good' to 'bad' stories of this kind even departing significantly from the ratio for all first stories. By contrast, stories about projects and individual work divide into 'good' and 'bad' in the same way for first and for later stories.

There are not significantly more lecture etc. stories amongst the first stories told, but significantly more of them in first stories and fewer of them in later stories, are 'bad' rather than 'good'.

It appears that the first story contains, in a magnified form, a tendency which is visible in the whole data. The same is true of variations in numbers of 'good' and 'bad' stories across the years: there are significantly fewer 'good' than 'bad' ones about the first year (16 to 48) as compared with the second and final years (13 to 16 and 10 to 3 respectively). The variation is highly statistically significant, supporting the view based on other evidence that feelings about the years become more positive as time goes by.



The diagram on the previous page illustrates these variations with story order, and in particular the magnifying effect of the first stories. The decline in numbers of stories told about the years taken in order, in the first story, is noticeable. It is larger than that for all stories, but the difference does not reach the level of statistical significance.

Any interpretation of these effects depends on having some view about the special nature of a first story, since it is the first stories which seem to be different. Some would argue here that people in general, and here students, tend to say first what is most on their minds, and later tend to rationalize away the prejudice they think they may have revealed. They would argue that the results suggest that recollections of the first year are decidedly 'bad' rather than 'good', associated mainly with main-stream teaching (lectures etc.). Others would argue that a nervous student at the start of an interview will not tend to produce anything very unpalatable. To square the data with this view one needs to suppose that the students thought we would specially welcome 'bad' stories, which we did our best not to do or to appear to do. Yet others will place more weight on later stories, feeling that they may show more of the student's considered judgement. They can take some comfort from the data, but to do so do have to dismiss the special character of the first stories as hasty or ill-considered.

In all, perhaps one might say that the results suggest at least that student's 'snap judgements' lean in a definite direction, a fact which, however one interprets it, may need to be taken into account in thinking about how things seem to them since in ordinary life it is such judgements which often weigh the most.

5.7 THE WEAK AND THE STRONG

Table 5.8 shows how stories of different kinds were distributed between 'weaker' and 'stronger' students, using the classification set out in table 5.2. Roughly, the 'stronger' were those with a decent expectation of a final class of 2.1 or better, and the 'weaker' were those likely to get a 2.2 or worse. A roughly equal number were poised uncertainly between the two groups.

The main point of this data is to check whether 'weaker' or 'stronger' students have had an undue influence on any of the results. The main outcome is that they have not. We can detect no statistically significant departures in the various ways their stories are distributed. The 'weaker' did talk a little more about lectures etc., and the 'stronger' a little more about

projects and individual learning, as one-might expect, but the difference is not significant. The 'weaker' students somewhat dominate final year stories by final year students, but only in proportion to the excess of weak students we happened to have in the final year sample (see table 5.2). In view of this, the evidence for a positive swing of feeling towards the final year, and for a special appreciation of projects and individual work, might be thought to carry more rather than less weight.

One very special group is the final year students telling first year stories about lectures, since data from them contributes substantially to the significance of some of the results about the first year. The composition of the stories is a little worrying, being:

Final year students; first. year lecture stories.

	Students	'Good' stories	Bad' stories
'Weaker'	17	1	6
'Medium '	14	0	8
'Stronger'	9	1	0
	40	2	14

Clearly, 'stronger' students have not contributed appreciably to these substantially 'bad' stories. The number from 'weaker' students is closely in proportion to their numbers, but stories from 'medium' students are large, and those from 'stronger' ones are small, in proportion to their relative numbers. The dependence of the pattern on the division into types of student approaches, but does not quite reach. statistical significance at the .05 level. Tracing back the records, four of the 'bad' stories came from 'medium' students at one university, all telling stories about the same lecture course. It does therefore seem likely that data from this group, while not heavily biased, ought to be treated with some caution.

Happily, other places where small numbers contribute largely to the significance of a result (such as first year stories about laboratories) show no such fluctuation.

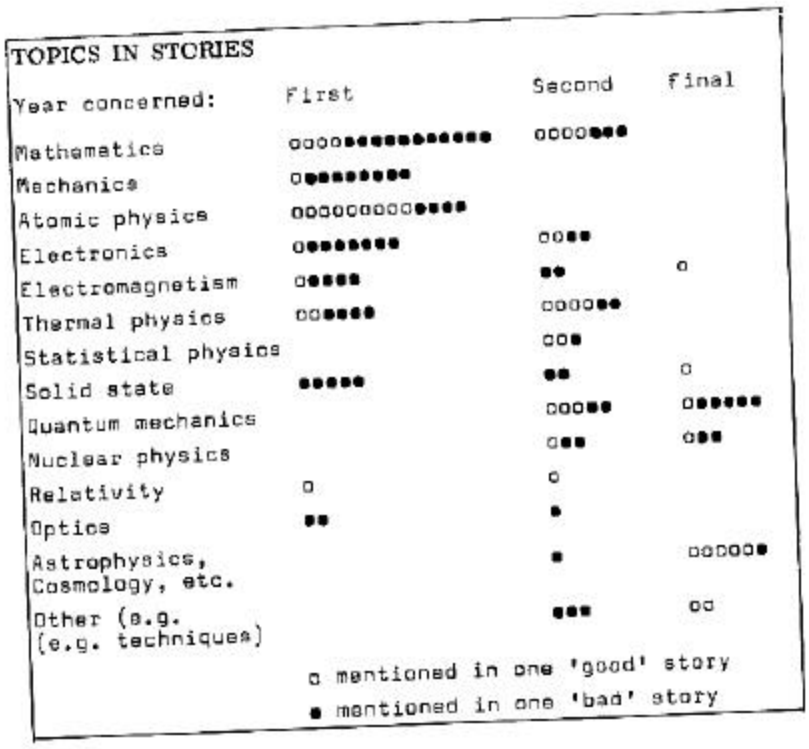
To repeat, overall there does not seem to be any important way in which 'weaker' or 'stronger' students have divided sharply in the kinds of stories they told. With respect to the present evidence, they are much more alike than they are different.

5.8 TOPICS TALKED ABOUT

Naturally, in talking about 'good' and 'bad' episodes students often mentioned the topic they were studying as being important. So we collected mentions of topics in stories about lectures, to see if any emerged as important or interesting.

In the first year, mathematics easily led the field. It just retained its lead in the second year, but where there had been more than twice as many instances in 'bad' stories as in 'good' ones, the numbers were now more equal. There were no mentions of it in final year stories.

The diagram below shows this and other topics mentioned.



Clearly, not too much can or should be made of this data. The 121 mentions naturally divide into 'good' and 'bad' in the same way as the 128 lecture stories from which they came. The spread over different topics is quite broad, and there do not seem to be obvious ways of grouping them into types which are

predominantly 'good' or 'bad'.

The first year pattern is clear and intelligible. It is in mathematics and mechanics, where as compared with school there is a sudden increase in formality and rigor (which many would regard as essential but some as a sometimes unnecessary demonstration of superiority) that things often go wrong.

Atomic physics, often regarded as relatively new and interesting, does seem to be so. The stories about electronics, it must be remembered, are about lectures on electronics. They do not seem to go too well.

Elsewhere, numbers are too small for inferences to be at all safe. It would be agreeable to think that second year thermal and statistical physics is better received than is often thought. It is sad but not unexpected that the difficulties of quantum mechanics appear to show up. It is interesting that unusual, often optional topics like cosmology do well, again as one might hope. None of these, however, amount to more than faint pointers.

5.9 THINGS TO THINK ABOUT

In the course of the chapter, we have offered a few tentative inferences and conclusions. They are all more of the nature of things that may be worth thinking about, than of the nature of firm conclusions. They represent part of the agenda for the rest of the book, not its message.

One thing we proposed was a possible shift in feelings through the years. So later we have tried to look at what those feelings were and at reasons for them.

Another was a division into work done individually, and work 'thrown at you', as producing quite different outcomes. So we have looked at the different sorts of feelings they produce to ask whether the obvious guess as to the reasons for the difference finds any support.

Within that, the different areas such as lectures, laboratories and so on, sometimes produced interesting variations (the relative 'badness' and importance of first year laboratories, for example). Accordingly, and also because it fits with the way most people divide teaching in their minds, we have organized part of the rest of the book around discussions of these areas one at a time. The next chapter prefaces that with a look at some of the overall patterns of feelings to be found in the stories.

TABLE 5.1
TYPES OF STORIES BY YEARS

Year of story		1	1	1	1	2	2	2	F	1,2,F
Student's year		1	2	F	1,2,F	2	F	2,F	F	1,2,F
	G	15	7	2	24	11	5	16	10	50
Lectures	B	20	13	14	47	13	9	22	9	78
	T	35	20	16	71	24	14	38	19	128
	G	4	1	2	7	2	1	3	2	12
Tutorials	B	5	3	0	8	4	1	5	1	14
	T	9	4	2	15	6	2	8	3	26
	G	3	4	0	7	8	0	8	1	16
Labs	B	15	3	3	21	2	1	3	3	27
	T	18	7	3	28	10	1	11	4	43
	G	2	2	0	4	3	3	6	11	21
Projects	B	0	0	0	0	1	0	1	1	2
	T	2	2	0	4	4	3	7	12	23
	G	9	3	0	12	8	3	11	4	27
Individual	B	2	4	2	8	1	1	2	3	13
work	T	11	7	2	20	9	4	13	7	40
	G	0	0	0	0	1	0	1	2	3
Other	B	4	1	0	5	1	2	3	0	8
	T	4	1	0	5	2	2	4	2	11
	G	33	17	4	54	33	12	45	30	129
All areas	B	46	24	19	89	22	14	36	17	142
	T	79	41	23	143	55	26	81	47	271

G 'good' stories
B 'bad' stories
T total 'good' and 'bad' stories

1 first year
2 second year
F third or final year

TABLE 5.2
DISTRIBUTION OF STUDENTS BY YEAR AND ABILITY

	Weaker	Stronger	Medium	Contra-dictory	Total
First year	9	8	15	2	34
Second year	14	18	8	1	41
Final year	17	9	13	1	40
All years	40	35	36	4	115

CATEGORIES Pairs of estimates of final degree class from staff and students were categorized as follows:

	One estimate	Other estimate
Stronger	1, 2.1, 1 or 2.1	1, 2.1, 1 or 2.1
	1, 1 or 2.1	no estimate
	2.1	2.1 or 2.2
Medium	2.1, no estimate	2.2, no estimate
	2.1 or 2.2	2.1 or 2.2
	2.2	2.1 or 2.2
Weaker	2, 3 or 2.2	no estimate
	2.2, 3, pass	2.2, 3, pass

TABLE 5.3 DIVISION OF STORIES ABOUT YEARS

Student's year	Final	Second	First	All students
Number of students	40	41	34	115
'Good' stories about:				
final year	30			30
second year	12	33		45
first year	4	17	33	54
'Bad stories about:				
final year	17			17
second year	14	22		36
first year	19	24	46	89

TABLE 5.4
SWING TOWARDS 'GOOD' STORIES

Year of story	1	1	1	1	2	2	2	F	1,2,F
Student's year	1	2	F	1,2,F	2	F	2,F	F	1,2,F
Lectures	-1.7	-2.5	-5.6	-9.8	-0.4	-1.7	-2.1	+1.0	-10.9
	-5%	-12%	-35%	-14%	0%	-12%	-5%	+5%	-9%
Tutorials				-0.1			-0.8		-0.4
				0%			-1%		-1%
Labs	-5.6			-6.3	+3.2		+2.8		-4.5
	-31%			-22%	+32%		+25%		-10%
Projects								+5.3	+10.1
								+44%	+44%
Individual work	+3.8			+2.5	+3.7		+4.8		+8.0
	34%			12%	41%		37%		20%
Other									-2.2
									-20%
All areas	-4.6	-2.5	-6.9	-14.0	+6.8	-0.4	+6.5	+7.7	
	-6%	-6%	-30%	-10%	+12%	0%	+8%	+16%	

Values are only given for categories having 10 or more stories. Values underlined are significant at .05 level or less (chi-square)

SWING The swing tabulated here is the number of stories which would have to switch from 'good' to 'bad' for the numbers of 'good' and 'bad' stories .in each category to be in the overall average proportion of 129/142.

TABLE 5.5
RELATIVE IMPORTANCE OF AREAS BY YEARS

Year of Study	1	1	1	1	2	2	2	F
Student's year	1	2	F	1,2,F	2	F	2,F	F
Lectures	-7%	-3%	<u>+32%</u>	+5%	-8%	+12%	-2%	-17%
Tutorials				+8%				
Laboratories	<u>+30%</u>			+19%	+13%		-17%	
Projects								+64%
Individual work	-3%			-5%	+10%		+8%	
Lectures Tutorials Laboratories Other	+8%	0	+23%	+9%	0	-5%	-2%	-28%
Projects Individual work	-40%			<u>-38%</u>	-1%		+6%	<u>+48%</u>

Values are only given for categories having 10 or more stories. Values underlined are significant at .05 level or less (chi-square).

IMPORTANCE The values tabulated are the differences (expressed as percentages) between the total numbers of stories told about an area by a group of students, and the total that would be expected if each cell in table 5.1 has its proportionate share of stories. The latter is found by multiplying the ratio of the number of all stories told about an area to the total number of stories, by the number of stories in the relevant year group.

TABLE 5.6
STORY ORDER BY AREAS

Story order:	First			Second			Third		
	G	B	T	G	B	T	G	B	T
Lectures	12	39	5 1	26	26	52	12	13	25
Tutorials	4	5	9	2	5	7	6	4	10
Laboratories	5	14	19	5	6	11	6	7	13
Projects	9	0	9	6	1	7	6	I	7
Individual work	9	5	14	14	5	19	4	3	7
Other	0	4	4	I	2	3	2	2	4
LTLO	21	62	83	34	39	73	26	26	52
PI	18	5	23	20	6	26	10	4	14
All areas	39	67	106	54	45	99	36	30	66

TABLE 5.7
STORY ORDER BY YEARS STORIES TOLD ABOUT

Story order:		First			Second			Further		
		G	B	T	G	B	T	G	B	T
Year	Area									
	LTLO	13	44	57	14	22	36	11	15	26
1	PI	3	4	7	10	2	12	3	2	5
	All	16	48	64	24	24	48	14	17	3 1
	LTLO	6	15	2 1	14	12	26	8	6	14
2	PI	7	1	8	7	1	8	3	1	4
	All	13	16	29	2 1	13	34	11	7	18
	LTLO	2	3	5	6	5	11	7	5	12
F	PI	8	0	8	3	3	6	4	1	5
	All	10	3	13	9	8	17	11	6	17

G 'good' B 'bad' T total

LTLO Lectures, tutorials, laboratories, and others
PI Projects and individual work

TABLE 5.8
'STRONGER' AND 'WEAKER' STUDENTS

Type of student:	'Weaker'			'Stronger'			All		
	G	B	T	G	B	T	G	B	T
Lectures	21	32	53	15	21	36	50	78	128
Tutorials	2	6	8	2	5	7	12	14	26
Laboratories	8	8	16	6	7	13	16	27	43
Projects	6	0	6	7	1	8	21	2	23
Individual work	7	5	12	10	3	13	27	13	40
Other	1	2	3	0	4	4	3	8	11
LTLO	32	48	80	23	37	60	8 1	127	208
PI	13	5	18	17	4	21	48	15	63
All areas	45	53	88	40	41	81	129	142	271
About year 1	18	3 1	49	18	23	4 1	54	89	143
About year 2	16	13	29	15	16	31	45	36	81
About year F	11	9	20	7	2	9	30	17	47
About all years	45	53	98	40	41	81	129	142	271

6. Patterns of feelings

6.1 KINDS OF FEELINGS

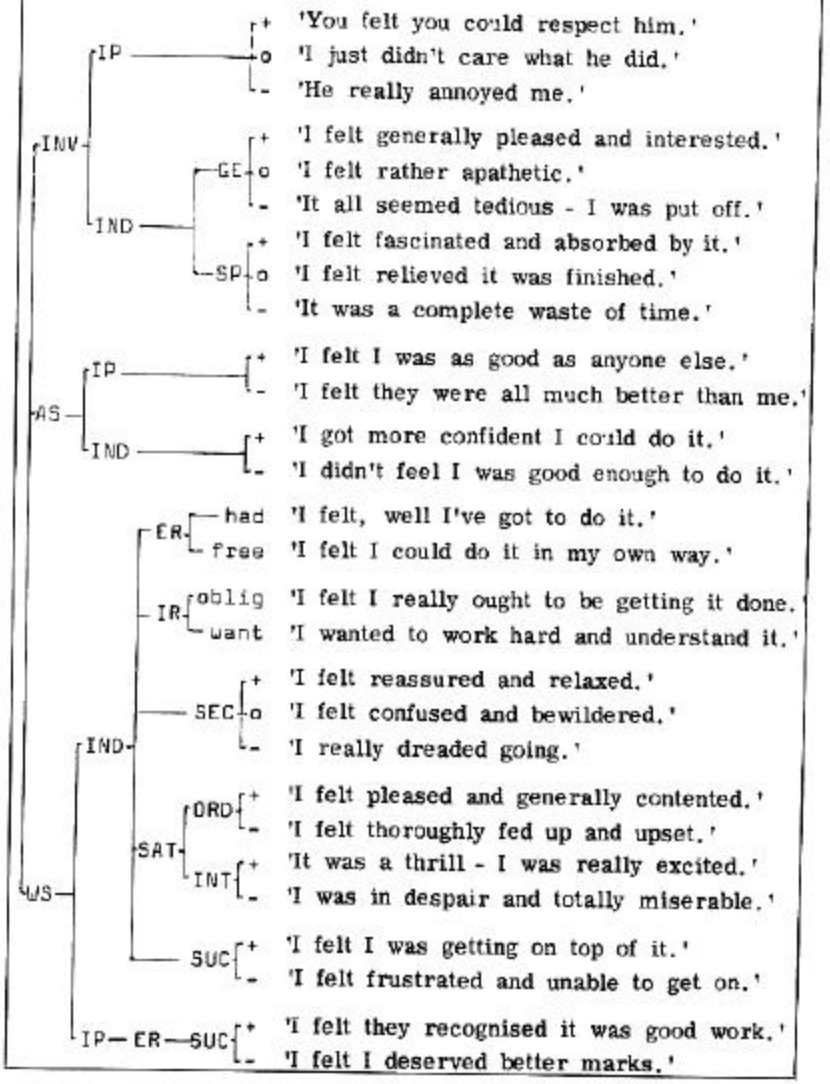
Where the previous chapter looked only at the broadest aspects of the stories, this chapter, while still taking an overall view, comes closer to the detail of the interviews. It asks what patterns of feelings can be seen in the stories as a whole, and what different patterns can be seen as between different areas, such as laboratory and project work, or between different kinds of student, such as first year and final year, 'stronger' and 'weaker'.

The chapter is based upon counts of feelings in various categories coded from the interviews. Table 6.1 at the end of the chapter gives such counts for all stories, and for two main groups of areas (lectures, tutorials, laboratories, and others, and projects and individual work). The table, like the diagrams in the chapter, uses an abbreviated form of the network of features describing feelings to indicate the various categories. Something of the development of this network has already been sketched in chapter 3, and the full network appears in the appendix. In the present section, the categories are briefly explained, with examples, so as to convey the force of the various distinctions. Without that, the discussion of patterns of feelings would lack a much-needed concrete reference.

The diagram on the next page gives brief examples of the type of expression of feeling we assigned to the different categories. It uses the same abbreviated network as table 6.1 and the other diagrams, and may be used as an informal key to them. The fuller significance of what goes in each place can only be grasped from the material from which the descriptive system was derived, namely the interviews themselves. That is the function of the more extended examples given in the text.

The first main group of kinds of feelings, at the top of the diagram on the next page, all concern feelings of involvement, abbreviated to INV. They divide into feelings of involvement with someone else (interpersonal, abbreviated to IP) and of individual involvement with work or a subject (abbreviated to IND).

EXAMPLES OF MAIN KINDS OF FEELINGS



Positive feelings of interpersonal involvement include respect, liking, trust, being cared about, gratefulness, contact, and so on. The following would count as an example:

> '...it was a personal contact with him. You felt he was a friend, and this sort of friendship is a good way to start learning...You get the feeling that now he is trying to help me, so I have got to do my best or he will be disappointed which will make me disappointed.'

The negative feelings include being annoyed, disliking, hating, resenting; feelings like:

> 'Nobody was asking questions,- we wouldn't ask him a thing. And people began to hate him - in the social area if he walked in it would just go dead quiet and everybody would ignore him and not say anything to him. That made for a very bad situation there.'

Besides such feelings of antagonism, we found it useful to distinguish feelings of the absence of involvement, indicated in the abbreviated network by a zero, not + or -. It groups things like not caring, indifference, lack of concern, lack of respect, remoteness, and lacking confidence in someone. The next quotation perhaps conveys the tone:

> 'I don't think it's the best conditions for a tutorial if you don't get on terribly well with the other people. I mean, I can't even tell you the names of the people in my tutorial, even though there are only five others. It's not the same as when you're one of a happy group and you can help each other and ask each other questions.,

The examples illustrate a point worth reiterating from chapter 4, that it is in the detail that one sees what is meant. The last example is clearly a case of non-involvement with others, however hard one might find it to pin it down more precisely.

The next group, of feelings of being individually involved in work, turns out to be a large one which it is not easy to divide in a reasonable way. Positive and negative feelings are easy enough - for example;

> 'It was always interesting, and it always kept you wanting to know more of what was coming next. Your mind was active. '

> '...thinking that I'd wasted an hour listening to this chap, or not listening to him, and I wasn't getting anywhere.'

Both, however, are relatively general, and we felt that they contrasted with rather more specific reactions to particular things, such as:

> '...you have a good idea that improves your previous method, and it suddenly works, and you're up on high again. It's good - sort of warm - and adds color to everything you do.'

> 'I was very annoyed, because I spent half an hour just trying to work it out, going through equations and everything. I knew it was fairly simple, so I was annoyed at not being able to get it out.'

Because we thought we detected this difference, we divided individual involvement in physics into a general and a specific kind (abbreviated GE and SP). The distinction was not very easy to maintain, and we do not have total confidence in it. That is, although the two categories do contain things like a general overall feeling of more interest on the one hand, and definite feelings of involvement in a particular piece of work on the other, intermediate cases were too common for comfort. Things like 'feeling a real interest in thermodynamics' went in the specific category, but were not easy to distinguish from more generalized reactions. If anything, then, feelings have too often been labeled specific.

In both groups, there were again feelings of zero involvement, such as apathy, emptiness, or deadness in the general category, and relief it was over, preferring something else, not bothering with something, or indifference towards a subject, in the specific one. Thus, for example:

> 'It was bitty and unconnected...One got to the stage where one sort of came in, sat down, rattled off a set of notes from the board, and dashed out again, sighing that another lecture on that was over...It became a bit of a joke really, almost a competition to see how many pages of notes would be produced and how many equations would be put up on the board.'

The next major grouping of feelings is one of feelings about oneself, abbreviated to AS. They again divide into interpersonal (IP) and individual (IND) feelings. So, to give a positive example of each:

> '...telling them to come and see me. It was quite nice, not that I like telling people things, because if anything they're more intelligent than me. But it was a nice

situation, because my (idea) did work, which is more than anybody else's did.'

'...pleased with yourself that you've actually done it. You just feel generally clever, whereas before when it doesn't work you feel a bit depressed. You think, "Oh I'm useless at this" and then (when it works) relief and "Hurray, I've done it".'

This last example illustrates the rather close relation between feelings about oneself such as feeling clever or pleased with oneself, and feelings which we have, perhaps unwisely, categorized differently, such as relief and freedom from worry or their opposites. The latter fall under feelings within oneself of security, insecurity, or lack of security (abbreviated WS and SEC +, o, or -). There is some difference, but it is not an easy one to maintain. The last example contains some of both. The following is a more definite example of insecurity:

'... lack of self-confidence. Which involves problems that aren't just associated with the academic side, but with being away from home too. You've got to impose your will to do the work, and though it's sometimes rewarding when you've done it, if you can't it's very depressing. You feel very miserable, really.'

Amongst feelings to do with security, we have a group of 'zero' feelings (as with involvement), of which the following is an example, revealing doubt rather more than the anxiousness of the last:

'... a bit confused... sort of futility...you get a bit tangled up in it and you can't sort it out.'

Returning again to the order of the categories in the diagram given previously, the first group of feelings within oneself (WS) are to do with rules, standards, freedom, or compulsion. Ones like that instanced by,

'...to do something totally on your own...you've done it yourself. '

have to do with feelings of independence or freedom, as opposed to others like,

'I was under pressure - I-had to get it done for exams.'

which have to do with some kind of compulsion. Both are about external rules or forces or their absence (abbreviated ER).

Related, but not the same, are feelings about the student's Own inner rules, feelings of wanting to work or of it being right to try hard, for example(abbreviated 'want' and 'oblig'). 'Obligation' here refers to feelings such as that one ought to work, learn, or try, and not to any outside obligation. Both kinds have to do with inner rules (abbreviated IR).

After security, comes a large group of feelings, also ones within oneself, but now of satisfaction or dissatisfaction. Here we felt it useful to divide the feelings into ordinary and intense ones (abbreviated SAT C}RD and SAT INT). The next two examples contrast ordinary and intense positive satisfaction.

> 'I used to .come out of the lectures and feel a sort of satisfaction that I had understood something, and that I had enjoyed myself...that you were getting somewhere, and that what you were doing wasn't a waste of time.'

> 'I found it tremendously upheaving - it made me feel really happy - my spirit felt lifted. You do the project yourself... and then to find that it all fitted together just as you were shown, was pure happiness really.'

The corresponding negative varieties are not hard to imagine, being things like fed up and discontented on the one hand, and despairing and miserable on the other.

The last group of feelings within oneself are feelings of success or achievement (abbreviated SUC). Examples of it and lack of it are:

> 'There was a sense of achievement in getting things done and finished.'

> 'I just couldn't keep up with it, so I had to give up on that topic. I felt it was too much for me.'

Finally, there. are feelings again to do with success, but this time related like freedom and having to do things to external pressures or rewards (abbreviated ER SUC). They are also interpersonal, since someone is responsible for the praise or blame.

In looking at all these examples, the reader will have noticed how any actual example contains traces of feelings in more than one category, even if it falls mainly within one. The categories are an abstraction from and a distillation of the many things the students said, and we did not attempt any close one-to-one correspondence between words on the page of the

transcripts and codes to represent feelings. Rather, we assumed that the whole of what was said was an expression of several feelings, and coded as many as seemed necessary to catch the overall meaning. Thus each interview generates several terms for feelings, falling under more than one category. Going back to the coded stories given before (1.4 and 3.2) for examples, the first (essay) story is recorded as containing feelings of pleasure (general satisfaction), being pleased with oneself (positive feelings about oneself), of having done something (positive achievement) and of working independently (internal regulation and freedom). The story is not one feeling, but a configuration of different kinds.

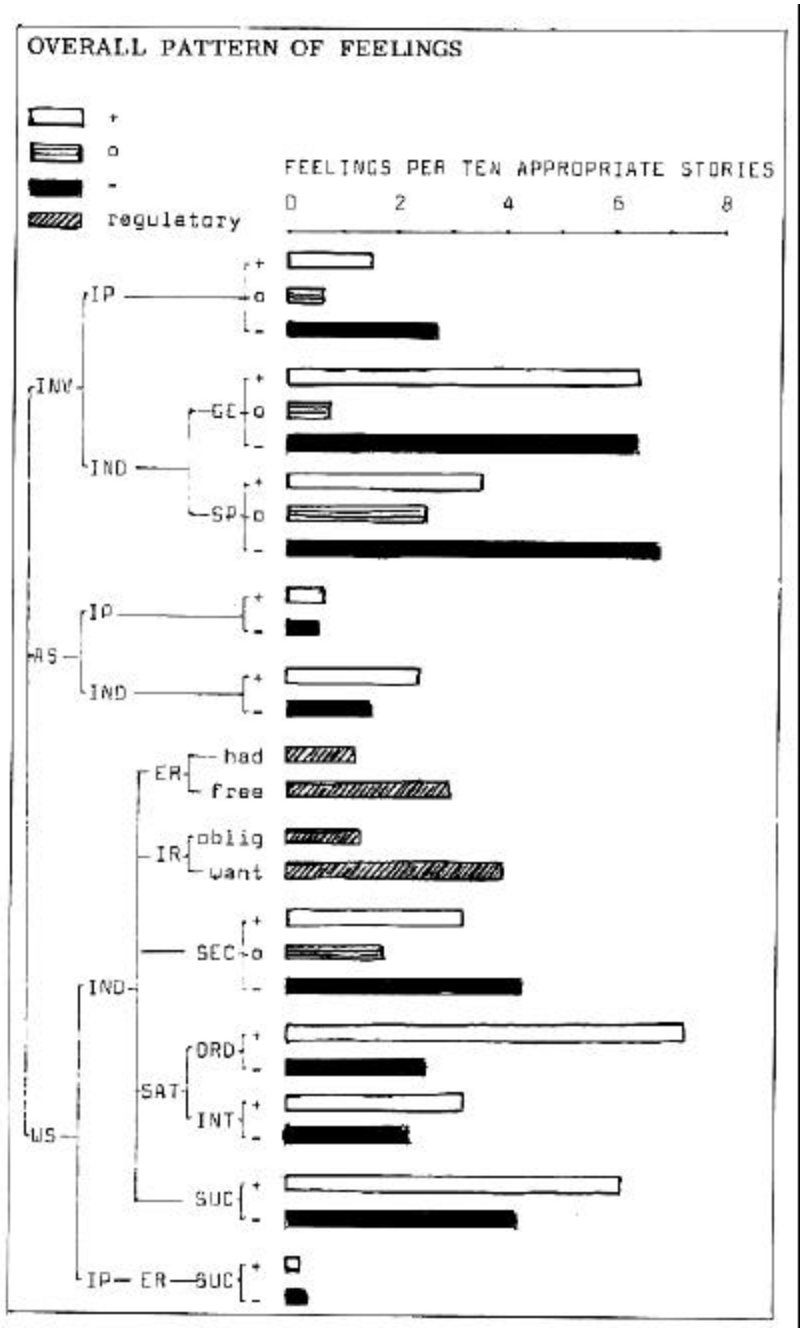
In what follows, the various feelings from stories are looked at to see which are more, and which are less frequent in different situations. Later in the book, the detailed connections between feelings, and between feelings and reasons, are looked at, but for the moment we choose to neglect those aspects.

6.2 THE OVERALL PATTERN OF FEELINGS

The diagram on the next page shows, using the categories and network just described, the frequency with which different kinds of feelings arose in the coded stories.

Since the number of feelings obviously increases with the number of stories, the absolute numbers in table 6.1 are best brought to a common basis, so that comparisons can be made with feelings from particular groups of stories. The basis is of the number of feelings per ten stories of the appropriate type. For the whole set of stories, the numbers of positive feelings have been reduced to the number per ten 'good' stories, and negative and 'zero' feelings to the number per ten 'bad' stories. This prevents the slight excess of 'bad' stories (142 to 129) from exaggerating the proportion of negative feelings. The four regulatory categories (having to, freedom to, obligation to, and wanting to) which more often than others arise both in 'good' and 'bad' stories, have been reduced to a per' ten story basis 'using the average of the numbers of 'good' and 'bad' stories.'

As with the overall proportions of 'good' and 'bad' stories in the previous chapter, the difficulty in commenting on the pattern is the lack of any standard of comparison. Despite that, one can point to some general features which are in line with, or. very much out of line with, what one might expect or hope.


OVERALL PATTERN OF FEELINGS
+
o
-
regulatory
FEELINGS PER TEN APPROPRIATE STORIES
0
2
4
6
8
INV
IP
GE
SP
IND
AS
had
free
oblig
want
ER
IR
SEC
ORD
INT
SAT
SUC
WS
IP— ER—SUC

Any comparison between proportions of feelings in different categories needs to be made with great caution. We may not have been as perceptive in some areas as in others. We may, though we tried not to, have been biased towards looking for one kind rather than another. Students may have found one kind easier to express than another.

We think it can be said that in the whole picture, involvement with the subject and satisfaction are the two most dominant categories. Feelings of involvement tend towards the negative, at least so far as specific involvement with a topic is concerned. Satisfaction, by contrast, tends towards the positive, especially so far as ordinary satisfaction is concerned.

This pattern may be thought to make some sense. Only when involved in work, that is, interested in it and engaged with it, is there much chance for a student to get satisfaction out of it. If he is not involved, or reacts against work, the possibility of dissatisfaction scarcely arises.

It may be that it is because involvement is prior to so much else that it is the largest single category. However, the very existence of several types will have tended to ensure that we coded a good number of feelings in this category, though it can also be argued that we found we needed many types because of the large number of feelings.

We also think it fair to draw attention to the systematic tendency of individual feelings to outnumber interpersonal ones. Involvement with other people is certainly present, but is much less important than involvement with the subject. Feelings about oneself in relation to others are less common than feelings in relation to the subject. Again, this need not occasion surprise. The very toughness, the demanding nature, of the subject, may make it seem even more prominent an actor upon the feelings scene than the people involved. And, at the same time, it is worth recalling the evidence that scientists anyway tend to be the kind of people who avoid what is for them excessive human contact (see the annotated bibliography, especially the work of Roe). Noting also the very minor importance of publicly recognized success, we feel inclined to call this aspect of the data 'the loneliness of the long distance physicist'.

This discussion raises a fundamental question of interpretation. Is the absence of some kind of feeling best regarded as caused by students not having it, or not wanting to have it? Clearly both causes will often operate. It seems likely that the small significance of external rewards is related more to their relative absence from the scene, though also to the

way many teachers, and it seems not a few students, would stress the value of the inner reward of having achieved something. It is, however, worth noting that inner success is mentioned in about half of all the stories, while involvement and satisfaction are issues in nearly all and in well over half respectively. It is not plausible to suppose that students do not want success and achievement, so it may be fair to remark that they do not get it as much as one would like (unless one thinks that more success would be corruptingly easy success - a view hard to maintain in the face of the psychological evidence that nothing succeeds like it).

Security, it appears, has a considerable importance, being mentioned (taken with feelings about oneself) in about half the stories. Recalling that many of the positive feelings are of such things as relief, it does look as though the confrontation with physics not infrequently tends to induce self-doubt and worry. 'So it should', some will say. Perhaps the more important feature, taking the loneliness discussed above into account, is the number of times this will be a private doubt, unable to be shared with or eased by others.

It would be agreeable if feelings of freedom and independence were more frequent than they are. Again, it looks to us more plausible to understand this as a lack of opportunity rather than a lack of desire. At the same time, feelings of 'having to do things' contribute rather little. In many interviews, the compulsion of lectures, work to do, and so on, was the taken-for-granted background, so much a part of life as to go unremarked. In such an area, dealing with things so much assumed that they are not said, our method of analysis and coding has the defect of tending to omit them. At least it is fair to report this subjective impression of a large proportion of interviews.

Returning to the question of involvement, the large amount of negative involvement is worrying. It reflects how, in the bulk of 'bad' stories, students cut off, turn away from work, and lose liking or appetite for it, all these often in the face of its difficulties or of unsuccessful teaching. What is most worrying is again that this may be private; that the student deals in a hidden way with anxiety and difficulty by avoiding the pain of trying, with the teacher aware only of some lack of response. When students do not throw brickbats (see the relatively small level of negative satisfaction and of interpersonal antagonism) the teacher may find it hard to detect when things are going wrong, and equally hard to correct it. Lack of involvement is likely to be dangerous if it leads to lack of feedback.

6.3 CHANGES IN FEELINGS WITH THE YEARS

When a final year student tells a 'good' story, is he likely or not to express feelings similar to those in stories about the first year? Are the feelings characteristic of 'bad' stories different from year to year?

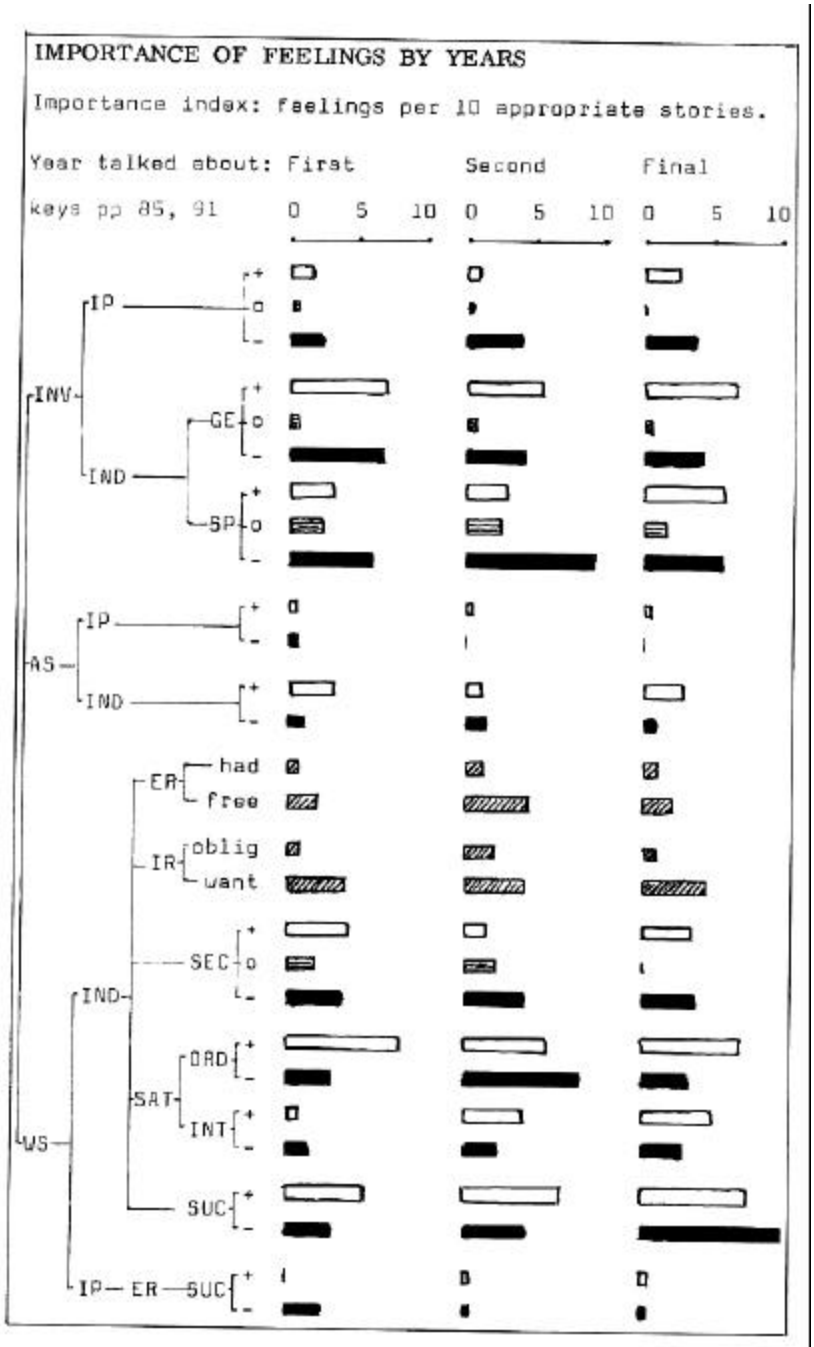
There are really two questions here. If there are more 'good' stories than 'bad' about a year, there will certainly be more positive than negative feelings about it, and this difference will reflect something important about how the year feels to a student; about the relative incidence of positive or negative feelings. But, in the 'bad' stories, some negative feelings may be much more important than others, and may be more important in 'bad' stories from one year rather than another. Only where there are as many 'good' stories as 'bad' do the two things become the same.

To give an example, in the final year there are 17 'bad' stories to 30 'good' ones. Table 6.1 shows that there are 18 feelings of lack of (inner) success, expressed mainly in the 'bad' stories, and 22 feelings of positive achievement, expressed mainly in the 'good' stories. The incidence, or frequency of occurrence in stories 'good' or 'bad' of success and lack of success is about the same. But the importance of the negative feelings is rather larger than that of the positive feelings, in that about half as many 'bad' stories as 'good' produced the same number of negative feelings as positive.

We have used as an index of importance for positive feelings the number of such feelings per ten 'good' stories, and for negative (and 'zero') feelings the number of such feelings in ten 'bad' stories. In the present example, this gives for positive feelings of success in the final year an importance index of (22/30)10 = 7.3, and for feelings of lack of success (18/17)10 = 10.5.

Where the numbers of 'good' and 'bad' stories are equal, for every ten 'good' ones there are ten 'bad', so that the index indicates the number of positive or negative feelings in every twenty stories, 'good' or 'bad', in that case. Where they are not equal, the number of .feelings of either kind per twenty stories of that kind is a suitable index of incidence of feelings, because were the stories to have divided equally so that the distinction vanishes, the two indices would have the same value.

In the diagram on the next page it is the importance of feelings by years which is shown, not the incidence. The latter can be estimated when looking at the diagram by increasing the


IMPORTANCE OF FEELINGS BY YEARS
Importance index: Feelings per 10 appropriate stories.
Year talked about: First
Second
Final
keys pp 85, 91
0 5 10
0 5 10
0 5 10
INV
IP
GE
SP
IND
AS
IP
IND
WS
IND
ER
had
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value shown for positive feelings and decreasing that for negative feelings when the 'good' stories outweigh the 'bad' (as in the final year), and vice-versa. In the first year there are about 30% more 'bad' stories and 30% fewer 'good' stories than there would have been had they divided equally, so the incidence index is 30% larger than the importance for negative and 'zero' feelings, and 30% smaller for positive feelings. In the second year the figure is 10% and in the final year 40%, but in both it is the index for positive feelings which should be increased and for negative feelings which should be decreased, to obtain indices of incidence from those of importance. In brief, in the first year there are more 'bad' stories than 'good', so the overall experience is more negative than the diagram indicates; in the final year the reverse is the case.

Looking first at the importance of involvement with other people (mostly the teacher), it seems that it tends to increase with the years, except that in the second year positive involvement is small and negative involvement is large. Looking instead at the incidence of such feelings, the experience of negative involvement becomes larger than positive involvement in the first year, and less in the final year.

The importance of involvement with the subject is generally larger than that of involvement with people. By the final year more 'good' stories contain feelings of specific positive involvement with a topic, as compared with the first year where general involvement is more important. That is, final year stories are more likely than first year ones to describe being deeply involved in an aspect of the subject. Second year stories are again a little different, the notable feature being the rather high importance of being turned off or not involved in a specific topic, in 'bad' stories. But again, because the importances of different kinds of involvement (positive and negative) do not vary much with the years, the overall incidence of feelings of involvement is appreciably negative in the first year and positive in the final year.

Security is often thought to be especially at issue in the first year. The diagram suggests that feelings of being secure are about as important in 'good' stories in all years as are feelings of insecurity in 'bad' stories. Feelings of 'zero' security (confusion and bewilderment) however, are present in first and second year stories, but have vanished in final year ones.

Tracing back the feelings in the data, it is in first year stories by first year students that feelings of security and of insecurity are particularly prominent. Indeed, taking them alone the index of importance rises from about 4 for all first year

stories as in the diagram to about 7 for those by first year students, this being true both of security and insecurity. Further, for these first year students, it is the laboratory which contributes the most, in that more such feelings arise there than do in lecture stories, from about half as many laboratory as lecture stories.

Although security appears to be about as important to all students over the years, the amount of it they experience changes. In the first year, the incidence of feelings of insecurity is larger than that of feelings of security; in the final year there is more security than insecurity.

Turning to the importance of satisfaction, it is notable how rarely intense satisfaction appears in 'good', and intense dissatisfaction in 'bad' stories about the first year. Later, intense satisfaction grows markedly in importance in 'good' stories, with an increase, but a smaller one, in the importance of intense dissatisfaction in 'bad' stories.

The incidence of intense satisfaction grows even more than its importance, so that by the final year there is experience in the stories as a whole of more than twice as much intense satisfaction as intense dissatisfaction.

Once again the second year shows some divergence from a steady trend, with the importance of general dissatisfaction, perhaps paralleling that of non-involvement mentioned before, being notably large.

The diagram does not present a fair picture of the incidence of satisfaction. In the first year, there is about as much satisfaction as dissatisfaction; while the final year stands out as containing many satisfying experiences. The second year remains a little on the negative side overall.

Success presents a picture of some interest. Feelings of lack of success in 'bad' stories grow in importance year by year. By comparison, feelings of positive achievement, though they grow in importance, do so by less. However, the incidence of lack of success is more or less the same in all years, because of the fall in the proportion of 'bad' 'stories year by year. The incidence of feelings of achievement, by contrast, grows each year, being nearly three times as great in the final year as in the first.

Tracing back the origins of the feelings, those of success in the final year stem overwhelmingly from project work and individual work. But this is not just a final year phenomenon: in both

first and second year stories, these areas are very important. They contribute about as many such feelings as do stories about lectures, tutorials, laboratories, and other things all put together, from fewer than half the number of stories. It does most forcibly seem that feelings of achievement are closely linked to work done alone, even when there is relatively little of it.

To sum up, several important points emerge, even if there are few surprises. The insecurity one might expect in first year students seems to be there, especially in feelings expressed close to the time. As time goes by, it fades, but more perhaps because there is less insecurity to cope with than because it is not important when it does arise. Again as one might hope and expect, students get a little more involved with teachers as' time goes by, though there is a hint of second year antagonism. More significant perhaps is the rather minor importance it has even at its greatest. The satisfactions of work also increase, though possibly with a second year lull. In all years students most often feel success when working alone, but because they have more chance to work in that way, experience success most often in the final year.

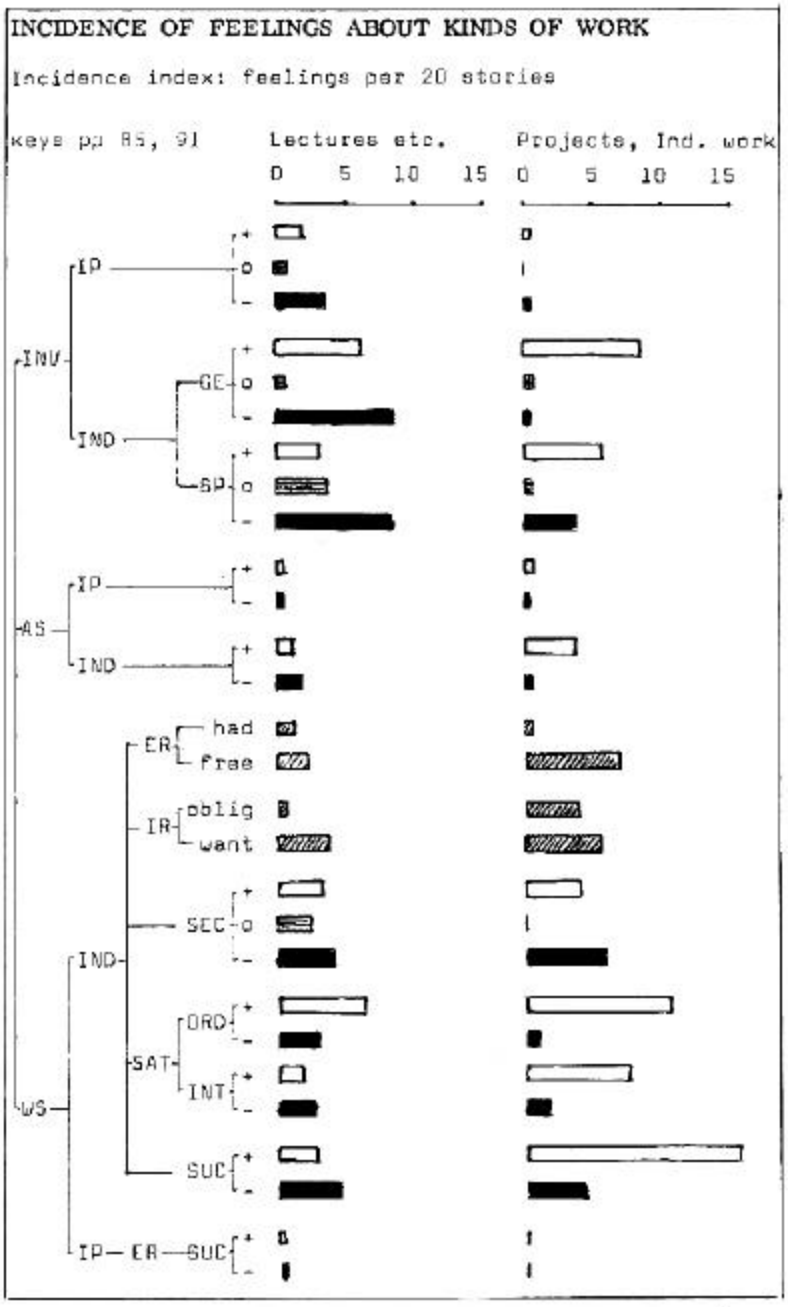
6.4 FEELINGS ABOUT DIFFERENT KINDS OF WORK

In the previous chapter, and a little in the previous section, we made a case for significant differences in reactions to projects and individual work on the one hand, and lectures, tutorials, laboratories, and other work on the other.

The diagram on the next page shows numbers of feelings divided according to stories of these two kinds. For this purpose, it seemed to us better to display the incidence of such feelings, rather than their importance (see the beginning of the previous section for the difference). That is, the diagram shows the pattern of feelings in a typical story of each kind; for projects etc. such a story is typically a 'good' one (48 'good', 15 'bad'), while for lectures etc. it is rather more likely to be 'bad' than 'good' (127 'bad', 81 'good').

The diagram shows, as one would expect, that projects etc. show up little personal interaction. The general tendency for personal involvement to be negative rather than positive is here seen to arise largely from lectures etc. alone.

The two groups of areas of work differ most in respect of involvement in subject matter in the marked lack of feelings of non-involvement in projects etc., as compared to lectures etc.


INCIDENCE OF FEELINGS ABOUT KINDS OF WORK
Incidence index: feelings per 20 stories
keys pp 85, 91
Lectures etc.
Projects, Ind. work
0 5 10 15
0 5 10 15
INV
IP
GE
SP
IND
AS
IP
IND
WS
ER
had
free
IR
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That which is there can be traced in the data to problem solving and revision, not to projects (or essays). Projects etc. do seem to be rather more positively involving than lectures etc., and it is good to see the considerable number of feelings of wanting to work hard which are associated with them.

Looking at feelings about oneself and at security together, projects etc. have the edge in producing good feelings of this kind. They produce none of the 'zero' feelings of security (bewildered, confused). But they are a real source of feelings of insecurity, more per story than lectures etc. The challenge of working alone is not to be neglected.

Satisfaction, and even more so success, is more a product of projects and individual work than of lectures, tutorials, laboratories etc. The increase in positive satisfaction and success is matched by a decrease in dissatisfaction and failure. The proportion of feelings of intense satisfaction in projects etc. is notably large.

It is worth commenting that the differences are mostly ones of which many teachers would approve. There is no reason to think that the (large) number of feelings of freedom and independence in projects etc. are lightly won: they are matched by less cutting off and lack of interest, more and deeper satisfaction in work, and by more feelings of achievement. The role of projects themselves in all this should not be overestimated. There is a substantial component from such things as essays, problem solving, private study, and revising for examinations. Lectures and laboratories will rightly remain with us, but it does look as if there is a case for making more of the work associated with them independent in nature. Here is some argument for the ideas pursued in another of the project's books, INDIVIDUAL STUDY IN UNDERGRADUATE SCIENCE.

There may also be a lesson for tutors too. Much of the independent work that shows up well here is of the kind often associated with tutorials. Indeed, the data may not quite do tutorial teaching justice, where work originating in tutorials is put in the category of individual work because the story is about the work done alone and not about its connection with a tutorial. At least it seems worth asking if there might be ways of capitalizing on getting students to work more on their own before and during tutorial sessions - even though this is much easier said than done.

6.5 DIFFERENCES BETWEEN 'STRONGER' AND 'WEAKER'

We looked to see if we could find any differences in the kinds of feelings expressed by 'stronger' and 'weaker' students (see table 5.2, chapter 5, for the basis of classification).

One might expect 'stronger' students to be less insecure, more involved, and to experience more satisfaction and success, than 'weaker' students.

Some difference shows up in feelings of insecurity in 'bad' stories, with 'weaker' students expressing 4.2 such feelings per ten of their 'bad' stories, while 'stronger' ones expressed 3.7 per ten of theirs. But the difference is only in the expected direction; it is not statistically significant.

On feelings of involvement, positive or negative, compared in the same way, there is no difference. 'Stronger' students do describe more success and less failure than 'weaker' ones, but again the difference is merely a small one in the expected direction. The same is true of satisfaction and dissatisfaction.

In all then, here as before, 'stronger' and 'weaker' students appear more alike than different. The evidence gives no reason to suppose that they feel very differently about the pleasures, challenges, or pains of work. Nor is there reason to think that either group has introduced a special bias into any of the results discussed in this chapter.

6.6 SOME EXAMPLES

To conclude the chapter, we offer some examples from interviews, to present in a sharper and more real form what some of the conclusions we have argued for might mean.

The first example illustrates some of the values students attach to project work, and hints at the comparison with other things. It is from a final year student.

> 'I think that gave me the first taste of doing something and thinking about it, rather than just regurgitating what was shoved down my throat. There were lots of difficulties...I spent a lot of time on it. I actually rekindled my interest in physics in that four weeks. So I worked hard, and was for the first time in three years interested in physics. I was really interested in something, and it really annoyed me that I couldn't think of reasons why

certain things happened...It meant reading quite a lot. Finally I got a picture of what was happening in my mind, and that gave me a kind of thrill, really.'

The next example, from a first year student, shows how working alone, not at a: project but just at understanding work from lectures, can be equally rewarding.

'... when the lectures have been stimulating, and you come out wanting to read a bit more...first of all going over the notes, and seeing you've understood... and then you come to examples and they tie in... and you know where to look for the relevant information if you can't bring it to mind...Everything fits together, and you feel, "I can do it", you know. It may take me four or five hours, but I know what I'm doing, and when I've finished I really feel I've got something out of it. I've learnt something, and I've enjoyed learning it. There's an immense satisfaction from that.'

Another first year story;. however, illustrates the importance of feelings of insecurity, and in the very same area the last one found so good.

'You go through the work, and you think, "Now then", asking about that work you have just read, "Do you know it?'. And the answer comes back nearly every time that you don't. So you go through it again, and think, "Right, now do you know it?', and you think you know it a bit better but perhaps you ought to go through it again. But time is going on, and you get more and more behind. You leave less and less time for each subject, and as you get closer to the exam panic sets in. Then you go completely off work and can't learn a thing.'

Finally, let a second year student exemplify - albeit a bit harshly - the kind of antagonism and lack of involvement they (and others) can develop.

'...then he would rush over something slightly complex-maybe he didn't think he could explain it. But anyway, that lost everybody...you just got lost from the beginning. If he lectured first thing in the morning you were bored and half asleep, but if it was later, it just became a great joke being there. You know, he gets really muddled up, and says, "Oh, where have I gone wrong?', and you are just sitting there thinking it's a laugh, that he is paid to do this and he doesn't even know what he is doing himself. It's a waste.'

TABLE 6.1
FEELINGS BY MAIN AREAS AND BY YEARS

			208 Lectures, tutorials, labs, other.				63 Projects, individual work.				271 All areas			
		Year:	1	2	F	T	1	2	F	T	1	2	F	T
INV	IP	+	10	4	6	20	0	0	1	1	10	4	7	21
		o	7	1	0	8	0	0	0	0	7	1	0	8
		-	19	14	5	38	1	0	1	2	20	14	6	40
	IND	GE +	31	15	3	59	9	9	8	26	40	24	21	81
		GE o	5	2	1	8	2	1	0	3	7	3	1	11
		GE -	63	17	8	88	1	0	0	1	64	17	8	89
		SP +	13	10	7	30	3	4	10	17	16	14	17	47
		SP o	22	10	3	35	1	0	0	1	23	10	3	36
		SP -	47	31	6	84	7	3	3	13	54	34	9	97
AS	IP	+	4	1	1	6	0	1	1	2	4	2	2	8
		-	6	0	0	6	1	0	0	1	7	0	0	7
	IND	+	11	2	0	13	3	4	8	15	14	6	8	28
		-	13	5	2	20	1	1	0	2	14	6	2	22
WS	IND	ER had	5	6	3	14	1	1	0	2	6	7	3	16
		ER free	7	13	1	21	9	7	4	20	16	20	5	41
		IR oblig	4	1	0	5	3	8	2	13	7	9	2	18
		IR want	20	8	9	37	6	8	2	16	26	16	11	53
		SEC +	19	4	6	29	4	3	5	12	23	7	11	41
		SEC o	18	8	0	26	0	0	0	0	18	8	0	26
		SEC -	28	10	4	42	8	6	3	17	36	16	7	59
		SAT ORD +	31	19	11	61	15	8	10	33	46	27	21	94
		SAT ORD -	24	3	5	32	2	0	1	3	26	3	6	35
		SAT INT +	4	9	4	17	2	11	11	24	6	20	15	41
		SAT INT -	16	5	4	25	1	3	1	5	17	8	5	30
		SUC +	15	13	3	31	13	17	19	49	28	30	22	80
		SUC -	24	10	11	45	2	5	7	14	26	15	18	59
	IP ER SUC	+	0	1	2	3	0	0	0	0	0	1	2	3
		-	2	2	1	5	0	0	0	0	2	2	1	5

7. Lecture stories

7.1 REACTIONS TO LECTURES

Lectures form a great part of the normal work of a science student; indeed it is no accident that nearly half of all the stories were about them. This makes it particularly important to understand a little better what makes a good, and what a bad, lecture experience.

Before looking at data drawn from students' reactions and the reasons for them, it may be helpful to try to catch something of what can be good or bad about lectures by examples. The first example comes from a first year student.

> '...we'd be going through a lecture, and he'd suddenly come out with a story relevant to what you're doing -about radioactivity or something like that - something to make the lecture interesting. Or maybe an analogy -you can't picture something and he'll suddenly draw it, or - well when some people couldn't understand about electron waves in atoms he drew a wave on a strip of paper and made it into a circle. And you can make notes that are concise and detailed, only a couple of sides a lecture. And he seems to get something out of his work which makes him happy in it, so a lecture isn't just writing on the board, it's talking to you, asking you questions, suddenly saying something different. So I felt as though it was worth coming to, and it made me generally more interested in the subject - I felt happier and that life was worth living. And it brought life inside and outside the university together. Then you're prepared to go and read about it - you think you could read and learn something more - so you work harder. '

As data given later will show, this extract is typical of several in containing a strong element of reacting well to the personal human qualities of the teacher as well as to his teaching ability as such. It is typical of many in that interest and a deeper involvement in the subject is perhaps the main result.

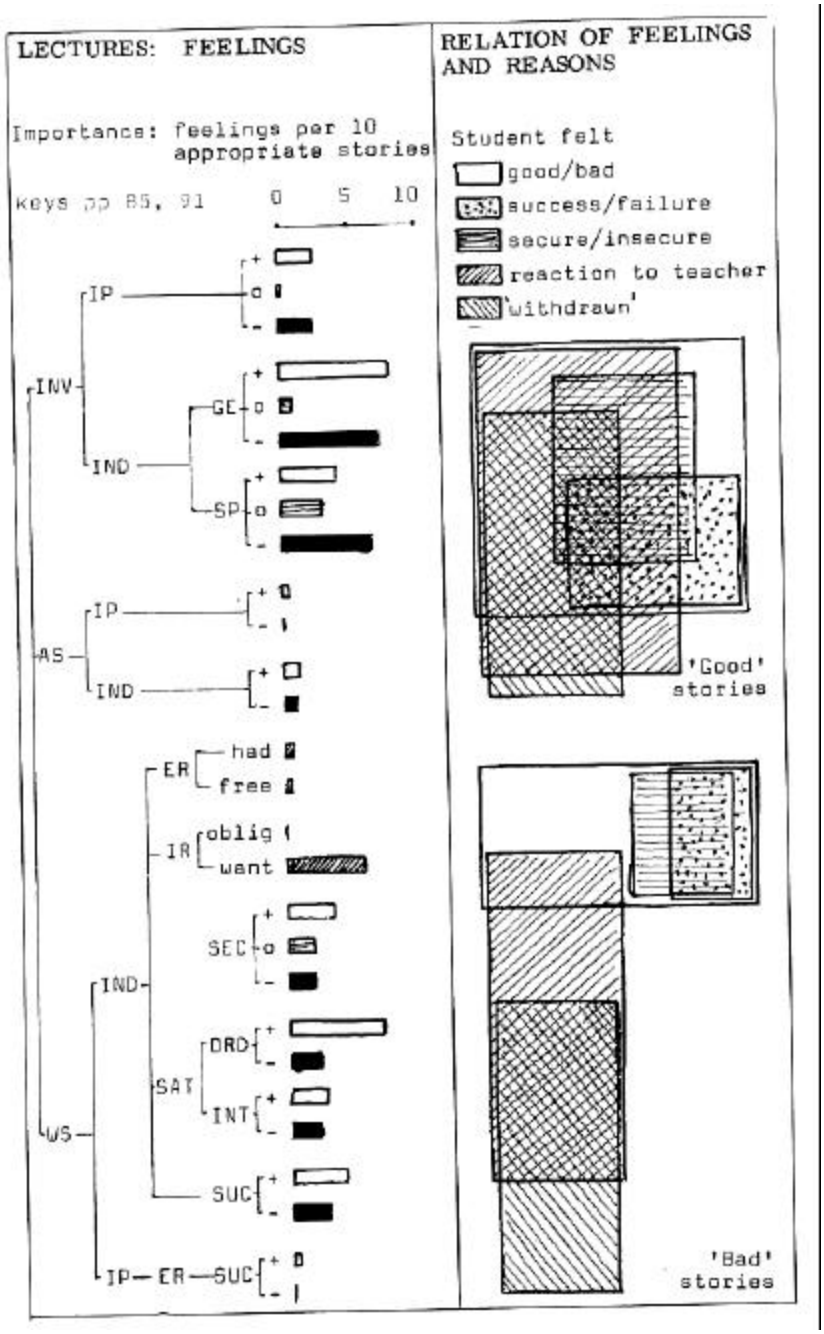
It is like not a few in stressing the strong human interaction. It is also like several in not having much stress on achieving something at once, or in feeling good about new-found abilities. Rather, the emphasis is on being able to cope and understand, and even more on pleasure. Like a heartening number of others, the student wants to work harder.

The second example is from a final year student.

> '...you sit down and you feel weary already, knowing what's coming. You get your papers out, and it's straight into it. You're absolutely shattered all the way through; you're sort of held in a trance, and the only thing you have to do is to get those notes down - it doesn't matter if you understand it or not because you just can't hope to - you can't hope to understand and also get it all down. So you reproduce the whole lot in an hour. At the end you're so shattered and fed-up and sick of it you just wish the course had ended, that you didn't have to come back again. You can't contribute to that sort of lecture. All you have got out of it is a load of notes that don't make sense and are full of errors.
>
> The lecturer just comes in, not as if he's one of the class, but superior, as a teacher, and he'll take his chalk and start. Soon the chalk is pouring across the blackboard, and he'll talk to the blackboard - he won't talk to - won't even necessarily look at - the students. I feel very anti him, anti what he's doing. You come to university not only to learn but to enjoy learning, and he is destroying whatever good atmosphere might exist by lecturing like that.'

Like a good number of others, this student is probably protecting himself from being made to feel bad about himself - to feel stupid or incompetent - by getting cross. Others do the same thing by cutting off, by disengaging mind, :and feeling from the situation. Some, of course, do feel bad, in varying degrees. Typical of most 'bad' lecture stories is the lack of interest and involvement in the subject.

The diagram on the next page summarizes the importance of various feelings in 'good' and 'bad' lecture stories (see the previous chapter for the abbreviations used). It also shows how some of the main features of 'good' and 'bad' stories relate to one another, using shaded areas in proportion to the importance of each feature, and overlap between them to show what proportion of stories have two or more features in common. The features include some not directly related to the analysis of


LECTURES: FEELINGS
Importance: feelings per 10 appropriate stories
keys pp 85, 91
0
5
10
INV
IP
GE
IND
SP
AS
IP
IND
ER
had
free
IR
oblig
want
SEC
IND
ORD
SAT
INT
WS
SUC
IP—ER—SUC
RELATION OF FEELINGS AND REASONS
Student felt
good/bad
success/failure
secure/insecure
reaction to teacher
'withdrawn'
'Good' stories
'Bad' stories

feelings as in previous chapters, but others related to the reasons students gave, exploiting the possibility offered by the network system of analysis of keeping track of things at this level of detail.

Images here

7.2 PATTERNS IN 'BAD' LECTURE STORIES

The diagram on the previous page clearly shows that the pattern relating feelings and reasons is more clearly articulated for 'bad' than for 'good' stories, falling neatly into two parts. For this reason, we discuss the 'bad' stories first.

We looked at the coded summary of each story, and put them in what seemed to be natural groups, according to the pattern of feelings and reasons in each. One group, of rather less than half the 'bad' stories, was of ones where the student felt bad in himself or about himself. That is, in addition to feeling bored or as if wasting time, he might feel puzzled, depressed, or confused; or he might feel that he was not understanding or not acquiring knowledge. Two sub-groups here stood out. One of them was of students who felt some real sense of failure, of not having achieved anything. The other was of those who felt personally inadequate or very insecure. Not surprisingly, these two sub-groups overlapped, with failure contributing to a sense of self-doubt.

The second sample story in chapter 1 (section 1.4.2) is an example of bad feelings of self-doubt and worry associated with not being able to understand. The following has some other not infrequently found features.

> 'It was like sitting there looking at a television screen: you know, just looking. He was tailing about transformations and different numbers of dimensions, and I could never understand how it was done. Maybe I had the symbols wrong, but the thing is, when I looked at the board and was copying things down, I never felt that what I was copying down had any meaning...My mind was just blank, I was just writing things down. Afterwards I wanted to go to the library and do some work on it and try to understand, but I never did. I felt too scared of the subject, and felt I couldn't do it. I felt "Oh God, this is far beyond me" - I was just like a zombie. I thought maybe I shouldn't have come to university. I don't think it was the lecturer's fault completely, but when I thought I would try I just became lost in a jungle of symbols and didn't take anything in at all.'

Besides the insecurity, a striking feature is the loss of meaning. All too often, students told us of blindly copying notes like a mindless machine:

> 'You just become like an automaton just writing down what is going on the board, while the words go right over your head.'

It is sometimes unkindly said that lecturing consists of the transfer of notes from the lecturer's notebook to that of the student without passing through the minds of either. Evidence that it happens is disturbing; less disturbing is the evidence that students actively dislike it:

> 'It seemed so stupid, just copying and not realizing what you were doing.'

Strongly associated with all this, of course, are not coping, getting lost, and getting left behind:

> 'Once you had lost your concentration, you had had it. Then we all just sat and copied. And we couldn't follow. You had lost the thread of what was happening, and you need a few minutes to sort it out, but you can't take the time off because you have to go on copying the notes.'
>
> 'You get further and further behind, until you think, "Sod it, I won't come this week".'
>
> 'He said, "Don't bother learning that - you'll pick it up as you go along - don't better if you don't understand it now." And I never understood it from there on.'

The second main group we identified, which also appears in the diagram relating feelings and reasons, is one of students who, rather than feeling bad in themselves like those above, reacted in some way against the teacher or the teaching. As the diagram shows, there is some small overlap between the two groups, but in general the students who fell bad spoke more of themselves and more incidentally of the teacher.

Those who reacted against the teacher did so in two main ways, indicated in the diagram. Rather less than half (including those who also felt bad) did so directly, blaming the teacher rightly or wrongly for such things as not seeming well prepared, not seeming to bother, not seeming to know what he was doing, or for being distant, brusque, or even cutting. The second example in section 7. 1 is a good instance of the genre. The antagonism comes out in such things as:

'If he's not interested enough in teaching us, why should we listen to him? Why should we 'do any background work of our own, when he doesn't seem interested in it either which comes from another story of the same kind.

Rather more than hall were much less aggressive, speaking of the teaching and not the teacher, of reasons to do with how ideas were not put across rather than being caustic about why they were not put across. These stories were ones in which the student seemed to us to be distancing himself; avoiding getting too involved in the situation. They tended to express indifference or lack of respect for the teacher, rather than annoyance or anger. They tended to look on the situation as one of having to learn without interest or stimulus. In the diagram, they are labeled 'withdrawn' - though 'distant' might serve as well or better. The standoffish tone comes over in the following.

'I could never really understand it. I suppose it's a big failing on my part...the lecturer jumped in at the middle - he'd draw a graph and not mark his axes and put a line and say that a transition takes place, and then when someone asked what transition, he'd put 'gas' and 'liquid' on the graph and then just move on...He was always trying to move on... so if he misses out a minus sign here or an e^{it} there but gets the answer he's not interested - he knows what he's looking for...I just said to myself that I'd go and look it up in the book, because there's absolutely nothing you can do in a lecture if you can't understand it. So I just didn't bother - I went along and just watched. You've just got to sit there and accept it as it is. You can't look it up in the book to see if he's going right and follow him all at once.'

With this group, the predominant feeling was one of lack of involvement; of lack of interest, not caring, of time-wasting. As the left hand part of the diagram showing feelings indicates, lack of involvement in the subject is the most common feeling in 'bad' stories. It appears in nearly all: students seem first to lose heart and interest, and afterwards sometimes to feel other things. What distinguishes the 'withdrawn' group is that they, in the main, only register lack of interest or concern. Some do so to the extent of hardly bothering to blame anyone or anything:

'You just feel like you want to get up and get out - to go for a walk instead of trying to copy all the little symbols down. It's lectures as a whole really, not really the individual lecturer's fault. I'd just say that

> the lectures were boring - you don't really get anything out of it. I'm just glad when it's finished. I go because obviously I need the notes, and you get a little bit more than if you copy someone else's. They're something I accept - they're there and you got to do them, so'.'

Any overwhelming desire to wring such a student's neck ought perhaps to be temporarily resisted. The consequences of the existence of such reactions, whether the last cold cutting-off or the previous distant disapproval, are we think very important. A lecturer who is not doing too well, whether for good or bad reasons, is likely to get a quite strong 'don't care' feeling from a class. If instead he got a sense of unease or unhappiness, he might find it easier to sympathize and so to alter things a little. As it is, he is only too likely to react with the aloof annoyance the last story so easily provokes. That, however, can readily create a distance between teacher and students that soon becomes too great to be bridged. It is a dangerous situation, because of the built-in feedback which tends to make matters go from bad to worse.

7.3 COPING AND DEFENDING

The argument at the end of the previous section involved a degree of interpretation. We propose here to extend that interpretation, and to consider how reliable it is likely to be.

We think that the difference in the diagram in section 7.1, between 'bad' stories where there is a rather clear division between students who felt bad and those who reacted against the teacher or are 'withdrawn', and 'good' stories where most feel good and more of those who distance themselves react and feel good, might be explained in terms of the need to defend oneself. Nobody likes feeling bad, and many people avoid doing so by two strategies: either they get angry (it is often less bad to feel cross than to feel rotten) or they refuse to feel anything much at all, ('I won't let it effect me'). These are the two things we see the students doing in the stories.

By contrast, nobody objects to feeling good. Further, having a warm or positive reaction to the teacher adds to the good feeling, so it is no surprise to find the two going together more often.

Such an interpretation is at best tentative. It is very likely that students in talking. to us avoided too sharp or too personal a criticism of the teacher - several said as much, and the tone

of most interviews which criticize the teacher is moderate. No less, those who felt inadequate, insecure, worried, or a sense of failure may well have been reluctant to say so. It is possible, then, that we may have overestimated the number of students who are labeled 'withdrawn'. It is also possible that some of those who felt bad took refuge in criticism only when talking to us, and not as an internal defense.

Against these cautions, it can be said that the proportion of stories in which the student merely expressed interest or lack of it, or reactions to the teaching in mainly cool, intellectual terms, was much the same in 'good' as in 'bad' stories.

A little reflection suggests that lectures are to be seen as something to cope with rather than as something to succeed at; success comes later if it comes at all. A lecture is done to one, not by one. Correspondingly, most stories, 'good' and 'bad', contain some reason having to do with understanding or not understanding, and about half mention reasons to do with coping well ('I was making progress') or not coping ('I got more and more behind'). This would make it likely that ways of defending oneself would come into play in 'bad' stories, as we suggest they do, and that pleasure, involvement, and happiness at making progress would be the trade marks of 'good' stories, as the data Suggests they are.

The interpretation applies as much to the teacher as to the student. It is a decidedly unpleasant experience to be giving a lecture course which is not going well. The danger mentioned at the end of section 7.2, that the teacher may protect himself by being cold and aloof (and who has not heard teachers writing off a whole class as idle or uncaring?) and drive the situation further downhill, can then be a real one.

None of this ought to outweigh the other half of the story, that a substantial fraction of students feel at best lost, and sometimes deeply worried and inadequate in some lectures. A lecturer may easily not suspect how many lonely reappraisals he triggers off, or occasionally causes.

7.4 PATTERNS IN 'GOOD' LECTURE STORIES

In looking at 'good' stories to produce the diagram in section 7.1 showing connections between feelings and reasons, we did not find that stories fell so sharply into groups. Rather, they shared a number of traits which, while tending somewhat to go together, only divided stories into overlapping groups. So

the diagram for 'good' stories has a lot of overlap. Too much should not be made of the contrasting lack of overlap in the diagram for 'bad' stories: students who felt lack of success or security in them did mention reasons to do with the teacher, though the diagram might suggest otherwise. But the feelings were more about the student himself, and the teacher's role in the story was often a minor one, so the division seemed natural. The opposite was true in most 'good' stories: features which were as close as we could get to the complements of those which distinguished 'bad' stories were certainly present and easy to identify, but tended to carry more equal weight in each story.

Roughly, the 'good' stories fall into three groups.

One group, of nearly half the stories, do not mention success or security or self-confidence, but are like the first example in section 7.1 in being about increasing interest in the subject, in the feelings being ones of pleasure and satisfaction, and in there being a good deal of liking for the teacher or at least appreciation of the way he did the job. The following is typical of the kind of satisfaction they expressed:

> 'It's just a good feeling really. You feel that you can manage it a lot better. You enjoy the work, and you're interested in it only when you can understand it. And this helps you understand better, so it makes you feel better about it too.'

Note the emphasis, argued for in the last section, on coping and understanding, rather than on personal achievement.

Many mentioned a personal response of the teacher:

> 'He was very funny...It was very relaxed for a lecture. You did concentrate, but it was nice to have a rest. It was fun, so I felt happy...You thought he was a great bloke, and you felt you could ask questions. He realized we didn't understand half of what was going on - you knew from what he said that he realized that, so you felt you could ask.'

> 'There'd be a hush the moment he walked in...everybody was interested...his jokes and comments genuinely got a response from us. There were always a lot of people to talk to him afterwards. And he wrote up a set of basic notes to take down, but he was making comments and remarking on details all through. He got on with the conversation - er lecture - yes, conversation is the right word - it was as if he was talking to you to

you individually. His was such a friendly approach.

Others of those who do not mention success or security have a much more low-key attitude. They are not wholly unlike those we called 'withdrawn' in 'bad' stories, so it is convenient in the diagram in section 7. 1 to use that label, though 'rather less involved' would be fairer. Those who respond to the teacher do so in a rather cool intellectual way, praising the teaching rather than the teacher. Others do not mention even that, but simply say that they were a bit more interested. So there are stories whose gist is little more than:

> 'You feel mentally stimulated - you feel you can go away and read up on it and be interested in it, and that you haven't wasted your time at the lecture.'

though a larger number get pleasure and enjoyment as well.

A second main group, of nearly a third of the stories, had to do with increased security or self-confidence. As one might expect, they were often very appreciative of the teacher. Their confidence was usually linked to understanding.

> 'You're more relaxed...He drew on work (I didn't know) so of course I was a bit behind and got a bit lost. But at least I thought that it would only be a matter of time before I could take it in and understand it. At least I didn't feel worried - I was fairly confident.'

Confidence, naturally, is often allied to examinations:

> 'I could start with the equation and work out the answer without looking at the notes, which I couldn't do for a lot of other things. It was the feeling that I'd managed to do it, I suppose - I felt a bit elated - that I'd got somewhere, and that the knowledge I had I could put to use - just by being able to work it out myself. And I was confident, going into the exams - I knew there would be questions I could do completely.'

The last student's confidence is tinged, like that of several, with a sense of achievement. A third group, again nearly one third of the 'good' stories, overlapping those about confidence, had this feeling. They were unlike other stories in having much less in them about the teacher; when a student feels he has achieved something he rather tends to take the credit, unlike what happens when someone gives him pleasure or makes him feel involved. The following is a good example.

'I had never understood magnetism - it was just a name. You could write down formulae, but I didn't know what it was. Then, in the relativity lectures, here was something - the opposite of equations - some sort of intuitive understanding. It's silly, but I felt a feeling of superiority that I knew more about it than anybody else on the course. It came about because I could write out an explanation myself on paper, without using the lecturer's notes and equations. If I have got a good idea of what's going on, then I can build upon it, happily. If it's based on a recipe which has been forced into me, then I'm not happy. '

It seems good that some students at least have a pride and pleasure in their understanding, and a shade unfair that their sturdy independence may leave the teacher with less sense of a job well done than he may deserve.

One strong feature in 'good' lecture stories is of wanting to learn more (a third of them all have it explicitly). It is most frequently associated with feelings of pleasure and enjoyment that go with a strong and personal reaction to the teacher, but appears also along with feelings of achievement.

'It is a feeling of generating interest - you don't feel particularly good about it because after all it is work, but it does give you some enjoyment in work. So you might work on that subject because you want to and not because you have too You were more able to learn, not for exams, but as something that would stay with you always. '

7.5 INVOLVEMENT AND UNDERSTANDING

Running like a thread through both 'good' and 'bad' lecture stories are both involvement and understanding. Essentially all 'good' stories mention interest, enthusiasm, and so on, If they mention nothing else. Essentially all 'bad' stories mention their gloomy opposition. Again, both kinds stress understanding or not understanding as the single most frequent reason for feeling 'good' or 'bad'.

Reasons often link the two, as in many of the above examples. The lecturer's words keep coming at you, many stories say, and if you don't understand you lose interest; indeed there is nothing to be interested in, in things which mean nothing.

7.6 DIFFERENCES BETWEEN GROUPS OF STUDENTS

We looked for differences in lecture stories between the years, but could only detect one. That itself is perhaps the most important conclusion: that lectures are much the same in all years.

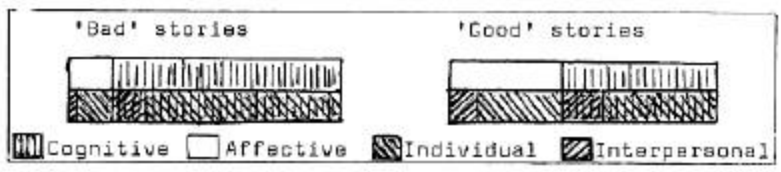
The one difference was that it was often second year stories which contained reactions against the teacher. If anything, there was a parallel slight tendency for those who felt bad to be talking about the first year.

We think it most likely that this is an effect of growing sureness about what is what at university. In the first year, it may be hard for a student to tell if what has gone wrong is his fault, the fault of others, or some of both. He knows too little of what to expect. Later, students more confidently apportion blame, and not, it seems, so often on themselves. Whether they are right or not is not the point; the consequence could be a certain coolness when things go wrong which somebody will have to deal with.

We looked also for any differences between 'weaker' and 'stronger' students, but found none. They told similar kinds of stories, and gave similar reasons.

7.7 DIFFERENT KINDS OF REASONS

The diagram below shows another difference, consistent with what has been said above, between 'good' and 'bad' stories. We looked at the reasons students gave for their feelings, which concerned the teacher. In coding, all reasons were assigned either the label 'cognitive' or 'affective' (by the appropriate network). That is, a reason like, 'He explained well' is about ideas, while one like 'He was cheerful and enthusiastic' is about an emotional (affective) characteristic. All were also labeled either 'individual' ('He knew the subject') or 'interpersonal' (He gave us a lot of help') - these both being cognitive as it happens.



The diagram shows how in 'good' stories, reasons to do with the emotional aspect of the teacher-student relationship are more prominent than in 'bad' stories, where the emphasis is heavily on ideas. It shows also how in 'good' stories, reasons to do with human interaction come more to the fore.

This is not to say that good lecturers are nice people who do nice things, or that bad lecturers are remote, cold, ideas-men. Apart from the fact that students may here as elsewhere have been selective in the kinds of things they would say, that would be a naive interpretation. It may just be that when things do not go well, concern for work and understanding overrides everything else. But it is still proper to point out that 'bad' lectures do from this evidence acquire a cold and distant character, as opposed to the more personal, more felt tone of stories about 'good' ones. Those who think that the human qualities of a lecturer are irrelevant, if there are any who do, should think again, just as should any who think being nice is enough.

In more detail, what kind of reasons did the students give? We have already stressed the importance in both 'good' and 'bad' stories, of reasons to do with the student himself, of coping, of understanding, of feeling involved in the subject. As to the teacher, in 'bad' stories 'too high a level' and 'assuming too much' taken together led the field. Not far behind came 'too high a pace', the point perhaps being well illustrated from a 'good' story about how a teacher did not go too fast:

> 'One lecturer told us it was his belief that students couldn't concentrate for more than twenty minutes, and that in the middle of the lecture he was going to give us a break, where we could walk about, ask him questions, go outside and smoke, and generally relax for five minutes. Then he would start again, so we would get two periods when we could concentrate, which seemed a good idea. (It was good) just to be able to sit and read back through your notes if you wanted to, and if you find anything you haven't understood to go and ask him. Like going and playing them back - going over it in your mind. Also it shows that he takes an interest in us, so you don't mind going to ask him something.'

A comparison with previously quoted remarks, especially those about blind or mindless copying, suggests that pace is often a problem, not so much of speed, as of a lack of time to reflect and consider. Since pace was mentioned in about half the 'bad' stories, it looks as if it ought to be taken to be a problem.

It is second and final year stories which most often mention the lack of clarity of explanations. Probably they know enough to know what they understand, while in earlier years the same thing looks more like a lecture at too high a level.

In 'good' stories, cognitive individual reasons still outnumber the rest - that is, things like being clear, making things understandable, and so on. But affective reasons, and interpersonal ones, are now more important - that is, things like being funny, or friendly, or clearly taking an interest in students. We think it quite important that students seem to interpret actions like giving them a break (as in the last example), telling them a bit about one's own work, or taking trouble over hand-outs, as 'taking an interest in us'.

7.8 GENERAL IMPRESSIONS

One general impression we have from the lecture stories is that it matters a lot whether the lecturer manages to resolve the tension between two contradictory purposes of lectures. One legitimate purpose is to teach and explain ideas and arguments. Another is to provide an intelligible framework for further private work. The contradiction lies in what students are led to expect: on the one hand something complete needing no further work, and on the other a basis for further work. Interacting with both is the pressure for complete coverage: in the first as, 'If we haven't been taught it how can we know it?', and in the second as, 'If it hasn't been mentioned, how are we to know that we should know it?'. A lecturer can opt for one approach or the other, but to try to do both can lead to rapid-fire racing through detailed proofs without any time to put them in perspective.

A second general impression is that students' desire to do more work, or their lack of desire to do it, has a lot to do with feeling that it is possible and not too threatening. So the 'good' stories say things like, 'I wanted to work more on it because I felt I could', and 'bad' ones things like, 'I didn't understand, and so I lost interest, and didn't want to work'. Most lecturers want to 'motivate students to work on their own'. The key seems to be to make that seem possible and not too hard, and to provide occasions for students to feel that they have understood at least a little. It is necessary, legitimate, and tempting to emphasize how much they do not understand; it is dangerous to do that exclusively. Rewards for small steps forward help people to essay bigger ones. Finally, thinking such work to be possible has to do with the teacher seeming relaxed and nice.

8. Laboratory and project stories

8.1 'PROJECTS GOOD, LABORATORIES BAD'?

> '... by then you have got quite a bit of knowledge of physics - or you think you have - and you are allowed to pick any subject you like and study it...You were allowed to apply your knowledge, and this is what I had been looking for, because until then it had all been theoretical apart from lab work, and that was just set experiments which had just been taken from a textbook, whereas now you were really coming up against problems and you had to think things out for yourself. They were not mundane any more - you felt you were facing that problem for the first time...One day you would feel elated because you had got something to work; another day nothing would work - it was up and down. And I think it probably helped me to decide on my future career - I liked the challenge but I decided that that sort of thing just wouldn't really suit me.'

> '...the experiment - it's the thought of being there for five hours at a time and when you come out you don't feel you've done anything. It's also the thing that thousands of undergraduates have done it before - it's so stereotyped you could almost use a tape recorder instead of a person...All right, you've got to build up from basics, but surely you must feel inside that you're doing something useful, because if you're not, what's the point of it? In my mind it leads to a lot of apathy.'

It would be easy. to arrive at the simple conclusion that projects are good and laboratory work is, mostly at any rate, bad. The balance of 'good' and 'bad' stories in these two areas (table 5.1) lends some support to this simple view:

	'good' stories	'bad' stories
Projects	21	2
Laboratories (first year)	7	21
Laboratories (later years)	9	6

As the above table shows, it may not be quite so simple (nor does the evidence advanced in the project's companion volume PRACTICAL WORK IN UNDERGRADUATE SCIENCE encourage the belief that it is)o There is a marked shift with time, with second and final year stories even favoring laboratory work. in the first year, .the number of 'good' stories is not so small as to be discounted entirely.

The obvious hypothesis about why laboratory work seems to improve is that it comes to share some of the values associated with projects; a view that would take support from the following:

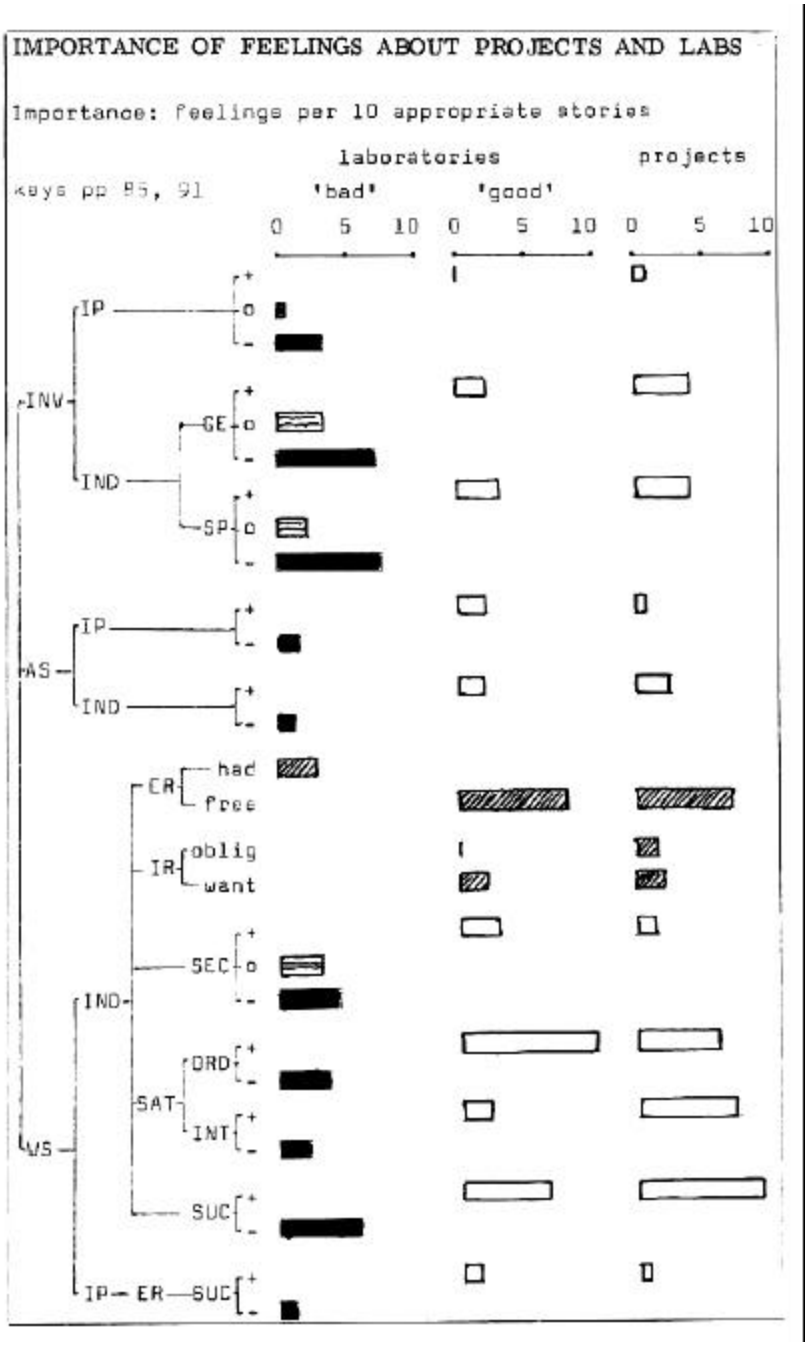
> 'I like the practicals in the second year because you don't have someone breathing down your neck - you are given a very open-ended approach to experiments. You are just given a few essentials and you go away and read up background literature, and are left on your own to make of it what you want... You have so much freedom for once - you are allowed to pick for yourself rather than have everything presented to you.'

All this offers a natural framework for the chapter. First, what makes projects mostly good? Second, what makes laboratory work bad, when it is? Third, what can make laboratories good, and how can there be more of it if it is worth having?

In the diagram showing feelings about laboratory and project work (using the format explained in chapter 6), given on the next page, the feelings about laboratories have been divided into 'good' and 'bad' so that a direct comparison can be made between 'good' laboratory stories and project stories. (Feelings from the two 'bad' project stories are not shown, because the small numbers make the importance values meaningless).

Notice how, in 'good' stories of both kinds, and by contrast with lectures, the importance of satisfaction and of success outweighs that of involvement. The projects win on intense satisfaction (elation, etc.), the satisfactions of laboratories being more ordinary (pleasure, etc.). Projects also win on feelings of achievement, though the importance of it for 'good' laboratories is relatively high. In both, the importance of freedom is striking (perhaps the labs win here because it is less to be taken for granted in them). Both make a noticeable contribution to feelings of security and self-confidence.

The 'bad' laboratory stories are much the obverse of all this, 'except that lack of involvement is, as elsewhere, more important than lack of satisfaction, and that insecurity is more than usually important. Feelings of failure are as important


IMPORTANCE OF FEELINGS ABOUT PROJECTS AND LABS
Importance: feelings per 10 appropriate stories
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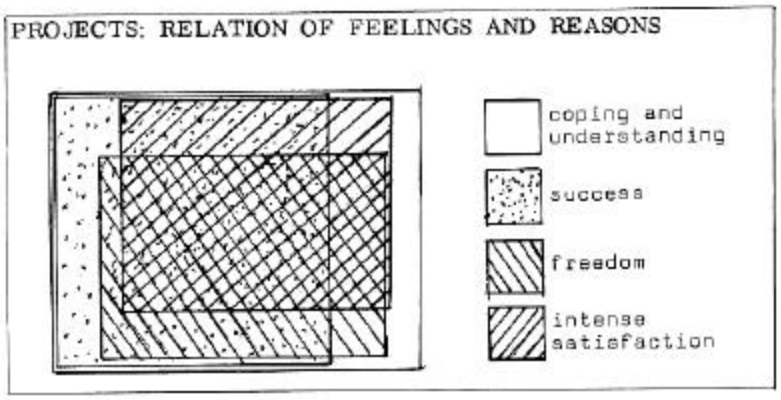
in 'bad' laboratory stories as feelings of success are in 'good' ones.

So far, then, the evidence suggests that projects and 'good' laboratories have much in common, except that projects offer more intense pleasure and a greater feeling of achievement.

8.2 WHAT IS SO GOOD ABOUT PROJECTS?

The best approximation to describing the reasons students gave for liking projects is to say that they mostly gave the same main reasons. That is, a half or more gave each kind of important reason, and where reasons were not given by nearly all, they did not cluster together but were evenly spread. The diagram below shows the importance and overlap of most of the main reasons.



Essentially all the stories contain something about coping and understanding; that is, about facing and surmounting a challenge, 'intellectual or practical, or about reaching new insight or knowledge. So 'coping' means things like:

> '...that got us really thinking about what we were going to be doing in practice... Things were rather slow to begin with - we had various hold-ups - but we were able to do some preliminary experiments, and after that we were able to make a fair bit of progress...I suppose it was being able to carry through an idea right from hearing about it in the first place, then finding out about heat pipes in general, then narrowing it down to what would be feasible. '

'Understanding' in the project stories often has the quality of 'things suddenly making sense', as in:

> '...the beauty of Saturday morning, when it melted'. That I'd got a fluctuation big enough to cause melting. I'd worked through the maths behind the fluctuation terms, and I'd got an answer, and it was right. There's a beauty behind it all - there's a reason'.'

> 'For the first time I actually had hold of a concept, and I could think about it - I was thinking inside something.'

In most stories, the degree of personal involvement is taken for granted, but is sometimes very explicit, as in:

> 'When you are doing a project you become part of it - I often walk about thinking about different things...I used to talk to it and even thump it - if anybody had seen me they'd think I was going mad.'

As the last diagram shows, success or achievement is mentioned in three quarters of the stories; only a quarter mention only involvement, coping, and understanding. The dividing line is not sharp, but the sense of achievement in many stories is sufficiently often so strong as to make it worth attempting some division. That is, things like:

> '... if what I'd found was right, then it would discredit all the work done by X...I'd read all X's papers, and realized that the areas he'd considered where errors could come in couldn't account for the discrepancy. It was a discovery that through my own intellectual ability, however limited it may be,. I'd actually come to some conclusion. '

and many more where the student has achieved something less dramatic but still real in his own eyes, are clearly very important parts of what projects offer.

Going with such success, but not exclusively associated with it, is frequently a sense of intense satisfaction not often found in other areas of work. 'Thrill', 'astonishment', 'a real kick', and so on are words common in project stories and rarer elsewhere. Such satisfaction and achievement is not exclusively scientific; it can relate also to the practical outside world:

> 'I had been trained, and I was doing something - I was being useful. I thought, if I can do that now, I can go off into industry and do it again. To be able to go out

> and do a job and earn a wage...You are keen on everything then...I didn't mind getting up early to get a bit more work in.'

Here, as so often, satisfaction, involvement, and achievement are inextricably mixed.

More than half the stories make a point of freedom, responsibility, or independence. To give examples:

> 'You make up your own mind, and you do what you want to do within reason. You have done it on your own, and you haven't been told how to do it.'

> '... at last you were being trusted with. it (expensive apparatus) - at last you were being treated as if you knew what you were doing, and didn't have to be watched over the whole time...You can go about it in any way - you can split up the work between your mates...You have got your own choice...You like people to think that you're responsible, that you're not just messing around...If you make a mistake, you take the responsibility for it. You get the credit when you do it right, and you get moaned at when you do it wrong, but at least you know, '',Well, that was all mine''.'

Two impressions, hard to capture in any analysis, remain with us from a reading of this aspect of project stories. One is the strong sense of release - of pent-up energy. The other is that the contrast is not freedom versus restriction, but freedom versus dependency; of not having to rely on others. A student is, after all, 'free' in a lecture course to work alone, to take what he wants from lectures, and so on. But he is still dependent on the teacher, and his 'freedom' is not as sharp and explicit as in projects. It may well be, we think, that lectures and the associated private study could be improved by marking out the areas of freedom and independence less ambiguously; by clearly setting aside certain areas for study which will not be 'gone over' in the lectures, for example, or by setting tasks such as writing essays in which a part of the work is 'covered' in that way alone. The sense of release we feel we detect suggests that students are more than ready for such a step.

The two 'bad' project stories deserve a passing mention, if only because they illustrate two problems relating to freedom. One is a story of frustrated hopes, of things obstinately not working. The student felt tense and frustrated, and had to take frequent breaks to calm down. Even so, it may not be insignificant that he says:

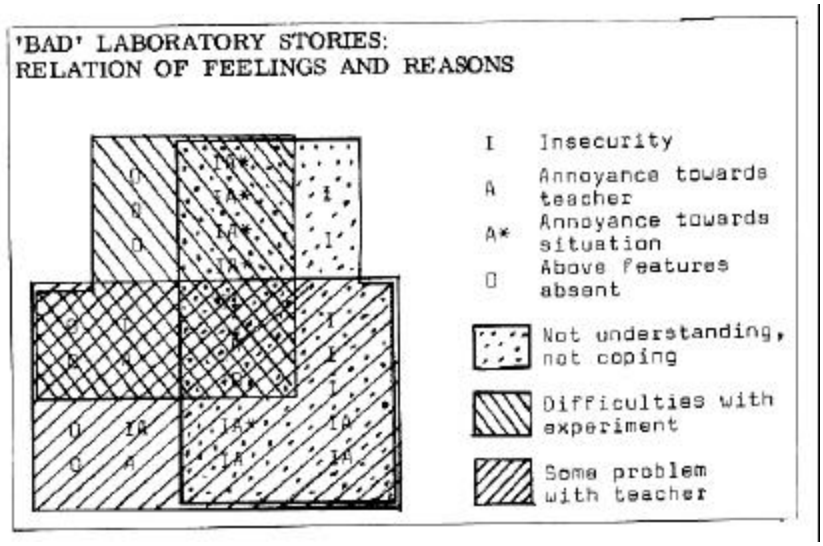
'It would take a lot to actually make me give up the whole thing. '

The other story is one of personal antipathy, of a girl who loathed the man she was partnered with. These and other problems are bound to arise; the remarkable thing is how few we were told about.

8.3 WHAT CAN BE BAD ABOUT LABORATORIES?

The importance of various feelings in 'bad' laboratory stories has already been shown in the diagram in section 8.1, and discussed there. Two of the notable features are the tendencies to negative interpersonal feelings, such as annoyance with the teacher, and to lack of security together with negative feelings about oneself - things like dread or self-doubt. The diagram below shows how these feelings are related to other reasons given; to whether the problem was some difficulty with the experiment (too hard, too long, apparatus did not work), to whether it was an inability to understand the ideas or to cope with the experiment or apparatus, and to whether a problem lay with the teacher (not getting help, not getting guidance, not getting recognition for what had been done)·

As always, these reasons are those as seen and reported by the student. We make no judgement as to their final truth.



Although the numbers are small (all 27 stories are represented on the diagram by a symbol), the pattern of feelings and reasons makes good sense. All but 2 out of 16 who felt insecure are those who could not understand or cope with the work. All but 1 of the 5 who were annoyed at the situation were those who both had difficulties with the experiments and could not understand or cope. All those who were annoyed with a teacher were those who described some problem with a teacher, though only 7 out of the 18 who described such problems got annoyed in this way. No one of the three kinds of reason looks critical by itself-all are about equally common, each appearing in rather more than half the stories.

In chapter 5 we identified first year laboratories as a problem area, especially those laboratories as they seem at the time to first year students.

Looking, then, at first year laboratory stories told by first year students, and contrasting them with stories told about later years, we found a clear difference in the kinds of reactions they contained. The difference is best shown by grouping the reactions into three kinds: 'turned off', 'upset', and 'cross'·

The feelings we called 'turned off' were such things as:

lack of interest
fed up
time - wasting
bored
indifferent
dissatisfied
pointlessness

The numbers of such feelings in the first year and in the later stories were in the same ratio as the total numbers of feelings in the two sets of stories So the two groups were equally 'turned off'.

Differences appeared in the other two kinds of feelings. Those we called 'upset' were ones like:

depressed
bewildered
worried

fearful
lost
inferior
inadequate
'I'm no good at it'
anxious
panic

The first year students produced more than their share of these, and students in later years fewer than their share (the disproportion being statistically significant at the .05 level, provided that one accepts the grouping as natural).

Thirdly, of the feelings we called 'cross', which were such things as:

frustrated
annoyed with the teacher
annoyed with the apparatus
misjudged
resentment
hatred

the students from later years produced more in proportion to their numbers than did the first year students (again statistically significant).

That is to say, both groups are 'turned off', but the first year students get 'upset' while second and final year students get 'cross'. One reason why first year stories by first year students seem to be critical (see chapter 5) seems to be the relative importance of events happening in the first few days or weeks.

> 'I was on the first experiment for three or four weeks -you get begged down and worried. You're afraid to break anything...At first you're afraid to go and ask, and the demonstrator at that time wasn't coming to ask me... You don't know anybody really, and you're afraid to show yourself up in front of people. And it's just very bewildering. You need someone to help you to adjust at. first, someone to come round and say you're all right. It was all rather depressing.'

When things go wrong it is easy to be put off, and hard for the new student to feel better by feeling cross:

> '...the first practical - after that I really felt like just giving up and going home because it was so bad. We didn't get any circuit diagram or anything, and we just sat around for the whole day fiddling with resistance boxes and not knowing what we were doing. I felt so fed up by the end of it, it was so absolutely awful. I thought, "If it's going to be like this I won't last here very long". I didn't know what was going on or anything, and I just sat and looked at the bits of wire and thought, "Help, what on earth do I do next?'. I still don't enjoy them at all - we have practicals on Thursday, and I start dreading Thursday by about the Tuesday before.'

When first year students do get cross, it is most often with themselves or the apparatus: they probably do not feel strong enough to get cross with staff. So, for example:

> 'I spent three whole sessions doing it, coming out with the wrong answer at the end. Doing something wrong all the way along -and nobody pointed it out. I got great tables of results, reams and reams of them, and it was all wrong. But you can't really be angry at anyone - it doesn't really seem to be anyone's fault. You can be annoyed but you can't really complain...Somebody walking around could well look at us taking all those readings and say, "Oh well, they're getting on fine". They're not going to know that secretly you're fuming away saying, "What a waste of time - this is silly".'

To sum up: the understandable initial nervousness of students seems to combine with the considerable effort needed in the laboratory; with the natural obdurateness of hardware; with their (correct) assumption that there is some kind of 'right answer'; and with their uncertainty about what kind of thing is expected (what staff will count as 'right'); to make them feel fed up and listless, and sometimes privately annoyed. What worries us is the contrast of this picture with the surface of things - with a room full of busy work- and with the frequently expressed laboratory ideal of leaning practical skill under the helpful tutelage of experts. What is hopeful is that few of these problems are all that difficult to put right,

In later years, students are more self-assured; some not even worrying about putting on a good front:

'If I did enjoy it, if I was interested in it, I'd think about it more...I don't take much interest in my work - I just do it because I have to.'

Happily, not many seem to be such hard cases. In their laboratory stories, apparatus still goes wrong, help is still not available just when they want it, and work is still lengthy and tedious. But the problems do not get under their skins in the same way as they tend to with first year students.

'...you spend a really phenomenal amount of time just waiting for somebody to explain what you're supposed to do. It's really very frustrating, and if anything goes wrong you have to wait again. It kills off any enthusiasm. And little technical things go wrong, with only one person who can fix them. A waste of time.'

Criticism which would upset students earlier now produces a reaction more tinged with indignation:

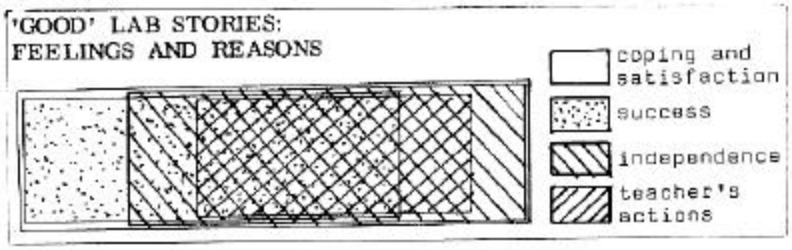
'...he turned round and 'said to me, "You're going to have a lot of trouble later on if your approach to work is this slapdash". I resented that slightly, because it wasn't really his place to criticize me like that, I didn't think. I know I tend to be a bit slapdash, but it was a bit like being kicked...he had drastically overstated the case. '

Lastly, these later stories tend to mention lack of independence, indirectly in talking about having to do things, or directly:

'I would rather it was more left in your own hands.'

8.4 WHAT CAN BE GOOD ABOUT LABORATORIES?

The diagram below offers a picture, more cheerful than that of the previous section, of the relation of feelings and reasons in 'good' stories about laboratory work.



All these 'good' stories have something in them about being able to cope or understand, and about the satisfaction which that can give:

> 'I can get a great deal of satisfaction out of doing something, carrying out a practical and learning something from it that perhaps I didn't understand, but because I've had to do it, it makes it a bit clearer. You've learned something in theory, and been told that there's this apparatus and what it does, but you don't actually know what it does until you've actually seen it...I felt quite chuffed that I'd actually managed to learn something this time...And a feeling of having completed something, of having succeeded, just for a little time. You feel happy about something having been done well. Even if other people don't think it's done well, you may think so. That's what matters. '

This is one kind of 'good' story about laboratories: stories about experiments which work, about learning something, about succeeding in doing a task. Teachers in the laboratory play a minor role in such stories; the main events concern the confrontation of student and apparatus - a confrontation which gives the student a sense of achievement when he wins the battle.

Another kind of 'good' laboratory story has to do with independence and freedom; one example appears in section 8.1 to illustrate the project-like virtues of some normal practical work. Some students grasp the opportunity eagerly:

> 'I chose this experiment deliberately because it was the hardest one to do... The fact that I could choose the experiment, knowing that I didn't understand it. And the challenge of being able to walk up to something and not know a thing about it, read the small blurb they provide for you, go and get the books and find out about it, and actually succeed and come out with an answer that's almost right. That's what I think physics is about.'

In stories of the first kind, which might be labeled using the words of one girl,

> 'Hurray, I've done it;'

staff in the laboratory have a difficult role to play. They are expected to give help when it is needed (and as the last section suggested, to guess when that is on flimsy evidence), but to let well alone when it is not. The next example nicely illustrates the balancing act which is involved.

'If you get any problems you have demonstrators to con-suit, but most of it is up to you. If they think the experiment is difficult they'll give you more help and more or less tell you how to do it word for word, but if they think you might be able to do it with a bit of thinking by yourself, they let you think it out by yourself, which is in some ways good and in some ways bad...If you can think for yourself it's all right, but if you can't you're having problems all the time. You can't keep going to your demonstrator and asking what's happening here and what's happening there. '

The help demonstrators give can be much appreciated:

'...having it explained, I realized what was happening, what I was supposed to do, and the sort of results I should get out. I went back to the experiment and did it, and it worked - I felt great. That was very satisfying - I'd learned something.'

It is not surprising that the student takes the pleasure and credit to himself, but it does mean that the events are more rewarding for him than for the teacher. Much the same can apply to the effects of a little praise:

'I was pleased with the pictures, and the demonstrator did say they were pretty good, better than they were used to. They had been having trouble with the set-up, and it took quite a long time to get it working, so I was quite proud of the results.'

This means that the area marked 'teacher's actions' in the diagram showing some of the relations between feelings and reasons must not be misunderstood. What the teacher does may be very important to the student, but the teacher may never know of its importance. This is obviously and especially true where staff maintain some distance, as the following illustrates,

'We had to do lab reports over Christmas, and I got a really good mark. That really pleased me - I felt as though I'd learned something. I'd learned how to write a report properly, just as they wanted it. It was the mark itself that made me feel pleased, and there was a comment on the report which pleased me intensely - "Clear, concise, very well written, put a lot of effort into it". Which pleased me because at last they realized that effort does go into some things.'

when taken together with just one other remark,

'I don't know who marked it.'

In the second kind of story, about freedom and independence, essentially all the reasons concerning the teacher are to do with his allowing or encouraging the student to work independently. Sometimes it is deliberate policy, and such a policy can help to deal with one of the problems of set experiments which came out in the previous section, namely that they may fail to give the sense of achievement just described but slip into seeming like pointless repetition. A student puts the contrast:

> 'I like to be given a few basic ideas and be allowed to make something of them in my own way, rather than be told everything that I have got to do. If you are told what you are going to do, you know the results - the outcome of the experiment - before you start, and it is a waste of time.'

Much thus depends on whether an 'experiment' seems to the student to be an experiment rather than an exercise. Such reactions are not confined to the later years; a first year student explains how a small, even accidental, injection of independence was quite important:

> '...one of the supervisors walking round said, "Oh, that's interesting" and I said, "Well, look, I'm not getting much out of this - can I just sort of look into it?'. So I did...I felt I had done something a bit different, that someone else hadn't done the week before... I just generally felt I had done something, not anybody else - nobody's done it before, nobody will do it next week. It wasn't of any particular interest, but I'd done it, and I was pleased and I was happy.'

8.5 MEANINGFUL TASKS

We think that many of the differences between projects, 'good' laboratory stories, and 'bad' laboratory stories, might well be understood in terms of the nature and meaningfulness of tasks in the laboratory.

In 'good' and 'bad' laboratory stories respectively, feelings of coping and understanding, or not coping and not understanding, are like mirror images of one another. The laboratory, unlike the lecture, presents a clear task with which one can cope or not, and in which success or failure is rather obviously apparent. Failure often leads to feelings of insecurity, but success

leads to feelings of achievement and satisfaction, not security (perhaps because another task will start next week:). Again, in ‘bad' stories, R is the experiment which is often seen as hard, long, or tedious; in 'good' stories the experiment is rarely praised. One rarely compliments an adversary on being decent enough to capitulate.

The importance of feelings of independence in 'good' laboratory stories, and in project stories, has, we think, to do with students finding it more meaningful - closer to real experimenting - to decide and act for themselves. Indeed, it is perhaps in the laboratory that many students take the important step of first thinking of themselves as scientists as opposed to science students (the step we all took on the day we first replied to a question about what we did by saying we were physicists).

But independence and freedom are not magic ingredients which will rescue the laboratory from every problem. In the 'bad' stories, students do not speak of lack of independence nearly as often as in 'good' ones they speak of its presence. A task which is defeating one is not the kind of thing one has feelings of freedom or lack of freedom about; the matter hardly arises. So those who want to capitalize on the value students attach to being responsible and independent need to set tasks which are neither too overwhelming nor too trivial.

Finally, alike as are 'good' laboratory stories and project stories, we do not think there are grounds here for saying that a well designed laboratory of set experiments can do everything projects can do. The intensity of the satisfactions produced by projects, by contrast with the more muted pleasure and enjoyment we find associated with 'good' experiments, is quite striking. A good laboratory can offer a lot, but it is hard for it to get the powerful and sustained involvement a project can provide.

9. Stories about individual work and exams

9.1 INDIVIDUAL WORK

In grouping the stories, we put together those about such things as essay writing, private study, solving problems, and revising for exams, as a matter of convenience. It was therefore pleasing to find that they produced a fairly consistent pattern of feelings and reasons. The numbers of each kind of story are small (5 'good' essay stories; 9 'good' stories about exam revision), so it seems to us best to treat them as a whole to begin with.

Essentially all the 'good' stories mention feelings of satisfaction; what is more striking is that three quarters of these 27 stories mention feelings of personal achievement. A little more than a half mention security or self-confidence, and almost a half mention being very involved in work. Taking these feelings together, the dominant pattern (60% of stories) is one of achievement and security or involvement or both, with of course satisfaction in work also.

The reasons the students give are even more consistent. More than four fifths mention understanding the work when they have done it. More than four fifths also make a point of the finding of information in books, of digging up references, and so on. Nearly two thirds regard themselves as having put in a lot of effort, and take pleasure in looking back at that hard work.

The different activities, such as writing essays or revising, are not distinguished by having particular sets of these feelings or reasons: the patterns are much the same for all.

The 13 'bad' stories divide up rather differently. 9 of them are about revising for exams, and it is this group of stories which contains all the feelings of irritation, annoyance, or dislike towards the subject. Feelings of frustration and of insecurity or lack of serf confidence are common also. Reasons are much the same for all the 'bad' stories, being essentially not understanding and not being able to cope in every case, with fear of failing an added reason in the exam stories.

Other reasons - mainly predictable - in exam stories are pressure of work, the need for more time, inadequate notes, and in general the looming presence of the examination.

Because of the importance of stories about revising for exams (18 in all, out of 40), we have brought together in this chapter these and the other stories about doing examinations which are classified under 'other stories'. First, however, we look at the nature of the good reactions associated with individual work.

9.2 FEELINGS ABOUT WORKING ALONE

Common expressions of understanding and achievement in study are that 'things suddenly clicked into place'; of things making sense. For example, a student talking about doing a problem said:

> 'I was quite bothered about it, because I hadn't kept up with the course very well...I was a bit bothered I . wouldn't be able to get through it. Then working through it, it suddenly came to me that this equation (was all it hinged around) and everything fell into place...(I felt) relief at having understood it, and marvel at the beauty of the logic that led to it and fell away from it...It's (also) happened once or twice when I was reading a text book... suddenly it was all falling out in one line in this one chapter...There's plain straightforward joy at being able to understand what's actually happening in something that exists - suddenly you've got something in front of you and it's not a mathematical abstraction.'

The story nicely illustrates a feature of individual work: the shift from doing work one must, to working for the pleasure and engagement with ideas that it offers:

> 'Once you've seen this sort of thing, you want to continue and try to understand more things. When it happens once you want it again.'

It also illustrates the initial insecurity of trying to cope with something difficult (often examinable). 'Relief that I could do it' is no less common than pleasure in success. The relief or self-confidence has often to do with that aspect in which the student feels himself a student, as opposed to feeling himself as a budding competent scientist:

> '...you see how it all slots into place. (You get) quite a sense of achievement, and it suddenly comes much easier...You get more confidence, and feel pleased with yourself...You feel you're on the right track and that this is a good sort of subject - one you'll be confident of in revising...that if you're presented with a similar problem again you'll be able to do it without any trouble-you hope.'

Students do, however, distinguish being able to cope with a set problem, and being able to understand it:

> 'If you're struggling through, arriving at an answer merely by following the formula but not understanding it, then you don't really benefit...It's not really your work.'

Study and problem solving can be a very frustrating and anxious business. Some get cross, and avoid anxiety by giving up:

> 'At first I sit there and wring my hands and tear my hair and generally feel tense. Then I throw the problem away, put it in a file, and go and have a coffee, sit in the kitchen and stay there and don't do any more work for the rest of the evening...The danger is if you go on doing that... '

Others get worried and anxious:

> 'You feel a sort of emptiness - you just wonder whether to carry on or not; whether the physics course is too hard for you - that it's too far beyond you and you haven't a clue what's happening.'

It is quite striking that the effect of success or failure at a problem can be to confirm, or cast doubt on, the student's whole idea of whether he is doing the right subject.

There were only 5 essay stories, all 'good', and although the number is small, they do seem to us to have a character of their own. Typically, students spoke of hard work, of a feeling of concrete achievement, and of reaching much deeper understanding.

> '...so I gave a sigh and went over to the library and got out about ten books, and went back, shut myself away, and started reading them. To my surprise I found that entropy is really quite an interesting concept and really hard to understand. When I finished reading...I still didn't understand it, so I had to go back and read

them all again, but once I had done that I got hold of the idea, and I got down to writing the essay and finished it two days later. I was just exhausted, but it was an amazing feeling seeing all those pages of writing in front of you, title and all. You can actually see it as a concrete achievement in front of you...The essay was just the symbol of all the time I had spent on it, but I was also pleased to find that what I thought was a very boring subject was really quite interesting if you knew something about it.'

Running through the essay stories is this sense of possessing ideas (see the transcript in section 1.4 also). Several contrast the learning they did then with other learning, with a mixture of realism and idealism:

'I used to think before that you can learn physics by going to lectures, but now I don't think you can do that. I think if you want to learn physics, it's got to be part somebody telling you something, but part learning it yourself - discovering by yourself...'

'A very small part of the time spent learning physics is spent in actually talking about it - articulating ideas... As often as not you can understand something well enough from a lecture to be able to solve a problem... but still never actually have a grip of the subject...It's really quite different to write about it, because you start off and realize you don't know whether what you're saying is exactly right or not...you really do have to understand it before you write it down. And if you do, you feel you've sort of conquered a small amount.'

Such remarks, consistently present in the essay stories(even when they also refer to, 'Relief at having done what you are supposed to do'), seem to us to make a modest but convincing case for the place of essays in science teaching.

9.3 EXAMINATIONS AND REVISION

Those who believe in the value of examinations in putting on pressure to work so as to encourage students to greater achievements, can find some support in the stories we collected. But so also can those who worry about the fear and misery they can induce, and who are concerned lest the pressure converts trying to learn into memorizing parrot fashion. Both should remember that, in the stories as a whole, well under 10%

directly concern exams or revision for them. They are mentioned in other stories, but again in well under 10% of the whole. So it seems that exams by no means form the ever present background to work that they are sometimes claimed to do. The immediate influence of other work is stronger.

One student puts the classic case for examinations:

> 'I feel quite good immediately before an exam, if it's a particular course in which, because of the pressure of exam work, I've really taken trouble to look through it, look up references, and get on top of the subject - especially having learned the proofs that I might have to reproduce, so that my confidence is increased.'

He then puts the classic reason weakening the case:

> 'It only lasts a short time, until you've actually done the exam, and then you more or less forget about it. You just sort of really get on top of it so that you can answer anything about it.'

Another student puts value on the understanding achieved after the struggle needed to learn something for an exam:

> 'I remember struggling with it for ages, and then I understood it. It was great, that I eventually understood it ...I was trying to remember the reasoning behind it, and just sitting there for hours trying to understand it, because if you understand it there is no learning involved - your reasoning takes you through...Eventually I got to the end, and I found that during the day I'd think, "I wonder if I can still do that?' - and I would write it down on a piece of paper - "I can still do it, you see".'

Confidence is often mentioned in the 'good' stories about exams and revision; lack of it is mentioned even more often in the 'bad' stories. Having completed a job is another feature of the 'good' side, and feeling that it will never be done a corresponding feature of the 'bad'. So one will say,

> '... looking back on a completed set of work...I like to work to some definite goal, and then say, "Well, stop -I have finished". Most of the time at university you continue working not really passing any goal posts.'

while another describes the nexus of all that there is to learn, of the fear induced by it and the difficulty, of it, and the way emotions spread from person to person:

> '...if everybody around you is worried, upset, and thinks they're going to fail, it doesn't do your confidence any good, and so you find it difficult to learn...One of my friends... came round to see me and sat and he burst into tears in my room. I felt really awful after that... you feel so hopeless, that there's no point in going on. You know, that you'll never know any more...If you don't know it now, you never will. If you don't understand it, no more just sitting reading is going to help.... But you know, even while I'm sitting there thinking I'm bound to fail, I'd be very shocked if I did fail. But there's a sort of knotted-up-inside feeling.'

One of the really distressing things about examination stories is the dislike of physics in a good number of them.

> 'We had nothing but physics, and it was just rammed at us all the time. I got to the point where I was so full up with physics that every time I looked at a physics book I wanted to be sick. Certainly in particular subjects I grew to hate it all.'

Most students are clear that learning parrot fashion is useless and disagreeable, but sometimes find themselves driven to it. Whether they are or not depends on the kind of examination, and on what they expect it to be.

> 'I tried to get a general, basic understanding, as much as I could...and then sat down in the exam, and the paper was almost entirely mouthing formulae, and derive this - derive that. That really did knock me down.'

By contrast, another describes an examination where notes could be taken in:

> '...obviously you get quite a lot more difficult questions. But it tests your basic understanding, rather than just leaning parrot fashion...you have got to have a basic understanding, and again it makes you learn more...If you can apply the word enjoy to exams, I enjoy it more.'

Little of what we have said here will surprise anybody. To some degree, examinations seem to do the job they are meant to do, and if that includes exerting pressure and raising tension, they certainly do that. There is an old argument that life involves working under pressure, and that examinations therefore properly test the ability to do it. Not all who use the argument appreciate the amount of tension involved, however, and it seems to us that it is sometimes too great.

10. Tutorial stories

10.1 HOW IMPORTANT ARE TUTORIALS?

We began this study with some personal bias in favor of tutorial teaching; indeed one of the project's books - SMALL GROUP TEACHING IN UNDERGRADUATE SCIENCE - is devoted to it. That may have been why, when developing the analysis, we happened to choose this area for a dummy run. But, as the reader may recall from chapter 5, there are not very many tutorial stories; only 26 out of 271. This rather surprised and depressed us, as we had hoped to find students valuing this one personal part of science teaching; to find plenty of them at least saying things like:

> 'When I had problems to sort out, I've always felt that I could go and see him about them - about anything really - and he's always shown himself to be prepared to give up time to have a chat about anything.'

The stories there are divide about equally into 'good' and 'bad'. What do students get out of 'good' tutorials? The answer seems to be the one which is the basis of the classic case for tutorial teaching: they get help and support, and sometimes make a valued relationship with someone they respect as a scientist and like as a person. The tutorial is not the place where achievements or successes are made; it is a place where problems may be eased, where confusion can turn into understanding so that learning becomes satisfying and involving. The tutor's role is both a subject role and a personal one - he explains and he makes one feel better.

What about the 'bad' stories? In many, the student turns against the teacher himself, as one might expect (however unfair it may be) in face-to-face teaching. In some he loses interest in or is turned against the subject. Both of the tutor's roles matter: his explanations and knowledge of the subject, and his personal help, interest, or skill in handling a group of students. Of the two, in the 'bad' stories, it is the latter which tends to outweigh the former.

10.2 THE TUTOR EXPLAINING THINGS

About half the 'good' stories, and essentially all the 'bad' ones, involve the tutor's ability, or inability, to explain things. The difference between this aspect in tutorials and in, say, lecture stories, is that the explanation works, or does not work, for me - the student - personally. So, for example:

> 'He was really helpful, because if you didn't understand a part of the course, he would go through it even three or four times if necessary. I think tutorials are the most important part of the course, because you do actually talk to a doctor close to and get something from him - and he is giving it only to you, he is able to concentrate on what you actually want.'

Naturally, several stories talk about help with problems, both routine help and that more valuable help which may come when a problem reveals a whole area of ignorance.

> 'He'd do all these questions on the board - and he was an expert tutor. ..Then one time, on Gauss' law - I couldn't understand it at all. It was really beyond me, and we spent a whole tutorial aimed at me, trying to make me understand. I gazed at him in awe because he could do it... but then I came out fully understanding, and that was one time I really got down to work and enjoyed it because I understood it.'

The main feelings in such cases are usually satisfaction and sometimes security.

> 'It was just a sort of general elation at the fact that I had learned something. That made me happy.'

> 'Suddenly you understand it, and you think, "Ah, I understand, and I don't have to worry now"...It's relief that you can understand it now whereas you didn't before. It eases your burden of worries.'

In addition, the satisfaction and relief can be a spur to further work:

> 'If you find you can understand that far, it urges you on to have a stab at the other bits.'

Inevitably, sometimes the tutor tries to explain, but fails. The following story about that also contains a characteristic reaction: annoyance directed at least in part at the tutor.

'We got the feeling that our tutor couldn't really explain it either. We were struggling away between us trying to sort it out, but he couldn't satisfactorily explain it to us. Maybe he did understand it, but he couldn't make us understand it. We went away feeling that we'd got absolutely nowhere - we seemed to have gone backwards, in fact. That really annoyed me I was cross. (Who with?) Partly with myself, partly with the others, and partly with my tutor.'

At other times, students feel no sense that the tutor is trying to help them at their own level, or even that he knows how to help them. The following story of this kind also contains two other common reactions: stopping bothering with the subject, and a loss of liking or respect for the tutor - the 'cold' reaction as opposed to the previous 'hot' one.

'He'd say, "Any problems?', and we would maybe bring up one or two minor problems, but he never really got to us in a sense, and we never brought him anything significant...Once we went to see him, and he got some textbooks out and went through them on the blackboard, until we discovered that he'd confused himself completely. Just didn't know anything about it. (So) I didn't bother revising it... and there was no respect for him.'

10.3 THE TUTOR AS A PERSON

The last story touches on the more personal side of tutorial teaching. The tutor and this (quite possibly disagreeable) student simply did not get on, or the student expected too much. For students, the interpersonal aspect is important. It will not do to think of a 'good tutor' as simply knowledgeable.

'You felt that this bloke cared about you...I always felt sad when it was over - if the conversation gets going an hour can just fly by. You felt he had put the effort in. Physics got taught there as well, but it wasn't, "Come in - let's do some physics", but, "Come in - have you got anything to talk about?'. Whereas with some tutorials it is, "Hello - come in - now what about Fermi energy - who knows anything about that?', and waiting for some brave guy to open his mouth and be ridiculed. And it' was reassuring to know there was somebody with a bit more knowledge of life that you could go and see - this bloke made it friendly, you know, at least he said you can rely on me.'

An important aspect of friendliness is the feeling that one can actually discuss things:

> '...any problem we've got, we discuss it with him, or discuss it together as well. A discussion with other students, who maybe understand better than I do, is a very useful way to understand.'

Part of the unfairness of the tutor's position is that when things go well, students are mostly unaware of his personal tact and skill, but when they go badly, are sharply critical of him.

> 'It is supposed to help us, and I suppose it does in a way...but it is just work all the time. You have no opportunity to get on with the person, or to know what he personally thinks about things...I thought tutorials would be where we could just sit down and tall about things between us - get to know what other people think - tall about all aspects of it, not just the mathematics, but the consequences. Mainly I'd like to be relaxed...I don't really feel as though I want to be there. It seems just like a task you have got to do...He knows what he is on about, but when a person just comes in and spouts words you tend to lose interest.'

This student's reaction is common in 'bad' stories: a reaction of withdrawal, of non-involvement. It is a particularly dangerous reaction, because the tutor feels himself faced with blank faces and all his efforts are coolly and covertly rejected. Sometimes, of course, the tutor really does misjudge his own actions:

> 'He said, "Oh rubbish" or something like that. I'd said something and it was sat on... At first I was upset, and then afterwards I was angry because he ought to have realized I was making a contribution.'

The tutorial does make considerable demands on students' self-confidence, and much of what students say reflects how well or how badly the tutor has dear with their nervousness. Their feelings can all too easily distort a situation out of all recognition:

> 'I don't think this particular chap would be interested in people going along and asking questions..."All these dull students coming and asking me stupid questions", he would probably think.'

To sum up, the tutor has a difficult job. At least students do respond very positively when it is well done.

11. Reflections and conclusions

11.1 SO WHAT?

At the end of such a book as this, the reader is entitled to ask, 'So what?'. So we here offer some personal reflections and conclusions; things which have struck us about the material we collected.

One thing that has struck us is the loneliness, the privacy and individuality of learning science, not only in the anonymity of the lecture hall and the privacy of the study, but also in the laboratory and even in the tutorial. Students speak very favorably of valuable personal interactions with staff, but such occasions seem to be rare. We think this at least in part reflects what science is like, and what learning it is like. Just because of its relative objectivity and impersonality, and because of its bull, science seems to have the feel of a 'thing out there' to be tackled; to be like a cliff to be scaled. Such a feeling shows up in talk about a problem 'coming out', or a difficulty being 'got over' or 'put aside'. To a degree it is bound to be like this, but we do wonder whether science should not more often be shown as something human beings do, by more intimate contact with those who do it.

A related thing that has struck us is the frequency of the reaction of cutting off from the subject, of disengaging the mind, when things go wrong or are difficult. We think it reflects the student protecting himself from the personal consequences of a potential failure which will be only too demonstrable (I didn't try, so I didn't really fail). This, we think, is how that annoying adjective 'boring' should be understood. It also seems to us that this is why teaching can be both unrewarding and hard to improve, because the teacher all too often faces an unresponsive class.

We have been struck by the evidence of a good deal of self-doubt and insecurity amongst students, sharpest in its negative form in the first year, but notable also later on when they value projects and other things for giving them self confidence. The challenge offered by the university is a c. considerable one. Those who think this necessary and good might, we think, ask them-

selves if its consequences never need remedial action.

We find it notable how very rarely students spoke of praise. Naturally, as one grows older, one is expected to rely less on a pat on the back, and more on the intrinsic rewards of a job well done. Further, it is often criticism which is seen in the university as the means of establishing standards. True as all this may be, few university teachers would be happy with no public recognition of their work, and why should students be different ?

Lastly, we have been struck by how students see learning science as a job (albeit temporary) on its own terms with little outside reference. A few spoke of learning so as to become worth a wage, or so as to contribute later to scholarship. Most saw it as an immediate set of demands to be complied with. At the same time, those who spoke of independence spoke of it favorably, and more important, responsibly. We think that there is here a too often neglected and powerful motor.

Many of these things must seem obvious or inevitable. Indeed, a major limitation of the study is its narrow focus on physics students, so that one can only speculate about whether features one sees are open to variation. It is therefore important for the reader not to take for granted those things which seem to him to be entirely natural - possibly they could be otherwise.

11.2 WHAT FOLLOWS?

What students should get clearly does not follow from what they like or dislike; they may hate the essential and delight in the unimportant. Further, their reactions may be passing ones; they may come to value having been made to do things they did not want to do. So what follows from the evidence we offer? Is it even 'evidence'; may not students simply have misunderstood what was intended?

The answer is two-fold. First, such evidence is just one of many things to be taken into account in making intelligent decisions. One may rightly act against it, but one ought not to do so without good reason.

Second, whatever the students have got wrong, what appears here is still a reality; the reality of how they see things. For the teacher, the realities may be very different, but it is just where the two realities diverge that understanding is most needed. Each reader will have to find such places for himself.

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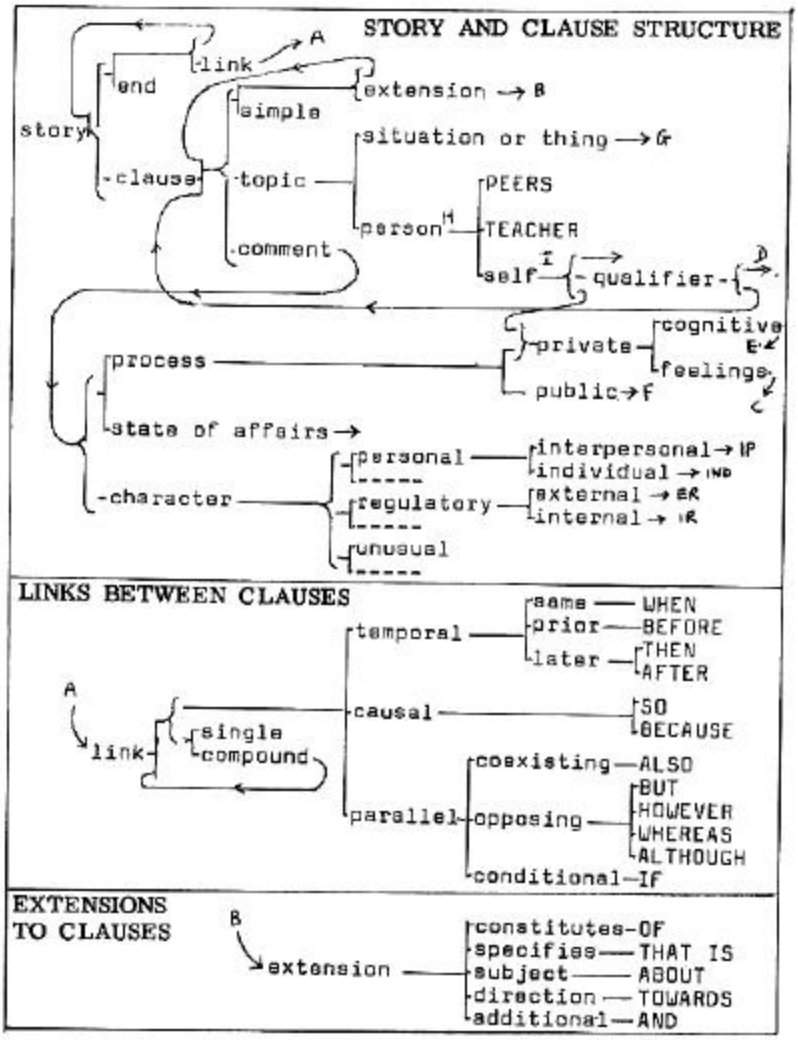
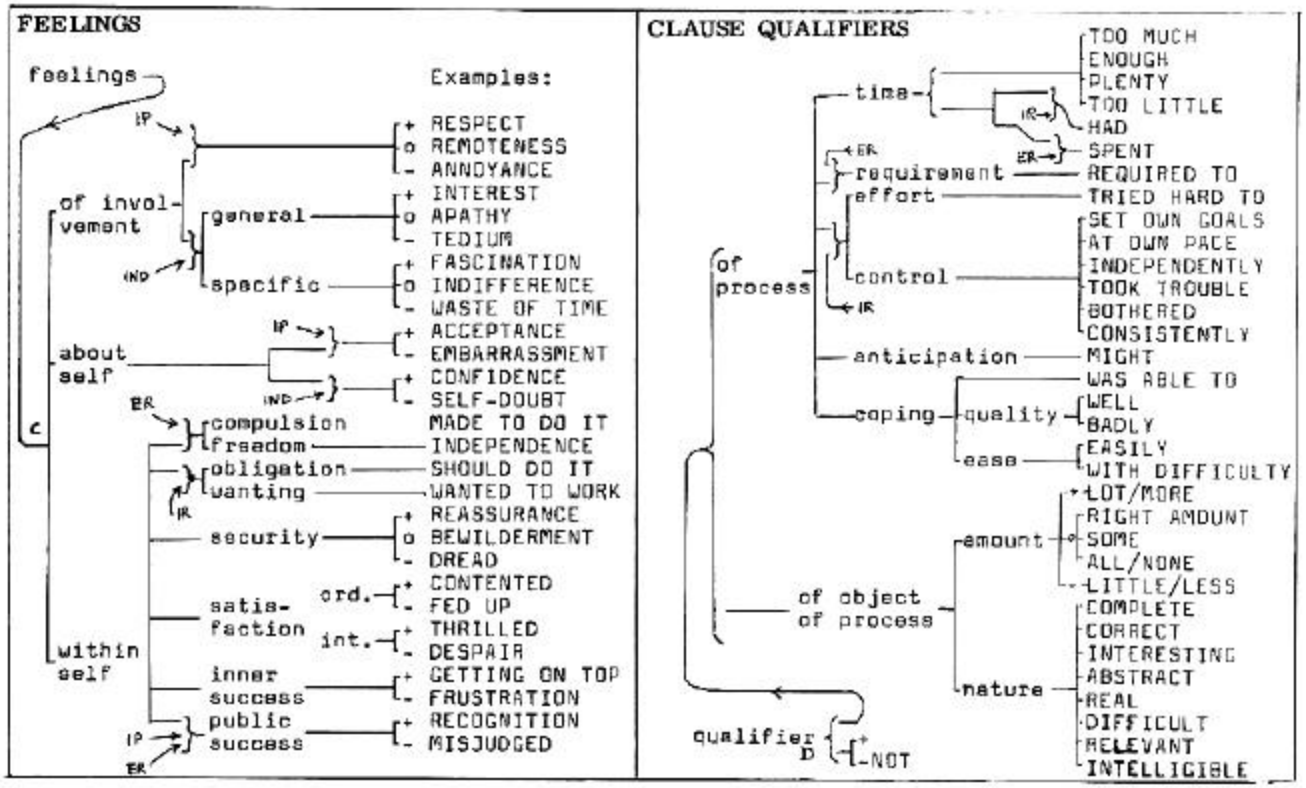
Appendix: networks

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o INDIFFERENCE
- WASTE OF TIME
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- EMBARRASSMENT
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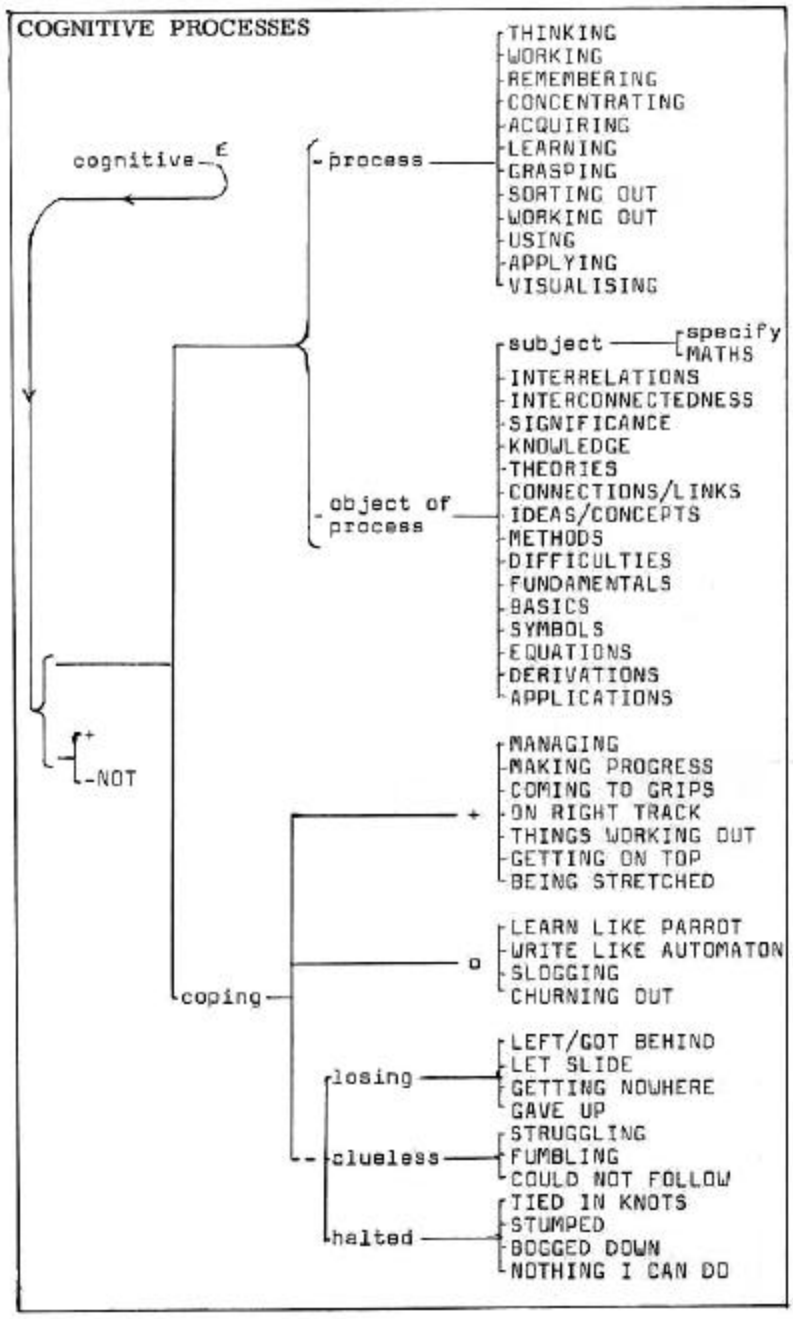
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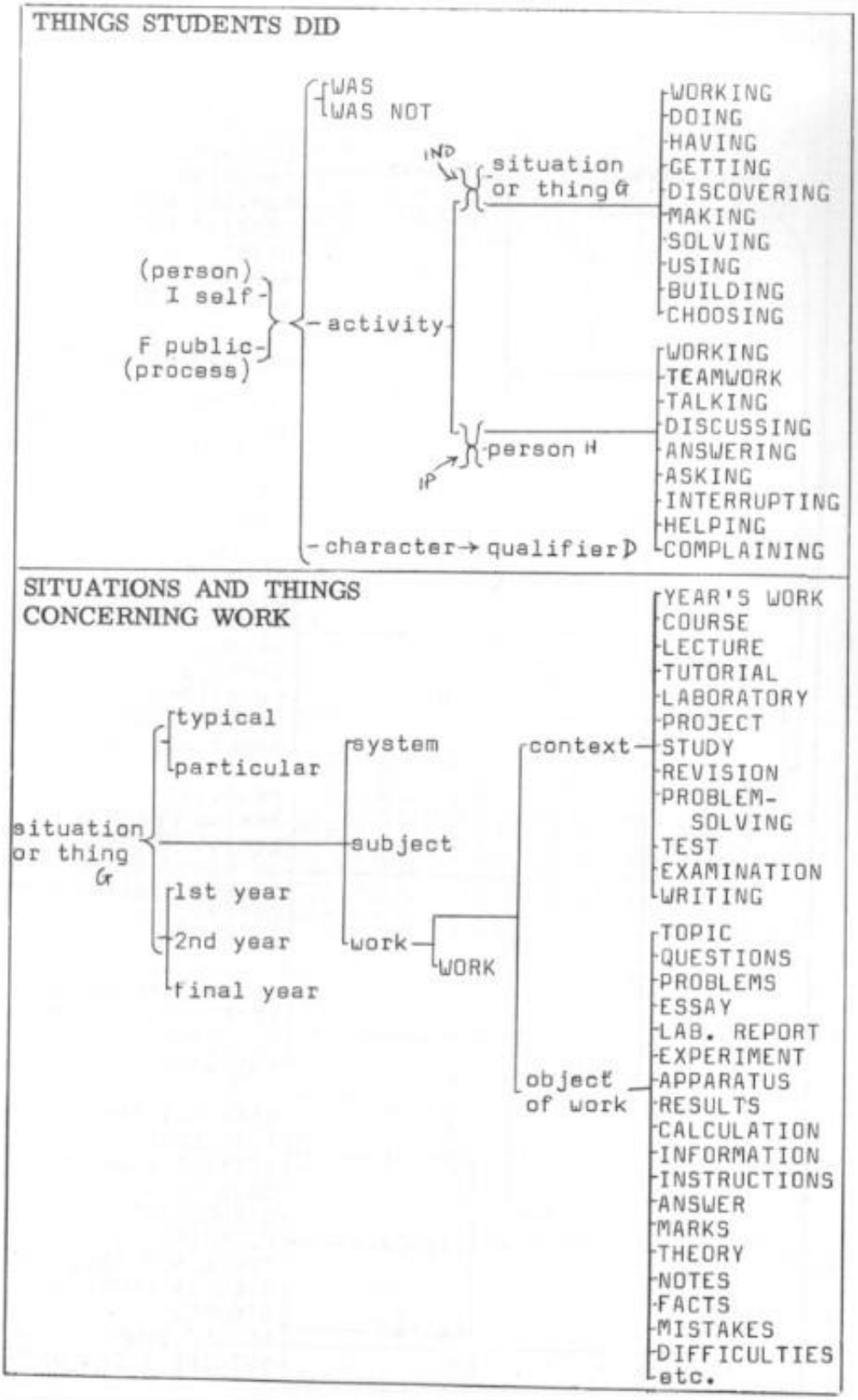
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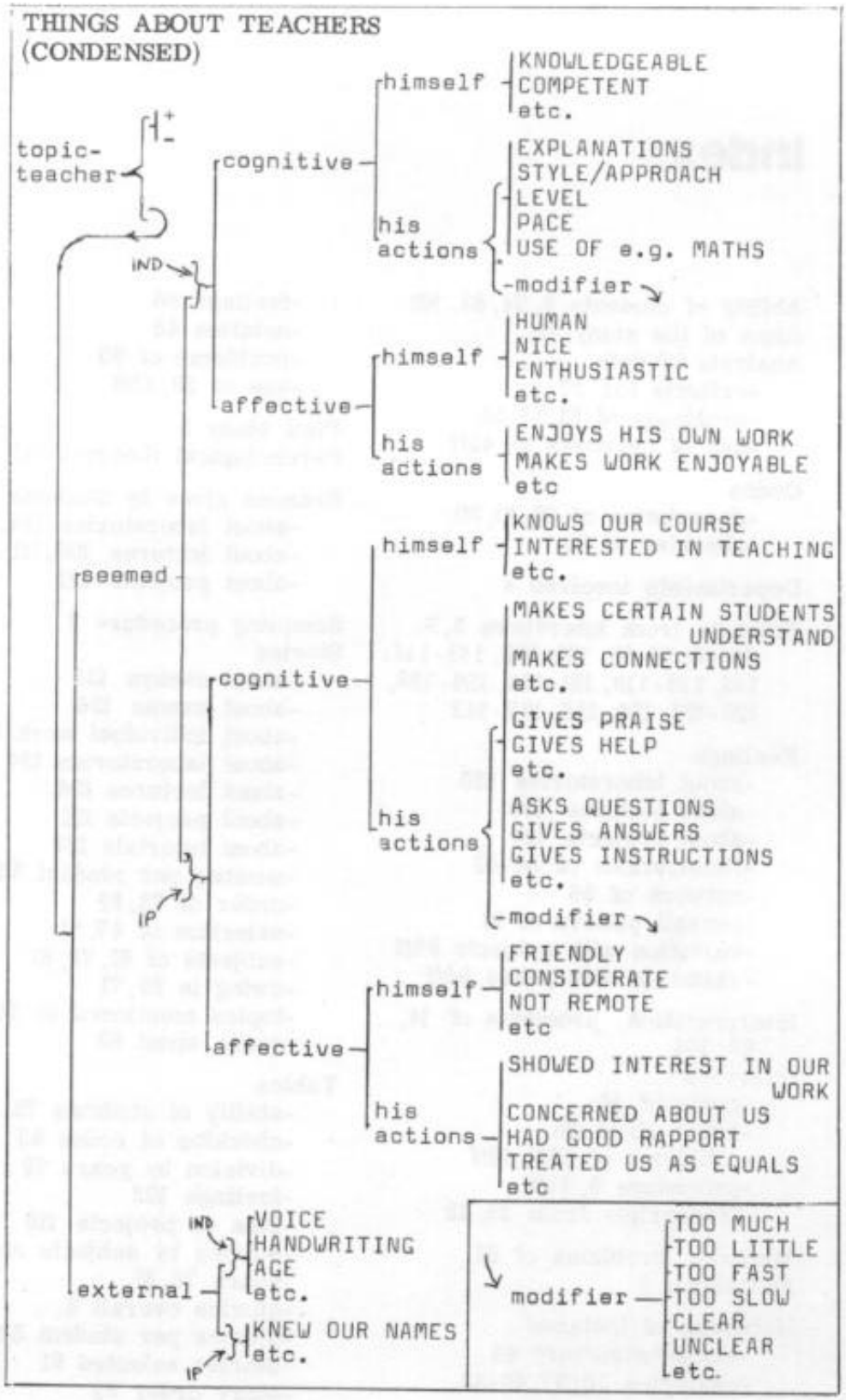
DIFFICULTIES
etc.


THINGS ABOUT TEACHERS
(CONDENSED)
topic-teacher
+
-
IND
IP
cognitive
himself
KNOWLEDGEABLE
COMPETENT
etc.
his actions
EXPLANATIONS
STYLE/APPROACH
LEVEL
PACE
USE OF e.g. MATHS
-modifier
affective
himself
HUMAN
NICE
ENTHUSIASTIC
etc.
his actions
ENJOYS HIS OWN WORK
MAKES WORK ENJOYABLE
etc
seemed
cognitive
himself
KNOWS OUR COURSE
INTERESTED IN TEACHING
etc.
his actions
MAKES CERTAIN STUDENTS UNDERSTAND
MAKES CONNECTIONS
etc.
GIVES PRAISE
GIVES HELP
etc.
ASKS QUESTIONS
GIVES ANSWERS
GIVES INSTRUCTIONS
etc.
-modifier
affective
himself
FRIENDLY
CONSIDERATE
NOT REMOTE
etc
his actions
SHOWED INTEREST IN OUR WORK
CONCERNED ABOUT US
HAD GOOD RAPPORT
TREATED US AS EQUALS
etc
external
IND
VOICE
HANDWRITING
AGE
etc.
IP
KNEW OUR NAMES
etc.
modifier
TOO MUCH
TOO LITTLE
TOO FAST
TOO SLOW
CLEAR
UNCLEAR
etc.

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