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ABSTRACT

This thesis focuses on the espoused beliefs, values, and attitudes of experienced A-Level Biology teachers in relation to the teaching of controversial biological issues. Of major interest is the thinking behind what the teachers in this study regard as the possibilities and problems for the teaching of controversial issues given the teaching context in which they work. In this study, an intervention approach is adopted and conceptualized as a wholly, negotiated venture between the researcher and four, individual, experienced A-Level Biology teachers through the development, implementation, and subsequent reflection on one or more lessons addressing one specific controversial issue. All participants teach in comprehensive Local Education Authority (LEA) controlled schools and are considered expert practitioners. The research seeks to gain an understanding of the rationale these teachers have for the use of controversial issues in their A-Level Biology teaching practice. Four issues are investigated: organ transplantation, infertility, diabetes, and animal experimentation. What emerged from this study is a set of variables which enable the identification of conditions whereby the use of controversial issues for the teaching of A-Level Biology might be possible. The significance and implications of these findings in terms of teacher education and professional development and an agenda for further research are discussed in the final chapter. (Author/NB)

CONTROVERSIAL ISSUES AND THE TEACHING OF A-LEVEL BIOLOGY: POSSIBILITIES AND PROBLEMS

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Abstract

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Controversial issues and the teaching of A-Level Biology: possibilities and problems

This thesis focuses on the espoused beliefs, values and attitudes of experienced A-Level Biology teachers in relation to the teaching of controversial biological issues. Of major interest is the thinking behind what the teachers in this study regard as the possibilities and problems for the teaching of controversial issues given the teaching context in which they work.

In this study an intervention approach is adopted and conceptualised as a wholly, negotiated venture between the researcher and four, individual, experienced A-Level Biology teachers through the development, implementation and subsequent reflection on one or more lessons addressing one specific controversial issue. All participants teach in comprehensive LEA controlled schools and are considered expert practitioners. The research seeks to gain an understanding of the rationale these teachers have for the use of controversial issues in their A-Level Biology teaching practice. Four issues are investigated - organ transplantation, infertility, diabetes and animal experimentation.

What emerged from this study is a set of variables which enable the identification of conditions whereby the use of controversial issues for the teaching of A-Level Biology might be possible.

The significance and implications of these findings in terms of teacher education and professional development and an agenda for further research are discussed in the final chapter.

CONTENTS

Chapter One: Introduction

Background to the Thesis

1.1: Autobiographical Context

The origin of the research reported in this thesis lies in the concerns and interests in the teaching of biology the writer had whilst working as an A-Level Biology teacher at several comprehensive, New South Wales high schools in Australia. During this time, apart from her role as co-ordinator of senior biology classes, she was actively involved in the exploration of new and innovative ways of presenting biology with colleagues at the schools in which she taught, and through the local professional science teachers' association. When the researcher in this role presented novel ways of learning biology to students, the response seemed to be generally favourable, not only from the more able students but also from the somewhat reluctant learners, particularly when discussion focused on recent media reports of a more controversial biological nature. At the time this appeared to be a powerful learning strategy for many students.

More recently, the writer has been a member of the academic staff of an Australian university department of education where she has been involved in the professional development of student science teachers and in the provision of on-going professional assistance to those science teachers involved with student practicum. It was in this role as science educator that the researcher had the opportunity to pursue two interests; first, to further conceptualise her perception of how controversial issues might best be used to teach biology to post-16 students and second, to present these ideas for comment to both beginning and experienced teachers.

As a consequence of this experience and the anecdotal evidence gathered from classroom teaching, the initial interest of the researcher was in the underlying reasons why many students found the discussion of controversial issues and the associated biological content of interest.

Therefore, the initial interest in this thesis was directed towards the manner in which students might best come to understand some of the major biological concepts underpinning more recent biological research and with this, some of its more controversial aspects. However on reading the literature concerning the teaching of controversial issues, the beliefs science teachers have concerning the nature of science and how science might be taught, it became apparent that a more appropriate focus would be an exploration of the beliefs, values and attitudes that experienced teachers of biology have with regard to the teaching of biological controversial issues in the context of their own teaching practice.

In addition, much of the science education literature dealing with curriculum innovation since the 1960's has as its focus the student as learner. The success of these innovations is based on some measure of student performance. However, within the literature there seems to be little mention of teachers, their perspective on curriculum innovation in terms of their concerns, beliefs and values and the key role they play in ensuring the success or otherwise of these innovations.

Given all of the above, A-Level Biology teachers were thought to be a suitable group for the conduct of this research for three reasons. First, apart from several minor changes over the past few years, the A-Level Biology syllabus had remained relatively stable in terms of its aims, objectives and content. The advantage was that it would seem likely that A-Level Biology teachers would not only have established ways of working with the syllabus but for this aspect of their teaching, they might not be overburdened with curriculum innovation fatigue. This stability was in contrast to, for example, the GCSE syllabus which as a result of the National Curriculum had undergone major changes in its aims and objectives resulting in the need for teachers to evolve new ways of working that syllabus. Second, much of the more recent material developed for the teaching of science-technology-society (STS) courses in Britain has catered for post-16 students. Finally, at A-Level, teachers teach within their subject specialist areas and thus their thinking about their teaching was more specific to those areas. Thus, in terms of stability of teaching approaches, the availability and wide dissemination of STS materials for post-16 students and gaining access to subject specialists' teaching, experienced A-Level Biology teachers seemed eminently suitable for the proposed research.

However, a concern was that the A-Level Biology syllabus itself might not be appropriate for the teaching of controversial issues. This potential problem is addressed in the following section by examining the aims and objective of the syllabus.

1.2: The A-Level Biology (Advanced Level) Syllabus

In order to demonstrate that the teaching of controversial issues could be used within the context of the A-Level Biology syllabus, it is necessary to provide an overview of the syllabus in terms of its structure, aims, objectives and assessment criteria.

The A-Level Biology syllabus is a course of study whose purpose is to provide post-16 students with a scientific and biological education either as a basis for further study at university or as part of a broader education.

Although numerous examination boards exist within England, Wales and Northern Ireland, each producing courses of study at Advanced Level from the sciences and humanities, all A-Level Biology syllabuses contain a compulsory, common core comprising 35% of each syllabus mandated by the Schools Curriculum and Assessment Authority (SCAA). The A-Level Biology syllabuses used by teachers in this study were those developed by the London Examinations University of London Examination and Assessment Council (LEB)[1] and the Associated Examining Board (AEB)[2]. Although there are differences between syllabuses in the selection of content outside that of the core material, the general aims and assessment objectives have much in common.

1.2.1: Aims

There are five overriding aims common to each syllabus. These are to:

- develop an understanding and appreciation of the significance of biological facts, concepts and principles in terms of structure, function, diversity and interaction of living things;

- promote and develop a scientific approach in terms of planning and conducting experiments;

- develop a sensitive approach and careful handling procedures towards living things and apparatus respectively;

[1] London Examinations Board (LEB), Stewart House, 32 Russell Square, London WC1B 5DN.

[2] The Associated Examining Board (AEB), Stag Hill House, Guildford, Surrey GU2 5XJ.

- encourage and promote an understanding of biology in terms of its social, technical, economic, environmental and ethical aspects;

- promote an education in biology as a basis for further study or as part of a general education at A-Level.

It is the first and the fourth of these aims which most obviously could be developed via the use of controversial issues. Close examination of the syllabus proper would seem to indicate that these syllabus aims could be mapped onto current syllabus content, for example, discussion of in-vitro fertilisation during a unit of work on human reproduction.

1.2.2: Assessment Objectives

These objectives are of two types, *knowledge and understanding*, and *skills and processes*, both of which are examined at the end of the course.

Knowledge and Understanding

Included in this objective are the following:

- factual knowledge, concepts, principles, theories, definitions and relationships;

- an awareness of the social, ethic, environment, economic and technological aspects of biology;

- appropriate understanding of experimental procedures and techniques.

Skills and Processes

Included in this objective are the following:

- apply biological knowledge, theories, principles and models to new situations in order to develop and test hypotheses, interpret results, make predictions, draw conclusions and make inferences;

- address issues of a personal, social, ethic, environment, economic and technological nature;

- undertake experimental work in a safe, organised manner, taking due care of living things and biological materials;

- interpret and communicate biological knowledge in various ways such as prose, models, diagrams, tables and graphs.

In addition, students are also required to have a basic understanding of various mathematical and statistical skills including the display, construction and interpretation of graphs, the calculation of percentages, ratios, probabilities, means and modes, along with an understanding of standard deviations.

Advocates for the STS approach in science education would regard the first of the knowledge and understanding objectives and the first two of the skills and processes objectives to be developed through the use of controversial issues.

1.2.3: Assessment

Even though variation exists between examining boards as to the emphasis each places on what is examined, there are generally two components of assessment: a written component, usually taking the form of two papers together comprising 80% of the final mark and a teacher-assessed practical work component comprising 20% of the final mark.

1.2.4: Rationale

The above analysis of the aims and objectives of the A-Level Biology syllabus demonstrates that there is a requirement for students to become familiar with the personal, ethical and social aspects of science. The teaching of controversial issues could be one way to approach this syllabus requirement. Furthermore, an analysis of the content to be covered seems to indicate that several areas of current biological research having social and ethical implications could be addressed, reproductive technology being one example.

Thus from the author's teaching and research conducted in Australia (Van Rooy, 1993b) and her reading of the literature concerned with science education, science technology and society (STS) and controversial issues, there seem to be several educationally sound reasons for using controversial biological issues as part of an A-Level Biology curriculum: first, assisting A-Level students to develop a deeper understanding of the nature of biology and its key concepts, in qualitatively different ways from those which traditional biology teaching might offer; second, enabling students to discuss the social and technological implications of science; and third, developing students' social skills.

However, the incorporation of controversial issues, arising from scientific research and its application into school science seem to present at least three major challenges:

- to determine what recent scientific research and applications might be included in school science courses, and how these might be presented to students in a meaningful, rational and coherent manner which motivates them to learn;
- to ascertain whether students, in the main, have the necessary academic knowledge and skills to grasp such new and often highly sophisticated content and contexts;
- to examine in what ways and to what extent the personal beliefs and values of teachers and the constraints under which they work affect the incorporation of controversial issues into their normal teaching practice.

It is primarily the last of these challenges which this research seeks to address.

1.3: Overview of the Study

This introductory chapter has detailed the origin of and rationale for this thesis. The following chapter provides a critical review of the literature dealing with the nature and teaching of controversial issues, and in particular, the possible reasons as to why controversial issues of a more scientific nature could play a more significant role in science education.

Chapters Three and Four give details of the research methodology. The first of these chapters details the procedures for data collection along with the rationale for the use of a qualitative approach as the most appropriate research strategy for this investigation. Rather than simply observing numerous teachers going about their usual biology teaching or interviewing them about their present teaching practices or even simply seeking their views on the teaching of controversial issues, an alternative methodology is adopted whereby a small group of teachers developed, implemented and assessed one or more lessons on a controversial issue with the co-operation of the researcher. Chapter Four describes the analytic procedures employed.

Chapters Five to Eight report on the findings for each teacher. Each chapter begins with a biographical account which describes the professional and related experiences relevant to each particular teacher together with their reasons for becoming involved in the study. Next, the particular controversial issue and how this issue is related to the syllabus is discussed. The main body of these four chapters represents a separate account of the beliefs, values and attitudes of each teacher with respect to the teaching of controversial issues. The accounts are written from the perspective of each teacher with the assumption being that teachers are experts of their own teaching practice and have a well-developed rationale for their classroom actions and beliefs. As a consequence, the research undertaken and reported in this thesis is from the perspective of each participant.

The thesis concludes with a summary chapter where the main findings are addressed, conclusions are drawn, implications are highlighted - in particular those for curriculum innovation - and future research directions are suggested.

Chapter Two: The Literature Review

Controversial Issues - their use in science classrooms

2.1: Introduction

This chapter deals with the extant literature pertaining to the teaching of controversial issues, the central purpose of which is to provide a critique of this literature, both in general curriculum areas and more particularly within the science curriculum.

Six themes emerge from the literature dealing with the teaching of controversial issues in schools (Stenhouse, 1970; Stradling, Noctor and Baines, 1984; Wellington, 1986) and, in particular, the teaching of science (Apple, 1979, 1982a, 1982b; Solomon, 1988, 1992, 1994a; Smith & McInerney, 1985; Layton, 1990; Pederson, 1992). Accordingly, the main body of this chapter is divided into the following sections representing each of the six themes, namely:

- **The *nature* of a controversial issue** - this section defines what for this research constitutes a controversial issue, given both its generic and educational contexts.

- **Arguments advanced in the literature for the use of controversial issues in classrooms** - this provides a general overview in terms of the curriculum.

- **General pedagogic practice in relation to controversial issues** - this addresses the role and responsibilities of teachers and teaching strategies which could be employed for their teaching.

- **Reasons advanced for using controversial issues in science classrooms** - this takes into account the recent development of the science, technology and society movement (STS) and its impact on science education generally.

- **Suggested explanations for the seeming lack of controversial issues in the curriculum** - this is evidenced in terms of the extant literature.

- **Possible reasons as to why controversial issues of a scientific nature might not play such a significant role in science education** - this is addressed via an examination of teachers' beliefs, values and attitudes towards science and classroom pedagogic practice.

Each section will now be addressed.

2.2: The *Nature* of what Constitutes a Controversial Issue

Three words, *controversy*, *controversial* and *issue* need to be defined in order to clarify the generic meaning for the phrase *a controversial issue.*

The Chambers Dictionary (1993, p. 371) refers to the word *controversy* as meaning a debate, contention, dispute, a war of opinions; *controversial* as relating to controversy, arousing controversy and, *issue* as a question awaiting decision or ripe for decision (*ibid*, p. 889).

The New Shorter Oxford English Dictionary (1993) gives more comprehensive definitions for *controversy*, *controversial* and *issue*, and further illustrates this with helpful examples from biology and the law:

> *Controversy* - a disputation or a matter of opinion or (formerly) rival claims, (prolonged) argument or debate, especially one conducted in public. A.Toffler-'A fierce controversy is ... raging today among biologists over the ... ethical issues out of eugenics'. (p. 500)
>
> *Controversial* - subject to controversy, forming an object of debate; (*ibid*, p. 500)
>
> *Issue* - the result of a discussion or examination of a question, a decision, a conclusion; the outcome of an argument, evidence.
> *Issue* (law) - the point in question, at the conclusion of the pleadings between contending parties in an action, when one side affirms and the other side denies. (*ibid*, p. 1428)

The Toffler example above is helpful because it encapsulates some of the meaning and context (later defined in this section) of what for this research in part constitutes a biological controversial issue, that is, one addressing those issues of a science, technology and society type nature. The meaning of *issue* in the context of the law is also helpful in thinking about the question of the nature of controversial issues discussion in terms of polarities of opinion.

Discussion of what is *controversial* and what is an *issue* depends upon what is seen as the essence of controversy as illustrated by the above definitions. The very nature of something being a controversial issue seems to imply three aspects. First, that there are several opinions on the matter, some of which are possibly based on value judgements and not necessarily on empirical evidence. Many of these opinions are expressed both publicly and privately. Second, that each opinion can be defended in a logical and rational manner using whatever empirical evidence, theory or ethical principles are appropriate. Third, that interaction can occur between groups and individuals holding these divergent opinions.

The remainder of this section will be concerned with various definitions of controversial issues in the context of education, most notably those found in the social studies curriculum (Stenhouse, 1970) where the discussion of controversial issues has had a more significant role in the curriculum than it has had in the science curriculum during the same time. This role will be discussed later in the chapter.

Controversial issues have been central to the social science disciplines for many years. The literature within these disciplines has made repeated reference to three eminent social science educators and curriculum researchers, L. Stenhouse in the 1970's and R. F. Deardon and B. Stradling in the early 1980's. The U.K. Humanities Curriculum Project led by L. Stenhouse in the 1970's was the most eminent and influential. Stenhouse (1970) in his work wrote:

> A controversial issue involves a problem about which different individuals and groups urge conflicting courses of action.
>
> ... by controversial issue we mean one which divides students, parents and teachers because it involves an element of value - judgement which prevents the issue being settled by evidence and experiment. (pp. 8-9)

Dearden (1981) follows on with an elaboration of Stenhouse's incorporation of conflicting courses of action, judgement and evidence to include reason, by writing:

> A matter is controversial if contrary views can be held on it without those views being contrary to reason. By 'reason' here is not meant something timeless and unhistorical, but the body of knowledge, criteria of truth, critical standards and verification procedures which at any given time has so far developed. It follows that what at one time is controversial may later be definitely settled ... (p. 38)

Stradling *et al* (1984) when referring to controversial issues in the context of school social studies reserve the term controversial issue for:

> ... those problems and disputes which divide society for which significant groups within society offer conflicting explanations and solutions based on alternative values. Such disputes may be about solutions based on alternative values ... about what has happened ... the causes of the present situation ... desirable ends to work towards ... appropriate course of action to be taken ... the likely effects of that action. (p. 2)

These three various meanings coupled with the previous dictionary references are useful in a general sense because they help to provide a view of what in educational terms might constitute a controversial issue, that is, a controversy which exists when one's ideas, information, theories or opinions are challenged and criticised by others who may hold differing viewpoints.

It is the Dearden suggestion as to the meaning of a controversial issue which the researcher found helpful in terms of providing a possible focus for science. In the context of science, controversial issues could be thought of as falling into two different epistemological categories:

- Those issues/debates which occur between scientists themselves, that is, debates within the scientific community about, for example, what might constitute reliable scientific evidence. The underlying assumption here is that given more time and work of an experimental and theoretical nature, the issue currently under debate and discussion might be resolved. This category would also include issues of a metaphysical nature such as those dealing with science and religion. These issues/debates are termed for the purpose of this thesis **Scientific Controversies.**

- Those issues/debates which occur between scientists (those within science) and the general public (those outside science). The controversy here is over a question of values, that is, the rightness and wrongness of values associated with various moral and ethical positions which are not resolvable by scientific method. These issues /debates are termed for this thesis **'Science, Technology and Society (STS)' Controversies.**

Wellington (1986), in the context of science education, further argues that what is to count as a controversial issue should not merely be a basis for *philosophical gymnastics* but a matter of real importance:

> a controversial issue cannot be settled by an appeal to facts, empirical evidence or experiment alone. (It will) ... involve value judgements so that the issue cannot be settled by facts, evidence or empirical evidence alone (and) ... be considered to be important by an appreciable number of people ... (pp. 2-3)

Wellington admits that such requirements rule out certain controversial issues, for example, those concerned with scientific or mathematical controversy. Here an example would be the controversy concerning the physical interpretation of the mathematical formalism of quantum mechanics[1]. It could be argued that the inclusion of scientific controversy into school science is important because it would give students a much better picture of what the scientific community is like, that is, how it operates, what are its governing principles and what are its own social norms. His definition although interesting is therefore somewhat limiting. Past and present scientific controversies have shaped and continue to shape scientific theory and understanding.

[1] See Baggott, J. (1994) for a more complete discussion of this controversy.

For Pederson (1992) whose interest is focused on students, the definition of controversy focuses on the social interactions of students and their social responses to new materials or ideas:

> A controversy can exist when one student's ideas, information, conclusions, theories, or opinions are incompatible with those of another student or when incompatible activities occur and the students involved try to reach an agreement. New information can be a source of conceptual conflict when the new information does not fit what he or she already knows. (p. 374)

This definition is helpful for the purposes of science education because it can be viewed alongside what happens in the scientific community, that is, dialogue and discussion of new information which can be a *source of conceptual conflict*, especially when the *new information does not fit* in with current understandings: more particularly what Kuhn (1970) would term a paradigm shift in order to facilitate scientific understanding.

Smith and McInerney (1985) address controversy as a challenge to both traditional scientific and social values:

> Progress in science increasingly forces confrontation with longstanding values and traditions. Those confrontations may result from the application of new technology, such as prenatal diagnosis of genetic disorders, or from more basic conflicts that result when science as an epistemologic system confronts other ways of knowing, as in the conflict between science and creationism. (p. 396)

This definition is useful because it incorporates aspects of the nature of a scientific controversy. It encompasses aspects of the history of science and its progress which at times has been in conflict with longstanding values and traditions. Charles Darwin's Theory of Evolution or the works of Copernicus and Einstein provide such examples.

Aikenhead (1988) points out that almost by definition controversy has no correct answer but as with dilemmas and decisions it is associated with values. He is also very much in favour of using controversy as a way of getting students to think:

> Many science teachers subscribe to the goal of 'teaching students to think'. The toughest test, and therefore the most productive learning approach, is to engage students in thinking their way through controversies or dilemmas. (p. 17)

Aikenhead's comments are useful especially for the purposes of this study because they focus on using controversies and dilemmas in order to teach students to think. He hints at the possibility of using controversial issues not only to engage students in productive learning but also as tools for teaching scientific understandings to students.

Bearing the above definitions in mind, for the purpose of this study controversial issues have been conceptualised as coming from two differing epistemological bases.

- **Scientific Controversies**

These controversies are about what research might be carried out, how research findings might be interpreted in relation to theory and/or how new theories/hypotheses might be put forward or tested. In this sense the debate could be thought of as being about scientific methodology which includes, among other things, conducting experiments, collecting data, analysing results and modifying hypotheses/theories in the light of new evidence. Essentially the debate here is about how scientific knowledge is advanced and progressed. In this context the controversy has the potential to be resolved by the application of scientific reasoning.

Examples of this type of controversy might include:

- The historical development of the understanding of disease and infection.
- The nature of light - particle/ wave duality.
- Metaphysical debate - evolution and the age of the universe.

From this perspective students at school might learn about:

- Scientific method - experimental techniques, data collection, formulation of hypotheses.
- Scientific debate - how science and scientists work in relation to the nature of the debate pertaining to what constitutes reliable scientific evidence through, for example, the development of a historical perspective on the ideas about the nature of light or ideas about photosynthesis.

Using the Dearden definition, one might say that the issue remains controversial until contradictory evidence is forthcoming which refutes one or both sides of the controversy, as with for example, the phlogiston theory of combustion.

- **Science, Technology and Society (STS) Type Controversies**

These are controversies about the moral, ethical and social impact of science and technology on society. In the STS context controversies centre around the social, moral and ethical aspects of how science affects the lives of people (society) and the environment in which they live. Such debates concerning the impact of science on society are not only those of a biological nature, for example genetic engineering, but also those found in physics and chemistry, for example nuclear power.

Viewing controversial issues from this social, moral and ethical perspective, it seems that for the present there is no generally agreed way of resolving the issues. Undertaking further experimental work and collecting more data will not resolve the issue. Using scientific methodology may not be helpful. So using the Dearden definition, one might say that these STS issues may be deemed controversial unless it can effectively be demonstrated that all but one of the opposing views with a social, moral or ethical base are contrary to reason.

Examples of this sort of controversial issue include:

- the release of genetically engineered organisms into the environment;
- the use of animals for scientific research.

Thus from the STS perspective of controversial issues, students could:

- learn about the impact of scientific knowledge on social, moral or ethical debate and vice versa;
- become engaged in learning about both types of controversial issues which together hypothetically have the potential to develop conceptual understanding of science topics taught in schools.

Either type of controversial issue has the potential to develop the scientific understanding of school students. However, advancing scientific knowledge within the science community depends upon the nature of science debate not upon the STS debate.

For reasons outlined above this research will deal solely with the STS type of controversy and so takes controversial issues to mean:

> *... those matters of a biological nature which involve social, ethical and/or moral aspects such that contrary views can be held without those views being contrary to reason.*

There are two reasons for adopting this definition in this study:

- students from this writer's teaching experience are aware of many topical STS issues which often are presented and discussed in the media;
- teachers more readily recognise social, ethical and/or moral biological issues as controversial rather than those to do with the nature of science or with scientific controversy (Van Rooy, 1993a).

In addition, the fact that the body of literature on STS is considerably greater than that on the teaching of controversial issues in science seems to suggest that it is more relevant to this study.

2.3: Arguments Advanced in the Literature for the Use of Controversial Issues in Classrooms

There is a considerable body of literature to date dealing with arguments and justifications for the handling and incorporation of controversial issues in the school curriculum both in general educational terms (Stradling *et al.*, 1984; Stradling, 1985; Solomon, 1988; Raw, 1989; Dewhurst, 1992), and in some subject areas such as the social sciences [e.g. The Humanities Curriculum Project - HCP (1972)] and science [e.g. The Discussion of Issues in School Science - DISS (Solomon, 1992)].

Arguments and justifications for the use of controversial issues in the school curriculum as presented in the literature to date suggest **four** main approaches: those concerned with ethical thinking; those concerned with the future civic and social responsibilities of students; those addressing the sociology of knowledge, and those with their basis in the psychology of learning. These will now be addressed in order to provide an overview for the context of this study.

2.3.1: The Ethical Line of Argument

The ethical thinking line argues that controversial issues help to clarify values for students, illustrate various moral positions to students, assist in their moral development, develop rationality and reasoning, and foster autonomous judgment. Dewhurst (1992) presents the case that the teaching of controversial issues could be seen as an interpersonal task between the teacher and the students. In this situation, both parties suspend criticism and confrontation in order to place themselves in the best empathetic position, before discussing various moral perspectives. He believes this to be a very positive aspect of the teaching of controversial issues with the proviso that the methods used by the teacher involve intervention:

> ... I do not see the teacher's activities as being limited to those of *facilitator*, *values clarifier* or any of the other roles which are recommended partly for their usefulness in helping the teacher maintain a neutral stance on the issues. (p. 153)

Dewhurst then sees the role of the teacher as encouraging students to take on the perspective of others; establishing points of contact which make reasoned discourse possible; and inducting students into a wider domain where they are provided with knowledge about controversies, as well as the skills for handling those controversies.

Singh (1989) warns that what teachers also need to bear in mind and guard against is:

> ... allowing pupils to come to hold views about an issue or to take a stand on it and to think that the justification of such a stance is simply a matter of subjective preference. (p. 232)

and Thelen (1983) points out that:

> Ideologies consist of a mixture of fact and values with values often masquerading as facts. (p. 188)

These writers collectively put forward further arguments to support the use of controversial issues in the curriculum. These are the educational desirability of students being open to the moral opinions and arguments of others, and of being actively engaged in interpersonal interaction and discussion, given that others are entitled to have their viewpoints recognised and understood, that the incorporation of controversial issues has the potential to foster intellectual independence and autonomous judgment for what might be termed *enlarged thinking* [Kant as cited in Dewhurst (1992)], and that any clarification of one's own values concerning controversial issues is a means forward to understanding the views of others.

Bridges (1986) sums up the ethical thinking line of argument by suggesting that controversial issues foster a number of principles: respect of persons, personal autonomy, honesty of opinions, personal detachment from opinions and criticism of beliefs which might be taken for granted. Such principles, he believes, are developed by constructive, as opposed to destructive, controversy in the classroom.

This then is the ethical thinking line of argument: incorporating controversial issues as part of the school curriculum gives students the opportunity to develop an appreciation of different values, and of how discussions about these values influence real-world situations. Whilst one might find it difficult to deny the value or desirability of such goals not only for the teaching of controversial issues but also for other aspects of learning, the question of feasibility of achieving such goals still remains.

2.3.2: The Civic and Social Line of Argument

This line of argument presents the case that controversy, debate, intellectual enquiry and discussion are all part of the social fabric. Since schools are part of this fabric and controversial issues are an integral and unavoidable part of society, they should be presented in the curriculum of all subject disciplines and not as a covert part of the hidden curriculum. Thus, any school or educational institution intentionally avoiding controversial issues could be seen as remiss and inadequate (Stenhouse, 1970; Thelen, 1983; Stradling *et al.*, 1984; Hobson, 1989).

These authors argue that students need the opportunity to learn how to deal intelligently with knowledge, values and societal issues which are all aspects of life that students confront either presently at school or certainly when they leave. Many controversial issues address contemporary social, political, economic and moral problems (Spafford, 1993) and as such, it is argued, they should be brought to the attention of students. Furthermore, to prepare students for adult life in all its facets is an educational responsibility of schools.

Many of the teachers engaged in education would probably not contest the desirability of these goals for schooling. As with those of the ethical thinking line of argument, the question still remains as to the practicability of achieving these goals. A search of the literature has not revealed any empirical studies focusing on how such goals might be achieved.

2.3.3: The Sociology of Knowledge Line of Argument

Together with the previous ethical, sociological and civic arguments for the use of controversial issues in the curriculum are those concerned with the sociology of knowledge. The status of knowledge and its social construction are both important elements in any controversy (Apple, 1979, 1982b; Ziman, 1980, 1984; Bell, 1982; Aikenhead, 1988; Solomon, 1988, 1992). The argument of these authors is that presenting controversial issues to students is a positive educational move because from an epistemological perspective, controversial issues show students that knowledge of every kind is developed and constructed by people and as such is not value free, neutral, clear cut or unproblematic. It also helps students to understand the grounds on which different knowledge is based, for example the use of empirical evidence in science.

This concern with the status of knowledge is seen as appropriately encompassing explorations of differences between what has been referred to by the sociologist Michael Apple (1979, 1982a, 1982b) as *legitimate, high status knowledge* if the knowledge is valued by and derived from the dominant culture and *illegitimate, low status knowledge* if it is valued by and derived from a subordinate culture(s). The philosopher/science educator John Ziman (1980, 1984) makes a related distinction when he refers to scientific knowledge as being insider or valid knowledge if the knowledge is held by the scientific community (the dominant culture), in contrast to outsider knowledge about science held by the general public.

Discussion with students about what constitutes knowledge could be seen as a desirable educational activity but there is a lack of empirical research elucidating how teachers could assist their students to grapple with the line of argument that knowledge is not value free and has differing status depending on its context.

2.3.4: The Psychology of Learning Line of Argument

The fourth line of argument for the use of controversial issues in teaching emanates from the literature on the psychology of learning. It is the work of cognitive development theorists [Flavell (1963); Kohlberg (1969) and Piaget (1948, 1950) as cited in Johnson, Johnson, Todd Pierson and Lyons(1985)] which is used along with supporting empirical evidence (Johnson and Johnson, 1979, 1988; Bell, 1982; Stradling *et al.*, 1984; Johnson *et al.*, 1985; Stradling, 1985; Barker, 1987; Finn, 1990; Solomon and Aikenhead, 1994) to put forward the argument that the teaching of controversial issues increases student understanding of the following: content knowledge; discussion skills, problem solving and decision making skills; clear, logical and rational judgment; motivation to learn; self-esteem and intellectual independence. The arguments and supporting evidence for each of these will now be discussed in the light of the more general argument that student exposure to controversial issues enhances cognitive development.

The thrust of the argument concerning content knowledge is that controversial issues are of interest and relevance to students and it is these two aspects which aid in its acquisition. The Humanities Curriculum Project as cited by Rudduck (1983) has as one of its concerns the *cynical student* who views learning with apathy and scepticism. The Project argues that for many students, school is irrelevant. Controversial issues, it is argued, provide an alternative pedagogy whereby student interest is harnessed in an attempt to foster motivation and learning, the assumption being that if issues of significance are discussed and/or brought up in class, students would be more motivated to learn and participate in lessons.

These arguments have subsequently been supported by Stradling *et al* (1984) who note that:

> It is now a commonly held view within the teaching profession that the interest of pupils is most likely to be addressed by topics which they perceive to be relevant to their everyday lives. (p. 102)

The argument that discussion, problem solving and decision making skills, and clear, logical, rational judgment are developed with the use of controversial issues, is asserted by various writers [Johnson and Johnson 1985; Rudduck, in J. Wellington (1986); Solomon, 1988]. It is also claimed that if the controversial issues presented to the students are seen by them as exciting, relevant and something with which they can engage, then discussion of these issues will raise students' self esteem and in so doing contribute to the goal of intellectual independence (Gayford, 1993).

It is further suggested that as such affective and cognitive skills will be needed in the future, and so ought to be embedded in the school curriculum [Stradling *et al.*, 1984; Ziman, 1984; Rudduck, in J. Wellington (1986); Layton, Jenkins, McGill and Davey, 1993; Solomon, 1993; Henderson, in J. Wellington (1994)], since they encourage communication through open-minded talk between individuals and between groups holding differing viewpoints (Bridges, 1979; Johnson *et al.*, 1985; Geddis, 1991; Gayford, 1992; Pederson, 1992).

Controversial issues teaching is also said to encourage divergent rather than convergent thinking as a result of the preparation of coherent, rational arguments from a variety of viewpoints and perspectives (Aikenhead, 1988; Geddis, 1991; Zoller, 1991a, 1991b; Solomon 1994a). Finally, it is said to encourage close scrutiny of views through, for example, testing hypotheses, weighing up evidence and examining source validity (Bridges, 1979; Pence, 1990).

Given the considerable wealth of literature dealing with the psychology of learning line of argument, it is the work of Solomon (1990, 1991b, 1992, 1994a, 1994b), Geddis (1991), Zoller (1991a) and Gayford (1992, 1993) which provide the most compelling evidence to support the teaching of controversial issues as a way of assisting student learning in all its facets. The strength and validity of this line of argument does however depend upon students being excited about and actively discussing controversial issues.

A recent argument presented in the STS literature by Aikenhead (1994) is that using controversial issues in the context of problem solving and co-operative group discussion encourages students to claim a sense of ownership of their knowledge and of their ideas. In this situation the pressure for students to perform as soloists is removed, leaving the classroom more relaxed and the students open to more fruitful discussion.

In summary, the justifications offered for the use of controversial issues in the curriculum are many: the main justification being that it is an educationally sound way of teaching because it is directed towards such neglected educational goals as empathy and tolerance for others, healthy scepticism, understanding the nature of knowledge, and social and political competence. Controversial issues are seen by many writers as being effective for the achievement of these and other educational goals.

2.4: General Pedagogic Practice in Relation to Controversial Issues

The literature dealing with the pedagogic practice of controversial issues addresses two areas: the role and responsibility of teachers, and the teaching strategies which can be used in controversial issues lessons.

2.4.1: The Role and Responsibility of Teachers

Discussion of the role and responsibilities of teachers focuses on three central concepts (Stradling, 1985): neutrality, commitment and balance.

Neutrality is a position where the teacher either supports all viewpoints equally (*affirmative* neutrality) or withholds support for any view (*negative* or *procedural* neutrality). The underlying assumption here is that teachers because of their position can influence student opinion. Therefore teacher neutrality is seen as a positive ideal for which to aim in teaching controversial issues (e.g. Humanities Curriculum Project). It is further argued that the adoption of a neutral stance minimises teacher bias, gives all students a chance to participate and communicate in open, free discussion and works well if there is a variety of resource materials. The disadvantages are firstly, that students might not be familiar with their teacher taking on the role of neutral chairperson and secondly, that neutrality could be difficult to maintain if the teacher has already established a harmonious working relationship with students based on their understanding.

Commitment is a stance where the teacher makes his/her position known at an opportune time during class discussion. The advantage here is that the teachers' views are seen by their students as being open to criticism, and so they ensure credibility in the eyes of their students. Counter to this is the possibility that students might not be willing to argue a viewpoint which is counter to that of the teacher. The result may be that open free discussion is stifled. The other possibility may be that students argue for no other reason than simply to contradict the teacher.

Balance is a position where the teacher presents a variety of alternative views including those which might be termed safe as well as those which might be termed unsafe or risky. The advantages of a balanced position where alternatives are presented are first that the teacher might be less likely to be accused of indoctrination by those outside the classroom and second, that it could stimulate a discussion where most of the class takes on one line of an argument. A disadvantage could be that those outside the class might see the teacher 'playing devil's advocate' as being somewhat subversive.

Depending on the nature of the controversial issue, the situation may arise when none of the three concepts of neutrality, commitment or balance alone is more appropriate than any other. In such an event, the teacher may need to weigh up the relative importance of each in order to achieve the desired teaching strategy. It might not be possible to lay down rules because it depends on the particular classroom context.

2.4.2: Teaching Strategies

The question that often arises is: what are the most appropriate teaching strategies for controversial issues teaching taking account of the relative merits of neutrality, commitment and balance? The teaching strategy commonly cited in the literature as being used in controversial issues classes is open discussion where students work together in groups on a task such as preparation of a debate, group research on a particular issue or viewpoint, or analysis of case studies.

Some authors argue that allowing students to debate an issue provided they are given sufficient time to collect the information, check the authenticity of the data and prepare materials, leads to an improvement in affective and knowledge skills, so that students become more active learners and come to enjoy the complexity of the topic [Bybee, 1987; Thier and Nagle in Solomon and Aikenhead (1994)]. Allowing students to engage in these activities, in particular checking the authenticity of data, might be one way whereby teachers can argue that they are engaged in a balanced approach.

Other writers argue that the presentation of a structured controversy, using a case study as exemplar, leads to an improvement in student empathy towards others in the community (Talbot, 1991). Such a teaching strategy one might argue, places students in a position whereby they might ask their teacher to state their commitment or perspective. However, given the range and frequency of controversial issues that arise, perhaps the most appropriate role and teaching strategy is one which ensures flexibility of approach to the issue at hand and the class in question.

According to a number of authors what teachers might aim for when using controversial issues in their teaching is for:

- controversy to be structured and managed in such a way that free discussion of ideas and tolerance of various viewpoints be promoted (Geddis, 1991; Riss, 1991);
- all class members to feel free and so able to contribute to the discussion (Pence, 1990);
- students to be able to change their opinions in the light of new information and renewed discussion (Bell, 1982; Compton, 1983; Bybee, 1987; Riss, 1991);
- students not to mimic the views and opinions of those in authoritative positions (Pence, 1990; Geddis, 1991).

In addition according to a number of authors in science/biology education, a biology teacher teaching biology using controversial issues, might aim to:

- increase student awareness of *state of the art* scientific research (Henderson and Lally, 1988; Morishita, 1991);
- increase student awareness of those in the community affected in some way by medical or bioethical issues as well as the value judgments which are often made in relation to such issues (Barman and Cooney, 1986; Kormondy, 1990; Ramsey, Hungerford and Volk, 1990; Lock, Miles and Hughes, 1995).
- enable students to become informed users of biological and medical technology (Lock *et al.*, 1995);
- develop effective teaching materials which enhance the learning of biology by students [Brinckerhoff, 1985, 1990; Zipko, 1991; Van Rooy, 1993b, 1994; Henderson in Wellington (1994); Lock *et al.*, 1995].

To summarise this section on pedagogic practice, what appears to be the most desirable educational situation for the teaching of controversial issues is one where teachers strive to be as reflective and flexible as possible in their teaching of controversial issues. That they remain ever conscious of the three central concepts of neutrality, commitment and balance and use them when appropriate and employ teaching strategies such as open classroom discussions which encourage student intellectual and social development, are significant demands for teachers.

2.5: Reasons Advanced for Using Controversial Issues in Science Classrooms

As pointed out earlier, the discussion of controversial issues, their place within the school curriculum and their educational purpose had until the late 1970s, been the somewhat exclusive concern of the social sciences rather than the natural sciences (Stenhouse, 1970; Stradling *et al.*, 1984; Marsh, 1987, 1988; Singh, 1989; Pence, 1990); the Humanities Curriculum Project under the guidance of Stenhouse (1970) being the most well known in terms of bringing current social issues to the forefront of the school curriculum.

However, what distinguishes the literature in support of using controversial issues in science education from the equivalent literature in social science education is the strong emergence in the late 1970's of the science, technology and society (STS) movement within science education, which placed the social and technological aspects of the discipline firmly on the agenda of science education and along with it the teaching of controversial issues. Associated with this concern for the teaching of the social and technological aspects of science, known popularly as *scientific relevance*, was a concern about the goals of science education and a concern for what the general public thought science was about (Layton, 1990).

Arguments and justifications for the use of controversial issues in science education have followed along similar lines to those in the social sciences (Hickman, 1985; Bridges, 1986; Bybee, 1987; Solomon, 1988, 1992, 1993; Pence, 1990; Yager, 1990; Bentley and Garrison, 1991; Zoller, 1991; Van Rooy, 1993a, 1994; Solomon and Aikenhead, 1994). The most prominent writers of recent STS literature (Ziman, 1980, 1984; Layton, 1990; Solomon and Aikenhead, 1994) all argue that what schools have traditionally taught has been a view of science as being both static and value free. Furthermore, these writers argue that the manner in which science was taught, that is, devoid of a social context and a social reality, failed to appeal to most students. Thus, an important argument for STS teaching, as far as the incorporation of controversial issues into science is concerned, is as a means of presenting the subject in an interesting, relevant and educationally sound way to students (Greddis, 1991; Zoller, 1991; Hennessy, 1993; Solomon, 1993). Aikenhead (1994) also argues that presenting science knowledge to students as being value-laden, as serving the interests of various claimants, as having limitations and as being problematic are for STS science teaching appropriate goals. Such a presentation of science in part forces students to develop techniques which will assist them in unravelling party interests and ideologies, and so enable them to make informed decisions about controversial issues, all things they will need to be able to do as adults.

Much has been written over the last twenty years about STS and how it might be integrated into school science (Bridges, 1979; Ziman, 1980, 1984; Aikenhead, 1988; Solomon, 1991, 1993; Black, 1993). Ziman (1980) lays the ground work in this area by emphasising that the main objective of STS is not only to reform, improve and complement science teaching but also to begin to allow students to see and experience science as it really is, a *human activity*:

> Even in academia the production of scientific knowledge is not simply a matter of experimenting and theorising by individuals: it is a social process, in which critical interactions between scientists and communal acts of validation play a vital part. The consensual knowledge that accumulates in the public scientific archive provides, in its turn, the intellectual framework for further research by individual scientists. (p. 58)

Research concerned with the public's understanding of science, carried out in the U.K. and the U.S.A. before the mid 1980s was primarily concerned with the level, depth and validity of the public's scientific content knowledge. This research assessed the public's understanding of science against the criteria used by the scientific community, rather than research about how the public *themselves* use science in specific contexts (Layton *et al.*, 1993). This was in keeping with the *positivist* view of science as being the *best* available explanation of natural phenomena because of its coherence, objectivity and certainty, a view synonymous with *traditional* science teaching. This positivistic view of science has been regarded by a number of authors as being unhelpful in improving science education practice (Ziman, 1984; Layton *et al.*, 1993; Millar and Wynne, 1993).

Ziman (1984), puts forward the argument that there exists:

> a serious mismatch between the interests of those who are already inside science, and the motives of those whom they would like to draw in. Most people find great difficulty in getting to understand the conceptual schemes of the sciences, which seem so very unlike the familiar structure of the life - world. (p. 185)

and that the work of the STS movement can encourage teachers and students to bridge this gap so that science does not remain:

> a distinct sub-culture whose actual contents are practically unknown to all but a tiny fraction of the population. (*ibid*, p. 185)

Thus Ziman would argue for the use of controversial issues in science education on the grounds that it makes science more accessible to students.

Similarly, the research of Layton *et al.*, (1993) although in the context of the general public, strongly indicates that if science knowledge is to be useful to people then it must be reworked and recontextualised. This reworking and recontextualising is what Layton *et al* refer to as the Interactive Model: a model thought by them to be appropriate for thinking about the public's understanding of science. These writers see the Interactive Model as properly replacing a previous approach which they describe as the Cognitive Deficit Model which is characterised by the view that the transmission of knowledge is unidirectional from *science* to the *citizen;* that scientific knowledge is context and content *neutral;* that *ignorance* in the public exists and needs to be *remedied* and that science is the most appropriate paradigm to validate *everyday thinking.*

Millar and Wynne (1993) take this idea of reworking and conceptualisation one step further in relation to school science by saying that:

> The only realistic way, however, to promote the kind of change required in the public perception of scientific knowledge and of the processes by which it is produced is through formal science education. The central point we are arguing is that there is at least as great a need for wider public understanding of the internal processes by which scientific knowledge is generated and validated as of the contents of specific areas of science. **It might appear that the time is particularly opportune, in the U.K. at least, for making such a case** (emphasis added). (p. 251)

Such concern about the promotion of positive public understanding of science is not voiced only in the USA and UK. In an article entitled *Why is interest in science waning?*, The Australian (25.3.95) raises similar concerns:

> Interest in science seems to be undergoing an alarming decline among school students. According to a study commissioned by the Federal Government, this is not necessarily just because students think science is intrinsically boring, it is because of the way it is often taught. Students also think science is difficult to learn and irrelevant to their future careers;

The writers also assert that this lack of interest in science:

> also paints a depressing picture of ignorance among middle managers about how to initiate and organise science and technology research projects. This combination of disinterest among our youth and ignorance among adult managers, carries the potential for future economic subjugation by the booming and the emerging Asian economies.

On the whole the STS literature to date has been mainly concerned with the public understanding of science (Ziman, 1980, 1984; Layton *et al.*, 1993; Millar and Wynne, 1993; Solomon, 1993); the interplay between science, technology and society (Bybee, 1987; Aikenhead, 1988; Solomon, 1989, 1993; Watts, 1991a, 1991b; Gayford, 1992, 1993; Pederson, 1992); the nature of classroom discussion on techno-social issues (Compton, 1983; Brinckerhoff, 1985; Henderson and Lally, 1988; Geddis, 1991; Solomon, 1991a, 1994a) and the goals of science education (Bybee 1987; Solomon 1993). It is interesting to note that this literature has not taken as its focus the perspective of the practising teacher. Rather, interest has been in the interplay of STS and the nature of the discussion of techno-social issues which have been used to argue the case for the inclusion of controversial issues into science education, with the long term goal being an improvement in the public understanding of science (Bybee, 1987; Layton, 1990; Solomon, 1993).

While most of the STS literature, as pointed out earlier, addresses the public understanding of science, there are a small number of empirical studies which involved school students. *The Discussion of Issues in School Science* project (DISS) conducted by Solomon (1988, 1992) has attempted to ascertain the quality of student discussion of techno-social issues in STS classrooms. This project, using as its focus human kidney transplantation, provides valuable empirical evidence through the analysis of student intragroup discussion, to support the notion that students are capable of effective, meaningful discussion on science related social issues without teacher assistance. The content and context of such discussions is easily recalled by students some time after the initial exposure.

Armstrong and Weber (1991) undertook a study involving a unit of work on bioethical issues with a group of high school students. The experimental group was given a series of formal lessons dealing with the controversial biological issue of genetic engineering, while the control group received no lessons on this issue. Both groups were given pre-tests and post-tests. Compared with the control group, the experimental group showed a better understanding of the controversy surrounding genetic engineering. These results are not surprising of themselves but what they do indicate is the possibility of using controversial issues, like those found in this area of biology, not only to interest students but also to teach major biological concepts.

Research by Smith (1984) claims that for a sample of engineering students who were addressing problems concerned with hazardous waste management:

> Structured controversies have great potential for helping engineering students master content, develop perspective-taking skill and improve their ability to work with and understand others. (p. 306)

Smith (1984) provides a description of classroom events which he argues supports his ideas about the possibilities of using controversial issues teaching. However empirical evidence to support these arguments is not strong.

Hickman (1985) talks about the acquisition of content knowledge in terms of the transfer of knowledge from one issue to another. She also suggests that if issues are too familiar, students might generate a false sense of expertise and so it might be productive on the part of the teacher to show students that the information they have already might be *flawed* or *incomplete.*

With the exception of these empirical studies, the STS literature can be criticised because it does not address the question of whether controversial issues teaching is a means whereby students might gain a wider and deeper understanding of major scientific concepts. This is an issue which has to date been somewhat neglected. It is not clear whether the STS enthusiasts are unconcerned about student understanding of specific science concepts, or whether they take it for granted that such concepts will be taught and mastered by students through STS, or whether they assume that traditional science teaching should go on in parallel with STS teaching. With respect to the teaching of biological concepts at the senior secondary school level, here again it has not been possible to identify any literature which deals with these dilemmas. It is unclear whether STS researchers assume biology content will be taught in the STS context or if biology content will be taught via the traditional mode of delivery with STS then being seen as an add-on.

Only two items in the literature on STS have been sighted which are critical of the use of social issues becoming the basis for science teaching rather than scientific concepts. Kromhout and Good (1983) have no objection to these issues motivating students but they are concerned that if these issues did become the basis upon which science curricula are organised, a movement away from science might well occur:

> Since the units are organised around a particular socially important problem, however, they are independent of each other by design, and therefore are unable to convey any real understanding of the structural integrity of science. (p. 649)

Good, Herron, Lawson and Renner (1985) are of the view that societal issues could never realistically form the basis of science education because they simply highlight the political and social aspects of science and not what science *is* about, which for them is:

> the discipline devoted to discovering, developing, and evaluating improved methods and materials to teach science, i.e., the quest for knowledge, as well as the knowledge generated by that quest. (p. 140)

Each of these critics then seems to view science education from the perspective of what scientists engage in, that is, the pursuit of objective knowledge of the physical world and the process of acquiring that knowledge. Given such a view of science education it is thus not surprising that they are opposed to the proponents of STS.

Whether or not controversial issues can of themselves assist students in content acquisition in an exciting manner qualitatively different from traditional teaching does not seem to have been addressed to any great extent. In addition the literature fails to address the needs of teachers as they go about conceptualising, planning and implementing STS ideas into their normal teaching practice.

2.6: Suggested Explanations for the Seeming Lack of Controversial Issues in the Curriculum

Although it was not possible to find literature explicitly opposing the use of controversial issues in teaching, possible contrary arguments can be found embedded within the literature supporting their use. These contrary arguments, as might be expected, are given little credence by the authors who mention them.

Of particular interest are three articles: Johnson and Johnson (1979), Johnson *et al.*, (1985) and Pederson (1990). All authors refer to the work of De Cecco and Richards (1974) as indicating evidence that in most classrooms conflicts are avoided and suppressed and that, therefore, teachers and students lack the necessary management skills to deal with controversy in the classroom. On reading the original reference, it is difficult to ascertain any substantive evidence to support this notion. The text provides an overview and commentary by De Cecco and Richards of U.S. secondary schools interspersed with student and teacher comments but, there is no mention of controversial issues in teaching. Absent from the text is empirical evidence to support the case against controversial issues. Johnson and Johnson (1979) and Pederson (1990) both cite the work of Deutsch (1973) as providing evidence that teachers and students lack the skills and procedures needed for effective conflict management. Again this is not supported by clear empirical evidence; indeed, in the Deutsch text there is no mention at all of students, teachers or schools. The point is that both Johnson and Johnson (1979) and Pederson (1990) do support the use of controversial issues through group work and problem solving, but the evidence they purport to have found which opposes the use of controversial issues in the school curriculum is difficult to locate.

From the literature three reasons emerge for the lack of controversial issues in the curriculum: curriculum issues are too politically, socially and morally sensitive to be discussed in schools; controversial issues because of their nature are conceptually too difficult for most students; teachers are ill equipped to handle the demands of controversial issues. Each of these three is now dealt with in turn.

2.6.1: Controversial issues are too politically, socially and morally sensitive to be discussed in schools.

Proponents of this line of argument take the view that the teaching of controversial issues in schools is inappropriate because these issues are politically, socially and morally sensitive. Discussing such issues in schools is seen as questioning accepted social values (Stradling, 1985). Those who oppose the use of controversial issues because of their political, social and moral sensitivity are usually from the more conservative right wing or some more fundamentalist religious groups (Jones, 1986; Brigley, Coates and Noble, 1987). Their stance is that *traditional* family values should be maintained, and the teaching of controversial issues could undermine such traditional family values.

Those who oppose the use of controversial issues maintain that such issues are about values, which are often too sensitive, potentially subversive and questioning of the basic social fabric to be adequately dealt with in schools. These issues and dilemmas are not acceptable in some communities and it is therefore argued that for reasons of community sensitivity they should not be debated or discussed in schools; the place for these issues is said to be in the home where parents have the duty to teach such values; the function of schools is to teach knowledge as facts, not factual reasoning and values formation.

The *New Right*, as seen by Brigley *et al.*, (1987) and Barker (1987) takes the view that schools should not be autonomous but that since they are socially financed they should be socially controlled. It follows then that traditional and commonsense beliefs should not be open to questioning lest contentious political attitudes are promoted amongst students [Kromhout and Good as cited in Bybee (1987); Barker, 1987]. Such arguments assume that among teachers there are social activists who manipulate and pervert education, people who are biased and liable to engage in gross indoctrination and that teachers cannot be relied upon to remain neutral and balanced when dealing with politically, socially and morally sensitive issues.

A second, though more tentative reason as to why the teaching of controversial issues might be regarded as politically, socially and morally sensitive by the general community is that they could question the status quo in relation to what are acceptable community norms. The work of the sociologist Michael Apple (1979) is helpful in this regard when this writer makes reference to the concept of *hegemony*, a term which refers to the maintenance and control by the dominant culture, so that the rules and the usual ways of doing things appear neutral, value-free and of benefit to all in society in order that consensus rules:

> the concept of hegemony implies that fundamental patterns in society are held together by tacit ideological assumptions, rules if you will, which are not usually conscious, as well as economic control and power. These rules serve to organise and legitimate the activity of the many individuals whose interaction makes up a social order. (p. 83)

Although tentative the argument here might be that teachers are constrained by the hegemonic, dominant culture of the society. Specific mechanisms whereby this control is exerted might include prescribed, mandatory syllabuses; public examinations; the publication of examination results or, the use of recommended texts and other resource materials. Through these mechanisms and in more subtle and informal ways, teachers come to learn and realise what are acceptable teacher behaviours and teaching techniques; what styles of learning are deemed appropriate for learning (for example, rote learning as opposed to open and free questioning of evidence to support knowledge claims); and what is important within the school curriculum. Thus in many mutually reinforcing ways teachers feel constrained to behave in ways which are consistent with the dominant culture.

This does not explain in itself why controversial issues teaching is not acceptable but it perhaps indicates the subtle processes through which the powerful social pressures beyond the school come to influence individual teacher behaviour and student learning.

2.6.2: Controversial issues because of their nature are conceptually too difficult for most students.

The main thrust of this argument is that most students are not academically mature enough to handle the political, moral and ethical complexities, ambiguity and uncertainty of most controversial issues (Thelen, 1983). Because of this, students will want to argue from their own subjectivity which could be highly emotional, prejudicial, unquestioning or apathetic, rather than being rational and logical. These then are the arguments which Johnson and Johnson (1988), Solomon (1988) and Dewhurst (1992) cite as reasons for opposing the teaching of controversial issues, although all three authors do support their use.

Another argument put forward is that students and in particular pre-adolescents are not aware of, capable of dealing with or interested in tackling controversial issues, a situation which Finn (1990) refers to as *lack of readiness*. Evidence for such an argument, although anecdotal is certainly not supported by the researcher's experience as a classroom teacher, nor by the recent work of Lock (1996) with regard to student understanding of the nature of biotechnology and genetic engineering.

The third aspect of the argument concerns students' ability within the classroom. It is argued that any discussion of controversial issues alienates those students who are less able to argue in favour of one position or another. The result is that middle to less able students feel outmanoeuvred, defeated or humiliated by the force and level of argument of their more able peers who might be more knowledgeable and skilful within their arguments. The outcome is reflected in the less able students feeling insecure about their abilities and dissatisfied with what they produce as a result of their own efforts. It might also be frustrating for the more able students because they lack the intellectual and verbal challenges from their peers, resulting in resentment, dislike and disdain by both parties. Other students might not be able to interpret empirical evidence or make valid inferences; others might not see the topic as being controversial; others might become apathetic and so withdraw. Advocates for STS, notably Solomon (1988), Pederson (1992) and Aikenhead (1994) argue against such descriptions of students as might be expected, but in dismissing such descriptions provide scant arguments to substantiate their view.

The argument that the teaching of controversial issues is inappropriate for most students is based on the premise that they are conceptually too difficult. Further, it is suggested that the students' inability to cope with these demands could lead to a reduction in the level of group co-operation and to more emotive discussions, the overall effect being to reduce student achievement. Learning is seen as more effective and efficient if knowledge is presented as the truth, as unambiguous and value free. The adoption of such arguments could suggest that from a practical perspective, teaching about controversial issues is an impossible task for teachers. These then are the reasons which various authors who support the use of controversial issues claim as possible arguments why controversial issues are not more prominent in the curriculum (Stradling *et al.*, 1984; Stradling, 1985; Hickman, 1985; Johnson *et al.*, 1985; Finn, 1990; Dewhurst, 1992; Pederson, 1992).

2.6.3: Teachers are ill equipped to handle the demands of controversial issues

Discussion concerning teachers and controversial issues centres on two main concerns: reluctance on the part of teachers to address such issues and, accusations by those outside the profession and some within, that teachers, because of their authority, are unable to divorce themselves from their own bias, values and beliefs (Barker, 1987).

Several possible explanations have been put forward in the literature for teachers' reluctance to teach controversial issues. These are as follows:

- Teachers wish to avoid student unrest and dissent, because they find student conflicts difficult to resolve. So from the teacher's perspective it might be more appropriate to avoid the issue (Jungwirth, 1980; De Cecco, 1974).

- Teachers are reluctant to engage in any instruction that questions the values, beliefs and ethical judgment of the school and the community in which they work. Such questioning is seen as being professionally risky particularly in communities where dissidents and dissent are not strongly supported (Pence, 1990).

- Schools exert pressure on teachers to conform via examination, syllabus requirements, time constraints and preferred styles of teaching. As a result of such pressure teaching controversial issues may not be a conscious professional priority for such teachers. They may, for these reasons, prefer the traditional expositional teaching style (Jennings, 1980; Jungwirth, 1980; Hutchinson, 1983).

- There is a lack of well documented and researched teaching resources. Reliance on multi-media for information is seen as being potentially risky and biased. Issues which are too current, might not be relevant in years to come and so the skills and knowledge specific for one issue might not be transferable to another issue (Stradling *et al.*, 1984; Stradling, 1985).

- Some teachers might also lack sufficiently developed conflict resolution skills to adequately deal with potentially uncomfortable students' questioning (Thelen, 1983).

However, for some outside the teaching profession, for example those of the New Right as cited by Barker (1987) and Brigley *et al* (1987), teaching controversial issues is seen as a problematic area open to individual teacher interpretation and intervention. Such a forum where teachers could potentially present their own views could lead to indoctrination and is therefore undesirable. What follows from this is that teachers' authority cannot be seen in the eyes of their students as differing from the teacher's personal opinions. Presenting a balanced and neutral stance on any issue is difficult (Jones, 1986; Dewhurst, 1992). As these authors point out, such arguments do not hold firm, particularly as indoctrination and bias still occur in traditional subjects.

Another possible argument is that controversial issues are not only time demanding but also put other curriculum demands at risk. It is also unrealistic for teachers to be asked not only to facilitate efficient and effective learning but also to clarify values and beliefs. Therefore the teachers' role should be limited to areas of study which do not include controversial issues and do not compromise knowledge acquisition. These are reasons cited by Dewhurst (1992) as possibilities, although he himself is in favour of the teaching of controversial issues.

Overall, the explanations as to why controversial issues might not be appropriate in the school curriculum deal mainly with their suitability and relevance for students and whether teachers are equipped to use them without bias and indoctrination. As mentioned above there is a paucity of literature presenting counter arguments for the use of controversial issues in the curriculum with much of this argument found embedded within the literature supporting the case for the use of controversial issues in classrooms.

2.7: Possible Reasons as to why Controversial Issues of a Scientific Nature Might not Play such a Significant Role in Science Teaching.

As discussed above, most of the extant literature dealing with the teaching of controversial issues throughout the curriculum as a whole is concerned with asserting the positive educational value of such teaching, with little substantive literature found addressing alternative perspectives. With the exception of the two commentaries referred to earlier by Kromhout and Good (1983) and Good, Herron, Lawson and Renner (1985) on the work of Hofstein and Yager (1982), there are no empirical or theoretical studies so far reported in the literature which focus on *why science teachers themselves* do not incorporate controversial issues into their teaching, or more specifically, the possibilities and problems for using controversial issues in the context of A-Level Biology teaching.

In the absence of such studies, in attempting to understand why it is uncommon for science teachers to adopt the teaching of controversial issues, it is necessary to turn to the broader field of science education and examine the literature on science/biology teachers' conceptions/beliefs about the nature of science, their conceptualisation of science teaching and how both of these impact on their classroom practice. It was hoped that these areas might 'offer up' clues and so help explain why, based on current literature, controversial issues are rarely used in any formal teaching. However much of this literature, particularly that dealing with teachers' beliefs about the nature of science (Matthews, 1990), seems to employ a deficit model of teaching with research reported being largely conducted outside both the specific social and classroom contexts of teachers and in addition, takes little account of teachers' perspectives (Brickhouse, 1990; Lederman, 1995).

Since there is a paucity of literature which addresses the use or non-use of controversial issues in science/biology teaching, it is necessary to turn to the literature dealing with two broader fields: teachers' understanding of the nature of science, and teachers' conceptualisation of their science/biology teaching.

Central to the arguments presented in this section is the contention that despite varying science curricula and lack of consensus as to what such courses should contain, the literature does seem to indicate that one of the desired outcomes of any course in science is the need as Lederman (1992) indicates for an 'adequate understanding of the nature of science or an understanding of science as a way of knowing' (p. 331) with the nature of science being defined for the most part as the 'values and assumptions inherent to the development of scientific knowledge' (p. 331). In this landmark review of students' and teachers' conceptions of the nature of science, Lederman points out that the individual's conception of scientific knowledge is dependent upon their seeing this knowledge as either value free or subjective, tentative or certain, empirical or theoretically based, creative or static. Given this, it is possible that there might be a link, however tenuous, between teachers' views of the nature of science and the use of controversial issues in science teaching.

Both of these areas of teachers' understanding of the nature of science and their conceptualisation of science teaching in relation to their classroom practice will now be addressed.

2.7.1: Teachers' conceptions of the nature of science and how this is thought on impact of their classroom teaching

Literature in science education addressing the nature of science via the history and philosophy of science (Hodson, 1985; Jenkins, 1990, 1994b; Matthews, 1990; Bentley and Garrison, 1991; Bybee *et al*, 1991; Ray, 1991), how the nature of science ought to be taught (Loving, 1991; Solomon, 1991b; Hodson, 1992; Jenkins, 1992, 1994; Callery and Koritz, 1993-1994; Yager and Lutz, 1995) and teachers' conceptions of the nature of science (Duschl and Wright, 1989; Zuzovsky, Tamir and Chen, 1989; Brickhouse, 1990; Gallagher, 1991; Zoller, Donn, Wild and Beckett, 1991a; Hodson, 1993, 1996; Pomeroy, 1993; Rubba and Harkness, 1993; Ruggieri, Tarsitani and Vicentini, 1993; Bingle and Gaskell, 1994; Nott and Wellington, 1995) is abundant. However, there is little which addresses how teachers articulate their understanding of the nature of science given the practical realities of their classroom. As Lederman (1992) points out, most research reported has 'focused solely on the development of curricula and/or instructional materials' (p. 339) which hoped to improve students' conceptions about science but 'unfortunately for the most part, the importance of the teacher as a variable was ignored' (p. 346). This, he believes, is due to the dominance of the process-product paradigm before the mid 1980s. The review also argues that the two former uncontested assumptions, which are that teachers' understanding about the nature of science affects students' conceptions of science and that this 'influence must be mediated by teacher behaviours and classroom ecology' (p. 346) are no longer tenable and ought to be questioned in the light of recent classroom based research: points later developed by amongst others as Koulaidis and Ogborn (1989, 1995), Lakin and Wellington (1994) and Lederman (1992, 1995).

2.7.1.1: The nature of science - history and philosophy of science

From the literature in science education dealing with the nature of science three areas of interest emerge: first, the need for teachers to have a clear, up-to-date understanding of the nature of science in terms of its history and philosophy; second, the need for all students to become scientifically literate and have an image of science which incorporates exploration, explanation and testing; and finally the need for any future science curriculum to be epistemologically valid, and in so being, reflect the current understanding of the nature of science (Hodson, 1985; Jenkins, 1990, 1994a; Matthews, 1990; Bybee *et al*, 1991). In addition all these writers point out that generally, curriculum developments have not been informed by such understandings. Since discussion concerning the need for all students to become scientifically literate and for them to have an appreciation of the nature of science is beyond the scope of this study, the ensuing discussion will focus on the first of the aforementioned areas of interest: the need for teachers to have a clear, up-to-date understanding of the nature of science in terms of its history and philosophy.

What has been well documented not only in the literature quoted above but also within what is cited in that literature, is a perceived inadequate understanding by teachers of the nature of science.

Whilst it would be incorrect to suggest that these writers (for example, Hodson, 1985; Jenkins, 1990, 1994a; Matthews, 1990) are not altogether sympathetic to the reasons why teachers have the beliefs about science that they do, they seem to share the opinion with writers more sympathetic to teachers (Bybee *et al*, 1991; Larkin and Wellington, 1991) that many science teachers believe science to be a set of facts independent of inquiry and divorced from morality.

Nevertheless, it is the contention of Hodson (1985), Jenkins (1990, 1994a) and Matthews (1990) that teachers do not have an adequate nor up-to-date understanding of the nature of science. Two reasons are given for this: firstly, the lack of any study concerning the nature of science in any teacher education and in-service programs and secondly, the view/image of science presented in textbooks and other resources available to teachers as referred to above. For as Matthews (1990), one of the most frequently cited philosophers in the field of science education, points out:

> If policy documents, curricula, and text-books embody and uncritically promulgate certain philosophical positions, it is not surprising that classroom teachers do likewise. A teacher's theory about the nature of science, his or her epistemology, can be conveyed explicitly or implicitly. This epistemology affects the classroom behaviour of teachers. How this epistemology is formed, what effects it has on teacher practice, and how it contributes to students' images of science, have been the subject of many recent studies ... One thing that is known is that a teacher's epistemology is picked up by osmosis: current prejudice is little bothered by historical information, or by philosophical analysis. (p. 39)

Given that teachers do have beliefs about the nature of science, deficient or otherwise, the literature is helpful in terms of this research in highlighting how difficult it might be for some teachers to move away from a view of science as a body of facts to one which incorporates a more updated view of the history and philosophy of science along with other ways of conceptualising and teaching science. The teaching of scientific controversial issues might be such a case in point.

2.7.1.2: How the nature of science *ought* to be taught

The difficulty with this literature is that there is little agreement not only about what exactly is the nature of science (Loving, 1991; Hodson, 1992; Callery and Koritz, 1993-1994) but also how it should be taught from a theoretical and practical perspective (Solomon, 1991a, 1991b). In terms of how it ought to be taught, some of this literature addresses the desirability or otherwise of teaching a more integrated/balanced science as opposed to the separation of the sciences. Another area of the literature addresses the question of process versus product. For example Hodson (1992) contends that any science curriculum ultimately rests on the 'fundamental philosophical problems concerning the nature of science and scientific practice and, to issues concerning the goals and practice of science education' (p. 541). For Hodson what is sorely needed in science education is a 'radical reappraisal' of the image of science, so that the currently outmoded stereotypical image of science as a collection of immutable facts is replaced with one which not only reflects 'contemporary thinking in philosophy and sociology of science' but also one which highlights scientific method as a 'dynamic process which changes and develops'. In such a way, Hodson (1992) argues, students would begin to appreciate some of the blind alleys that occur in scientific research and the significance of the personal ambitions, research funding and politics in science. This is what Matthews (1990) terms a *contextualist* approach to science education which incorporates 'an education *about* science as well as *in* science'. These ideas are helpful in terms of the possiblilities of controversial issues making a significant contribution to what these researchers view as one of the more important aspects of any science education: an appropriate view of the nature of science.

With the exception of Solomon (1991), none of these authors seriously confronts or gives practical assistance to the very real problems which teachers may face when confronted with a curriculum whose philosophic basis is not in tune with their teaching practice. So in this sense, in terms of the focus of this research this literature is not of immediate relevance.

2.7.2: Teachers' conceptualisation of science/biology teaching and how this is thought to impact on their classroom teaching

The second broad area of science education which might offer up clues as to why controversial issues of a scientific nature do not play such a significant role in science teaching, can be found in science teachers' conceptualisation of science/biology teaching, and whether or not this impacts on their classroom teaching - an area of research dealing with teacher thinking/cognition.

Research in the field of teacher thinking/cognition has been largely undertaken since the mid 1970's as a reaction against the process-product paradigm. What the literature of that time seldom addresses is any sensitive, perceptive understanding of teaching from the perspective of the teacher, with many research conclusions remaining largely prescriptive (Hagger, 1995, p. 8). For Clark and Peterson (1986) this shift in the focus of research which now began to deal with the 'thinking, planning and decision making of teachers', rested on two broad assumptions: firstly, it is within the psychological context of teaching that curriculum is interpreted and acted upon - where teachers teach and students learn and secondly, that 'teacher behaviour is substantially influenced and even determined by teachers' thought processes', with the final aim being to 'construct a portrayal of the cognitive psychology of teaching' (p. 255) useful to those involved in education.

For Yinger (1986) research of this kind is useful in coming to a clearer understanding of what teachers do when they teach, whether articulated or tacit:

> Research on teacher thinking has yielded rich descriptions of the nature of teaching. It suggests that what teachers do is strongly influenced by what and how they think, that is, little of what teachers do is merely spontaneously reactive. Also, teaching practice is based on thoughtful and systematic (though often implicit) notions about students, subject matter, teaching environments, and the teaching process itself. (p. 274)

Because of its relative newness as a field of educational research, most of what has been reported in the literature has addressed the more general aspects of teacher cognition (Pope, 1993) rather than that for specific subject teacher cognition (Stein, Baxter and Leinhardt, 1990; Brown and McIntyre, 1993; Moallem, 1994a, 1994b; Even and Tirosh, 1995). Consequently the literature dealing with teacher cognition in science, particularly that for experienced teachers working within their school laboratories, has remained somewhat sparse. As Cornet, Yeotis and Terwilliger (1990) comment:

> While several studies have investigated the relationship between teacher beliefs and action, this research has not taken place in the science classroom. There is a dearth of literature related to science teachers' beliefs and their impact upon the curricular and instructional practice of teachers from *the perspective of the teacher* (their emphasis). (p. 518)

Much of what has been written since the late 1980s examines the importance of teachers' beliefs/conceptions about the nature of science and whether this is indeed reflected in their teaching. This research has largely focused on differences between experienced and beginning science teachers [Cornet *et al.*, 1990; Carlsen, 1991a, 1991b, 1992; Geddis, 1991; Gess-Newsome & Lederman, 1993; Fischler in Carlgren *et al* (1994); Schoneweg Bradford, Rubba and Harkness, 1995], between experienced teachers when asked to teach familiar and unfamiliar science content (Hashweh, 1987; Tamir, 1990; Barba and Rubba, 1993) and differences between elementary/primary teachers who may have little background in the sciences compared with their secondary school colleagues (Smith and Neale, 1989; Wallace and Louden, 1992; Geddis, 1996).

In the ten years since the landmark Clark and Peterson (1986) review, there are only a limited number of empirical studies which attempt not only to unravel teachers' views about the nature of science in any deep sense but also the thinking and decision-making strategies experienced teachers in particular employ within their classrooms [Tobin in Tobin, Tippins and Gallard (1994); Lyons and Freitag, 1993; Moallem, 1994a, 1994b; Lederman, 1995]. Other empirical studies, although examining the teachers' beliefs about the nature of science, do not view their research from the participant teacher's perspective (Tamir, 1990; Hauslein, Good and Cummins, 1992; Freire and Sanches, 1992; Crawley and Salyer, 1995).

Although specific details vary, research concerned with teachers' beliefs about the nature of science has shown that these beliefs are seldom consistent across each of the reported findings and teachers' beliefs about the nature of science do not necessarily influence classroom practice even when some teachers hold views about the nature of science aligned with those of Matthews (1990), Jenkins (1994a, 1994b) and Hodson (1992), who urge curriculum reformers to adhere to the importance of teaching students about the history and philosophy of science. The research concerned with teachers' beliefs about the nature of science has focused on three areas of interest.

First, individual teachers do not necessarily adhere to just one view of the nature of science. Recent work by Koulaidis and Ogborn (1995, 1989, 1988) and Lakin and Wellington (1994), in contrast to that of Russell and Munby (1989), has shown that teachers hold various eclectic philosophical positions which depend upon the context in which questions are asked. That teachers hold such eclectic positions, Koulaidis and Ogborn (1995) believe is useful, but what they note could be more helpful would be a deeper understanding of the differing philosophical positions teachers might hold. This in turn may assist in any analysis and representation of their thinking. These comments are helpful in understanding the current status of controversial issues in biology teaching. Whilst it would be inappropriate as Koulaidis and Ogborn (1995) indicate to suggest that 'teachers tend to believe that the scientific method is the pinnacle of methodologies' (p. 279), they are nevertheless unable or unwilling to articulate what for them is the meaning of the nature of science.

Second, this research addressing teachers' beliefs about the nature of science also indicates the strong influence of textbooks in its portrayal of science as both *revealed truth* and as an objective body of knowledge - rigorous, rational, reproducible but lacking in explicit epistemological reflection. Furthermore Gallagher (1991) contends this is achieved in textbooks using the traditional didactic mode of presentation. As concluded by Brickhouse (1990) in her research which examined the beliefs of three experienced biology teachers:

> It is not reasonable to assume that teachers who have been in the classroom for over a decade, such as Lawson and Cathcart, are acting on the same beliefs about science they formed during their formal education. Their philosophies of science are likely to have been influenced by their years of teaching science in American institutions that often encourage control over creativity and emphasise learning facts rather than developing understanding. (p. 61)

Third, the research does seem somewhat inconclusive as to the extent to which teachers' beliefs about the nature of scientific knowledge are expressed in their pedagogic practice. The work of Brickhouse (1990) suggests that teachers' beliefs about the nature of science is reflected both in lessons and in the more implicit curriculum. She suggests that those teachers with well-developed content knowledge are more effective in making explicit a view of science which sees such knowledge as socially constructed, related to both observation and theory and progress, than those teachers who view science as the accumulation of 'revealed truth'.

In addition to examining the role of textbooks as previously discussed Gallagher's study (1991) also highlights how difficult it is, even for experienced teachers, who had been involved with *Project Physics*, a major curriculum project whose focus was on the contemporary view of nature of scientific knowledge, to articulate anything other than a positivistic view of science.

> Both (teachers) see science as tentative, changing with new information. Both understand that science develops as new questions and techniques allow scientists to conduct new experiments. Both see science as a creative endeavour that has engaged some of the brightest minds, but neither clearly articulated an understanding of the processes by which scientists formulate new knowledge, of the controversies among philosophers of science about those processes. (p. 132)

Such findings are useful for this study given that experienced teachers will be used.

The Duschl and Wright study (1989) reports that 'little more than lip service was given to topics on the nature of scientific inquiry' (p. 488), that teachers gave little if any considerations 'to scientific theories and to the nature of the structure of the subject matter in their decision making concerning the selection, implementation and development of instructional tasks' (p. 491) and that effective teaching of the curriculum in terms of student learning is ignored in favour of pressure of accountability. These findings are helpful because of the warning they offer that indeed some of the problems with respect to the teaching of controversial issues might not be linked with teachers' understanding of the nature of science but rather with external factors outside the immediate control of teachers. Curriculum guidelines might prove to be one such constraint.

This trawl through the literature concerned with the broader fields of teachers' understanding of the nature of science and with teachers' conceptualisation of their science teaching has been useful to this study for a number of reasons. These include: an awareness that teachers do have well developed beliefs and rationales about their teaching in general and more specifically about the nature of science, some teachers being better able to articulate these than others; an awareness that even within these broader areas of science education few clues are offered as to why the teaching of controversial issues is not more widely reported in the literature and an appreciation that teachers' ongoing conceptualisation of their teaching practice is influenced by numerous factors often well beyond their immediate control. Perhaps the most useful lesson to be learnt is that in order to understand teachers in their classrooms, it is necessary to adopt a methodology which is sensitive to the perspective of teachers rather than to apply a pre-determined model to their actual teaching.

2.8: Conclusion

The literature to date suggests that controversial issues are an aid to good teaching and learning because, amongst other things highlighted in this chapter, they foster problem solving and effective social skills in students; skills which the literature supporting the use of controversial issues views as part of good teaching and learning (Jungwirth, 1980; Henderson and Lally, 1988; Geddis, 1991; Solomon, 1991a, 1991b). While there is a difference of opinion with respect to how to present controversial issues in the classroom, nonetheless there do exist major principles which have emerged in the literature giving guidance for their use in general but little for specific subjects. What is missing from the literature is any theoretical thinking about how, why and if at all, the use of controversial issues in biology can be used to foster, help and assist students in understanding major biological concepts.

The central question investigated in this thesis concerns the feasibility of using controversial issues to teach A-Level Biology.

What remains unclear from the literature and is here investigated, is why, given the vast amount of literature available both in the popular press and in scientific journals, biology teaching has not moved towards the use of controversial issues to any significant extent. Coupled with this is the question as to why biology teachers are committed to their current teaching practice without the incorporation of controversial issues. Given that curriculum innovations often have a short life in schools (Solomon and Aikenhead, 1994), there remains the question of what it is that prevents the long term incorporation of seemingly educationally sound and good ideas, such as controversial issues, from being incorporated into the work of practising biology teachers.

It is the interplay between curriculum materials concerned with the teaching of controversial issues and the beliefs, values and attitudes of biology teachers about biology and its pedagogy which is a challenge for research.

Chapter Three: Research Methodology 1

Data Collection

This chapter sets out the rationale for the research design and the principles and procedures used for data collection: a design intended to explore some of the specific, research questions arising from the literature review.

3.1: Research Questions

The main research question for this study arising from the review of the literature is:

> **What are the possibilities and problems for teachers in using controversial issues to teach A-Level Biology?**

Other research questions used to assist in answering the question above are:

1. What is the nature of teachers' understanding of the term 'a controversial issue' and their perception of its educational value?
2. Given A-Level Biology teachers' understanding of the term 'a controversial issue', what opportunities, if any, do these teachers identify for using controversial issues to teach A-Level Biology?
3. In what ways and to what extent have teachers' perceptions of these opportunities been affected by the A-Level Biology teaching context and by their own personal and epistemological beliefs, values and attitudes?

3.2: The Overall Research Strategy

The purpose of this research is to explore, and so develop an understanding of what A-Level Biology teachers perceive are the possibilities and problems for using controversial issues to teach biology. One way to begin might have been to identify a group of teachers who are routinely using the teaching of controversial issues as part of their everyday A-Level Biology teaching practice. If this is the choice then a naturalistic, ethnographic approach for example might be appropriate. However, previous work by Van Rooy (1993b) and anecdotal evidence from Oxfordshire schools, suggests that it would be difficult to find such a group of teachers.

Such considerations led to the development of a research design based on the use of an intervention, which it was hypothesised, would afford a greater opportunity to understand the nature of A-Level Biology teachers' thinking about the use of controversial issues. Other approaches, for example, observing teachers engaged in their normal classroom practice, or interviewing them, or asking them to use suitably prepared curriculum materials would have been possible had the purpose of the study been different. Moreover, it was also hypothesised that undertaking the intervention over an extended time frame would result in an increased chance of gaining access to revelations about the thinking of the teachers given that such 'crucial revelations are much more likely to emerge from chance incidents, extended comments, and both informal and formal gatherings' (Bryman and Burgess, 1994; p. 250).

The intervention used in this study was intended to be a collaborative, wholly negotiated venture between each participant and the researcher, through the development, implementation and subsequent reflection on one or more lessons addressing one specific controversial issue. In this study the teacher was conceptualised as the major actor and mediator between the A-Level Biology syllabus and the students. The teacher was conceptualised as part of the action in the classroom not just students alone whose opportunities for learning were in many ways under the guidance of teachers.

Given all of the above, it was necessary therefore to devise a research strategy that would enable teachers to teach one or more lessons using a controversial issues approach, and then use those lessons as the basis for developing a grounded understanding of teachers' thinking about the possibilities and problems for use of controversial issues. Such an approach contrasts with other more traditional intervention studies used in previous work in educational research and more specifically in science classrooms where the focus has been centred on student performance.

In the past intervention studies have generally been undertaken in the process-product tradition using quantitative experimental designs where pre-test and post-test instruments are used to ascertain specific improvements, generally in student performance, with respect to one or more variables. These studies are portrayed from the standpoint of the researcher with little more than passing reference made to the teachers involved or their perspective with regard to the often imposed intervention - the Project Physics Course (PPC), Chem Study and the Biological Sciences Curriculum Study (BSCS) of the 1960's and 1970's being examples within science education research of that genera. That such an approach exists is not surprising given that the focus of science education research of that time is on the development and implementation of curriculum programs whose specific aim is to portray to students, and to teachers, the distinctive nature and currently accepted scientific ideas of each of the then four traditional science disciplines. As Hurd (1991) points out, the 1980's sees a marked shift in focus away from the acquisition of content knowledge towards that of the learner, largely based on the work of current cognitive scientists who view students as being in control of their learning. Like in the previous two decades, the role and perspective of teachers is given little significant attention. Even now in the late 1990's, there remains little significant consideration of the role, contribution and perspective of teachers in science intervention studies, and the importance they perceive they play in student learning. For as far as Hurd (1991) indicates:

> Unless the research in science education is in some way related to the problems of teaching, learning, and curriculum criteria inherent in the reform movement, there is no way to justify its worthiness and no base for absorbing its findings. (p. 726)

and more importantly:

> As partners, teachers provide insight, feedback and experience needed to validate the cognitive worth of research findings. Unless research on instruction, curriculum, and learning is tested in practical endeavours, its findings are cut off from verification and the study at best can be regarded as only an interesting exercise. Teachers should have opportunities to propose problems for research as well as participate in the conduct of studies. (*ibid.*, p. 728)

A search of the science education literature (ERIC 1987-1996) yields few studies specifically focusing on the perspective of teachers or their contribution to the conceptualisation of or participation in any intervention study. That such a situation would be regarded as favourable, indeed a fruitful area for research in terms of its impact on science teaching practice, is mentioned by Finley, Lawrenz and Heller (1992) in their review of current research in science education:

> Among these studies (curriculum and instructional intervention studies), the ones that described the teachers' reasons for implementing or not implementing curricula were particularly interesting. If we can learn what promotes and inhibits the implementation of new curricula then we can consider those factors while developing them and plan what types of inservice may be required. Without this knowledge, we run the risk that excellent programs will not be used extensively. (p. 278)

Such remarks have been reiterated by Lederman, Gess-Newsome and Zeidler (1993) in their subsequent review of research:

> With as many aspects of the classroom being dependent on the thoughts and actions of the teacher, it is amazing how few studies dealt with this issue in 1991, especially when compared with the wealth of studies reported in the area of student cognition and achievement. (p. 485)

In reference to one specific science curriculum intervention (Cronin-Jones, 1991), Ledermen *et al.* (1993) comment:

> Although certain components of both teachers' belief structures enhanced the success of curriculum implementation, their existing belief structures were incongruent with the underlying philosophy of the intended curriculum, thus hampering successful implementation. (*ibid.*, p. 489)

More recently three studies, the Cognitive Acceleration through Science Education (CASE) project (Adey and Shayer, 1993), the Salters Approach (Campbell, Lazonby, Millar, Nicolson, Ramsden and Waddington, 1994) and the Discussions in School Science (DISS) project (Solomon, 1992) all investigated the use of particular strategies to develop students' understanding about, for example, STS issues within the context of their more day-to-day experiences. Such studies are conceptualised in terms of changes experienced by students as a result of their exposure to these projects. However, it is not the brief of these studies to focus directly on the effect of such interventions on the teachers involved in the project. It seems that the Salters Approach does involve teachers through their involvement in the development of lesson themes appropriate for young people (Campbell *et al*, 1994). Ultimately however, intervention studies apart from the Salters Approach have in the past sought to define what teachers ought to do rather than how teachers think about, and make sense of, particular approaches to teaching. It is the latter which is the purpose of this study.

It is not the intention of this research to evaluate the success or otherwise of the intervention in changing teachers' minds about the use of controversial issues or students' success in learning biological concepts, for example, through the use of a controversial issues lesson; nor was the concern with the extent to which teachers had the necessary competence to use the approach except insofar as they highlighted this as an issue in relation to their own thinking about the use of controversial issues in their teaching. Rather, the intervention in this study was atypical in that its purpose was to create opportunities whereby teachers could articulate their thinking about the use of controversial issues, an articulation grounded in the reality of a controversial issues lesson. Such an approach, far from implying a deficit model of teaching, casts teachers in the role of expert practitioners and the researcher in the role of attempting to understand their thinking about teaching.

Therefore, in order to have the best possible chance of accessing teachers' beliefs, values and attitudes in relation to the teaching of controversial issues, it was necessary to devise detailed principles to guide the development of the research design. These principles are discussed in the next section.

3.3: Principles of Research Design and the Development of the Research Plan

In terms of this study there were seven factors which needed to be addressed in the research design. These were the identification and removal of surface constraints[1] which could hinder the teaching of controversial issues, the relevance of the study to teachers, the adoption of a phenomenological stance, the interaction between the teachers and the researcher, the implementation of the controversial issue lesson, the role of the researcher and finally the ownership and control of the lesson. Each of these factors will now be discussed and their specific design principle stated.

- **The Identification and Removal of Surface Constraints**

The first factor which needed to be addressed in the research design was the identification and subsequent removal where possible, of those surface constraints which might hinder the teaching of controversial issues. It was important that this be done for two reasons; first, to enable teachers to teach a controversial issues lesson and second, to enable the researcher to access if possible any deeper constraints which might exist. Thus the purpose of identifying and removing the surface constraints was to facilitate the intervention itself. It was not to obtain any immediate access to the beliefs, values and attitudes with respect to the teaching of controversial issues. It was hypothesised that if these surface constraints could be identified and subsequently addressed, then opportunities for teachers to articulate other, possibly deeper concerns about the use of controversial issues, would be encouraged. This is addressed in the first design principle.

Principle 1:

Surface constraints need to be identified, effectively addressed and if possible removed for each participant in order to implement the intervention and so enable the participants to articulate their deeper concerns, if any, about using controversial issues in the teaching of A-Level Biology.

This would mean that in the pre-lesson interviews these surface constraints would be identified by the researcher with the assistance of each teacher, and the researcher would need to be flexible in devising ways of removing or meeting these constraints, that is, in the planning and implementation of the controversial issues lesson.

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[1] These were constraints which had been identified previously as dealing with, the time necessary to access, collect and collate resources, and the time needed to integrate these resources into teachers' schemes of work (Van Rooy, 1993b). In practice they could be removed by the researcher.

- **Relevance of the Study to Teachers**

Given the surface constraints mentioned above, there was the possibility that teachers might find the teaching of controversial issues irrelevant to their present A-Level Biology teaching context. In addition, whilst some surface constraints might well require interaction between the teachers and the researcher in order for them be removed, it seems *a priori* that relevance should be an important feature of the principles of the design of the research and therefore a key issue in designing the intervention. To overcome this situation the following principle was adopted.

Principle 2:

The proposed lesson has to fit both the A-Level Biology syllabus used by each participant and with what participants are teaching at the time of the intervention.

In light of this principle, it was necessary to be prepared for each participant choosing a different controversial issues and to take steps to ensure that the intervention caused as little disruption as possible to the otherwise normal delivery of the A-Level Biology course.

- **The Adoption of a Phenomenological Stance**

This was the third factor which needed to be addressed in the research design. The desire of the researcher was to understand the beliefs, values and attitudes teachers had about the teaching of controversial issues. In order to achieve this a phenomenological stance was adopted. Adopting such a stance in terms of accessing teachers' subjective meanings, meant that the intervention had to be conceptualised from the perspective of each participant in the context of their teaching environment. The suggestion by Brown and McIntyre (1993) that:

> It would be possible to understand better what kinds of changes teachers would find it practical to implement if we knew more about how teachers perceive and think about what they do in their own classrooms. Such an approach would recognise that teachers' existing patterns of classroom teaching are highly adapted to the circumstances in which they find themselves and the purposes to which they find they have to give priority. To have any chance of being perceived as practical, plans for innovation would have to take account of what is already being done (particularly what is being done well) in classrooms. (p. 15)

while not immediately relevant to this study is nevertheless helpful in its approach to interviews where the purpose is to obtain subjective understanding of interviewees.

The third design principle then is concerned with this conceptualisation.

Principle 3:

Teachers in this study are conceptualised as experts of their own teaching practice and therefore given the status of someone whose contributions are valued for their clear, rational, considered and logical perspective.

- **The Interaction between the Teacher and the Researcher**

This was the fourth design principle which needed consideration. The problem here was to devise a principle which would provide the researcher the best possible access to the data required to answer the overarching/main research question. Thus in order to access what teachers saw as the potential for the teaching of controversial issues, the researcher needed to work collaboratively and co-operatively with each participant over a period of time.

Principle 4:

The interaction between each teacher and the researcher is to be supportive of the needs of the teacher and extend over a period of time.

- **The Implementation of the Controversial Issues Lesson**

It was hypothesised that teachers would be unlikely to concede significant time willingly to both the preparation and teaching of controversial issues lessons. Even though the interaction with the teacher could be extended, the intervention itself, that is, the number of lessons dealing with the controversial issue in question, was likely to be of short duration, except insofar as teachers might deem otherwise.

Principle 5:

The teaching of the controversial issue takes place over one or two lessons.

In terms of practicality, the question remained as to what could be covered in such proposed lessons.

- **The Role of the Researcher**

The difficulty here was in deciding which role(s) the researcher should adopt in order to develop the most appropriate field relations, adequately address any surface constraints, achieve a phenomenological stance and in so doing gain the best possible chance of understanding the thinking of these teachers about the potential benefits, if any, of a controversial issues approach to A-

Level Biology teaching. It was felt that the researcher could achieve this if a number of roles were adopted.
Principle 6:

The researcher's roles in this study are to access, collect and collate lesson resources requested by teachers and present them for comment, and to act when appropriate as an associate lesson planner, non-participant observer and professional colleague.

Several actions resulted from the implementation of this principle. These were that the researcher became somewhat ingenious in her endeavours to locate suitable resources and often undertook the physical preparation of the lesson under the direction of the teacher. An example of the latter was in the preparation of folders used for group work, the contents of which was determined by teachers.

- **Lesson Ownership and Control**

This was the final factor to be considered. An associated problem with the role of the researcher was lesson ownership and control. If the researcher had assembled all the resources, then teachers might have experienced a loss of both lesson ownership and control. The principle designed to overcome this potential problem was the following.

Principle 7:

Teachers in this study are in control of all matters dealing with the choice of controversial issue, the selection of relevant resources, the planning, organisation, timing and subsequent implementation of the lesson, and the researcher's visits.

This principle had three implications. First, it was necessary that for three teachers the controversial issue should fit with what they were doing at the time; moreover for Teacher C, it meant that the issue chosen also fitted with her ideas about introducing students to the A-Level Biology course at the beginning of the year. The second implication was that teachers should be able to reject, modify or accept any of the resources and lesson plans. The final implication was that interviews should be arranged at the teachers' convenience and at school.

Summary:

Given the above, it was felt that the intervention used in this study had to have the following characteristics. It needed to be non-aggressive, collaborative, flexible in its response to the needs of teachers (*Principles 1, 3 and 6*) and extend over a period of time yet minimise any disruption to the otherwise normal delivery of the A-Level Biology course (*Principles 2, 4 ,5, 6 and 7*).

Governed by the principles outlined above it was decided to divide the research into a number of chronological stages. These will be discussed in more detail later in this chapter. These stages would involve the following:

- Identification of teachers who were willing to participate.
- Preliminary discussion with teachers in order to identify what they saw as a controversial issue and what they themselves identified as surface constraints which hinder the teaching of controversial issues.
- Collaborative planning of one or more controversial issues lessons with the researcher responding flexibly and positively to the needs and demands of each participant.
- Implementation of the lesson.
- Debriefing each teacher after every lesson.
- Seeking the response of teachers to various claims made by the researcher about their involvement in the study after data collection was completed.

3.4: The Sample

Taking account of the principles and characteristics of the intervention outlined above, along with the nature of the research questions, decisions needed to be made regarding the selection and size of the sample. What was needed were teachers who were interested in the study and willing to both collaborate with the researcher and volunteer their professional time and expertise.

In terms of sample selection, a choice had to be made between beginning or experienced A-Level Biology teachers or some combination. Since the research questions were in part addressing what teachers had undertaken in the past and the decisions they had made with regard to their use of controversial issues, it was felt that experienced teachers alone would be a more suitable sample. It was not the assumption that experienced teachers would somehow, as a result of their previous teaching, have a more sophisticated and complex view of their teaching that motivated this choice. Rather, it was simply that the researcher was interested, not only in teachers' perception of the use of controversial issues, but also the extent to which, if at all, they had been used in the past, and the rationale for incorporating them in or excluding them from the curriculum. For these reasons A-Level Biology teachers with a minimum of three years A-Level Biology teaching experience were sought.

The second decision concerned the sample. This was governed by three reasons of practicality: first, the 2-3 months of each intervention, with data collection for each completed before another began; second the time needed to analyse the wealth of data generated by each intervention, given the desire to understand the nature of how teachers conceptualise the potentiality for the teaching of controversial issues in the context of their A-Level Biology teaching; and third, the length of time needed to foster and develop appropriate field relations. It was for these practical reasons that no more than four willing and experienced teachers became involved in this study. Fewer teachers, although still offering the same richness of data from each participant, might not have provided the breadth of coverage of controversial issues addressed in the intervention or the level of potential comparisons which could be made between teachers. In this regard the comments of Miles and Huberman (1994) are helpful because they lend support to the way in which this study attempts to access the beliefs, values and attitudes of teachers in their social world, the A-Level Biology classroom along with the advantages of choosing more than one participant:

> ... with much recent practice to support us, ... multiple cases offer the researcher an even deeper understanding of processes and outcomes of cases, the chance to test (not just develop) hypotheses, and a good picture of locally grounded causality. (p. 26)
>
> Multiple-case sampling adds *confidence* to findings. By looking at a range of similar and contrasting cases, we can understand a single-case finding, grounding it by specifying *how* and *where* and, if possible, *why* it carries on as it does. We can strengthen the precision, the validity and the stability of the findings. (*ibid.*, p. 29)

3.5: Principles of Data Collection

Four principles form the basis for data collection in this study and are as follows:

Principle 1:

Both the data and methods for its collection have to be such that each can assist in answering the research questions and in the development of an account for each participant set within an empirical phenomenological perspective.

Principle 2:

Data collection needs to be such that sufficient data is gathered which encompasses the beliefs, values and attitudes of experienced A-Level Biology teachers in relation to both their general A-Level Biology teaching and that for the teaching of controversial issues, and that these data collection procedures be flexible enough to accommodate emergent issues and to detect data inconsistencies.

Principle 3:

The data collected should come from of variety of sources, possibly of varying strengths but nevertheless be such as to provide clues to answer the research questions.

Principle 4:

The data collection be guided via a thorough reading and rereading of all teacher interviews and lesson transcripts, so that areas of uncertainty can be identified and further investigated in subsequent teacher interviews.

Data collected for this study were in the form of in-depth, semi-structured teacher and student interviews[2], audiotape transcripts of controversial issue lessons along with fieldnotes and lesson observation notes. For this study it was the teacher interviews and the controversial issue lesson transcripts which formed the substantial and substantive portion of the data and of these, the teacher interviews were of most importance in terms of directly answering the research questions in the formulation of knowledge claims. For as Lythcott and Duschl (1990) point out, provided that due attention is paid to reliability and validity during data collection, defensible claims about the research can be made:

[2] Student interviews undertaken before and after the controversial issue lesson were used only for illustrative purposes in Chapters 5 to 8, not as part of the data analysis.

> The clinical interview method, and its modifications, have proved to be most fruitful for generating rich data. When used with a conscious effort toward sound argumentation, with attention to the warrants, and a directed effort to find the authority, the legitimacy in the backings for them, such data can yield defensible claims. (p. 459)

These claims with respect to authority and legitimacy can only be made in the context of this study for the interviews and lesson transcripts because these sources of data were a record of what was *actually spoken* by the teachers during interviews or what was *said by* teachers and students during the controversial issue lesson(s). The same cannot be said in respect of lesson observations notes and field notes. These documents were the researcher's interpretation of what, for example, occurred in a lesson or what was heard in transcripts, *not* what was directly spoken by each of the participants. Therefore, lesson observations and field notes along with student interviews acted as aids to the interpretation of teacher interviews and lesson transcripts of the controversial issue lesson(s).

In the view of Miles and Huberman (1994), interview data with teachers as collected in this study is 'better' than that from field notes since each participant is 'knowledgeable, close to the event, action, process or setting' (p. 268). This interpretation of data, the product of a systematic collection and double checking of findings and an awareness of the status/weighting of evidence are, according to the writers above, both reliable and valid. In the context of this thesis, the approach has been as follows:

> (to) self consciously set out to collect and double-check findings, using multiple sources and modes of evidence, the verification process will largely be built into data collection as you go. (*ibid.*, p. 267)

Data collection for this research was seen as consisting of three distinct data sets: teacher interviews, lesson transcripts and lesson observations/field notes.

3.6: The Organisation of the Research - Collection of Data

In this study data collection was organised into four major phases[3]. These were in occurrence:

- *the pre-lesson interview phase*
- *the controversial issue phase*
- *the post lesson phase*
- *the proposition phase*

The general pattern above was the same for each teacher. However, internal details within each phase differed between teachers. For example, Teacher C requested a second post-post-lesson interview in order to continue with her critique of the controversial issue lesson and her views concerning the teaching of such issues. Further details concerning these differences are found in Table 3.1.

An important aspect of the organisation and data collection in this study was that, apart from the first interview (Pre-Lesson Interview 1), opportunities were taken during subsequent interviews to seek clarification and elaboration of issues arising from previous interviews. This was achieved as a result of a thorough reading and annotation of transcripts in order to identify any emergent issues. What could potentially occur was that questions in the final interview could have as their basis the responses made by participants in early interviews. This revisiting of interviews in order to seek clarification and elaboration is indicated in Figure 3.1 by solid arrows. In addition, with the exception of the first interview, interview questions were not necessarily identical for each teacher; an approach entirely appropriate given the researcher's conceptualisation of the participants as individuals.

The discussion which now follows concerns the organisation of the four phases of data collection. Table 3.1 indicates the number and duration of interviews within each phase and identifies each teacher's choice of controversial issue. Table 3.2 shows the type and form of data collected along with a brief commentary where appropriate.

[3] All appendices for this chapter in the form of tables, figures and interview schedules are located in Appendix A.

3.6.1: The Pre-Lesson Interview Phase

There were three purposes for the pre-lesson interview phase[4].

- to facilitate teachers' articulation of any professional concerns they might have in relation to A-Level Biology teaching albeit in a decontextualised situation;
- to access teachers' opinions, albeit in a general way, about the use of controversial issues in their teaching;
- to develop a controversial issue lesson which would be integrated with both what was currently being taught and what was contained in the syllabus.

To achieve this a series of semi-structured interviews of 45 to 60 minutes duration was held at the school over four to six weeks. Each interview was transcribed and made available to each participant. Points needing further clarification were addressed in subsequent interviews.

Four Pre-Lesson Interviews[5] seemed appropriate in order to begin to address the research questions. Audio tapes and the transcripts of each interview, undertaken on or near the day of the interview, were available to teachers. This was done in order to:

- allow teachers quick and easy access to their own verbal reports;

  (By doing this the researcher hoped to develop a professional rapport with each participant.)

- facilitate data familiarisation by the researcher;

  (This allowed for some of the nuances and impressions from the interview to be recalled and noted on each transcript in the form of memos.)

- facilitate opportunities for ensuring consistency within and between interviews.

(This was done so that some initial understanding could be established before the next phase of data collection in terms of each teachers' thinking about the teaching of controversial issues, and if available, that of their A-Level Biology teaching practice.)

---

[4] Interview schedules are located in Appendix 3.1.

[5] Four semi-structured interviews for the first teacher (Teacher J) were found on preliminary analysis to yield sufficient data to begin to answer the research questions with some confidence. These interviews were then used as a guide for subsequent participants.

During this time, each teacher's A-Level Biology lessons were observed and a written record made in the form of fieldnotes. These fieldnotes were later used to enrich the analysis of the interviews and to enrich the development of the account for each teacher.

In this phase of data collection the interviews increasingly took the form of an informant style in contrast to the initial interviews where the style was more respondent (see discussion by Powney and Watts, 1987, p. 17). This change of format necessitated the interviewer to be flexible in her approach to the manner in which questions were asked, whilst still working within the boundaries of the research questions.

This change in the style of interview, the efforts on the part of the researcher to seek clarification and elaboration of points raised in previous interviews and the desire to maintain internal consistency within and between interviews as mentioned above, are exemplified in the following excerpt.

In Pre-Lesson Interviews 2 and 3, Teacher S spoke of two aspects of her teaching practice which at this stage of the intervention needed further explanation. These were the practices of not voicing her personal views concerning moral and ethical issues to students and not undertaking whole animal dissection. Because the exchange of one's views concerning moral and ethical issues was thought to be of a more personal nature, and because field relations were still being established, revisiting these practices was left until the final Pre-Lesson Interview.

> W: In the other interviews I was asking you about doing whole animal dissection ... you don't do whole animal dissection.
>
> S: No.
>
> W: Can I ask you whether that is a personal stance that you take ... if that is something that you don't want to discuss ...
>
> S: It is not a requirement. It is an inconvenience if we had to do that ... arranging the animals to be here at school and sorting all that out ... if we don't have to do it then I am quite happy not to have to do it. If we had to do it I would not have any qualms about getting on with it for the sake of what they are required to do.
>
> W: When you said that you didn't dissect whole animals ... I am aware now that it is not in some syllabi, but I was wondering if it was a personal thing ...
>
> S: If they are required to do it then I would do it on a small scale but I would not have an animal each or something like that. I would do it on a very small scale if they had to do it and if they had to see it. I would not mind doing it.

I wouldn't want to put them at a disadvantage over other people. I wouldn't leap wholeheartedly and get loads of animals in. I could not do that.

W: Do you have strong views about dissection?

S: I think that it has its place. The school is not the place for dissection and I don't think that you can gain anything from that activity that you can't gain to the level that you are required to know for that particular information ... you are not going to gain from that by cutting the animals up.

W: Where is the place then for dissection?

S: Dissection ... I can see its place in trainee doctors, vets work but only if they are in a situation where they are going to handle that tissue and be expected to be proficient in it.

W: Do you see any value ... is it about the technique of cutting it up.

S: Yes.

W: It is not seeing the different organs arranged is it?

S: No they are not going to gain much by seeing it in front of you.

S:Pre4, 261-288[6]

Interview 1

This was the most formal, respondent style of interview conducted for each participant. It served to establish field relations and the first two general purposes of the Pre-Lesson Interview Phase. The purpose of this interview was to seek clarification of what for each participant was their meaning for the term 'a controversial issue' and helped familiarise the researcher with the teaching context of each participant in particular A-Level Biology teaching. For example clarification of the term 'a controversial issue', along with whether or not each participant had used such issues in the past as part of their A-Level Biology teaching was attempted using a list of controversial issues as a prompt for discussion[7]. These, the researcher believed, were current socio/ethical controversial issues.

Interview 2

The agenda for this interview revolved around clarifying the organisation of the proposed lesson and elaborating on discussions begun in Interview 1. In terms of organisation, it involved the place of the proposed lesson in relation to what was currently being taught and its context within the A-Level Biology syllabus. For example, Teacher J was involved with a unit of work on animal physiology and hence saw organ transplantation as an appropriate issue. A dialogue thus ensued with the researcher as to where the controversy might

[6] Notations: S for Teacher S, W for researcher, Pre4 for Pre-Lesson Interview 4, 261-288 for lines of transcript.
[7] Refer to Appendix 3.2.

lie and which aspects of it might be addressed. In contrast, Teacher R held many clear and well articulated views concerning the management of diabetes which he expressed explicitly in the previous interview. It was these issues which Teacher R believed ought to be addressed if he was to develop any lessons on diabetes management conducted within the context of a unit of work on hormone control. He discussed this in this particular interview.

In terms of viewing teachers as experts of their teaching practice and as being in control of the proposed lesson, this was best exemplified with Teacher J. For her, the proposed lesson plan partly drafted in the previous interview was used as a focus for part of this second interview. On this lesson plan sheet were recorded J's comments and suggestions for improvement. This was done by the researcher throughout the interview as a means of indicating to Teacher J that her comments and suggestions were noted, important and of value to the study. By doing this, it was hoped that J would view the lesson as hers - part of the notion of lesson ownership - and thus believe herself to be in control of its purpose, direction and subsequent implementation. This was subsequently undertaken in varying ways for each of the other three teachers.

As a result of the preliminary analysis of these two interviews, in terms of data familiarisation and memo taking, three professional concerns emerged for these teachers in relation to A-Level Biology teaching: the syllabus, available time to adequately cover the syllabus and the external examination. At this stage of the intervention, it seemed from the perspective of each teacher that content acquisition could not be compromised. This notion of teachers' professional concerns was subsequently integrated into future interview schedules.

Interview 3

This interview was divided into two parts: the first dealt with further organisational and time management matters pertaining to the lesson(s), and the second addressed what for teachers were their perceptions of A-Level Biology teaching. Both parts of the interview were designed to gain access to the beliefs, values and attitudes for the teaching of controversial issues in relation to their usual A-Level Biology teaching.

In terms of applying some of the principles used in the research design (*Principles* 2 and 3), this is best exemplified with Teacher R. For R, the use of controversial issues in his A-Level Biology teaching meant addressing both the social and ethical aspects of science and the presentation of current biological understanding. For strong personal reasons Teacher R was committed to student understanding of diabetes. He believed that it was a medical condition which needed more community awareness especially in the onset stage. With regards to the social and ethical aspects of biology, R was concerned that drug companies in the past who had manufactured bovine/porcine insulin were no longer now making this product available to diabetics. The dilemma which Teacher R wanted to bring to the attention of his A-Level Biology students, was that some diabetics were now forced to use humalin, a genetically engineered form of human insulin, despite the major side effect of diabetics being unable to detect their low blood sugar levels.

Interview 4 [8]

This interview focused on:

- confirmation of the organisation and content of the proposed lesson as discussed in previous interviews - further adjustments being left to the discretion of each teacher;
- continued elucidation of what for each teacher were the possibilities and problems (alluded to in the previous interviews) for using controversial issues as part of their usual A-Level Biology teaching practice;
- teachers' knowledge and perceptions of their A-Level Biology students;
- the understanding of the nature of science and biology held by each teacher;
- future goals for teaching biology at A-Level.

A fortnight's interval was allowed between this last Pre-Lesson Interview and the lesson. This allowed time for the researcher to transcribe the interview and undertake final preparations for the lesson as requested by each teacher. As with previous interviews, some responses in this interview were used to guide the formulation of questions for interviews in later phases of data collection. Such responses included professional concerns for the use of controversial issues, understanding of the nature of science/biology as perceived by participants and descriptions of what for each teacher was their normal A-Level Biology teaching practice.

[8] There were just three Pre-Lesson Interviews for Teacher R. He had already decided during an informal conversation before the Pre-Lesson Interview Phase that he would like to further explore diabetes. This was an issue he had already used in past lessons and could, he believed, be successfully integrated into what his A-Level Biology students were learning at the time of the study. This saved time and was also more convenient for Teacher R.

3.6.2: The Controversial Issue Phase

The Controversial Issues Lesson(s)

It was not the intention of this study to compare the success or otherwise of the four different controversial issues lessons in terms of how they were implemented by teachers or received by students. The purpose of this phase was to continue with the endeavour of exploring participants' thoughts about the possibilities and problems for the teaching of controversial issues in the context of their A-Level Biology teaching practice, by collecting data in the form of audio tapes and fieldnotes which could be used in subsequent phases of data collection.

As already discussed, one of the purposes of the Pre-Lesson Interview Phase was the preparation of a controversial issue lesson. The controversial issue phase sought to give teachers the opportunity to implement a lesson where previously identified surface constraints, such as the required time to collect and collate resources had, for all intention purposes, been addressed. For the researcher it was also an opportunity to observe teachers and students in less familiar teaching and learning contexts, and to access teachers' thinking about their teaching, in particular these lessons, in a different way from previous interviews or lesson observations. What was important was not what teachers articulated to students during each of the controversial issue lessons but rather their commentaries in the subsequent Post Lesson Interview Phase. Apart from Teacher R who had previously taught controversial issues lessons, such lessons were a novel experience for the other participants. Table 3.3 gives specific details of the controversial issue lesson(s) taught by each teacher.

Because of syllabus demands, time and teachers' concern with syllabus coverage for the final examination, all of which were identified as concerns in the Pre-Lesson Interview Phase, the choice of controversial issue and the number of lessons taught were left to the discretion of each teacher (Table 3.1). To illustrate *Principle 7* for example, that of lesson ownership and control, Teacher J thought it best to spend one lesson on organ transplantation, an issue she had chosen. In contrast, Teacher S canvassed students' opinion for their choice of issue and during the first lesson on animal experimentation decided to extend student presentations to a third lesson. The following data segment taken from lesson observation notes for Teacher S (25/11/94), shows how she allowed students to make their choice of a controversial issue :

Context: OHT (Overhead transparency) of CI (Controversial Issues) of possible student interest displayed whilst students enter the lab.

11.25 T (teacher) explains aim of research
- CI/no clear solution (T says that)
- asks students to decide what they are/aren't interested in.
T had OHT of CI already up/ready to go. T hands out sheet (voting sheet) to students. Students immediately start talking amongst themselves & with T (about what's on OHT)
(Meantime - T organising what's going to happen for the rest of the lesson.)
Student comment 'Miss, we've ticked them all!'
11.30 T talking to some students, explaining ...

Essentially, the controversial issue under consideration was integral with both the current A-Level Biology syllabus and what was taught by each teacher at the time of the study. Because of variations in syllabi and times of involvement in the study, it was thus appropriate that different controversial issues be used to ensure that the issue chosen fit with the current scheme of work. The following extract shows how one teacher, Teacher R, introduced the issue of diabetes to his A-Level Biology students and how he believed this issue fitted with what they were currently learning. The extract does not indicate however, and this is heard on the audio tape, the way Teacher R cajoles his students into class participation:

> We are going to be looking at the control of blood glucose levels in people and this is on the syllabus because you have to look at various ways that the body controls the levels of substances, and blood glucose is one of them. We are also going to look at what happens when the control of blood glucose goes wrong and that is a condition called diabetes that you might have heard of.
>
> We are going to look at what diabetes is and the treatment of diabetes as well. As part of the research the lessons will be taped, which is why I have got a tape recorder on me and why there are tape recorders placed around the room to tape what you are doing. The idea is to record everything during the lesson and she will want to talk to you about the lesson at other times, not in the lesson. You can be as free as you want with your comments because I will not want to see the transcripts of those conversations or hear the tapes (*the class laughs*). I don't get to hear or see those things. She wants to know your side of things as well as my side. That is why the tape recorders are about. Any questions about that then? Anything ... not clear on?

> So that is what we are going to be doing and that is the piece of work that we are going to be looking at. I am going to start this lesson by telling you a bit about how the level of glucose is controlled in your blood without you even noticing that it is going on ... assuming that you have not got diabetes, and then introduce you to diabetes itself. So, pens ready.
>
> We have done respiration, so you know that glucose is a major respiratory fuel and we did the pathway of respiration. We assumed that glucose is the respiratory fuel. You know that your cells can use other fuels apart from glucose for respiration.
>
> R: Lesson 1, 1-30

Even though the lesson fitted in with both the syllabus and with what students were studying at the time of the intervention, teachers introduced the nature of the controversy in different ways.

During the lesson development and for part of the lesson itself, the researcher acted as the classroom assistant, by ensuring that all lesson materials, such as student folders which might have needed alterations in the light of Pre-Lesson Interview 4, were returned to each teacher several days before the lesson and that all lesson resources were in place before the lesson(s) began. Once the lesson commenced, the researcher became a non-participant observer and positioned herself at the back of the classroom where she attempted to remain unobtrusive. However, this role of non-participant observer was difficult to maintain since teachers often came to confer especially when students were actively engaged in discussion and did not require their assistance.

3.6.3: The Post Lesson Interview Phase

This phase involved the collection of interview data over two distinct time frames. The first interview, termed The Post Lesson Interview, was held on the day of the controversial issue lesson(s) and the second interview termed the Post-Post-Lesson Interview conducted some two weeks after the lesson. Both contained elements of the respondent and informant style of interview.

The Post Lesson Interview[9]

This interview held on the day of the lesson(s) dealt with two areas - debriefing, and further elucidation, if possible, of each teachers' thinking about controversial issues teaching and their own A-Level Biology teaching.

- *Debriefing the lesson*

In order to recall and so access teachers' thinking during lessons rather than accepting what might seem plausible, the researcher heeded the advice given by Brown and McIntyre (1993, p.35) which was to commence the interview with non-threatening questions focusing on the teachers' perspective and along the lines of 'How did the lesson go, do you think? Could you tell me about some of the things that went well today?'. The interview then moved to three areas of discussion: the pace, flow and content of the lesson and how this might have differed from the norm, teachers' perception of how students reacted to the format and content of these lessons, and the future place, if any, of similar lessons in the context of their A-Level Biology teaching practice.

- *Teachers' thinking about controversial issues and their own teaching*

During this interview accessing teachers' thinking on a broader level proved difficult because of the proximity of the controversial issues lesson. What teachers wanted to do was simply talk about and reflect upon the lesson itself rather than engage in any lengthy discussion of their teaching practice in the light of the day's lesson. Teachers were tired rather than not interested. Further discussion was left until the Post-Post-Lesson Interview.

Post-Post-Lesson Interview(s)[10]

The Post-Post-Lesson Interview(s), sought teachers' reactions to various segments of the lesson(s) and their thoughts about the teaching of controversial issues in the light of their recent experience. The former was done by selecting and replaying audio tape segments which highlighted aspects of their lesson(s) and the latter by inviting participants to make comments during the interview - the rationale for which is explained below.

These interviews followed a format whereby the researcher would briefly recap the major lesson steps and recall the student tasks. This was followed by replaying segments from each of these lesson steps with the transcripts used as additional prompts: in the first playback segment the teacher was heard addressing the class during the lesson introduction; in the second,

[9] Unless inconvenient for the teacher, this interview followed each lesson.
[10] The number of these depended on the number of controversial issues lessons.

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[9] Unless inconvenient for the teacher, this interview followed each lesson.
[10] The number of these depended on the number of controversial issues lessons.

various groups of students were heard engaged in their tasks without the immediate presence of the teacher and in the third tape segment, both teachers and student groups were heard engaged in dialogue. A second tape recorder was used to record teachers' comments and reactions to what they had heard or recalled from the lesson, and what was written on the transcript. At all times teachers were free to stop the recording to make comments, an opportunity which the researcher often used to note points of clarification on the transcript.

Several decisions were made in regard to the selection of appropriate segments. For the lesson introduction a decision had to be made as to whether to replay segments where teacher talk centred on lesson organisation or to play segments where teachers were questioning students about what they already knew or thought about the issue under consideration. Because the researcher had already observed teachers in the former situation, it was decided to replay the latter type of segment since it involved active rather than passive interaction between teachers and students, and so was thought to provide further clues as to how teachers might view students, particularly in terms of their content knowledge. Decisions about the second and third lesson segments which involved teacher/students and students/students dialogue were based on more practical considerations such as the fluency of student talk[11] and the level of audibility of the tape.

As this was the final interview before a complete data analysis was undertaken, it was essential that any information or points still needing clarification in order to answer the research questions be sought. For this reason, audio tape transcription and basic analysis, which included rereading and annotation of transcripts along with making memos, was done beforehand. For reasons of practicality there was a two week time lag between this interview and the previous Post Lesson Interview. Although labour and time intensive, in terms of transcription and initial analysis, any further time delays between the controversial issue lesson and this interview might well have lead to further loss of lesson recall for both the teacher and the researcher.

The researcher regarded this verbatim transcription of teachers and students *at work* as an essential aspect of the research. Such a process allowed for easy and continual revisiting of transcripts and opportunities for the researcher to add impressions and comments in the form of memos during the interviews. As Miles and Huberman (1994) point out:

> Memoing helps the analysis move easily from empirical data to a conceptual level, refining and expanding codes further, developing key categories and showing their relationship, and building toward a more integrated understanding of events, processes and interactions in the case. (p. 74)

[11] There was often periods of silence when students were thinking or examining resources.

Teachers found the replay of tapes and reading of transcripts interesting. They commented during these interviews that they often gave them new insights into how some of their students might learn in more novel classroom situations. It was also hoped that the replaying of selected segments could provide the researcher with clues for understanding the reasons teachers might have for the ways in which they viewed the teaching of controversial issues.

3.6.4: The Propositions Phase

The Propositions Interview

The purpose of this interview, conducted as a result of data analysis and before each teacher account was written, was to serve as a source of respondent validation. It involved the teacher responding to a series of theoretical statements, termed propositions for this study, constructed by the researcher as a result of fine grained data analysis. Comments made by each participant were subsequently integrated into the specific teacher accounts located in Chapters 5 to 8.

In order to allow for comparisons at a later stage between participants related propositions were sorted for convenience into groups known as propositional themes. These themes and the propositions found therein represent the researcher's theoretical abstractions about how each teacher seemed to conceptualise their beliefs, values and attitudes about the teaching of controversial issues in relation to the context of their A-Level Biology teaching practice. The propositions of this study serve as a description of what Schutz (1990, p 41) terms the *homunculus* or the essence of the inner core of the individual's meaning, that is, second order constructs. Details of how these propositional themes and their associated propositions were generated using all of the data available for each participant, will be discussed in the following chapter dealing with the procedures for data analysis and the generation of propositions. Propositions specific for each teacher can be found in the relevant teacher account.

The propositional themes used in this interview, along with illustrative propositional statements from participants are illustrated as follows:

- The A-Level Biology Teaching Context

  A-Level Biology teaching was for S an exciting pedagogic challenge. She saw this challenge in terms of assisting students to come to an appreciation of biology as a complex series of interrelated concepts, open to further biological research and intellectual challenge.

  Teacher S: Proposition 1(b)[12]

[12] The proposition numbers are not significant for the reader, they are merely the researcher's own notations. The propositions illustrated here are examples of those presented to teachers

Maintaining one's professional reputation as both an A-Level Biology teacher and as Teacher in Charge of Biology seemed, for Teacher C, to involve three distinct but nevertheless overlapping aspects:

- External and internal professional concerns.
- Student success both in examinations and as autonomous thinkers.
- Professional development.

Teacher C: Proposition 3(a)

- Views of Science/Biology

Discoveries in science and so forward progress in scientific research was painstaking and time consuming, and at times boring and tiresome - although she recognised that some of the most significant discoveries in science were made occasionally by pure chance.

Teacher S: Proposition 4(b)

- Teaching Students in the A-Level Biology Course

R aimed to foster a lively interest and enthusiasm for biology amongst students who as future members of society he believed ought to be scientifically literate.

Teacher R: Proposition 4(c)

- The Teaching of Controversial Issues in relation to A-Level Biology

J believed that controversial issues teaching was possible within her A-Level Biology teaching but only as one off, short, distinct lesson activities the value of which lay within the domain of students' social skill development, not in terms of developing biological content knowledge and understanding.

Teacher J: Proposition 3(a)

Discussion, elaboration and reflection upon each of these propositions occupied the major proportion of this interview. The remainder of the propositions interview was informal and not recorded. In this part of the interview, teachers sought details about how the data was analysed, what decisions were made in the analysis, what controversial issues had been used by other teachers in this study and how such lessons were implemented. Teacher, student and school anonymity were upheld through this and all other interviews.

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in this interview. Each of these propositions was reexamined and modified in the light of this interview and therefore there are slight differences between these and those of the propositions found in the accounts.

Even though these interviews took place some 12-18 months after the completion of data collection, and so might be questionable in terms of teachers' current thinking, they were nevertheless viewed by all participants, as far as they could recall, as both plausible and credible, and for the most part, a succinct account of their thinking about both the teaching of controversial issues and their own A-Level Biology teaching practice at the time of their involvement in the research. Evidence for this can be found in the very few substantive alterations which were made by teachers to the list of propositions. Such changes can be found incorporated within each of the teacher accounts.

3.7: Conclusion

This chapter has presented and described the nature of the research strategy along with the principles of research design which guided data collection, aimed at answering the research questions. It has provided a rationale as to how each of the four data collection phases were developed and how data needed to answer the research questions were collected.

Interview data, lesson observation notes and fieldnotes relating to how each participant viewed the problems and possibilities for the teaching of controversial issues in the context of their current A-Level Biology teaching practice were collected over several weeks. This systematic collection of data over an extended period of time was valuable because it helped the researcher not only to become familiar with the A-Level Biology syllabus content but also in time to come to an understanding of what it means to be an A-Level Biology teacher. It was then that an understanding of the rationale participants had for their views about the teaching of controversial issues could be achieved.

The following chapter presents the principles and procedures used for data analysis.

Chapter Four: Research Methodology II

Data Analysis

This chapter sets out the principles and procedures used in data analysis. As discussed in the preceding chapter, not all the data collected were given equal status. Rather, it was the substantive data in the form of teacher interviews and controversial issue lesson(s) transcripts which were analysed. This data comprised the verbal utterances of participants, not the interpretations of the researcher. Other data in the form of field notes, lesson observations and transcript memos were used to enrich the analysis. This was data dealing with contextual settings or ideas of potential interest and import.

Since the purpose of this study was to encapsulate the beliefs, values and attitudes of teachers in relation to the teaching of controversial issues, the process of data analysis required the development of:

> specific methods for the interpretation of the subjective meaning the observed acts have for actors.
>
> (Schutz, 1990, p.27)

To achieve the purpose of developing ways to interpret the subjective meaning behind this substantive data, an approach to data analysis had to be developed which would address one of the central problems in the social sciences, that of developing:

> a method in order to deal in an objective way with the subjective meaning of human action and that the thought objects of the social scientist have to remain consistent with the thought objects of common sense, formed by men in everyday life in order to come to terms with social reality.
>
> (*ibid*., p. 43)

Given the above, the approach chosen for data analysis was that developed by Schutz where the goal was to develop a series of second-order constructs, in this study termed *propositions*, which would encapsulate each of the participant's beliefs, values and attitudes with regard to the teaching of controversial issues. To achieve this end principles were set in place which were based on the three Schutzian postulates of logical consistency, subjective interpretation and adequacy.

The postulate of logical consistency is what Schutz (1990, p. 43) refers to as the need of the social scientist to design scientific constructs which are clear, logical and distinct from those developed as a result of the normal thinking process of daily life. In terms of this study it meant the construction of a set of propositions which would reveal some of the thinking with respect to the teaching of controversial issues held by participants. The second postulate, that of subjective interpretation refers to the explanatory model (and its associated characteristics) which the social scientist constructs, in order to explain in a logical and clear way the subjective meaning which actions and their results have for the actors themselves. In the context of this study it meant the construction of teacher-specific propositions which were recognisable to each participant whilst still remaining sufficiently abstract so as not to report what was directly said by each teacher. The third postulate of adequacy refers to the necessity of the construct to be not only understandable to the actor but also understandable to 'his fellow-men in terms of common-sense interpretation of everyday life' (*ibid.*, p. 44). 'His fellow men' in this case is taken to be other professional colleagues.

The use of these three postulates also raised questions of validity and plausibility in terms of the propositions generated and how they were used in the construction of the final teacher accounts. These concerns were addressed as follows. First, as detailed in the previous chapter, points of clarification and elaboration were sought from each participant during each phase of data collection except the controversial issue lesson phase when no interviews were carried out. Second, propositions were presented to each participant for criticism and changes made where indicated by participants. Changes to the propositions and the draft accounts suggested by participants will be further discussed in Sections 4.2.3.2 and 4.2.4. Ultimately the validity of data analysis relied on the responses teachers made to questions of clarification during the interviews and the way in which these were used to guide subsequent interviews, and teachers' reactions to their own specific propositions and their reading of the draft accounts.

What now follows is a discussion of the principles and procedures used to guide data analysis with exemplification based upon data drawn from across all four participants.

4.1: Principles Used to Guide the Analysis of Data

Three distinct sets of principles were developed to guide the analysis of both the semi-structured teacher interviews and the lesson transcripts[1]: first, overarching principles which focused the analysis in terms of answering the research questions; second, principles concerned with sorting the emergent themes, useful for data familiarisation and finally, principles guiding the development of propositions.

[1] Unless otherwise indicated *data* refers to both these data sets.

- **Overarching Principles**

These principles were developed in order that all of the data be used to answer the research questions.

Principle 1:

Since the aim of the analysis is to reflect the perspective of each participant all the data apart from social small talk is subject to analysis.

Principle 2:

The analysis procedures must seek out and attempt to clarify an understanding of the beliefs, values and attitudes with respect to the teaching of controversial issues from the perspective of each participant.

- **Principles for Sorting the Emergent Themes**

These principles were used so that data could be grouped into emergent themes themselves grounded in the data[2].

Principle 3:

All themes emerge from the data, are clearly defined in terms of that data, reflect the essence of that data and in addition are mutually exclusive.

Principle 4:

The purpose of sorting the data is to assist in both data interpretation, and data storage and retrieval.

- **Principles for the Development of Propositions**

These principles were used in the construction of Schutz's second-order constructs[3] which for this research comprise the propositions underpinning each specific teacher account.

Principle 5:

Propositions are mutually exclusive theoretical statements, derived from and supported by the data, and reflect the essence of that data.

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[2] Emergent themes are key points and tentative ideas (the result of data familiarisation) which both formed the basis for the later construction of propositions.
[3] *First-order constructs* in this study are the substantive data.

Principle 6:

All data with the exception of social small talk is allocated to one and only one proposition.

In addition to these more general principles for the development of propositions are two sets of principles dealing with the initial development of propositions and their subsequent testing and modification. For reasons of coherence and clarity of presentation they are located in Section 4.2.3 dealing with the construction of propositions.

4.2: Analysis of the Data

The data for this study were analysed using a multi-stage approach. Its basis is found in the Miles and Huberman (1994) notion of data reduction, data display and conclusion/verification. The general process in this thesis was that the researcher became immersed in the data in order to seek patterns and identify phenomena pertaining to the research questions whilst remaining sensitive to possible divergent and contradictory views held by participants (Hammersley and Atkinson, 1983 as cited in Bryman and Burgess, 1994, p. 6). What the researcher sought to do was to generate an understanding of the beliefs, values and attitudes of experienced A-Level Biology teachers concerning the teaching of controversial issues in biology using as its basis the notion of grounded theory developed by Glaser and Strauss (1967, p. 43) where the collection, coding and analysis of data is done continually, that is, using what these writers term, the constant comparative method (*ibid.*, p.101). Any patterns or interesting phenomena which emerged from data analysis were grounded in what each participant had to say. Given the above, the analysis was conceived as a hierarchical nested structure involving four major events each composed of one or more stages. These events were:

- **Data Familiarisation**
    - . the transcription phase - becoming familiar with the data
    - . the interview map - mapping the interview
    - . the interview story - telling a 'story'
- **Sorting the Data**
    - . the sorting matrix - sorting the data into emergent themes

- **Construction of the Propositions**

    . developing initial propositions

    . testing and modifying propositions

- **Development of the Accounts**

    . writing the draft account

    . seeking respondent validation to the draft accounts

    . constructing the final account

Each stage of analysis listed above was conceptualised as a distinct and discrete analytical event developed initially for the first participant Teacher J and subsequently trialled on data for the second participant Teacher C. Given the strength of similarity both in the nature of the data and in the A-Level Biology teaching context amongst these two participants, few adjustments were needed. The stages of analysis were then applied to Teachers R and S.

Each of the four events will now be addressed with the first event, data familiarisation discussed in generic terms, and exemplification selected from all participants. In order to achieve clarity of presentation and logical sequencing of procedures, the remaining events will be illustrated using one participant Teacher J.

Initially each transcript was reread and annotated[4] in order to construct an interview story. This was the first event - data familiarisation. The second event involved sorting the data into emergent themes, the principles of which were discussed in the previous section. The penultimate event was the development of teacher-specific propositions, subsequently modified in the light of the Propositions Interview to form the basis of the final event, the development of each teacher account.

[4] As discussed in the preceding chapter, initial data familiarisation occurred during data collection.

4.2.1: Data Familiarisation[5]

There were three stages to this first event, the purpose of which was to become more familiar with the nuances of the data.

Stage 1: The Transcription Phase - becoming familiar with the data

The purpose of the transcription phase was for the researcher to become conversant with all aspects of the data including its content and multifarious nuances.

There were three distinct steps in this initial stage of data analysis: first, the verbatim transcription of all audio tapes undertaken close to the day of the interview; second, numerous replays and rereading of each interview or lesson transcript where points needing further clarification were noted alongside the transcript[6] and third, areas of potential interest noted separately from those on the transcript[7] .

Stage 2: The Interview Map - mapping the interview

This was a display process where interesting and possibly significant pieces of information were located within each interview and controversial issue lesson. This information in the form of key informant and descriptive phrases, along with key words was mapped onto a broad sheet where the information was linked using arrows to form an interview map[8]. The interview map was a useful part of the data analysis process because it allowed the researcher to revisit interviews and lessons at a later date without necessarily having to reread transcripts or listen to audio tapes. Essentially the map allowed for the visualisation of the data and in so doing facilitated the search for trends and possible comparisons within the data. In addition other forms of data, for example field notes, could also be noted on the map. Ultimately the construction of the map was a useful part of data analysis because it assisted in the conceptualisation and preparation of the second event, sorting the data using a matrix. These maps were constructed for each interview and controversial issue lesson.

[5] All appendices for this chapter are located together in Appendix B.
[6] Appendix 4.1a: Event 1 (Stage 1) - *The Transcription Phase I.*
[7] Appendix 4.1b: Event 1 (Stage 1) - *The Transcription Phase II.*
[8] Appendix 4.2: Event 1 (Stage 2) - *The Interview Map.*

Stage 3: The Interview Story - telling a 'story'

Although tentative and assisted by the memos and annotations from stage 1, the interview story[9] was the beginning of the more formalised written interpretation of the data. Each story told of the rationale for each interview, the tentative themes and nuances which seemed to have emerged, areas of potential interest and where possible, links within and between previous interviews. This detailed commentary was supported with quotations identified from the interview map, as possibly interesting and significant. Stories were written for each interview and controversial issue lesson.

4.2.2: Sorting the Data

The Sorting Matrix - sorting the data into emergent themes

Apart from the Propositions Interview which for reasons discussed in Chapter 3 formed a separate interview, this stage of data analysis, that of sorting the data, was undertaken for each teacher once all interviews and controversial issue lesson transcripts had been analysed up to and including stage 3 of the first event as discussed above.

For this study the process of sorting the data was accomplished via the construction of a data sorting matrix[10] which served three purposes; first, as an additional means of data familiarisation, achieved by revisiting each interview in the light of the existing analysis; second, as a means of data reduction whereby data could be summarised and located within each of the matrix cells and finally, as a data storage and retrieval system so that key elements of each interview, for example quotations, could be compared alongside those from other interviews. Since most of the talk in the controversial issue lesson involved students working in groups without the immediate presence of teachers, these lessons were not sorted onto the matrix.

In order to achieve these purposes the following procedures were followed, initially for the first participant, Teacher J, then reassessed and subsequently employed for the other participants. This sorting procedure was not conceptualised as an analysis of the content of each interview, that is, as a process of categorisation, but rather as a means of uncovering the key points and ideas located within the data so that the goal of developing 'emergent themes', based on previous tentative ideas and key points, could be achieved. The sequence of events was as follows:

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[9] Appendix 4.3: Event 1 (Stage 3)- *The Interview Story*.
[10] Appendix 4.4a: Event 2 - *The Sorting Matrix*.

- *interviews were revisited with key points and ideas which would eventually form the basis for an emergent theme(s) noted on the transcripts.*

  In order to find these key points, the researcher examined the data by asking such questions as 'What is this word, phrase, statement or paragraph about? What evidence is there to support or refute this? Does this idea or point appear anywhere else? How much of the data does it occupy?'.

- *the key points above were collected and collated, re-examined for consistency alongside the data and checked for exclusivity.*

  If there was overlap or misplacement, supporting data was re-examined and either relocated into a more appropriate point or a new and separate point was devised.

- *all the key points were summarised into a general statement and given a title. These became the definition and name of the emergent theme respectively.*

Since these key points proved suitable in capturing the essence of each interview, they were now known as emergent themes[11]. This is now exemplified using the first emergent theme for Teacher J - What Teacher J likes to teach. Each emergent theme is stated along with a definition and supporting data segments.

Emergent Theme 1: What Teacher J likes to teach

Definition:

This emergent theme refers to what it is about teaching which for Teacher J is rewarding both professionally and personally. It refers to the content this participant likes/does not like to teach, the resources she prefers to use, the students and the classes which she enjoys teaching, the rationale for how she believes science/biology courses have been constructed and the ways of teaching with which she feels most comfortable.

[11] Refer to Appendix 4.4b: Event 2 - *Framework of Analysis* for the complete list of emergent themes for Teacher J.

Illustrations:

Context: Content knowledge, course structure and students

> Because I like biology, and the modular science (*GCSE years*) is not always biology. It is a mixture of sciences ... not that that is very fair comment because at the moment I am teaching biology in the modular science but next week I shall be starting to teach energy which goes off the beaten track as far as I am concerned.
>
> Mostly I teach the animal side of the syllabus - the structure ... and perhaps the mature attitude ... but mostly because it is the biology and that is my love.
>
> J:Pre1, 7-15

Context: Preferred/not preferred teaching techniques

> Environment Issues I don't tend to take on board very much because I don't teach that side of the syllabus. That' s dead narrow but you don't because you haven't got time. Reproductive Technology ... I can't remember ever having used anything from the papers terribly much ... although I have loads of cuttings I don't always remember to fetch them out ... depends if I am teaching the topic at the time ... that's always the acid test. If I am teaching the topic at the time like I am now with the nervous system ... those happen to be in the papers ... that's brilliant ... I fetch them out and waver them about ... talk about them.
>
> J: Pre-1, 84-91

This iterative process began for the first interview of Teacher J and formed the basis for seven of the subsequent eleven emergent themes. All subsequent interviews underwent the same process with additions made as appropriate to the initial list of emergent themes. These themes were specific for Teacher J and not tested on other participants. Even though the sorting procedure was repeated for each participant, it was the intention that emergent themes be specific for each teacher. Like that for Teacher J, the emergent themes for each of the other three participants were then used to assist in the examination of each of their subsequent interviews with adjustments and additions made where necessary. Even though emergent themes from one teacher were not imposed on the data of another, there were similarities between teachers. This was not surprising given the contextual similarity in which A-Level Biology teachers were working and the nature of the intervention used in this study.

Once the sorting process was completed for the first interview, a n x n matrix was constructed using the advice from Miles and Huberman (1994) in the building and use of such matrices. These writers recommend that if this form of analysis is to be used to its full advantage then entries need to be thick and dense:

> When in doubt, make the entries "thicker". The usefulness of any data display being greater when "data density" is higher. More information is better than less. Too-thin cell entries keep you away from the meaning of the data. ... retrieved chunks ... should include some form of "source tag" so you can easily get back to them in context if need be. (p. 242)

In terms of this study 'thickness' and 'density' were obtained by ensuring that all cell entries were succinct and representative of each interview. In each cell was located the essence of each interview pertaining to each specific emergent theme.

The advantage of the sorting matrix was that it was now possible to display comprehensively all the data for each participant, and in addition be sensitive to and so reflect on both similarities and differences between each participant. This could be achieved by comparing each of the four sorting matrices. However, although a potentially useful analytic strategy this was not the intended purpose of the data matrices.

For Teacher J, eleven themes emerged from the data, the first ten of which concern the teacher with an additional emergent theme relating to the ethics of this study. The emergent themes were:

1. What Teacher J likes to teach
2. Scientific knowledge and understanding
3. Routine A-Level Biology teaching practice
4. Past and present uses of controversial issues
5. Constraints for the use of controversial issues
6. Potential uses for controversial issues
7. Thoughts about students
8. Personality traits of the teacher
9. Particularities about the proposed lesson and the manner of its delivery
10. Reflection on the controversial issue lesson
11. Aspects pertaining to research ethics

For Teacher J, the sorting matrix took the form of a table where the first horizontal row represented each interview and the first vertical column the eleven emergent themes listed above[12].

In summary, the purpose of the data matrix was to map, sort and store the key ideas for each emergent theme. It was used as a process of data reduction, data familiarisation and as a storage system, and not in the direct formulation of propositions. However, the process did alert the researcher indirectly to the potential difficulties in coming to fully understand the subjective meaning of the data and of developing a sufficient number of propositions which would encapsulate all the data.

There was no restriction on the number of emergent themes which might result from this sorting process. What seemed important was that as much as possible of the interview talk be sorted into one and only one emergent theme. However, given that teachers in this study did not as a rule simply talk about any one theme, mutual exclusivity was often difficult to achieve. Thus the purpose of this stage of the analysis was to use the matrix as a data storage and retrieval system, not as the primary tool for the development of the teacher accounts. The formulation of propositions, discussed in the following stage of analysis, served this purpose.

4.2.3: Construction of the Propositions

Beginning the theoretical abstractions

This section elucidates the principles and procedures used in the construction, testing and modification of propositions. In the context of this research, propositions are theoretical statements constructed by the researcher as a result of the fine grain analysis of all substantive data: the ultimate purpose for the construction of these second-order constructs, as mentioned, was to form a basis for each teacher account.

Before a detailed discussion is given, a brief overview is now provided to set the context for the construction of these propositions.

Propositions were guided by the analysis of the data undertaken so far, and written as a result of the researcher's prolonged and sustained reading of all the raw data. Once each proposition was formulated it was then tested across all the data for that participant. Any data which could not be allocated to a single proposition or was found to be more pertinent to

[12] Refer back to Appendix 4.4a: Event 2 - *The Sorting Matrix* and Appendix 4.4b: Event 2 - *Framework of Analysis* for the working meaning of each of these themes along with illustrative data segments.

another proposition, was placed aside and later re-examined. Eventually all data was allocated within one proposition. Because the initial set of propositions was often not as succinct as those eventually presented to teachers in the Propositions Interview or those presented in the accounts, this procedure allowed for 'non fitting' data to be re-examined and re-located into the original or any revised propositions. The aim was to generate propositions which were mutually exclusive and encapsulated all of the data.

In reality teachers made few changes to their specific propositions either in the Propositions Interview or in subsequent correspondence with the researcher, and therefore, it would seem from the perspective of each participant that these propositions accurately reflected their thinking about controversial issues and some of the various aspects of their A-Level Biology teaching practice at the time of the study. Why this might have occurred is discussed further in Section 4.2.3.2 dealing with the Propositions Interview itself.

The principles and procedures used to construct, test and modify each proposition in preparation for the Propositions Interview are now outlined. The aim was to develop the minimum number of mutually exclusive propositions which would encapsulate the data and simultaneously withstand rigorous analytical scrutiny. Two sets of principles were developed for this purpose - the application of each involving three distinct steps.

Principles for the Initial Development of Propositions

Step 1: The Initial Development of Propositions

Step 2: The Construction of Clusters of Linking Propositions

Step 3: Reappraisal of Steps 1-2

Principles for Testing and Modifying the Propositions

Step 4: Testing Propositions

Step 5: Preparing Propositions for the Propositions Interview

Step 6: The Propositions Interview

For reasons of clarity and continuity with the previous section dealing with sorting the data, it was felt that these steps could best be illustrated using data from one teacher alone, Teacher J, rather than from all participants. Each set of principles will now be presented and discussed.

4.2.3.1: Principles for the Initial Development of Propositions

Two principles were formulated to aid in the initial development of propositions.

Principle A:

Propositions must reflect the meaning of the actions of each participant, with respect to the teaching of controversial issues, and be supported by evidence found within the substantive data.

Principle B:

In order that all the data be encapsulated into propositions, there is no restriction on the number of propositions.

Step 1: The Initial Development of Propositions

Formulation of initial propositions for each participant came from an examination of the interview map (Event 1), the interview story (Event 1) and the data sorting matrix (Event 2).

Since the purpose of all propositions was to come to understand the subjective meaning of the actions of each participant with respect to the teaching of controversial issues, there was no intention to restrict the number of propositions at this early stage of development. Rather it was to develop as many different propositions as possible which would capture all the substantive data.

Illustrations of how these principles were carried out in practice are taken from the analysis of data concerned with Teacher J. For Teacher J, there were fifteen initial propositions. These were:

> 1. This teacher's choice of content and ways of conducting lessons consistently reflect her concern with external examinations, her concern with the predetermined syllabus and her belief that there is no time for anything that does not aim at examination performance and syllabus coverage.
>
> 2. This teacher's view of controversial issues teaching did not change throughout the study.
>
> 3. This teacher has strongly held views and articulated content knowledge on at least one controversial issues, that of organ transplantation, which she says she willingly expresses to students whenever it is appropriate.

4. Lack of time does not always allow this teacher to collect, use and transform teaching materials to support her A-Level Biology despite her belief that controversial issues are important and her wish to incorporate them into her teaching.

5(a). This teacher believes that controversial issues teaching is possible within her A-Level Biology teaching but only as a short, distinct activity within a particular lesson.[13]

5(b). The value of controversial issues teaching for this teacher is seen in terms of students' social skill development not in terms of developing biological understanding.

6. This teacher feels she does not have the teaching skills necessary to deal with controversial issues type lessons - organising group discussion and whole class debates.

7. This teacher's view of biology/science is as a set of known facts about the world which she reflects in her teaching practice.
(*Alternatively*[14]: This teacher's epistemological understanding of Biology is as a body of facts which is reflected in her teaching practice.)

8. This teacher finds it difficult to link the biology in the media with her use of the syllabus because the constraints of time, syllabus and examinations pervade and dominate her pedagogic thinking in such a way that she is unable to bring her wider biological perspective to bear on her A-Level Biology teaching.

9. On the one hand this teacher sees students as mature, confident, articulate, academically able and possessing sound general knowledge, whilst on the other hand she sees them as lacking in basic biological understanding.
(*Alternatively:* This teacher seems to hold conflicting views about students.)

10. This teacher seems to conceptualise learning and teaching as the transmission of knowledge to students in what might seem like a highly didactic, lecture type format.

11. This teacher thinks of examination success in terms of students possessing a large collection of facts.
(*Alternatively:* Successful A-Level Biology teaching for this teacher is seen in terms of students possessing a large collection of facts which they can then use to score high examination grades.)

12. There are constraints for the use of controversial issues which are specific for this teacher's pedagogic persona.

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[13] These are different propositions in terms of their supporting data. They were inadvertently not correctly numbered.

[14] These are simply re-statements of the propositions illustrated here as part of the researcher's thinking about that specific proposition.

13. This teacher appeared not to think about controversial issues in terms of using them to teach biological concepts despite having read and listened to transcripts and audio tapes where students were applying their biological knowledge.
(*Alternatively:* Despite intensive professional assistance with the planning and implementation of a controversial issues lesson, conceptualisation of the use of such issues to teach biological concepts remains difficult for this teacher.)

14. From her perspective, controversial issues lessons can only be realistically perceived as *one-offs* whose value lies in the development of students' social skills.

Step 2: The Construction of 'Clusters of Initial Propositions'

Given the number of propositions developed during Step 1, and the desire to scrutinise each proposition against all the substantive data, it was decided for practical reasons to link similar propositions into groups termed 'clusters of initial propositions'. This made it easier to allocate data to propositions.

These 'clusters of initial propositions' were later to form provisional propositional themes. These themes contained specific propositions which were later presented to each teacher for comment in the Propositions Interview. For Teacher J there were seven clusters of initial propositions housing all the propositions from the list above.

Cluster 1: Examination Constraints *(Propositions: 1,4,5(a),8)*

Cluster 2: Teaching Concerns *(Propositions: 2,5(b),14)*

Cluster 3: Biological Knowledge about Controversial Issues *(Proposition: 3)*

Cluster 4: Teaching Skills *(Proposition: 6)*

Cluster 5: View(s) of Science *(Propositions: 7,11)*

Cluster 6: A-Level Biology Students *(Propositions: 9,10)*

Cluster 7: Specific Constraints for this Teacher *(Propositions: 12,13)*

These clusters were later collapsed into five 'provisional propositional themes'[15] for use in the Propositions Interview. The rationale for the collapse was that grouping together similar propositions would facilitate

[15] Appendix 4.6 lists these five provisional propositional themes and their respective propositions for Teacher J.

the response to the propositions by each teacher. On the basis of evidence from this interview, these five provisional propositional themes became the four propositional themes[16] which were used subsequently to form the basis of the account for Teacher J. This is discussed in more detail later in this section.

Step 3: Reappraisal of Steps 1-2

This step involved a reappraisal of the two previous steps in the analysis and was achieved by re-visiting each interview and lesson transcript searching for data which would support or refute each proposition. In order to maximise the efficiency of this process, those clusters containing the majority of initial propositions were examined first. The rationale behind this decision was, that since propositions themselves were derived from previous analysis (data familiarisation and sorting the data), it was possible that most of the data would be concerned with, and so be relevant to, these particular clusters.

Once a segment of the data had been identified as being associated with a cluster, this along with its support or otherwise of the appropriate proposition, was annotated on the transcript and recorded in a data table[17]. This process of allocating data segments to propositions was done for all propositions in turn. Once this was completed the transcripts were checked for data which had not been allocated hitherto to a proposition. This data was re-examined and either located within an existing initial proposition or used to develop a substantially different proposition. The discussion will now focus on the principles and procedures used to test and modify these propositions.

4.2.3.2: Principles for Testing and Modifying the Propositions

These principles involved the reassessment and subsequent modification of each proposition in the light of step 3. Modifications were made only when the *data corpus* for each proposition was found to be wanting. Four principles were developed to allow for this modification.

[16] These propositions are found in Appendix 4.7.
[17] Refer to Appendix 4.5 for an example of this procedure for Cluster 2: Teaching Concerns.

Principle C:

Propositions may be strengthened in either of two ways.

Condition 1:

If new supportive data is allocated to an existing proposition, then the proposition may be strengthened to encompass the data.

Condition 2:

If existing data overwhelmingly supports a particular proposition then the data must be re-examined with the view to strengthening the existing proposition.

Principle D:

Propositions may be weakened in either of two ways.

Condition 1:

If less supportive data is allocated to a proposition, then the proposition may be weakened in order to encompass the data.

Condition 2:

If, on re-assessment, the existing supporting data seems weak then the proposition must be amended.

Principle E:

Propositions may be refuted if there is no supporting data and hence removed.

Principle F:

One proposition may subsume another proposition if all the supportive data for one proposition(A) is found to be wholly located within another proposition (B). The former (A) is thus subsumed by the latter (B).

The above principles are illustrated in Appendix 4.5 and further discussed in step 5, the preparation of propositions for the interview.

Step 4: Testing Propositions

In this step each data segment was again checked to ensure that it had been allocated to the most appropriate proposition. If not it was either reallocated or temporarily put aside as *propositionless data* to be re-examined and if necessary reallocated once all the data had been located to a proposition and existing propositions had been re-examined in the light of its allocated data. This iterative processes of data checking and modification of propositions continued until all the data had been re-examined.

Step 5: **Preparing Propositions for the Propositions Interview**

Preparing propositions in readiness for this interview involved two often simultaneous actions; first, determining as a result of previous data analysis whether propositions had been allocated to the most appropriate cluster (if not, they were re-located to another cluster) and second, determining if the number of propositions within clusters could be reduced without loosing the nuances of each proposition. This is exemplified now using Cluster 2: Teaching Concerns from Teacher J.

As previously documented this cluster contained three initial propositions [numbers 2, 5(b), 14] concerned with the potential use of controversial issues. Once the strength of each of these propositions was tested against all its allocated data, and each data segment examined in turn for overlap with other propositions within the cluster, it was found that much of the data was common across all three propositions. This being the case, the three initial propositions were collapsed into the following proposition.

> This teacher believes that controversial issues teaching is possible within her A-Level Biology teaching but only as one off, short, distinct lesson activities whose value lies within the domain of student social skill development, not in terms of developing biological understanding.

The process whereby the number of initial propositions within clusters was reduced or whereby propositions themselves were relocated to other clusters, often resulted in name changes to clusters. It was thought this would captured the essence of each proposition and its supporting data. For Teacher J, this process resulted in the original seven clusters being reduced to five and subsequently renamed as:

- About A-Level Biology Teaching
- Professional Concerns about A-Level Biology Teaching
- About Controversial Issues Teaching
- About A-Level Biology Students
- Views about the Nature of Science/Biology

So as to avoid confusion with the original clusters, these were renamed, 'provisional propositional themes'. At this stage of analysis none of the propositions had been subjected to any critical examination or comment from each participant. This would happen in the Propositions Interview, details of which now follow.

Stage 6: The Propositions Interview

This was the last step involving the construction of propositions, and as discussed in the previous chapter, its purpose was to seek respondent validation for propositions developed in the five previous steps[18]. It was also seen as a source of further data for grounding propositions.

In this interview teachers were invited to comment on and critically examine their own specific propositions located within the provisional propositional themes described above. What was important to the research was the degree to which the three Schutzian postulates had been adequately addressed, the success of which could be seen in the level of support participants gave to their specific propositions and what from their perspective, they saw as the need to add, amend or substantially alter one or more propositions. That the three Schutzian postulates had been adequately addressed can be illustrated by supportive comments from each participant:

> *(Referring to the second provisional propositional theme - professional concerns about A-Level Biology teaching)*
> Part (d) is absolutely right. Juggling the syllabus, it does, it gives you an eternal worry ... Part (e) other constraints - these three are the main constraints. No there are no others. No, no, that is all of it really.
>
> Teacher J

> (*Referring to the provisional propositional theme - professional concerns about being an A-Level Biology teacher*)
> Well that is still the case. Hm. I would go for all of that. Yes I would still go for all of that that is down there.
>
> Teacher C

[18] Refer to Appendix 4.6 for the list of propositions presented to Teacher J and her subsequent amendments.

(Referring to the provisional propositional theme - teaching the A-Level Biology course)
This is all what I think are the main aspects of my teaching I would imagine ... I broadly think that I still have these opinions on b, c and d ... I think that I would still say similar things if you asked me the same sorts of questions again to do with that. Not many things have changed.

Teacher S

(Summative comment at the end of the interview)
Yes, that is a good summary. I could not have distilled my thoughts in the way that you have just done. Fine.

Teacher R

Apart from minor changes, few substantial alterations to the propositions were needed. As mentioned in the introductory remarks to this section, the question does arise as to why this occurred. It could be that participants were in agreement with the researcher and thought that the propositions encapsulated their thinking about the possibilities and problems for the teaching of controversial issues or they simply did not wish to voice their disagreement. Whatever the reasons might have been, when changes were indicated by participants the researcher had three choices. First, the change could simply be ignored because it was thought to be irrelevant: an untenable position given the nature of the study and the contribution made by each teacher to the research. This was never considered as a viable option. Second, any changes could be given the status of extra data but not of sufficient weight to result in any substantive changes to the original propositions. Many suggested changes were simply restatements of previous opinions as shown in the quote below:

(reading proposition relating to controversial issues teaching)
... less convinced that they would foster a knowledge of biological concepts ... um ... I think what I really mean is, I am quite happy that you can get to the biological concepts but I just fell that the coverage is somehow less complete.

Teacher C

These comments from Teacher C were no different from her previous sentiment which was that the use of controversial issues in order to teach biological content remained problematic. The second option became the norm

Third, suggested changes made by the participants could be seen as a source of further data in terms of what else it was that participants were informing the researcher about which had remained tacit (Quote 1) or which the researcher had not been sensitive too (Quote 2).

Quote 1:

I think a lot of the time the most successful and significant scientists are the ones that throw in, if you throw in enough ideas into the pot, there is always going to be something that is going to have a grain of truth in it. Probably the people who generate enough ideas will have thrown in a few grains of truth. I think quite often it is like that I would imagine. That is my view.

Teacher S

Quote 2:

This particular set I saw as mature and responsive. They were fairly unusual in that respect ... but for that of students in general or at the beginning of the Year 12 course, I think that that would be a bit broad to describe them as mature and responsible and motivated students.

Teacher S

These views about the nature of science and about students had not been evident in the previous data and therefore were subsequently incorporated into both the draft and final accounts for Teacher S.

In summary, responses made by participants during this interview were incorporated to varying degrees into their accounts.

4.2.4: Development of the Accounts

Writing from the perspective of each teacher

This was the final event of the analysis process. First, it involved writing a draft account for each participant using as its basis the propositions formulated in the previous event along with their associated supporting data. Second, this draft was sent to each teacher inviting them to read and provide a critique and finally, the construction of teacher accounts which incorporated participants' comments on the drafts and the researcher's theorisation with regard to the similarities and differences found between participants were written. The final accounts are found as Chapter 5 to 8.

Each draft account was idiosyncratic and for ethical reasons contained no reference to the other participants of this study, and in no way presented the researcher's final theoretical explanations and comments. However, the overall structure of the draft was similar to that of the final account in terms of layout but the finer details, the result of the researcher's further reflective analysis, were left until the final account. Even though respondent validation had been sought throughout the phases of data collection in terms of clarification, other than for the presentation of propositions in the Propositions Interview, the draft accounts were the first formalised texts seen by participants. It was therefore important that if these drafts were to form the basis for the final accounts, they be written in such a manner as to reflect the perspective of individual participants in terms of what they saw as the possibilities and problems for the teaching of controversial issues within the A-Level Biology course. Comments on the draft accounts were received from Teachers J, C and R, and like that for the Propositions Interview, these comments were integrated within each account.

At the time of data collection teachers were conceptualised as individuals and therefore data analysis was carried out on a one by one basis using the same analytical procedures as already described. However, on examining the draft accounts in the light of respondent comments it became more apparent that there was a degree of similarity between individuals which could be used to enrich the final accounts without loosing the distinctive nuances of each participant. As mentioned, this was not surprising given the context in which these teachers were working. Commonality between participants therefore came to be seen in terms of four propositional themes, not unlike those of their predecessors, the provisional propositional themes discussed in Step 5 of the previous section. The four common propositional themes were:

- *The A-Level Biology Teaching Context*
- *Views of Science/Biology*
- *Teaching Students in the A-Level Biology Course*
- *The Teaching of Controversial Issues in relation to A-Level Biology*

These propositional themes were used to structured the final accounts with the specific-teacher propositions reflecting participants idiosyncratic features located within these propositional themes. It was never the intention that these themes nor the specific-teacher propositions be conceptualised *a priori*. Rather, they were a feature of the data which emerged as a result of analysis. What emerged from the writing of each draft account was not only a sense of commonality between participants, as came to be reflected in the propositional themes, but the need to write the four final accounts as 'linked accounts' rather than as 'distinct accounts' which was the original intention. Writing 'linked accounts' would serve a dual purpose, that of reflecting both similarities and differences between participants.

Therefore, the accounts begin with Teacher J, the first participant, and then move to Teacher C, the second participant. In the second account, similarities and differences between the two participants are discussed in order to identify if possible those features thought to be idiosyncratic to each participant, and those thought to be more general. These features were then re-examined in the account for Teacher R. In the final account, that for Teacher S, all four participants are compared and contrasted.

Such an approach with its emphasis on progressive focusing was thought not only to enrich each subsequent account, but also to facilitate a fuller understanding of the idiosyncratic and general features of previous participants.

The final accounts reported in this study therefore represent the researcher's accumulative theoretical understanding of what for these experienced A-Level Biology teachers are the possibilities and problems for using controversial issues in the A-Level Biology course, something which echoes with what Schutz (1990, p.41) refers to as the 'homunculus' of each actor.

In terms of structure each account begins with the biographical context for each participant, the rationale for their choice of controversial issue and a description of the controversial issue lesson(s). This is followed by the more substantive part of the account, the analysis of each propositional theme and the propositions therein, and where applicable, similarities and differences between participants are discussed.

4.3: Conclusion

This chapter has described how the substantive data for this study in the form of teacher interviews and lesson transcripts were analysed. The concern throughout data analysis was to develop principles and procedures, based on Schutz's three postulates of logical consistency, subjective interpretation and adequacy, which would lead to a phenomenological understanding of what experienced A-Level Biology teachers saw as the possibilities and problems for the teaching of controversial issues using current A-Level Biology syllabi.

The analysis had no *a priori* themes or propositional statements based on a theoretical model which needed to be tested. Rather, inductive analytical procedures similar to those described by Glaser and Strauss (1967) and Miles and Huberman (1994) were developed which assisted in the writing the four accounts which now follow.

Chapter Five: Teacher J

Participant 1 - School A

5.1: Background

Teacher J (known as J) volunteered to participate in this study as a result of a formal meeting, instigated by the Head of Biology in School A, where the researcher was invited to present the broad aims of the research project and negotiate access.

J has a first degree in biology along with twelve years of teaching experience. At the time of the study she was teaching in the biology department of a co-educational, years 7-13 comprehensive Local Education Authority (LEA) school where she had been a staff member for the past seven years. The other members of the biology department were the Head of Biology and one other teacher all of whom were following the Associated Examining Board (AEB)[1] A-Level Biology syllabus. J was regarded by the Head of Biology[2] as experienced, competent, well liked by students and able to produce high examination grades, an opinion shared by those students who were interviewed[3].

From her perspective, Teacher J believed the atmosphere in the biology department and in the science department as a whole to be collegial, citing whole faculty decision making as evidence. She believed that the school fostered high academic success for all students by which she meant that students ought to gain at least a passing grade in all examinations, in particular those at A-Level. The importance attached by this teacher to the academic success of students was a recurrent theme throughout this account and came in many ways to define her professional identity.

During the time of this study J taught two A-Level Biology classes - one in Year 12, the other in Year 13, the biology component of a Year 10 modular science course, a Year 9 class and in addition was responsible for Years 12 and 13 in the role of class tutor.

The work with Teacher J was conducted over a period of 10 weeks during terms 2 and 3 (April - June) of the 1993/94 school year with her Year 12 A-Level Biology class which consisted of 13 boys and 4 girls.

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[1] The Associated Examing Board, A95/03, 1995 Syllabuses, Biology and Human Biology.

[2] Informal comments made by the Head of Biology and recorded as fieldnotes by the researcher.

[3] Apart from preliminary analysis, detailed analysis of student interviews is not reported in this study.

5.2: The Nature of the Controversy

For J, a controversial issue was concerned with various value positions:

> It is about using transplants. It is about something that not everyone may agree with presumably. Something which people could give for and against and not something the whole world would agree with, I presume.
>
> J:Pre1, 20-25

J appreciated that the conception of what was controversial would vary between individuals. Thus for J personally, organ transplantation *per se*, for example, was not a moral or ethical issue but she was aware that for some students belonging to certain religious affiliations or whose families had experienced medical requests for organ donation, this issue might well be controversial and highly sensitive.

However, this did not prevent her from voicing her personal stance to students - "I find it quite difficult once they are old enough not to give my point of view which I ought to keep quiet but ...". She made particular mention of two aspects of organ transplantation; the donation of organs and the carrying of donor cards. For organ donation in general J was aware that students' reaction might not be favourable to donation itself, as she remarks:

> They might jump at me if I asked them if they were prepared to do it. That is always the big ball game. Yes they think it is a good idea, you should do it in theory but not themselves ... they recoil in horror sometimes at the very thought of the prospect.
>
> J:Pre2, 32-40

As regards the carrying of donor cards, this was an issue she believed needed to be considered by all students before the age of 18, as a matter of civic and social responsibility, as the following comments reveal:

> I have a real thing about donor cards and I always do go on about them when I do the kidney in year 10, because I carry one and I think every one should. It would be really nice if all of them had a think about that ...
>
> J:Pre2, 312-314

In addition, J knew a great deal about organ transplantation which when the occasion arose, she articulated to students. Thus, during several Pre-Lesson Interviews, when requested resource materials were presented to J for assessment in terms of suitability for the proposed controversial issue lesson[4], J stressed several aspects concerning organ transplantation which needed to be highlighted: those of a biomedical nature, such as why people might require transplants and what technology was currently available to assist with

[4] All appendices for this chapter are located in Appendix C. Resource materials for this lesson are found in Appendix 5.1 and Appendix 5.2.

organ transplantation; and those of a bioethical nature, such as organ procurement, the NHS monetary medical cost, doctor-patient-family sensitivity and the legal status of donor cards. This last aspect was highlighted when she came across differences in the legal position of donors and their next of kin in the British opting-in system, and in the opting-out system currently in place in Belgium. She was aware that this knowledge, along with that of other controversial issues, needed to be continually updated for controversial issues teaching.

From J's perspective, then, this was an example of her discharging her moral and ethical responsibilities, in the sense of making students aware of what she saw as their future adult responsibilities.

At the time of her involvement with the study, Teacher J was engaged with her Year 12 A-Level Biology class in a unit of work dealing with the mammalian circulatory system[5]. Given what had already been covered in a previous unit of work on gaseous exchange and respiration[6] and what was to follow in a unit dealing with homeostasis[7], Teacher J thought that the issue of organ transplantation would fit with what she had planned for this unit and with future areas of the syllabus[8]. Given the above, the lesson itself was planned to consist of three steps:

- *Lesson Introduction* - here J outlined to the students the purpose of the lesson. It would involve student group discussion concerning various aspects of organ transplantation, something which linked with more recent work on kidneys. J then invited the students to respond to a series of questions about organ transplantation which she had prepared during the Pre-Lesson Interviews[9], and hoped would stimulate their interest. Despite her belief that students knew little about organ transplantation, this proved not to be the case. A preliminary analysis of this section of the lesson revealed that students were able to answer all questions without prompting.

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[5] The Associated Examing Board, A95/03, 1995 Syllabuses, Biology and Human Biology; Section 2.3.1: Heart and circulation in mammals. Capillary circulation and the role of lymph. Regulation of bold pressure. Advantages of a double circulation. Histology and functions of blood. ABO and rhesus blood groups in humans. Principles of immunity and tissue rejection.

[6] Section 2.2.1: Detailed structure of lung. Transport and exchange of respiratory gases: role of haemoglobin and hydrogen carbonate ions as carriers and buffers. Control of ventilation.

[7] Section 2.4.2: The functions of the skin, kidney and lung: ... hormonal control of homeostasis especially in relation to blood-sugar level and water balance.

[8] Notably, immunity and tissue rejection between donor and recipient (Section 2.3.1), genetic compatibility (Section 5.1), kidney dialysis (Section 2.4.2) all of which in turn could conceivably be linked with STS issues (Syllabus Aims 2 & 5) such as medical costs of drug to combat organ rejection, perceived differences in the social value of persons in terms of organ availability or geographic proximity of potential recipients to organ transplantation clinics (Beauchamp & Childress, 1989; Charlesworth, 1993; Singer, 1993).

[9] Refer to Appendix C: Appendix 5.1 and Appendix 5.2 for the list of these questions.

- *Group Discussion* - this involved students being assigned into four groups in order to complete teacher assigned tasks dealing with various aspects of organ transplantation[10]. These tasks were favourably received by students as evidenced by both their recorded talk within the lesson and their post lesson interviews with the researcher. Each group addressed one of the tasks and a spokesperson reported their findings to the whole class.

- *Lesson Summation* - it was here that a spokesperson from each of the four groups presented their findings to the whole class. Although each group participated the time available was short. This meant that students could not question presenters, something that had been envisaged by J during discussion about lesson preparation in the Pre-Lesson Interview Phase.

Overview:

However, despite J's enthusiasm for participating in the work on organ transplantation, it seemed that STS type issues did not, indeed could not, form a significant part of her normal A-Level Biology teaching. The reasons for this became apparent as the research proceeded. Whilst J was willing to entertain the use of controversial issues in A-Level Biology teaching, she did so in a way which was heavily influenced by what for her was the prime imperative of teaching A-Level Biology: maximising the probability of examination success.

Thus, J's approach to the teaching of A level biology consistently reflected her need to meet a set of public and personal professional concerns. Essentially the public concerns centred around the need to prepare students appropriately for the final examinations, and achieving this meant having to use efficiently the limited time available to cover a content dense syllabus. In her words:

> Because A-Level Biology could encompass quite a lot of things and yet ... saying that ... the syllabus is relatively ... not strict ... but it does have its guidelines and really we are pushed for time and so we have very little time for anything like that.
>
> J:Pre1, 144-146

J's private concerns centred around three beliefs about biology and about herself: first, that biology, at least as an A-Level subject, was best conceptualised as a body of neutral, static facts; second, that this body of knowledge was so large that it was difficult for her to remember it in its entirety let alone keep up-to-date with new developments; and third, that she

[10] Refer to Table 3.3 located in Appendix A and Appendix C - Appendix 5.3 for more specific details.

lacked the confidence needed to use non-teacher centred learning activities such as small group and whole class discussion. The last belief took the form of (i) a lack of personal confidence in her ability to do these things well, part of which stemmed from a belief that discussion was unplanned, indeed fundamentally could not be planned:

> ... any discussion at any length other than a quick 10 minutes at the beginning of the lesson ... or as you go around the lesson and have a chat.
>
> J:Pre1, 1446148

and therefore, required social skills and social performance which did not marry with J's need to be in control, and (ii) a lack of confidence that students would learn anything other than social skills from such activities. This latter view was strengthened by her belief that students were lacking in basic knowledge of the discipline and that they learnt most efficiently through receiving factual information transmitted by her using standard texts. Consequently, whilst J was interested in, and would wish to promote students' understanding about controversial issues, they could constitute nothing more than one-off, unplanned activities sometimes in response to questions from students in the context of A-Level Biology teaching. This is demonstrated in the extract which follows dealing with the issue of reproductive technology:

> Reproductive Technology ... I can't remember ever having used anything from the papers terribly much ... although I have loads of cuttings I don't always remember to fetch them out ...
>
> J:Pre1, 84-86

Each of the four propositional themes referred to at the end of Chapter 4 will now be discussed for Teacher J.

5.3: The A-Level Biology Teaching Context

J believed that her primary professional responsibility was to ensure that A-Level Biology students were given what she considered the best available opportunities to score high examination grades. To discharge this responsibility J ensured that the A-Level Biology students in her classes were provided with the content knowledge and appropriate practical skills necessary for examination success. Consequently, in order for her to meet this requirement, she felt that there was no time for anything which might delay syllabus coverage and so compromise examination performance. Personal and professional fulfilment for J meant that she was able to implement successfully a syllabus whereby content knowledge and its associated skills were transmitted to students who, as a result of her teaching, became interested and motivated in biology and thus aided by a conducive learning environment were able to achieve high examination grades. This also provided professional rewards which came from being seen as successful by colleagues and students and from her belief that she could contribute much to both teaching and learning. The following proposition encapsulates what for this teacher represented the essence of her A-Level Biology teaching.

J's revealed practice as an A-Level Biology teacher consistently reflected the importance of a set of public and personal concerns:

- ***Public concerns*** **centred around the primary professional responsibility, that of maximising the probability of examination success. In order to achieve this, given a content heavy, predetermined syllabus, there was a need to manage efficiently the available time to cover the syllabus.**
- ***Personal concerns*** **centred around issues to do with J's subject matter knowledge, a desire to be 'in control' and a perceived deficit, from her perspective, in relation to the social skills needed to implement group work and classroom discussion.**

Each of these concerns will now be addressed in detail.

Public Concerns

These were the external examinations, the content of the syllabus and the time available to cover the syllabus in readiness for the examinations.

These three interwoven professional concerns were voiced by J throughout the entire study including the Propositions Interview. Each seemed to dominate her thinking about A-Level Biology teaching and were reflected in her approach to its teaching as reported to, and observed by, the researcher:

> Yes the three concerns are there as ever. The external exam and the syllabus are always going to be the way that you are going to have to operate. I think, it is an objective system. The time available is with biology the most worrying thing. We get the same number of lessons as any other subject but we could certainly do with more when we are doing the practical investigations. These are very demanding. I agree there is no time for anything that would delay syllabus coverage. It really is a worry if you lose one lesson to catch that up.
>
> J:Prop, 65-71

J seemed to view student examination success as her primary professional responsibility, so that by the end of the two year A-Level Biology course, students would be in a favourable position to obtain pass grades. It is the implications of this in terms of how she came to view herself as a teacher that is of interest, in particular what she herself saw as the possibilities and problems for incorporating the teaching of controversial issues into her present A-Level Biology teaching practice.

Because controversial issues were generally viewed by J to be outside the syllabus proper, in the sense that she believed she had addressed every aspect of the syllabus in her lesson preparation, when they did arise during lessons they were given the status of interesting but peripheral concerns which could be addressed as one-off, five minute chats and commentaries, often exemplified as:

> I would love to be able to discuss but I just (sigh)[11] ... they would have to be just little quickies.
>
> J:Pre1, 435

In terms of the meaning which J gave to her teaching, these three concerns shaped the way in which she viewed her teaching. They also provided meaning for her in her role as teacher in terms of what she perceived were her professional responsibilities. How these three professional concerns were manifested in her teaching can be seen in two ways; her talk regarding lesson preparation and syllabus implementation, and her rationale for not employing planned formal discussion or group work in her repertoire of teaching strategies. Each of these will be addressed in turn, after the discussion and analysis of J's personal concerns which now follows.

Personal Concerns

Being an A-Level Biology teacher was important professionally to J. It gave her a sense of professional identity and purpose, and thus seemed to define who she was as a teacher. Professional identity was reflected in what she perceived were her pedagogic responsibilities. For example, J saw the increase in her biological content knowledge since beginning A-Level Biology teaching, and her deeper understanding of the workings of the syllabus, both professionally and personally fulfilling. However, having to come to grips with the demands of the syllabus, she found, remained an intellectual challenge as is seen in the following quotation, particularly in her use of terms such as 'nerve racking', 'mug up' and 'remember':

> It is quite nerve racking initially. Because I have got a very poor memory, my short term memory is okay but my medium to long term memory is non existent so I have to mug up very thoroughly before each batch of lessons ... I do lots and lots of reading again and again but that does not guarantee that I am going to remember everything.
>
> J:Pre3, 662-675

[11] Plain text in brackets indicates a response made by the participant, italicised text in bracket indicates a point of clarification made by the researcher and square bracket with plain text respondent validation.

Nonetheless despite these concerns, J felt that she had now begun to master the syllabus content, basing this judgement on her students' examination success, her classroom interactions with students and the quality of their work. She now felt confident and at ease with her classroom performance and as such better able to gauge student progress. Such sentiments are illustrated in the quote below:

> I have got more confidence. ... they have all passed (laughs) ... well feedback (*and*) I suppose it is their enthusiasm and the quality of their work that they produce for homework that kind of thing. If they can't do the homework, which I have set because it is geared to the work that I have set in class and I will then think again about how I have taught the stuff ... generally their demeanour in the class ... hopefully you have got them all geared up and keen and enthusiastic but not all of them all of the time. I can't always hope to do that but most of the time they are enthusiastic.
>
> J:Pre3, 646-662

A persistent theme throughout the research was J's expression of a feeling of 'needing to be in control'. This seemed to imply three things - to be organised, to be prepared for the unexpected and to follow a time schedule so that lesson objectives were achieved. These were all part of what she saw as her professional responsibility and when these did not occur as planned she felt uneasy:

> I can't cope *(if not prepared)*, it has to go in the right place ... otherwise there is no point ... life is a disaster if you can't organise it (*referring to the lesson resources*).
>
> J:Pre4, 124-126

Thus despite J's stated belief that discussion and group work were both educationally sound techniques, especially for the teaching of controversial issues, they were nevertheless aspects of teaching which made her feel both personally and professionally uncomfortable and hence were not part of her own image as teacher, a view encapsulated by the following remarks:

> I don't find it easy in discussion work unless I am really well prepared other than a quick chat. It does not come easy to me.
>
> J:Pre1, 237-239

> Discussion is not something that I do, it is not something that I find easy, and it is not something that I thrive on. But that is not to say that I should deprive them of the chance of doing it. I mean it also depends on the size of the group.
>
> J:Prop, 263-266

Such a view married with her desire to control the delivery of content and in turn student learning, as seen through such comments as:

> Well basically whole class discussion I find ... it is like the survival of the fittest and the fittest come forth in the class as the loudest and hopefully the most informed and I don't think everybody gets involved in the discussion ... and I lose my way as well if it is a whole class discussion, you tend to get side-tracked ... you might spend a whole lot of time on question two and the rest is gone because time goes ...
>
> J:Pre3, 179-190

Lesson preparation and syllabus implementation

Given the prime concern of maximising examination success J believed this was best achieved by ensuring all students had the opportunity to acquire the biological content knowledge and practical skills as set out in the syllabus. Given the public and private concerns previously discussed, achieving this goal required all lessons to be highly structured, teacher centred and controlled. Such a highly teacher directed teaching style meant that J could manage time efficiently and be assured that all students were acquiring the knowledge they needed. Moreover it also accommodated her concerns about subject knowledge acquisition and social skill development by students.

This meant that opportunities for content and skills acquisition during lessons were undertaken in the form of lecture type sessions where students often took notes, practised written examination type questions, responded to teacher questioning or participated in formal practical work, all of which she guided in her role as teacher. Conducting lessons in this manner was seen by J to be most appropriate given the current syllabus and available teaching time. This feature of her teaching practice was exemplified in her talk concerning her usual approach to lesson preparation, the manner in which she handled lesson introductions, summations and unforeseen events, and the way in which she was able to implement the syllabus. Asked how she went about preparing her lessons she commented:

> I prepare my lessons very thoroughly ... with OHTs (*overhead transparencies*), with the words that I am actually going to say, the words that are going to come out of my mouth and I have them written down. That is why I am not such a creative person ...
>
> J:Pre3, 688-690

However, J seemed to suggest that during the course of actual lessons, changes to the prepared lesson plans often arose. Such changes were accommodated and later reconsidered by her in view of future lessons. This is illustrated in the extract which now follows:

Well in preparation yes but I do go off at different angles because it does happen because it is human nature but I do have to be so well prepared in the first place that I have to be able to allow myself to do that ... go off at an angle ... but once it is prepared I will modify it if it has not gone well so that next time it is ready. I stick with the way I had prepared it with its modification and give that a go.

J:Pre3, 690-695

Moreover, it also seemed that J was willing to depart from her usual way of doing things during lesson planning itself. For example, normally J's lesson introductions were short, teacher centred and used to give procedural instructions. However, she was prepared to alter this approach when more appropriate alternatives became possible, as was seen to be the case for her in the proposed organ transplantation lesson. In discussions about the introduction to this lesson, she raised the possibility of using a series of questions about organ transplantation as a focus, and then for students to begin to think about and exchange ideas on the issue:

I would much rather have something to look at and for them to look at, rather than them looking at me all the time but I would have just done a quick introduction and I very often try to deflect them from me if I can because if it is a straight lesson where you can't ... that is fine ... but if you can do that, it is lovely ... that is just the way to do it and that brings them out talking.

J:Pre3, 218-223

Nevertheless, it appeared that for J, A-Level Biology teaching and learning was the transmission of interlinking facts using a highly didactic mode of instruction[12] where content acquisition and its presentation to students was under her direct control. However, this initial description of her teaching, as being highly didactic, was something which J perceived to be a negative criticism as indicated in the correspondence below. Such a term J believed implied that her teaching style and lesson delivery were boring. What the researcher had observed was a traditional mode of whole class instruction. This concern with the term didactic and what she saw as her personal image, were evidenced in the oral and written feedback later received by the researcher as an attempt to seek respondent validation and criticism from Teacher J of the draft account. To quote from J's written correspondence:

... I suppose I feel a little concerned about the overuse of 'pedagogic' and 'didactic' and the inference that my lessons are dry and uninteresting. This gives the wrong impression about lessons full of humour and anecdote making heavy content lightweight and accessible.

Letter dated 6 June 1996.

[12] The phase *highly didactic mode of instruction* was initially coined by the researcher to describe Teacher J's style of lesson. On reading the draft of this account J requested that it be replaced with whole class lecture type instruction. This was undertaken in accordance with her wishes.

Thus what J seemed to value about her teaching was that her lessons were not without humour despite being 'heavy in content'. That lessons were heavy in content was due not only to her professional concerns, but also to her view that in general A-Level Biology students were not knowledgeable in the discipline. J's perception of students will be discussed in a following propositional theme.

The following quotation, taken from a discussion concerning the summation of the controversial issues lesson, illustrates what J saw as the importance of an efficient delivery of syllabus content in lessons. It illustrates the tension she felt when faced with decisions about, for example, the depth of coverage which needed to be made in the course of any lesson:

> You can't share everything at the end of the lesson, that's the only thing. At least that gives a good range ... I don't know ... I never know or am too sure what is the best thing to do there (*referring to lesson changes*). I **want everyone to know everything** (*emphasis added*) because it is such a shame if they don't if the opportunity is there. When it comes to structuring a lesson you might end up with a very bitty end.
>
> Unless you picked one of the groups that had been particularly good and summated theirs but that always leaves the others out, which I think is a great shame.
>
> J:Pre2, 245-249

The ability to cope with lesson plan changes, like that shown above (see J:Pre4, 124-126 and Pre2, 245-249), whilst remaining calm and flexible were skills J thought needed her continual refinement, and were indicative of her need to feel in control This was particularly the case with controversial issues which tended to be raised by interested students often as a result of recent media coverage. Her need to remain in control (not wishing to be diverted from her planned course of action) is most aptly illustrated in her reflections on the organ transplantation lesson:

> I think that I ought to let them talk more. It swings about in (*sic*) roundabouts making sure that you get through the questions. I find it quite hard to do something like this (*being diverted*).
>
> I can easily be side-tracked as when there is something interesting. We could have easily have been more side-tracked more than we were already which is probably what slowed everything down and made the end of the lesson not as good as the beginning.
>
> J:Post Post, 14A, B

In essence what students received from her lessons J believed were 'solid, well researched facts' which she felt stimulated their interest especially for those students who were high achievers. Lessons which were teacher centred, well planned and implemented were thus seen as the way in which she was able to discharge her prime professional responsibility, that of preparing students for the final examination.

Planned formal discussion and group work

The second way in which Teacher J's professional concerns were manifested, related to planned formal discussion time and group work. The importance of this approach to teaching lies in the stress placed by most advocates of STS on the central role of group work and whole class discussion in student learning. However, this stress was problematic for J for two reasons. First, she was neither confident nor convinced that students could learn anything of consequence, with the exception of social skills, from discussion or group work. This was because students lacked biological knowledge rather than the ability to discuss. Second, J lacked personal confidence to use these as teaching methods. Discussion in particular was something which happened spontaneously in her lessons and was therefore unplanned.

That students were capable of achieving her lesson objectives using discussion without her immediate presence and direction was a revelation for J. This was evident in her surprise during the Post-Post-Lesson Interview when she heard students organising themselves and completing her assigned group tasks during the organ transplantation lesson with interest, ease and purpose:

> *Student H: Shall we go onto the next question then? Some people carry donor cards, should people above the age of 18 be asked to carry one? Why? What should or should not be on this card, how does one decide the answer to this question, would you carry a donor card?*
>
> This is amazing. Amazing! ... Yes absolutely astounding! I would have thought N would have done that role but she (H) has taken that on and she has taken on the talking. He always does do the talking but she ... I am astounded that he has subsumed for her ... or that she has even taken it on ... she does not seem to have been pushed into the role, she seems to have just done it ... AMAZING. H is amazing. She is amazing. She is thinking. I did not think that she was up to it really. That is quite nice.
>
> J:Post Post, 19A, 20

Her appreciation of the role of discussion in student learning was also reflected in her talk about what she might consider and ought to do in the future - "I ought to stop talking ... should let them do more, that is quite obvious ... I could let them talk more", continually tempered, however, by her concern for time in relation to syllabus coverage:

> ... there is never time to let them talk about it as much as I ought to let them.
>
> J:Post Post, 5A

Despite such positive comments about her students, who responded favourably to the tasks during the organ transplantation lesson - "some of my students are brilliant at discussion", J maintained her view that students' discussion skills, and the amount of biological content covered and understood by them in this lesson were still limited. Lack of discussion practice, something she admitted she shied away from, and students' limited biological knowledge were cited as the main causes. That some students took on leadership roles in group discussion was a complete revelation - "you get a totally new insight into the students" and certainly of interest to her. Nevertheless formal discussion still took up time which she as teacher could ill afford because - "there is so much information coming at them that they can't cope with it all and handle it all". And so for these reasons she preferred to teach using more traditional type approaches such as whole class instruction.

In addition, discussion as a teaching technique and the skills needed to adapt readily to unexpected lesson events, in particular meaningful discussion of controversial issues, were all aspects of her teaching which J felt needed attention. Discussion was something she believed other colleagues were more skilled at than herself - " some people are better at it than others and I don't think I am good at it". Because of her concern with the constraints of time, syllabus and examinations, teaching techniques where students in some way controlled how and what they learnt, were in her view inappropriate given the current A-Level Biology teaching context. Similarly, J often mentioned her reluctance to use whole class and small group discussion because she was in some doubt as to whether these would allow students access to all the biological content of lessons. To use her words she tended to - "pass the buck on things like that" to colleagues who were more adept than herself - "to those who are very good on such matters". The next quotation is indicative of her reluctance to instigate formal planned discussions:

> I don't find it easy in discussion work unless I am really well prepared other than a quick chat. It does not come easily to me ... I don't mind it coming up during the course of the lesson out of the blue but to initiate it is not something I have ever found easy.
>
> J:Pre1, 236-244

Nevertheless they continued to remain aspects of teaching which she thought she ought to do because they "enrich your teaching" and "it could make it sparkle". Given the extent of influence of the professional concerns encapsulated in this proposition, neither formal planned discussion nor group work as teaching techniques would appear to be part of what Teacher J normally did in her A-Level Biology lessons even though they were clearly part of what she considered to be good teaching practice.

It would seem that J conceptualised learning and teaching at A-Level as necessarily involving the transmission of a large body of factual knowledge, defined by the syllabus, in a limited amount of time. To achieve this it was necessary to construct carefully planned lessons which emphasised students acquiring content knowledge and mandatory practical skills [add reasoning ability, understanding and appreciation][13]. This might well explain, at least in part, why Teacher J preferred to employ a formalised, whole class lecture type teaching format [with variety in group work when needed to lighten up the atmosphere] rather than any planned group work or whole class discussion whereby students took responsibility for some of their own learning.

J found this approach to Biology teaching where lessons were fully under her command successful. Such an approach enabled her to discharge many of her professional responsibilities, and therefore she saw little reason to change a teaching practice which for her had so far been both personally and professionally rewarding. A practice which had in the past resulted in considerable examination success on the part of those students who worked consistently.

A syllabus which J believed to be content dense, an examination system which emphasised knowledge recall and a school timetable which allocated insufficient time to A-Level Biology, all led her to conclude that there was simply no time for anything which could potentially affect examination preparation and performance. Thus for J, her day-to-day A-Level Biology teaching focused on preparing and delivering lessons that were organised to meet the demands of a syllabus which she believed left little time for teaching those areas of biology not directly related to the syllabus. As will be discussed later, one of these areas was that of controversial issues. Such professional concerns might then help to partly explain her reluctance to incorporate these and other STS type issues into her general A-Level Biology teaching:

[13] These comments in square brackets were forwarded to the researcher by Teacher J as a result of her reflection on the list of propositions presented to her in the Propositions Interview.

> That the current A-Level Biology syllabus is so packed with content if you introduce something else I don't really think ... I would feel that they (*students*) would risk displacing the information they have got (*ie. what she has taught students from the syllabus*) in favour of this (*controversial issues*) this is more up-to-date and not do so well in the exam.
>
> J:Pre1, 314-319

This section brought together some of the characteristics of J's biological teaching practice, revealed through the study, which together formed part of her professional identity as an A-Level Biology teacher. Much of J's A-Level Biology teaching practice centred on the preparation and delivery of well-organised, factual biological information to students using a whole class lecture type format, a teaching strategy she believed covered the syllabus in as efficient a manner as possible thus ensuring that examination success was achievable by all students, and for herself as teacher, the maintenance of her professional reputation.

Juggling the syllabus and the external examination with the amount of time available seemed to dominate and pervade J's thinking about A-Level Biology teaching. Whole class or group discussion which focused on content acquisition (*syllabus*) and for which she was not fully in control (*her perceived professional responsibility*), was thought to be inefficient (*time*) because there was the possibility that some students might miss syllabus directed content knowledge needed for high grades (*exams*). For these reasons she taught the way that she did.

These characteristics will be compared and contrasted with those of the other participants throughout each of the three following accounts. Some of these features might be idiosyncratic for Teacher J, whilst others more common to all participants.

5.4: Views of Science/Biology

Teacher J seemed to have two views about science/biology, encapsulated by the following proposition.

On the one hand J indicated that biology was a collection of accumulated interlinking, immutable facts which students needed to acquire for examination success, whilst on the other hand, she saw biology as a form of knowledge where ideas, theories and experimental results were open to questioning and modification in the light of new evidence. It was the former view of biology which seemed to be portrayed in her teaching practice.

Several aspects about what Teacher J believed was the nature of science/biology remained unclear throughout the study: first, whether her views on the nature of science were identical with her views on the nature of biology; second whether the views of science/biology made available during the study were part of a more inclusive view she had about science/biology; and finally, whether her views about the epistemological nature of science/biology in relation to what was taught at school differed from that of scientific research.

Thus as part of her ongoing personal interest in biology, J suggested that she tried to keep abreast of current biological thinking, experimental techniques and developing technologies by continually updating both her scientific and her science education based reading. That she acknowledged the need to keep abreast with current biological research suggested that in some way she believed scientific knowledge to be provisional.

Indeed as part of her interest in biology education J reported that she collected and collated relevant articles which she intended to incorporate into her lesson plans and schemes of work. The following quotation exemplifies this wish to remain familiar with contemporary developments through reading:

> The New Scientist which I have weekly and the Biosciences Review which I have quarterly and my ASE Journal ... with lots of articles by science teachers which is quite good. There is a lot of Chemistry and Physics in it which I ignore and the papers ... and also the newspapers which are good ... the reports in the Guardian and they were excellent articles ... related to what I will be teaching as well.
>
> J:Pre1, 46-50

However because of the large amount of time needed to marry these resources in with the syllabus, J found it difficult to apply this wider biological perspective to her A-Level Biology teaching. Furthermore, even though J indicated to the researcher that she read relevant biology articles in at least two science education journals, it was difficult to ascertain in what ways, if at all, this had informed or influenced her A-Level Biology teaching. Given the constraints under which Teacher J felt she was working, the daily demands of the A-Level Biology course did not seem to allow her sufficient time to fully utilise such materials, a point exemplified by the following extract:

> ... depends if I am teaching the topic at the time ... that's always the acid test ... if I am teaching the topic at the time like I am now with the nervous system ... those happen to be in the papers ... that's brilliant ... I fetch them out and wave them about ... talk about them.
>
> J:Pre1, 86-90

As mentioned in the beginning of this propositional theme, teasing out a clear distinction between J's view of the science taught in school from the activities which engage scientists, remained difficult. The following quotation typifies this difficulty. It seems to reveal J's belief of science as an accumulation of facts - " finding out and understanding about everything that is going on ... not creative because all the facts are out there, although there are new ones coming in", and what she perceived was the link between the science taught at school and that undertaken by the research community:

> I mean I don't know for sure what goes on, I think perhaps the science research community is a lot more boring and tedious and repetitive than what goes on in schools. I think that schools are much more exciting places ... because well perhaps you are not allowed the time to delve deeply in anything because you don't have the time because there is too much content and so you have to do a bit and move on and then do a bit and move on. It is much more of the moment and surface ... and ... I would think that any student going into research would find it a totally whole different ball game than the quality of the stuff that they had to do at school because of the need for depth.
>
> J:Pre4, 508-517

It could be that J had several ideas about the nature of science each of which were context dependent. Whether or not Teacher J had been informed by or was presenting more recent views on the nature of science currently discussed in many science education journals remained unclear.

When invited to respond to this proposition in the Propositions Interview J was somewhat hesitant, preferring to forward her comments in writing after the interview:

> I would have to think about that. It is, that is exactly what it is, isn't it? It is about thinking and transmitting information and all sorts of other things but I guess that it is about the philosophy of the biology course which I would have to think about before I actually launched into that. I don't quite know what other ... it is a part of our culture which I think it is essential to know (*biology*). It is part of being a rounded human being. Basically, I think it is part of being that.
>
> J:Prop, 209-215

Additional comments, concerning the proposition of this theme, received via correspondence from J included:

> *. an appreciation of the wonder/structure and functions of the natural world*
> *. problem solving ability encouraged*
> *. understanding of ethical/moral biological problems*
> *. a way of gaining a form of training-scientific ready for use in degree work etc.*

Again such comments did not include any direct or more explicit mention of the nature of scientific research and enquiry as such, other than that already stated in the proposition.

Of interest was J's unsolicited contrast between her view of school biology and that of school mathematics, the significance of which lay in support of the researcher's hypothesis that for J her view of biology at least at A-Level was as an aggregation of interlinking, language specific, content rich, factual information. Mathematics it seemed was more about understanding concepts, rather than as was the case in biology, acquiring a language whereby new concepts and content could be understood:

> If you can do Maths then you can do it and there is no problem and it does not cause you any aggravation like in biology because of the high amount of content. Content rich and concept understanding as well. You cannot understand biology until you have mastered the concepts and also the language, at least that is for some of them ... I think in Maths they don't have to learn such a vast amount of content like in Biology. In Maths they just have to be able to handle it. In biology you have to handle it, and learn the biology content as well. You have to learn a new language and then use it.
>
> J:Prop, 295-304

Such a view of biology as outlined above at least in terms of A-Level Biology was not shared by those of J's students who were interviewed. For many students, "real biology" as they termed it, was about handling living materials, and undertaking practical and field activities often outside the classroom. In contrast, these activities were seen by J more as a means of highlighting content - "it certainly highlights things, it certainly peppers it up". From the perspective of students, biology was not about note taking and the learning of facts, which many believed did not assist them in their learning of biology, rather biology was about actively engaging in the practical activities which this subject offered. In the words of two of J's students:

> The best bits are mainly the practicals, getting to grips with everything. You mainly understand things better if you do things rather than just write things down on paper. We do a lot of copying from the board and it ... most teachers write it on the board and when you copy it they are talking at the same time so it is hard to listen to them and write from the board and they don't give you much time to do it ... absorb it all ... that is why we get so much homework.
>
> Student E

> I think that they (*field trips*) are interesting. They make people more relaxed and that is like one big experiment ... more doing the ... outside. That (*field trips*) is more technical as you can get. It is like going out and instead of having seeds in the lab you go and see them where actually they do what they do and we experiment on them there.
>
> Student S

Such a perspective was supported, albeit indirectly, by two other students who talked about biology in school, in particular one student's ambivalence about reporting experimental results and conclusions:

> We still have to write them up. The equipment goes wrong and you still have to write it up as if it went right and say what should have happened. A lot of them have all gone wrong recently and they just say ... Well it worked okay last year.
>
> Student G

> Biology is presented as straight facts for learning. They tell you.
>
> Student B

This difference in perspective between J and her students was highlighted in the following quotes dealing with comments and discussion of her current teaching (Pre-Lesson Interview 4) and what in her opinion students saw as worthwhile "real biology" (Propositions Interview):

> They love it (*practical work*). The majority of them have said that one of the highlights of the course is the practical work and the highlight of the practical work is the dissection ... amazing! They just love seeing the insides. I think it was perhaps the mouse dissection that was the main thing and they also loved the field trip. Again it is the practical aspects, the real aspects of the course - doing proper Biology. They seem to consider that is proper Biology.
>
> J:Pre4, 412-415

> The field trips are a real joy because the students find that that's a ... very very hard work but that it is real biology. ... It is the handling of living materials, it is the whole thing about what they think biologists do. Handling live materials and assessing it from basics. It is not giving them data but they have to gather the data themselves. They have to do an investigation from scratch at the field trip as part of their skills. They have to design it themselves and we do have some suggestions but they have to do it themselves. Mostly they have ideas themselves. ... That is quite hard for them having to do all this from first principles. They have done some work in the first few days. Hopefully by the end of the first year they should be able to do that, that is, think on their feet. The excursion hopefully helps them to achieve that ... they get it done.
>
> J:Prop, 308-321

What this propositional theme has sought to do was to unravel Teacher J's views about the nature of science/biology and attempt to link these with the context in which she was currently teaching. What seemed to be the clearest articulated belief about the nature of science/biology was as an accumulation of knowledge used and constructed by scientists to explain the natural world rather than it being thought of as a context dependent social construct. The former view then helped explain J's continued reading of current popular scientific literature which she did for personal interest and because she saw it as generally valuable to her teaching. However, because of professional concerns previously discussed, J was somehow unable to incorporate this wider biological perspective into her A-Level Biology teaching practice. Issues of an STS/controversial scientific nature were therefore not a significant component of J's revealed or observed teaching. The reasons for this were found in the rationale for the way in which J conceptualised and hence constructed her teaching, and through these portrayed biology to her students as an accumulation of known facts, something her students often questioned in terms of their conceptualisation of biology.

5.5: Teaching Students in the A-Level Biology Course

Apart from the very able students, who inevitably succeeded academically, for the most part Teacher J believed that she was better able to assist those students for whom potentially at least, the acquisition of biological knowledge was problematic. This was juxtaposed with an affective view of students as mature, social individuals who enjoyed interacting with each other in her lessons. The following proposition is concerned with how J conceptualised students as learners of biology. Other than an addition, shown in *italics* below, which was highlighted by Teacher J in the Propositions Interview and subsequently integrated into this section of the account, her views about students remained stable throughout the entire course of the study.

One the one hand J seemed to think of students as mature, confident, articulate, generally academically and socially able, interested in controversial issues and debating, and possessing a fund of general knowledge, whilst on the other hand she seemed to think that they were often lacking basic biological knowledge. Furthermore, J seemed to believe that the more able students succeeded in achieving high A-Level Biology examination grades despite her teaching while the less able students achieved passing grades because they undertook the required teacher directed tasks - *Practical skills and understanding.*

Each of these two aspects, academic and social competence will now be discussed, beginning with academic competence.

Academic Competence

J's professional concern with examination success could also be seen in her dialogue concerning A-Level Biology students. Her hope was that not only would all students obtain passing grades but that the more able students would obtain the highest grades of A and B. The current Year 12 A-Level Biology students were described by Teacher J as "quite able", had obtained grades A and B in the recent GCSE examinations and came from the top set of their year. J's role then was to drive students forward so that this goal could be a reality by the end of the course. This she believed was part of being a successful A-Level Biology teacher. From J's viewpoint, the goal of successful examination performance could be achieved if two criteria were met: firstly, that students possess a sound body of factual information, to which she added practical skills and understanding in the Propositional Interview as indicated in *italics* above, and secondly, that students link this factual information into a conceptual map of biology compatible with examination success. Details of the latter were addressed in the previous propositional theme dealing with the views Teacher J had about the nature of science/biology.

According to J, the more academically able students were able to meet both the above criteria by the end of two years - "I am eternally grateful that those who are going to get A's from the moment that they entered that group got A's and that one candidate who was a B got his B". However for those who were less academically inclined or for whom biology was conceptually difficult, meeting either one or both criteria remained problematic - "H failed and we did not enter her, she had to enter herself because she was bone idle. She found if difficult as well".

As discussed in the first propositional theme student examination success meant for Teacher J that she had discharged her professional and moral responsibility as a teacher inasmuch as she had attended to all aspects of the course and had assisted all students in their learning, including those experiencing conceptual difficulties - "there is a subtle difference between those who are bone idle and those who find it difficult and then work, I have got time for those". Accordingly, much of her teaching, essentially undertaken in terms of the transmission of content, was focused on this group of students. They were at risk of not achieving pass grades and therefore in most need of her attention. That some students chose not to travel along what she believed was the most appropriate path leading to examination success was not a deficiency on her part as teacher, rather it was an inappropriate choice made by some students. As far as J was concerned she had taken due care in terms of creating a classroom environment where syllabus coverage could be maximised in the available time. Well planned lessons were testament to this.

J's conception of good, often ideal A-Level Biology students were usually more aligned with those more academically able. In her view good students were flexible in their thinking, willing to learn, persevered with assigned tasks and used their biological knowledge to transfer and link concepts, for example, between one syllabus topic and another, or between new and established situations. In addition J believed that she could assist less able students to achieve passing grades provided they too showed a willingness to persevere, typified by:

> They have to persevere at working constantly and consistently right from the word go, and persevering at answering questions from beginning to end instead of dipping in. I have just been writing reports for the upper 6th and time and again, those that have struggled and are not terribly high ability A-Level students, those that have succeeded and we think will pass despite their low ability at the subject are the ones that have stuck at it.
>
> J:Pre4, 392-397

In contrast Teacher J saw her assistance of able students as somewhat limiting. These students she believed achieved examination success despite her teaching. This view became particularly evident during discussion on how students generally mature during their A-Level years:

> I think that the bright ones are there always. ... I think perhaps the able ones haven't changed at all but the ones who are middling to low have risen and that is what I had always hoped to do. You can't do any more for the most able student other than keep them up on the straight and narrow and keep them at their high ability and assume that they will get the A that they would always get anyway. You can't value add ... this thing ... but for the middling to lower you have got to hope to bring them up from the possible fail ... but in the mean time you have got to keep the high ability students highly motivated.
>
> J:Pre3, 706, 717-723

J thus believed that her impact on the learning of those students who experienced few conceptual difficulties with biology was far weaker than on those who had difficulties but were nevertheless committed to passing the examination. This latter group, J believed, needed more assistance from her in the classroom and more detailed feedback on homework and practical reports. With the former group, she saw herself more as a guide and motivator. Essentially, J believed her role was to ensure that all students covered the syllabus so whatever she asked students to do in class was directed towards that purpose. As discussed in a preceding propositional theme, what she thought students needed were "well-prepared, solid lessons" which addressed the content required to pass the A-Level Biology examination. To do this J ensured that content delivery be it in the form of whole class teaching or as practical work, was controlled by her alone.

These clearly articulated views about her A-Level Biology students generally and about their overall academic ability remained stable as indicated by J's few additions and deletions to these propositions in both the Propositions Interview and in her comments of the draft account:

> (*In*) worthwhile lessons they acquire content and understanding. Yes. Content, understanding and application, yes, definitely. The next bit here, completes task and applies content to new and novel situations ... yes that is fine. They are underpinning physical knowledge at that level, like diffusion, they can use that everywhere where it might crop up. I agree with that first one (*the more able students*) yes and unless ... the less able students did not stick at it and failed. If they stick at it then they will pass. I am always grateful that the more able students especially in a class like that don't sink lower and it is easy to go down to a common denominator.
>
> J:Prop, 185-192

As a result of her A-Level Biology teaching experience, J thought she had become more aware of differing student academic abilities. She now was able to adjust her expectations of their realistic academic performance provided they were willing to work and persevere with the required tasks. A highlight for her had been the success of some of the less able students in achieving pass grades. This confirmed her belief that she had adequately prepared students for the final examination and so had discharged her professional and moral responsibilities as an A-Level Biology teacher.

These views concerning students' academic ability and their associated examination performance seemed to have little bearing on J's other perspective about her students, that of social competence.

Social Competence

Throughout each interview J asserted that in the main, students were a mixed social group: some were quiet, mature and tended to speak only when they were quite sure of their facts and opinions, others were chatty, voluble and bright personalities, whilst others were confident and interested in discussing any topic, controversial or otherwise, in a mature, rational manner. It could be that J held somewhat differing views on students which caused her no cognitive difficulty: the first view being that as A-Level students they were often lacking in essential biological knowledge and the second view that as adolescents they were in the process of forming their own beliefs, values and critical opinions.

Not surprisingly then J also acknowledged that certain students in this Year 12 class, in particular those who had taken A-Level Biology seriously, had strong opinions on many issues of a moral/ethical nature, for example, meat consumption and animal dissection. For this reason she believed the class would appreciate the opportunity to make informed opinions based on current available evidence and to participate in classroom debate.

As will be elaborated in the theme dealing with the teaching of controversial issues and given J's beliefs about the variety of students' social skills, the lesson on organ transplantation could be seen in two ways: as an opportunity for some students to consolidate their discussion and group work skills, and for those who find interacting with their peers difficult an opportunity to ease this difficulty. This is well supported in J's immediate reaction to the lesson and later on hearing her students engaged in discussion, as the following two quotations indicate:

> ... it sparked for them (*referring to the discussion as a whole*) ... in many respects what it did for A was that it brought her out socially talking to two boys because she was beetroot red.
>
> I would like to keep them on a buzz like that and to keep them well like they have got to know each other better, it is like a maturing time for the lower sixth (*year 12*)
>
> J:Post, 175-178, 274-279

> I think that they were impressed with what they did and the way that it was done and what they were asked to discussed. I think socially it has been a joy especially since it is just before the field trip when they will be thrown together and working in a similar fashion which is brilliant because it will get them together.
>
> J:Post Post, 30C

However, the need to provide students with relevant information remained:

> If you have the information here then they can make informed opinions which certainly a good proportion of that class would want to do. Lots of people can talk off the top of their head but we (*I*) would like it to be informed opinions.
>
> J:Pre4, 194-197

Accordingly, J predicted that students would probably not be familiar with organs which could be transplanted other than perhaps the kidney, heart and liver, nor were they likely to be familiar with the physical symptoms displayed by patients and the many reasons why people and their next-of-kin donate organs. The reason for this, J thought, was that often what students knew in this respect depended upon what was currently in the media:

> ... otherwise they are not going to know. I will have to tell them unless they have some information sheets. They have got to be fed that information don't they ... They will know nothing ... I may have made a miscarriage of justice here in saying that but unless they have seen something in the newspapers or on the TV I don't think anybody is terribly informed about it.
>
> J: Pre2, 194-203

Such comments were not surprising given her belief that many A-Level Biology students lacked adequate content knowledge and therefore needed to be given information. J's reluctance to provide students with opportunities to engage in small group and whole class discussion stemmed from her twin concern with their perceived lack of mastery of biological information and with her underlying wish to retain authority in the classroom as the dispenser of any such information. She was not concerned with student social skills as much as she was with their content knowledge and therefore it seemed that from her perspective, there was no need to necessarily address these in lessons. Productive discussion she believed was dependent upon the acquisition of biological knowledge. It was for this reason that she approached the organ transplantation with her focus on what she considered to be her responsibility for ensuring that students received factual information either from her directly in the lesson introduction, or from information sheets given to students during their group discussion. Such a concern for students' lack of biological content knowledge, evident in the way in which she implemented group work (see quotation below) and her belief that lecture type lessons were the most appropriate form of instruction because they guaranteed equal and efficient content coverage for all students, persisted throughout the study:

> The lecture type format, yes you try to break away from that by doing what I did last week when they had enough of hearing me talk. I split them into groups, small groups and gave them each a little bit to do, very very precise tasks, one group who were not very good in ability just had to prepare a poster to show a cross section through a root to show the Casparian strip. Then they had to present it in the order that I needed it presenting and that was fine. But I still had to add my little bits as well. I am not then 100% about the understanding but at least I think that helped a little bit with the quality of the lesson. So that is something that I do. But they would happily have me lecturing all the time because it is easier, isn't it?
>
> J:Prop, 176-184

From the students' perspective, obtained from a preliminary analysis of their recorded interviews, A-Level Biology was perceived as enjoyable regardless of what some thought was the - "heavy emphasis on tedious, boring note-taking" which for some was of little educational value. Practicals and fieldwork were seen as relevant because both represented "real biology", something scientists were engaged in on a daily basis. Many students commented that parts of the course were outmoded and needed to reflect current biological research. The lesson on organ transplantation helped bridge this gap because it dealt with current problems concerning organ acquisition and rejection, as well as some of the social and ethical aspects of biology. Some students thought that controversial issues lesson could be integrated within a unit of work or be used as a topic summary. Many also believed that such discussion lessons if undertaken too frequently would affect their final exam grades because biological knowledge was not presented in a formalised manner, a view in keeping with that of their teacher. It could thus be hypothesised that if students also had well developed rationales for what they considered to be appropriate learning and teaching in order for them to obtain examination success then they too would have sophisticated ways in which they influenced, even constrained, the classroom practice of teachers[14].

This propositional theme has examined Teacher J's beliefs about her A-Level Biology students from both an academic and more social perspective. Highly academically able students were rare, inevitably successful despite her teaching and usually motivated. Less academically talented students or those who were academically able but chose to appear to be otherwise, were more common, potentially unsuccessful academically, often lacked adequate motivation and needed to be driven towards the goal of examination success. Therefore J's lessons seemed to be structured in such a way that students would obtain pass grades. By doing this she had discharged her professional responsibilities. J also believed that all students whatever their perceived academic ability to be mature, articulate and social individuals who welcomed classroom opportunities for discussion.

What Teacher J viewed as the problems and possibilities for using controversial issues in her teaching practice will now be discussed.

5.6: The Teaching of Controversial Issues in relation to A-Level Biology

Controversial issues for this teacher were an excellent teaching technique for the development of students' social skills. For the most part these issues arose spontaneously in class, either raised by students or herself and therefore treated as unplanned five minutes chats.

Two propositions encapsulated what for Teacher J was the essence of her thinking about the teaching of controversial issues at A-Level. Disentangling each of these propositions proved to be an arduous task and thus, although

[14] Evidence to support or refute this notion for A-Level Biology students, could come from their views about themselves and what they believed teachers thought of them as learners along with their beliefs about the nature of biology and how they could best come to an understanding of its concepts. However, this is beyond the scope of this research.

not combined into a single proposition, for ease of reading will be addressed concurrently. Additions provided by J in her comments on the draft account are noted in *italics* and subsequently integrated into this section of the account.

(i) **J believed that controversial issues teaching was possible within her A-Level Biology teaching but only as one-off, short, distinct lesson activities the value of which lay within the domain of students' social skill development, not in terms of developing biological content knowledge and understanding.**

I feel it would help re-reasoning skills/thinking before discussions.

(ii) **Despite a willingness to invest her professional expertise into the planning and implementation of a controversial issues lesson, acceptance of the possible usefulness of such issues to teach biological concepts remained difficult.**

Would need high ability/highly motivated students.

Throughout each interview, there was much talk about what J saw as the possibilities, if any, for the teaching of controversial issues. From her perspective as a practising A-Level Biology teacher, aware of the demands of time, syllabus and examination, the possibilities of controversial issues teaching was seen, for the most part, as developing students' social skills. These included mature discussion whereby each member of the student body felt free to voice an opinion and so make a contribution to the debate, and group co-operation in both practical and field work. Often formal class time was limited and so in reality controversial issues were either brought up spontaneously by students or were used by J as stimulus materials to spark student interest and attention. As to the value of this particular lesson within the context of her more usual A-Level Biology lessons, J viewed it as an opportunity to develop students' social skills and a divergence from what she termed "a content dense syllabus". Her present practice was that when such issues did arise, which they invariably did with able students as evidenced in the first quotation of this propositional theme, J tended in her words to "flash" relevant articles in front of the class, read out relevant pieces of information in passing, or cope with each situation as best she thought she could, given that most of what was raised were currently topical, transient issues highlighted by the media. For all of these reasons, controversial issues were viewed as often unplanned, unstructured, one-off events.

> ... there may have been a TV programme as well. It is very much a chance thing whether it is coming up at that time in the media.
>
> J:Pre1, 228-229

Consolidation and elaboration of these views occurred throughout the study and are discussed further throughout this propositional theme.

Given the nature of the professional concerns discussed in the previous propositional themes, what seemed to be the proviso for J was that controversial issues were excellent for developing social skills - "what it did for A was that it brought her out socially talking to two boys", but not in terms of biological understanding - "it does not teach them content which is always my worry because it is a very heavy content course". The place of controversial issues and their possible value given current syllabus arrangements could be seen only realistically as short chats - "you know the social thing", exercises in discussion where - "students took (it) in turns rather than just shout", "warm-ups" for other aspects of lessons or simply one-off, short activities the value of which was seen it terms of student motivation - "oh well, I think using controversial issues is brilliant, because it stimulates them in a way no other can do" and finally, stopgaps when unforeseen disruptions occurred in planned lessons - "I have done it for various reasons, sometimes because my original lesson has gone array because the practical apparatus has not turned up or I couldn't find a worksheet". Apart from a passing reference to the possibility that controversial issues might broaden students' general biological knowledge in terms of its moral/ethical dimensions, and another reference to the possibility that they might assist in the academic progress of more able students, this was J's consistent and considered position[15]. Any significant change from what was formally stated in the syllabus but perhaps more importantly, what was perceived to be required by the examinations, was not considered. Her focus in terms of controversial issues was on social skills and rarely on biological understanding as clearly explained by her before the organ transplantation lesson:

> I think it is going to be more social actually, some don't mix terribly well. There are lots of biological concepts that will come across unwittingly ... It will be very good for thinking and social. Some of them are just not very good at doing either of those: thinking and/or chatting about what they thought. They just keep their heads down.
>
> J:Pre4, 337-343

The key issue was that J believed very little substantial biological knowledge could be learnt by students using controversial issues as a basis. Such an opinion was very much tied to the professional concerns and responsibilities already mentioned, along with her sense of professional identity as an A-Level Biology teacher. Apart from a brief mention at the end of the study when J thought they might be useful to extend the more able students, but only when their delivery was controlled, this was never seen as a possibility.

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[15] Teacher J's position and her rationale for this position were discussed in the first of the four propositional themes - The A-Level Biology Teaching Context.

There seemed to be several reasons for her position. First, because of their inherent controversial nature, these issues were thought to distract students from learning the content of the syllabus and from the goal of examination success. This sentiment permeated her thinking as is typified by such statements as:

> If you start throwing in wider reading and informing them about something that you have just read then you can throw them of balance in terms of their concentration and so I have to be just careful and so I don't tend to let that worry me. If there is something in the papers then we just talk about it. I almost always do talk about it now.
>
> J:Prop, 76-80

J therefore used controversial issues as one-off events - often arising spontaneously during lessons - as affirmed in her mention of the cloning of sheep in the context of genetic engineering:

> ... we have mentioned the cloning of sheep the week before last. We talked about that because we were doing genetic engineering just at that moment in time with the upper 6th, so that came in ... it came out of the blue in the newspaper but I would have mentioned it anyway and put it in because we are doing genetic engineering at the moment ... so that was lucky.
>
> J:Prop, 83-91

The second reason was that J seemed to believe controversial issues stood on their own as interesting topics. Since many of them stood outside the syllabus proper, there was no requirement therefore to use them in any significant way in her teaching, and given the way in which the syllabus was arranged, there was no need for them to be integrated into current schemes of work especially if they compromised content coverage. For these reasons they were conceptualised by J as optional bolt-on extras. Such views were evident particularly in her remarks concerned with time and syllabus linkage:

> ... it might be that you could give a selection of these cuttings out and get them to do a quick presentation say a quick five minutes if that ...
>
> J:Pre1, 232-233

> ... it would be really very good if I could lead it up onto something else. I can't see that I can lead it onto something else, this particular one onto something else because I think they would think that it would be even better.
>
> J:Post-Post 30

The last part of the latter quotation refers to J's concern that if discussion of a controversial issue was allowed to continue to any significant extent, students' concentration would be shifted away from the business of the syllabus.

The third reason which might be put forward for J's position on controversial issues concerned her view of students as learners. Because students lacked basic biological understanding, they were therefore not in a position to make what she would term "informed decisions", something essential from her perspective, in any meaningful discussion of a controversial issue. That students were able to handle the discussion of controversial issues, in this case that of organ transplantation with ease, was best evidenced in her surprise at the quality of one student's presentation, but even more so as this person was thought neither to be one of the more academically able students nor one of the more social members of the class:

> ... I was gob smacked at D doing that presentation all on his own ... he never speaks. I was astounded. It was fantastic. I could not believe my eyes when he walked up to the front and presented quite clearly, one of the better presentations ... the questions and the answers ... I was astounded. That was wonderful, that would have boosted his confidence no end ... I was amazed.
>
> J:Post, 58-70

As mentioned above the only situation envisaged by J where controversial issues might be used to foster biological understanding concerned academically able students but there were nevertheless reservations -"Yes, it depends ...". The stipulation made by J was that any proposed unit of work employing such an approach to learning would of necessity have to remain well-structured and resourced and, importantly, that students be supplied with written notes of sufficient quality for them to pass the external examination. This marries with many of her previous comments about the possibilities for using controversial issues:

> Yes it depends ... you could give it to students of a certain ability, controversial issues, and then they could research a whole ... lots of things and a vast broad area of work. This would be wonderful. It would have to be so structured though for A-Level. I just don't know if the students would actually do it well enough to produce a set of notes for themselves to enable them to pass the A-Level. I am sure that some of them would but that would have to be the very high ability students.
>
> J:Prop, 150-158

Broadening students' views about the nature of biology and its moral/ethical dimensions were for J the only other possible uses for the teaching of controversial issues. Each was mentioned only briefly whilst reflecting on the lesson and students reactions to it; evidence which seemed to indicate that such lessons remained singular events. In terms of students becoming aware of some of the moral/ethical considerations which might need to be considered with regards to controversial issues, and in this way broadening students' horizons, J only remarked in passing that:

> Well, I think it may have made them consider questions that they may never have considered in their lives, some of the questions in some of the folders. That is why they did so well ... watching them in their discussions because it was different ... they have to think this sort of thing through ... the morality.
>
> J:Post, 112-120

And for one student in particular, who had similar reservations about the value of the lesson for advancing his understanding of biology, she remarked:

> N said to me now, he is in my tutor group, he said " It was good, it was really good but there was no biology in it". He is a straight and narrow boy and I am trying to broaden him. He has a problem putting enough detail down in essays and things. He won't broaden and thinks it should be all BmBmBmm. I pointed out to him the discussion skills, the thinking skills and the interactive skills and he said "Oh yes". He needs telling that and I think it was very valuable in that respect.
>
> J:Post, 287-292

For the most part, J believed that A-Level Biology students were socially competent and therefore liked to engage in discussion activities. However, meaningful discussion of biological controversial issues was not possible unless students were conversant with all the facts first, rather than using what biological information was available together with their discussion skills to construct informed opinions. Acquiring biological information first before any discussion took place was thus seen as a priority. For the more able students the acquisition was readily achieved and therefore there could well be time for the discussion of controversial issues. On the other hand, the rest of the student group who were in the majority and for which it has been argued J was more professionally committed, needed more direction in their learning. The majority of students needed to be pushed, others needed to be encouraged, all of which took time, some needed to be spoon-fed and therefore the use of controversial issues could only be viewed in terms of short, five minute lesson segments.

Even though J strongly believed that controversial issues teaching was excellent for social skills development rather than for the development of biological understanding, she was willing nevertheless to invest her professional expertise and time into the planning and implementation of a controversial issues lesson which she saw as a way to further her own professional development. J volunteered to take part in this study because she thought it would be interesting to discuss biological controversial issues of an STS nature and at the same time avail herself of the opportunity to assess whether of not such issues could be realistically incorporated into her present A-Level Biology teaching. Given Teacher J's present A-Level Biology teaching circumstances, using controversial issues other than for social skill development was problematic and therefore unrealistic, an entirely logical, consistent and professionally sound position.

> I ought to do it more and more. I ought to ... yes definitely. It is a way of getting their interest. I mean you can throw them in during the course, after the course, anytime ... it is just being aware and making yourself do it because it is much easier to do the factual stuff.
>
> J:Pre1, 477-480

To sum up syllabus requirements, examinations and time clearly moulded Teacher J's thinking particularly in the way she had come to conceptualise her A-Level Biology teaching. Her view of students as learners, her reluctance to incorporate biological content knowledge deemed outside syllabus boundaries - " I would really have to rethink a lot of topics in a big way in order to do this and I can't see that it could be used often" and her wariness in using certain teaching techniques such as discussion and group work, all led to her hesitation to employ STS type controversial issues - " ... but again it is time". It was thus not surprising to find that Teacher J remained to be convinced that controversial issues did anything other than foster social skills.

Chapter Six: Teacher C

Participant 2- School B

6.1: Background

Teacher C (known as C) became a participant in the research after attending an in-service afternoon presented by the researcher in February 1994 which dealt with the teaching of controversial issues to A-Level Biology students.

C has a joint first degree in both zoology and psychology. After her PGCE training[1] C became an industrial psychologist and later a medical representative. C joined the teaching profession seven years ago and is currently the Teacher in Charge of Biology at a co-educational, 11-18 comprehensive, LEA controlled school. She has been at this school for three years and Teacher in Charge of Biology for the past two. The other members of the Biology team include the Head of Science and two other teachers. At the time of the research, C was teaching the A-Level Biology course developed by the University of London Examination and Assessment Council[2].

C saw the development of her teaching career in terms of diversification, that is, in terms of her developing a variety of teaching roles. Currently these included her position as Teacher in Charge of Biology, her involvement with the mentoring of student teachers and her teaching of science outside mainstream biology. In the future, C aimed to expand the available GCSE and A-Level options to include psychology and to become involved with pastoral care, in particular that of being Head of Year. At the time of this study she taught two A-Level Biology classes - Year 12 and Year 13, some of the biology and physics options to GCSE classes and an integrated science course to both Years 8 and 9.

The study with C began in June 1994, continued until the end of September 1994 and involved a group of twenty five Year 12 A-Level Biology students at the commencement of the 1994/95 academic year. During their two GCSE years all students had been taught by C who thought these students quite capable of undertaking studies at A-Level given their performance at the recent GCSE examinations though she did recognise some might experience problems.

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[1] The Post Graduate Certificate in Education (PGCE) is a course for the professional development of beginning teachers.

[2] University of London Examinations and Assessment Council - General Certificate of Education - Advanced Level Biology (9040), 1995 syllabus.

6.2: Nature of the Controversy

For C, a controversial issue in biology was one in which there were often differing value positions, and therefore no single clear answer:

> It is something in Biology where there is no clear cut answer. It is ideal for some sort of discussion because that is where the kids have a variety of different views. They will no doubt recognise that there is a whole lot of things going on in the world where there is no yes or no answer.
>
> C:Pre1, 50-53

As far as presenting her own views to students in general concerning controversial issues, or in particular the moral/ethical issues and associated technological aspects of infertility, this was not C's intention. In this sense she differed from Teacher J who, as one of the consequences of choosing organ transplantation, wished to articulate to students her views on carrying donor cards. Instead C's aim was to foster student questioning of available evidence and the discussion of interesting biological issues with moral/ethical dimensions.

In previous years C had begun the A-Level Biology course without any introductory work, something she felt had been unwise as students quickly left the course. This she interpreted as being due to the volume of work rather than their lack of interest. One reason therefore that C became involved with this research was that she thought it would provide her with an opportunity to explore, develop, implement and evaluate a planned, alternative teaching approach as illustrated in her following comments:

> I have not sat down and tried to work it out ... I don't know how you would do it (*referring to alternative ways of teaching*). I guess being involved in this project, that is something I hope to find out about. It is a difficult one. It is looking at it from a different way ... Doing it the other way around, is the bit I need to find more about.
>
> C:Pre1, 243-246, 310

Such an opportunity C believed could best be undertaken during the first three weeks of the 1994/95 school year. This would be a time when students could not only sample various topics but also begin to develop some of the skills, such as group discussion, practical work and problem solving, which needed to be developed over the coming two years rather than an emphasis being placed on the acquisition of biological content. The latter she felt had in the past left many students bewildered.

These sentiments are reflected below by C, referring to the need to raise the confidence levels of students so that they could cope with the content demands of the syllabus:

> I mean it is nice if you can keep their confidence going all the time and say "Yes, you did know, you did know that." We have a number of kids especially ... we have one quick group and one slower group this year and there is one group where they need a lot of confidence building and a few in my group that need to have their confidence pushed up all the time. So yes giving them that opportunity (*referring to practical work and discussion*) is very good.
>
> C:Pre2, 55-59

In order to chose an issue which students would find interesting, C thought that the best idea would be to canvas current Year 12 A-Level Biology students as to what they thought might be interesting controversial issues for discussion[3]. This she did, with issues concerning reproductive technology the preferred option, hence the choice of infertility as the controversial issue.

For C, teaching human reproduction using infertility as a focus was both new and interesting. However, C was concerned that her own knowledge about the various aspects concerning infertility was poor - "it does strike me that there is a mass of information", but clearly indicated that this situation would be rectified if relevant information was forthcoming - "... but I don't know enough about a lot of these topics so I will certainly need more information about these". Such information was obtained from various British charities and self help groups[4] as well as government funded agencies[5] dealing with infertility. This, along with her request for a glossary of terms[6] useful to both students and herself during the proposed lesson was presented to C for comment:

> The table and flow chart would be a smashing tool for them because it would be easy to read ... they can extract the information from them very easily to help them with their discussion.
>
> C:Pre2, 355-357

As a result of reading this literature, C raised several aspects about this issue which would need to be highlighted in the proposed lesson. These were a basic review of what students already knew about human reproduction, a brief introductory explanation of infertility, mention of currently available technology to relieve the condition and the possible moral/ethical dilemmas associated with the use of reproductive technology. C saw the issue of

[3] C presented a list of controversial issues to her 1993/94 Year 12 students for comment. These were students who at the time of the proposed lesson would be in Year 13. Refer to Appendix 3.2 in Appendix A.
[4] **Infertility Advisory Centre Research Foundation**, 3 Spanish Place, Manchester Square, London, W1M 5AN and, **British Association for Betterment of Infertility and Education (BABIE)** PO Box 4TS, London W1A 4TS.
[5] **Human Fertilisation and Embryology Authority**, Paxton House, 30 Artillery Lane, London E1 7LS.
[6] All appendices for this chapter are located in Appendix D. Lesson resources are found in Appendix 6.1 through to Appendix 6.4 of Appendix D.

infertility in terms of its possible future, personal relevance to students, and as an opportunity for raising other associated sensitive reproductive issues:

> This idea of CI (*controversial issues*) is a very interesting one. It is excellent because it really is bringing biology into the real world. Here (*referring to infertility*) are things that the kids will learn and really are the issues that they should be dealing with and will be dealing with in their future so that is really good. I think there should be some element of it.
>
> C:Pre1, 342-345

The lesson (70 minutes duration) addressing the above aspects of infertility consisted of three steps:

- *Lesson Introduction* - there were two purposes for this part of the lesson: firstly, for students to recall the name and function of each organ of the male and female reproductive system, and for them to begin to think where reproductive problems might occur and how these might be addressed; secondly, to set the context for the lesson which was for students to explore some of the biological and ethical issues involved with infertility and its treatment. Most students were able to recall the names and functions of both reproductive systems. The issue of human fertility was introduced by C during her talk about the tasks required for the lesson.

- *Group Tasks* - the purpose here was for students to become involved in a discussion of various aspects of human infertility[7]. This involved students being assigned into one of five groups. Each group addressed one task and a spokesperson was nominated by the group to present their findings. This occupied the major proportion of the lesson. These tasks were favourably received by students as evidenced by both their lively in-class discussions and their post-lesson interviews with the researcher[8]. During this part of the lesson C moved throughout the class assisting students when necessary.

- *Lesson Summation* - the purpose of this final part was for each spokesperson to present the group's findings and to answer peer questions. This resulted in a very active whole class debate where questions of a moral/ethical dimension were addressed.

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[7] Refer to Appendix 6.2 located in Appendix D.

[8] The results and analysis of these are not reported in this thesis except insofar as they serve as a points of clarification or enrichment for the account.

In terms of C's perceived aims for this lesson, as part of the introductory component of the A-Level Biology course, these had been achieved. Students had become aware of the problems of infertility and had participated both in small group discussions and in the whole class debate during the lesson summation.

Moreover, C viewed the lesson as having contributed to the development of students' social skills:

> Well it is really nice to have them discussing things together. They get to know something about each other and about their personal views ... the morality ... which is something that we don't often have time to do. That is one of the reasons that I imagine that they enjoy doing this ... finding out about each other ... which is going to be common in a controversial issue lesson where you are dealing with questions of morals in some instances.
>
> C:PostPost1, 492-494

Finally, she felt that the lesson had encouraged the students to see A-Level Biology as interesting and enjoyable which she regarded as important at the beginning of their studies:

> I hope that they will see that biology is a fun subject ... have it filled with inspiration and they think "YES!! I have made the right decision. This is the one to go for." Get them on the right foot and then everything follows on. Like there is a bit of inertia going on ... I think that they will enjoy it ... So let's make a good start and hopefully the rest will follow.
>
> C:Pre4, 13-19

Overview:

Maintaining one's professional reputation was a central concern for Teacher C and helped to explain her professional identity as an A-Level Biology teacher. How she maintained her professional reputation appeared to be influenced by what she believed were the external and internal professional concerns with which she had to work.

The teaching of controversial issues represented for C a distinct possibility as an alternative teaching approach but, as became evident, was made difficult by the need to prepare students for the final examination and the teaching environment at the school where she was working. Throughout the study C identified various aspects of school and government policy which she believed did nothing to facilitate the professional growth and development of teachers. C believed that interference from central government, the lack of clear support from the senior members of staff for innovative teaching approaches and the professional isolation of many teachers in the school all seemed to lower teacher morale. Even though C was of the strong belief that controversial issues were educationally sound, she could see no positive incentive to employ such alternative approaches in her day-to-day teaching of

A-Level Biology particularly when these techniques required a significant amount of time to be adequately developed for student learning to occur. This caused her anxiety and tension.

As for J, the remainder of this account has been written around the same four propositional themes. However the propositions within each theme are different and so reflect the specific characteristics of Teacher C. Nonetheless there still remain similarities between these two accounts and therefore comparisons with Teacher J will be made where appropriate.

6.3: The A-Level Biology Teaching Context

Maintaining one's professional reputation characterised the view Teacher C had of her A-Level Biology teaching and involved four actors - herself as teacher, her students, professional colleagues, and school governors, parents and examination boards. This is reflected in the following proposition.

Maintaining one's professional reputation as both an A-Level Biology teacher and as Teacher in Charge of Biology seemed, for Teacher C, to involve two distinct but overlapping concerns:

- **External and internal professional concerns.**
- **Professional development.**

Each of these concerns will now be addressed in turn.

• External and Internal Professional Concerns

Two areas of professional concern seemed to have a major bearing on many of Teacher C's day-to-day, A-Level Biology teaching practices.

The first of these has for convenience been termed, *external professional concerns* (external concerns). These were concerns which C felt were outside her direct control. They were of two types: first, those dealing with the construction of the A-Level Biology syllabus, available time to adequately cover syllabus content and the pressure of external examinations; second, those concerns dealing with the control that the school administration exerted on teachers to conform to school norms of teaching practice. Thus when it came to A-Level Biology much of C's professional energy was directed towards students' examination performance and in many indirect ways towards her performance as teacher.

The second set of concerns, termed *internal professional concerns*, were those for which C felt she had some overall control but because of everyday teaching demands was not always able to address adequately. On the one hand C recognised the educational value and importance of STS issues and approaches for her A-Level students and on the other her lack of familiarity with specific knowledge about, and moral and ethical awareness of, some controversial issues. This tension she felt unable to resolve because of her need to complete the A-Level Biology course within two years.

External and internal professional concerns will now be addressed in detail.

External Professional Concerns

As for J, the central constraint on Teacher C's A-Level Biology teaching practice was the professional responsibility for ensuring that A-Level Biology students were given the necessary biological content knowledge and associated practical skills for examination success[9]. C believed that lack of time to cover adequately the A-Level Biology syllabus and the pressure of external examinations themselves left her little opportunity to fully embrace this responsibility. This caused her tension as she explains in the following quotation:

> ... they are three very difficult things that I have to cope with - examinations, time and the syllabus, and they have a massive effect on the way that I teach. This results in me teaching in a way that they (*the school*) think is right. I am forced to rush through the syllabus extremely quickly ... I am in danger of not actually finishing the syllabus. I have just had a situation where I have had to squash two lessons into one. This means that I did not go into the amount of detail and I am not happy with the fact that I don't know how well the kids are understanding.
>
> C:Prop, 32-36, 38

Much of C's talk dealing with the preparation and planning of the human infertility lesson therefore touched on this central professional responsibility of examination success. C felt she was driven by the syllabus, concerned with the depth of understanding required of students in the available time, and judged by colleagues and students as competent if she had succeeded in covering the syllabus within the allocated time frame.

C's concern with content coverage was often observed in her teaching practice, in the discussion of what she thought could be realistically achieved in the proposed lesson and in her recall of what she did in her usual A-Level Biology lessons. For example, when asked to articulate the latter and why, she replied that if the introduction was a recall of past work then she would

[9] Juxtaposed to this responsibility was added her belief that as a teacher she should also ensure that students became informed, autonomous decision makers. This will be addressed in a later propositional theme.

normally tell students what they already knew. She did realise that by doing this she was depriving students of the opportunity to articulate their knowledge, something she knew they enjoyed. However this took more time than was available, and thus was seldom undertaken in her teaching, as typified in the following extract:

> I am just thinking about what I usually do which tends to be ... to skate over what they have already dealt with which I know is not good because then they don't get this nice personal buzz "Hey I remembered!"... and I guess now that I am thinking about time it is very difficult to describe a diagram and so to cut time I usually launch into it and give them an A-Level type diagram ... the advantage is that I cut time and the disadvantage is that they don't get a chance to show what they do know which they find nice.
>
> C:Pre2, 34-42

In many ways this extract is similar to Teacher J in her talk about what she normally did, especially when because of time restrictions and for more personal reasons, teaching techniques such as discussion and groups work were not common. For these reasons lessons were more content driven and teacher oriented.

In general C seemed satisfied with the syllabus as it currently stood "I am happy that it gives a pretty broad knowledge of biology which is good" and she felt she could work with its aims and objectives; although she admitted finding the syllabus "quite restrictive", she stated that she did not "disagree" with it. In addition she did feel that there was also a heavy emphasis on content acquisition which was made difficult to consistently achieve because of inadequate time - "I don't think that the board has done that effectively enough ... they are going for content ... they are forgetting the limited amount of time ... the external exams are the biggest problem".

However what really troubled Teacher C was the disparity she felt existed between her understanding and interpretation of what one examination board[10] required of both students and teachers, and those of the examiners. She pointed out that often what was stated in the syllabus preamble and rhetoric was not necessarily reflected in past examinations or in the examiners' comments. Because she believed teachers were never given the opportunity to make significant contributions to the workings of the syllabus or to its examination, it seemed that in many ways she was a passive consumer, with little she herself could do to alter the situation.

[10] University of London Examinations and Assessment Council : London Examination Board (LEB).

In addition, what C found particularly disturbing was the lack of examination of those aspects of student understanding which required the writing of imaginative, thoughtful biological prose. In particular was her mention of the personal, economic, social and technological aspects (PEST) of science/biology, a theme which was required by the examination board to be mentioned throughout the course[11]. C believed that the examination board did not regard PEST aspects as important despite what it explicitly stated in its syllabus - "in the syllabus it says that we should do the PEST section ... yes, you think to yourself that is interesting and fascinating but when are they ever assessed on it?". C cited two examples to support her belief. First, even though the syllabus was updated, it still had not addressed, for example, human in-vitro fertilisation, a technology which gained prominence in the late 1970s. For C such examples of PEST were important because they were representative of what for her was "real, current biological research", something which she believed all students should be exposed to, not only to excite and motivate them to learn, but also to further their biological understanding. In this sense controversial issues were part of PEST. Second, C believed that the Board's main concerns were with the recall of facts and experiments, and the handling and analysis of data. She provided past examination papers as evidence to support her belief. These points are well illustrated by the following typical comments:

> Nobody (*referring to the examiners*) is interested in whether they know anything about that (*PEST*)... that side of it at all. There is no place in the exam where they are tested on that. Well if they are not going to be tested on that then that will not change their grades ... that is what they do it for so that they can get good grades to go on to university ... so if putting an emphasis on that takes away from the skills that will get them a good grade you just don't do it.
>
> We are not encouraged to do any more than pay lip service to that.
>
> C:Pre2, 399-409, 458

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[11] This theme is stated as:

- Aim (d) - promote an awareness and appreciation of the development and significance of biology in personal, social, environmental, economic and technological contexts (p. 2).

- Assessment objectives (a) (iii) - the personal, social and environment implications and the economic and technological applications of modern biology (p. 2).

- Syllabus content - throughout the teaching, an understanding of the principles of biology should be developed and topics should be illustrated by reference to relevant applications of biology, particularly those of a personal, social, environmental, economic and technological nature (p. 9).

From C's perspective then little purpose was served in pursuing the PEST aspects of the syllabus simply because they were not examined - "why bother if it is not going to be assessed ... if content is the only thing that is being assessed then that is the only thing that I can afford to teach". Even though she believed PEST aspects to be important, their absence from the examination although a concern was, she felt, beyond her control. Her central professional responsibility, like that for Teacher J, was in preparing students for the examinations and the maintenance of her professional integrity. Nevertheless, in contrast to J, the personal, economic, social and technological aspects of science were still on Teacher C's agenda.

The second type of external professional concern was that exerted by the school administration in its control of staff teaching practice. One way C believed this was done was through its interference in classroom practice when sensitive topics or unusual teaching techniques were employed. To C such interference was unacceptable professionally, especially when these topics and teaching techniques were used to enhance student learning and understanding, a point attested to by the following extract:

> I just believe that if there is some reason for discussion of it and particularly if it is related to the syllabus, I am just not going to move away from that, if it is related to the syllabus and the kids are learning something from it then I think a strong case can be made and I would defend the right very strongly if I were tackled.
>
> C:Pre1, 150-154

This strong personal belief in her right to defend what she believed was her duty as teacher and for which she had sound educational arguments, independent of the school milieu, was in contrast to J. It is possible that J's teaching practice had never been called into question by senior management in her school simply because she did not contemplate doing anything controversial in her teaching because of the perceived time constraints.

Such a personal commitment by C to PEST, especially when directly related to the syllabus, is best illustrated in the following extended passage where as a matter of professional etiquette, she informed the school administration about her involvement in the study[12]. In addition this passage captures C's strong personal reaction to such questioning by members of the school establishment, and her belief that teaching about controversial issues was part of good education and therefore appropriate for the A-Level Biology course.

> I think it is as well to be defensive and make sure that they know exactly what is going on and that there is nothing that they need to worry about. So I will just pass these folders onto them. If I get them and then show them the folders in advance ...

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[12] A more detailed analysis of Teacher C's position in relation to the teaching of controversial issues is found in a following propositional theme.

> I am convinced that there is nothing going to be covered here that the school needs to worry about ... but it is a smart move to get in quick before they start worrying and looking for problems. If you are up front about it and say this is what we are talking about, giving them an opportunity to object if they wish to in advance so that when the lesson runs we know that they we have got their approval and we have no hassle with anybody else at all. Whereas if they don't feel that they have been fully informed they might feel justified in having a go after the lesson and just sort of tarnishing it all slightly. I would rather keep everybody happy and on our side ... and if there are any problems I would rather know about it before we run the lesson rather than after the lesson when we have to justify what has been done. I rather not be put in that defensive position. This does not reflect my view at all.
>
> ... people like to feel that they have been consulted which is what I am saying about the senior staff (they) should be consulted.
>
> C:Pre3, 233-250

For C, maintaining one's professional image involved liaison between school governors, senior staff, parents and students - "when you get onto sex education or reproduction, that is one of the areas where objections are going to come up". It was therefore important that her involvement with this research be known to the school's senior staff:

> ... so to make sure that objections are not going to cause any sort of problems the school has to be 100% convinced that what is being done in the lessons is okay. I don't think that they are able or willing to pass that responsibility onto individual teachers. It has to be something that has to be agreed at a slightly higher level than that.
>
> C:Pre3, 280-285

C was not aware of any potential interference before participating in this research. What she had not anticipated was that her professional status and judgement would be called into question when the school management team realised what her involvement in this study meant. This last point is exemplified in her wish not to have her professional reputation compromised or questioned:

> If I was to give some controversial information which their parents did not agree with then they might feel justified in tackling the school about it and then the school is put into an awful situation where they have to decide who they are going with ... the parents or me. So we just avoid the whole situation if the senior staff are involved and they know what is going on. I am passing the responsibility onto them. I guess what we are doing is just making sure that they know exactly what we are teaching them.
>
> C:Pre3, 289-296

As is illustrated by the preceding extracts, it appears that on the one hand C was resentful of any interference but on the other hand seems resigned to its acceptance. Nevertheless, C believed that external professional concerns had to be taken into account when planning her A-Level teaching in general and more specifically for this study in terms of what she saw as the problems and possibilities for the teaching of controversial issues in the A-Level Biology course. Any substantive use of controversial issues or for that matter any other alternative teaching approach was therefore only possible if both of the following conditions were met; first and foremost, that both the issue under question and the method of its presentation to students be within acceptable teaching norms as deemed by the school administration and second, that at A-Level the prime concern of students examination success should not be compromised.

Internal Professional Concerns

Even after a number of years teaching A-Level Biology, the various demands of the syllabus still presented C with a personal challenge and allied to this were at least two identifiable internal professional concerns. These were the unease she felt when students made mention of areas of biology outside her expertise - some controversial issues fitted in here - and the requirement to complete the A-Level course within the allocated two years. As with the external professional concerns these concerns affected what she saw as her professional reputation. This unease was not unlike the tension experienced by Teacher J in terms of what she referred to as her need to "mug-up" due to "lack of short-term memory".

C's perceived lack of familiarity with STS materials, content knowledge about some controversial issues, and an awareness of their moral and ethical dimensions was a source of discomfort and at times even tension - "if they think that I don't know my stuff they won't have confidence in me". This discomfort C attributed to a lack of time for professional reading caused by syllabus and administrative demands, rather than the issues themselves. As she remarks:

> I tend to be driven with what I am dealing with at the time rather than use something sensational as a starting point for the lesson. I am worried about whether it is relevant and what I am supposed to be dealing with.
>
> C:Pre1, 93-95

However, the image of teachers C wished to portray to students was that of someone knowledgeable in their subject, confident in their pedagogy and willing to allow students to challenge the thinking of teachers. What C wanted for students was for them to acquire the necessary skills in order to achieve examination success, and for them to become informed autonomous thinkers:

> I hope it (*biology*) teaches them to challenge me. If I say something daft that they will notice it, so that they notice any errors that I make but also it will give them the confidence to feel that they can question. That I am not right all the time, and because they have got a different view or that they don't understand something it does not mean to say that they are at fault it could be that I am at fault. They then can believe that they can say "Hang on a minute Miss ... explain that again". I want to teach them to be questioning individuals.
>
> C:Pre4, 41-54

The second internal professional concern was what C saw as her need to complete the A-Level Biology course given the demands of the final examination. This she did by preparing well-structured lessons where students felt confident in her as their teacher and in their ability to understand biological concepts. This gave meaning to her teaching and in turn enhanced her professional identity. It was important therefore that students had a clear understanding of the direction of the A-Level Biology course. She thought students expected her to be familiar with the contents of the syllabus, to prepare lessons which reflected that syllabus and for her to facilitate their learning of biology. Each of these sentiments is reflected in the quote below:

> So when they are evaluating whether you are a good teacher or not and whether therefore they have confidence in you, will depend on a variety of things and one of them is whether we get through the syllabus ... and they get very very fidgety if they don't.
>
> C:Pre1, 106-110

The most appropriate way C felt she could complete the course was in her preparation and implementation of well-organised, interesting lessons. Accordingly, it was important for C that the rationale for each lesson and their implementation procedures be clearly established in her own mind, and as a consequence of this, her teaching be seen by students and colleagues as well-planned, structured and following syllabus guidelines - "I do feel very much driven by the syllabus and I guess you are protecting your reputation". C cited three ways in which she accomplished her goal of preparing well-organised lessons. First, she used recent government guidelines to help sharpen her professional outlook. Although specifically directed at GCSE level, they were helpful because they now required teachers to be more focused in their teaching, and for student assessment to become more rigorous. Asked to elaborate on such changes in terms of her own teaching she replied, whilst referring to the assessment of students' science process skills:

> I have not changed as a person but I was not doing all these process type things as much as they do now in such depth. It has done me some good ... it has made me think about things like dependent and independent variables. I was never brought up on that. I have had to get to grips with that ... So that is good because it has really sharpened us up a bit.
>
> C:Pre2, 543-548

However C still found the balance between such guidelines and the potential risk of too much interference in daily teaching difficult to reconcile - "they don't trust us. I think ... I don't take it personally, it is just the way that education is going at the moment".

An indication of the second way C ensured her teaching was well-organised was found in her more general talk about the teaching of controversial issues. If the issue under discussion was likely to take up a substantial portion of any lesson, as opposed to a five minute chat, then the lesson itself would need to be well-planned and structured to ensure maximum student learning. For Teacher C, class discussion and small group work, unlike Teacher J did not pose a problem. What Teacher C aimed for was a lesson where she had planned the lesson steps and what to expect from students so that she could accommodate any unplanned discussion should it arise. In the following quotation, C recalls her unease with the lesson introduction due she says to her lack of confidence possibly in its content and context, and for this reason seems unable to accommodate such discussions:

> I lost my way and I did not know what I was up to. I think it was lack of experience as much as anything and I was definitely nervous because I couldn't help but feel the pressure of getting it right ... you know ... it was the one-off lesson and it had to go well and if it didn't go well it had to go for some other reason not because of me and so I did feel that pressure and I know that I do get quite nervous about special events.
>
> C:Post, 110-115

This incident lends weight to C's first internal professional concern, her familiarity with STS type materials and her knowledge of some controversial issues. Because of the unfamiliarity of the situation, C felt that the lesson introduction was problematic: it lacked a clear direction, she felt nervous - "when I was just standing there I was thinking ... oh ... I don't know where I am going", and what was later disclosed, a lack of lesson ownership, even though she pointed out there had been the opportunity to prepare, collate, examine and alter materials - "I suppose because partly it is your lesson ... I should have made it my lesson ... and so when I went in there and started the lesson it was almost as it I am the puppet". In contrast once student group discussion began, C felt confident even though the lesson content was unfamiliar:

I was okay there... I was on the way. I was quite happy there. That is the bit that I enjoy, going around and talking to people and I mean in my teaching I like the communication with the kids ... so that is where I am communicating with kids. That is fine and that is enjoyable.

C:Post, 202-205

The third and final way in which C seemed to achieve her goal for structured and organised lessons was through her use of texts and to a lesser extent, her reading of professional journals. Using texts as a reference source, seemed to be the basis of lesson preparation for both Teachers J and C, rather than the media or journals, for as C comments - "we use modern textbooks so whenever a new textbook is chosen, it will be an up-to-date one. I suppose that is where most of my information comes from". Possibly these participants found texts more accessible to their immediate needs. Locating, reading and collating other potential resources for teaching took time, which they both felt they could ill-afford given the context in which they were teaching:

(*The Z text*) which is a good book, a wonderful book ... absolutely superb ... and it explains things so clearly that I am in the process of revamping my notes so the explanations become a lot more simple and clearer so that has been a great improvement. Just the fact that I have done a number of experiments a number of times and I know the pitfalls and I know what to look out for. That is an improvement ...

C:PostPost2, 61-62

As for how C herself viewed A-Level Biology lessons generally, this was always considered within the context of time using the resources which were available, so that lessons were structured to meet syllabus demands and the maintenance of her professional integrity. As she often remarks:

A lot of my lessons are very dull and boring. I don't have the time to be very imaginative and a lot of it does come straight out of the book and it is a poor side of my teaching but it is just that I have so much to do that I just draw the line at a certain point. Many of the lessons will be dull and boring.

C:Pre4, 240-248

Thus despite what C might have considered to be more appropriate ways of presenting biology, for both personal and professional reasons she preferred to use a more traditional lecture-type format for the delivery of content and structured practical activities. It is interesting to note that while her approach was similar to that of J, the rationale for its adoption was quite different. These reasons are defended by C in the following passage:

... I like a lot of structure so that I know where I am going and not being the most imaginative teacher of the brightest of people as well I like to be able to follow a textbook to a certain extent so that I can keep everything well organised/ordered.

C:Pre1, 347-349

To conclude, Teacher C appeared to be able to think about her A-Level Biology teaching in different ways. For example, she recognised that PEST aspects of biology were in the syllabus and thought them important. However, the external and internal professional concerns detailed in this section, forced her to employ teaching techniques which quickly covered the required syllabus but did not necessarily involve active student learning - "how can you have a discussion with a group like that - twenty five students in this class? Lecture at the front, I talk to you, how can I ask for contributions and get all the kids involved!". Such strategies along with large classes, discussed in the next section, did little to address individual student differences - "there is no individual attention at all".

The second aspect of this propositional theme, professional development, will now be addressed.

- **Professional Development**

Lack of professional development and opportunities for collegial discussion about science education generally and A-Level Biology education in particular were for C a continual frustration - "we don't have time to sit down and talk about educational ideas or share experiences at all". Professional development and collegial discussion were both important if teaching was to remain sensitive to the diverse needs of students on the A-Level Biology course. The absence of this support C believed, affected her professional motivation and her sense of pedagogic worth. Her perception about the lack of any clear commitment to professional development in her present school, led her to feel that there was no real incentive for her to explore the possibility of using alternative approaches to teaching A-Level Biology. Sharing ideas, whether of biological interest or of professional interest, was something Teacher C valued as part of her professional development. Since she perceived such support to be lacking for a variety of reasons as discussed later, C saw her involvement in this research as an avenue for her own professional development, as reflected in her following comments:

> I know that this is taking up a lot of time that I don't always have but I really welcome the opportunity to talk to someone about biology and the teaching of it. It keeps you thinking.
>
> C:PostPost1, 341-343

Associated with the notion of professional development was how C perceived herself in the role of teacher. It appeared that for C engaging in professional development was important in terms of informing and developing one's teaching practice and enhancing one's professional reputation. It seems that for C, enhancing her own professional reputation could be achieved in three ways: first, by establishing a good rapport with students, second, by being imaginative in her presentation of lessons and third, by keeping abreast of major developments in biological research. The latter C viewed as not necessarily being one of her particular strengths - "it is a weak area for me. I can't claim to be particularly up-to-date".

C believed that her talents as teacher rested with the rapport she was able to build with students and her diligent efforts in ensuring that they succeeded in the final external examinations rather than necessarily being imaginative as a teacher. Possibly the latter could be an additional reasons why she sought opportunities to explore controversial issues with the researcher. Speaking of her personal teaching characteristics she says:

> I make no claims to being academic at all ... when it comes to motivating kids, encouraging them, making them feel good ... I think that I am successful.
>
> C:Pre4, 229-235

Nevertheless, the presence of the final examinations meant that her lessons were very much content driven and aimed to cover the syllabus requirements in the most efficient and effective means possible. Doing this meant for C that she kept within what the school would term the norm. In this sense she was similar to J, believing that she could discharge her professional responsibility to both students and to the school by implementing lessons whose ultimate goal was examination success.

As for her own professional development, C indicated that in the past this had come about through her own teaching experiences, random INSET days and her interaction with student science teachers. She undertook further professional development through readings of professional journals and attendance at public lectures dealing with biology.

In more general terms, professional communication, collegial support and the sharing of teaching experiences at all levels of the profession were considered by C to be of real importance for the continued professional development of all members of the teaching profession. Such a perspective was found to pervade much of her dialogue dealing with professional development and is illustrated in the following quotation where she recalls an incident caused by a lack of professional communication:

> We use G&T, the green A-Level text book, which I find a fairly horrendous book. It has questions as you go through and I thought these are nice questions and I can set these as homework for the kids and I looked at these questions and I thought 'I can't answer that'. I never told anybody but it was only a couple of weeks ago, after working at this school for two and half years that Teacher A said that he couldn't do them either. It has taken a long time for me to realise that that book is inappropriate and it is not just me being stupid but that many people find that difficult as well.
>
> C:PostPost2, 13-19

As a member of the teaching staff, C noted three school practices which she believed did nothing to advance professional development, nor the removal of professional isolation as described by her above. This in C's view was another way in which the school administration exerted strong controls on the general teaching practice of its teachers. First, the Head Teacher used designated INSET days for the dissemination of school administrative matters rather than for whole staff discussion of important and pressing educational issues such as the continual improvement of the delivery of the syllabus, for which the teaching of controversial issues might well be of some relevance or, the allocation of teaching staff and resources, which C believed led to inequitable workloads. Of concern was the fact that her incoming A-Level Biology class would have twenty five students compared with other A-Level classes of three[13] - "I know that there are some subjects that I don't consider to be key subjects (except Maths) which are run with very small groups". C's argument was that A-Level Biology was a key subject and therefore the policy of the Biology staff was to welcome students of all abilities. It seemed inevitable then that such an open-door policy attracted a large number of interested students, and therefore staffing ought to be arranged to cover student numbers - "well, we don't even talk about workload, that is definitely a no no ... we are professionals!". In addition, she was concerned that despite A-Level students attracting more funding, part of this funding was not being directed to lowering the staff student ratio in A-Level Biology. As a consequence staff workload remained high, and as the following quote reveals, caused her considerable irritation:

> There was also the issue yesterday of staffing levels ... twenty five at A-Level is too difficult. It is what it implies that is important ... apparently there is no money to staff it (*a second class*) but the A-Level students bring in so much money for having them.
>
> C:Post, 4-8

For C the inevitable result, something which she came to resent, was that the quality of teaching and the amount of individual student attention would fall. Teachers would, she predicted, be forced to turn to traditional lecture-type delivery of content, something she felt was unsatisfactory especially when the A-Level Biology course required students to actively participate in meaningful practical work. Given this situation, it would appear that for C using controversial issues other than for five minute chats, even though desirable, was simply not possible.

The second school practice concerning professional development was that the number of INSET days available for teachers outside the school irrespective of professional needs was limited:

[13] Figure confirmed from the 1995/96 School Prospectus. In correspondence dated 7th June 1996, mention was made by C that class sizes in key subjects like Maths had been increased but this had not happened in what she perceived were *non* key subjects.

> I said earlier in the year that I needed to go on 2 INSET days. One of them was on meeting the moderators and examiners for the GCSE psychology. Basically I had to go on that because it was on instruction about how to assess and submit course work. ...The other one was more general ... it was on teaching psychology and teaching new ideas and new issues. It was a chance to get some psychology teachers together with a chief examiner from one of the boards just to talk about the teaching of psychology. At the time I was told ... Yes I could go but I should choose carefully because that would mean that there would be nothing else for me to go on that year ... that is me out for the year. So there is no point in me looking for INSET days because I won't be allowed to go. There is no money to send me. That is frustrating, yes that is frustrating.
>
> C: Prop, 102-115

Limited opportunities for professional development meant for C that when INSET opportunities arose which directly impacted on her teaching practice, she was simply not able to attend, irrespective of their educational value. Thus the chance to participate in this research was a welcomed professional opportunity even though time consuming; as C said "I was hoping to pick up some tips and ideas".

The third and final obstacle to professional development occurred within the Science Faculty. C regarded herself as part of the teaching team and hence expected to be consulted on matters of professional importance. Because science faculty meetings were purely administrative, there was seldom an opportunity to share issues concerning science or science education. The result was that for many teachers in the science department, working in professional isolation was the norm. This was highlighted for C on a recent fieldtrip when discussion between a biology colleague and herself focused on day-to-day A-Level teaching. She recalls from that episode:

> When Teacher B and I were away on the field trip we sat down and talked biology. We had a few conversations about it then and he admitted that he talked more about biology with another member of staff then than in the previous five years. I am pretty sure that that is just not me.
>
> C:PostPost2, 29-32

That other colleagues shared similar anxieties and concerns about their A-Level Biology teaching practice was in some sense for C, positive. She was not alone.

In terms of her role, responsibilities and future plans as Teacher in Charge of Biology, C believed in the importance of professional development for all staff. However here was a dilemma she felt was difficult to reconcile. On the one hand C believed in the importance of maintaining cohesion amongst the Biology team; on the other hand, in light of time constraints, colleagues and workloads, she was hesitant about forcing her views and ideas on them. For C there remained the ever present problem of somehow persuading her biology colleagues of the benefits of discussing as a team, issues as important as the merits of various teaching approaches and the resolution of pedagogic difficulties, a point attested to by the following comments:

> ... it is something that I am thinking about and now that I am nominally Head of Biology and it is something at the back of my mind. We should make opportunities to sit and talk about it. Having said that, there is probably going to be opposition from the other teachers if I do that because it is taking up time and they would probably prefer to struggle on as they are.
>
> C:PostPost, 20-24

Finally low teacher morale and a perceived threat to pedagogic success both caused by lack of professional development was, C believed, the direct result of the government's assault on teachers' professionalism. Even though she thought the National Curriculum had merit - "I am quite happy to have some sort of curriculum to lay down the basics but I am not happy with the way it is at the moment", in the sense of giving weaker teachers direction, the increased number of central government directives were considered by C to be somewhat intrusive. For example, C was not happy with this large amount of direction, since it eroded her sense of professionalism in terms of her ability to make informed decisions relating to her teaching practice. For C teaching, and in particular assessment, had now been reduced to a paper shuffle, where more time was being spent on marking, collating of assignments and assessment rather than on the actual business of teaching. One reason C gave for this increased central government direction was her perception that central government with its low opinion of teachers' intellectual calibre, regarded teachers incapable of making informed educational decisions. Notwithstanding this opposition to what she saw as an over-intrusive government, C was concerned about the quality of some science teachers - hence her view that some government direction might be appropriate for some teachers:

> Because scientists have been able to get jobs in industry I wonder if science teachers are on the whole are a bit weaker in the subject I don't know if there is any truth in that. It is a situation that I could imagine as being true. Like if you are a physicist you could get a well paid job in industry so if you have to be really devoted to kids to be a Physics teacher ... either that or be bone idle or nothing at all ... so then you are likely to be poor calibre anyway. So to make sure that kids get a good education in science I wonder if you do have to lay down some sort of rules to say that you must cover this, this and this.
>
> C:Pre2, 473-480

In spite of her expressed concern about potential interference in her teaching practice, C was enthusiastic about participating in this study as she believed she could develop professionally by being involved. Any changes to her current A-Level Biology teaching practice were governed by the need to maintain her professional reputation. Maintaining such a reputation meant that Teacher C had to take account of both external and internal professional concerns, student success and the limits to professional development currently available. Any shift in her current teaching practice, apart from the incorporation of mandatory syllabus changes was regarded as professionally risky.

An account of Teacher C's views about the nature of science/biology, how this might have influenced her teaching and what she might regard were the possibilities and problems for the teaching of controversial issues now follows.

6.4: Views of Science/Biology

C believed that it was important for A-Level Biology students to be aware that biological investigations were carried out in many educational, industrial and research settings. Replicating such settings could only be partly achieved during fieldtrips and in long term practical investigations and for this reason most investigations carried out at school could simply only replicate past work. Two propositions summate what for Teacher C constituted the nature of science/biology and how it might be portrayed ideally in school.

(i) **C seemed to have a view of science as a body of theoretical and empirical knowledge which was open to challenge, that is, an active, verifying, falsifying and modifying activity and so, essentially a system of ideas which helped to explain how and why phenomena worked.**

(ii) **These views about the nature of science were closely aligned with what C viewed as the most appropriate way of teaching science/biology to school students, that is, one where anticipated results were not known by students before any activity.**

It appeared that C experienced a tension between the view of science she held for scientific research and what she portrayed in her A-Level Biology classroom. What seemed to be C's central belief/perception about the nature of science/biology[14] was as a body of knowledge derived from both theoretical assumptions and empirical evidence which were both open to challenge - to use C's own metaphor "facts on the move". Associated with this central view were three other features. These were that science/biology was also:

[14] There was no evidence in the data to suggest whether C conceptualised science differently from biology. This being the case they have been treated as one.

- a system of interlinking ideas and concepts which helped to explain how and why objects worked.

> This is the area where A-Level Biology students are probably weakest. Right the way through they tend to be poor at connecting one unit of work and another. This is the thing that we see as our main job in a way. Trying to make sure that they make links between one topic and another.
>
> C:Pre4, 95-98

Both Teachers J and C identified this as being difficult for many students.

- a creative endeavour in terms of the discovery of ideas, themselves subject to continual modification.

> The sort of creative bit ... What I am talking about is the discovery of ideas but it is not necessarily a straight forward jigsaw puzzle where you can easily predict the next stage. Sometimes you can but sometimes you have to use a little bit of extra flair to go of maybe in a different direction. So that is the kind of creativity that I am talking about rather than creative in the aesthetic sense
>
> C:Pre4, 390-396

This was a view not necessarily shared with Teacher J who on one occasion made the remark that - "it is out there".

- a collegial activity where people work together to develop ideas, test these ideas against possible contradictory evidence and modify such ideas when needed.

> Yes I agree with the first one definitely, it is certainly open to challenge. We don't get anywhere if it isn't. Verify, falsifying and modifying activity - wait a minute until I handle that. It should be an active (*her emphasis*) activity.
>
> C:Prop, 172-174

It was this central belief about the nature of science and the three associated features, along with the importance of practical work, fieldwork and visits to educational venues of biological interest, for example the zoological and botanical gardens, which for C constituted *real* biology. Ideally it was this view of science which she wished to convey to her students.

> When kids leave school and go to university, if they do use their biological skills it would probably be in data handling and analysis and so on. It is not going to be on remembering the name of that tiny little creature that used to wiggle around on the slide but who cares you can look that up in a book. So I would like to emphasise the skills that they will need to use in future.
>
> C:Pre1, 386-390

This espoused view of science outlined in the above quotation would seem to indicate that the teaching of controversial issues and other STS issues fitted comfortably with what C referred to as real biology - something which she would ideally like to see happening in her classroom.

C was of the opinion that a working understanding of the nature of science could be achieved by students if she fostered the appropriate intellectual and practical skills and used the correct technical language. It was the mastery of these basic skills in particular language, which Teacher C thought important for students, for as she comments:

> My knowledge has increased, it is sharper ... it has improved enormously. I am a lot more precise than I used to be and I try to use more scientific language because the kids have to learn ... I will emphasise technical words and will say them slowly and repeat them and write them up so that I make sure that they grasp things like that.
>
> C:Pre4, 293-298

Therefore given this perception of the nature of science/biology in relation to A-Level Biology, C saw one of the potential benefits of the use of controversial issues as a way of stimulating students' interest in learning and so complement, enhance and integrate their broader biological understanding, providing that the issues chosen were concerned with real, currently researched biology.

Whilst acknowledging the impact that the external examinations, syllabus and time all had on how she thought about A-Level Biology, presenting biology as a dynamic discipline was her goal. Ideally for C, A-Level Biology should not only reflect the essential features of current biological research but it should also provide students with opportunities to experience this for themselves. This could be achieved C thought with fieldwork, visits to scientific institutions and the teaching of controversial issues. What C found frustrating, and a hindrance to attaining this goal of *real* biology, was the continued reluctance of the school to grant time away for such activities - "everybody hates it when you take them out of school. I get a certain amount of flack for the biology field trip. They don't like the kids going out".

In the context of classroom reality C believed things were different. Here the three constraints of time, syllabus and examinations impacted on C's teaching practice. Her talk suggested that she employed two somewhat contradictory views of science/biology. Firstly, as already discussed, that biology was a series of interconnecting ideas where current ideas were applied to new situations in order to expand knowledge and secondly, that biology was ordered "just like the natural world", where ideas and facts could be verified using neatly controlled experiments with predictable results. Each of these positions is now illustrated. In the first quotation C elaborates on why it is important that students question evidence, part of the notion of applying ideas to new situations:

> I don't think that you are going to be a good scientist if you don't look at things critically. If you are satisfied with an answer because it looks right to you ... then you stop questioning it and examining it, and you may not progress any further.
>
> C:PostPost1, 75-78

In this next extract she explains why she chooses to use experiments the purpose of which was to "see biological systems as we understand them to work", and where expected results most often occur:

> I decide which practical is going to be done and one thing that the kids like and which I also like is that they will get a set of results which show what we are setting out to show. While generally I don't agree with a right answer, I do agree that you have got to have something to go on because they can come up with such absolute tripe. There would be many situations where they do an experiment where it would not work.
>
> C:PostPost2, 102-107

Thus, despite C's views of science/biology as a body of theoretical knowledge open to challenge, she tended to structure her A-Level Biology teaching to meet the perceived constraints of time and syllabus coverage. Consequently, apart from fieldwork where students were required to design, undertake and report on their own investigations, A-Level Biology practical work as evidenced above and more emphatically in her correspondence which now follows, was concerned with verifying accepted findings, as deemed important by the syllabus and examined at the end of the course.

> I like experiments that work - it is easy to teach the facts from these experiments. However, a proportion of students will always make an error or modification to the experiments so that unpredictable results are achieved. I consider those to be valuable[15].
>
> Using experiments which are very 'open' are less closely linked to the point of the lesson. It may be valid/interesting biology but it is less likely to illustrate the point in question.
>
> Correspondence from Teacher C received 6 June 1996
> with regard to the draft of this account.

[15] This comment appeared to contradict the evidence collected throughout the study. Given that it was made after the major part of the study, respondent validation was not sought. There was no evidence in the rest of the data to support this change of view or what this teacher might have done with these "unpredictable results".

For C such a way of teaching meant the collection and collation of information and formal practicals found in prescribed texts. It was therefore important that experimental results be clear and correctly interpreted by students, that is, verifying ideas and hypotheses. In this sense she was discharging her professional responsibility as an A-Level Biology teacher, rather than necessarily presenting a view of science/biology to students with which she wholeheartedly agreed.

6.5: Teaching Students in the A-Level Biology Course

C believed that biology was seen by many A-Level students as an attractive, accessible option despite the heavy workload. This was made possible by the science faculty's policy, which C endorsed, of encouraging students to think about the value of doing a science at A-Level and by providing them with opportunities which foster biological understanding rather than merely focusing on their potential examination grades. For many students who were not sure whether or not to take a science at A-Level, C reported that biology remained their preferred option because, in her view, it captured their interest.

Teacher C seemed to have two aims[16] for her A-Level Biology students irrespective of their academic abilities. These were as follows:

(i) Students should become clear, articulate, critical, independent thinkers, able to make informed decisions about major life events and issues.

(ii) Students should be given the necessary skills to critique actively scientific/biological experimental methodology and make links between biological concepts.

[16] Correspondence from C with regard to the draft of this account indicated that these were still her aims but as she says, *As I write now I can't honestly say I am wholly successful.*

Teacher C saw both of these as part of a *good* education, something she believed was reflected in her teaching practice - "I believe that kids should be able to make informed choices as long as as much information is presented as possible".

The first aim that C had for her A-Level Biology students was that they be given the necessary intellectual skills in order to become critical thinkers, able to make informed decisions not only about matters biological but also about those of a more general nature - "a lot of kids are very edgy about making a contribution because they don't want to be seen as stupid". It was here that controversial issues could make a contribution. During talk about her expectations of A-Level Biology students, C mentioned that in the past most of her students had not pursued a science related career nor did she believe would they ever use or even need such detailed biological knowledge as found in the current A-Level syllabus. Rather what was needed by A-Level Biology students were basic scientific literacy skills, which she believed contributed to a good overall education. The A-Level Biology course could potentially do this for students as she indicates in the next quotation where she espouses this ideal:

> I just don't see the value in making kids sit down and remember loads of facts for the exam because they just forget it all. It is useful for part of their training because they may need that skill but I don't see that the total emphasis has to be on it (recall) ... there are lots of other valuable skills that they can also develop ... Your idea of giving them a medical problem for example and then having them dip into their knowledge and having to sort out some sort of solution to that or give them data about this controversial issue so that they can work out on it ... that point of view. That is a very good way of doing it.
>
> C:Pre3, 370-380

Concerns and comments about the amount and depth of student content knowledge were not raised by Teacher C. Unlike J, C was not necessarily of the view that students were lacking in content knowledge, what she highlighted in her talk about students was that they had - "very little interest in the things that are going on around them", and as a result were- "quite narrow in their outlook". C tended to focus on the more long term goal of encouraging students to be critical and articulate thinkers.

On the one hand C had an idealised view of students and what she believed was beneficial for their progress which seemed to be at odds with her desire to maintain her professional reputation. Again as for J, one of the prime purposes of her teaching was examination success. Student success at the final examination and their development as autonomous thinkers were an integral part of C's self-image as an A-Level Biology teacher. This is illustrated in the following extract, when C was reflecting on the events of the lesson:

> Well the main goal is to put them through this exam, that is the first and foremost. Another goal of any teaching is to have a bit of fun with them. I think that that is important. Isn't that funny (*meaning strange*), I don't often think of goals. I would like them to become independent thinkers, I would like them to have good experimental techniques, I have to teach them the knack of them writing their essays and doing their practical reports and fairly mundane stuff like that.
>
> C:Post, 390-395

C's second aim was that students should develop competency in data collection and analysis, and sufficient confidence to ask intelligent and searching questions when presented with challenging evidence. Typical of such sentiments is the following:

> I want people to keep asking me questions, never to accept things just because they have been put in front of them because it looks right but to keep on saying, "Is it right? Is there another way of looking at it?" That is the thing that I am trying to encourage.
>
> C:PostPost1, 94-98

Such remarks held true for her talk about group work and discussion but were not always borne out in her talk about practical work or in her emphasis on the write-up of such activities. As regards student competency in handling scientific evidence C seemed to vary in her opinions. What she seemed to prefer were - "nice and neat controlled experiments" where "it is a nice little jigsaw and you can see how one thing affects another". In contrast, there were other times, for example on field excursions, when she required students to design their own activities which called for a more open approach. This dichotomy of opinion[17] is reflected in her talk as:

> I shall be pushing for them to use the right methodology and this idea of a right answer I shall be looking at pretty carefully ... I don't go looking for a right answer and it is something for whatever reason they have been trained to believe is there ... we try to train them to be a whole lot more critical. There is not always going to be something that turns out to be perfect and right.
>
> C:PostPost1 75-81

For C giving students the opportunity freely to discuss their views especially in small groups built up their confidence, allowed them to participate in discussion and provided them with an opportunity to share their ideas, opinions and knowledge - "I think this is essential for their progress". This was a way in which she was able to give particular help to those students who might not otherwise offer an opinion or a contribution.

[17] This was later confirmed (7/6/96) in her written comments as *My ideas seem to be contradictory - I particularly enjoy physiology - I can't really explain why! However I don't regard it as being more important than other aspects of biology. I consider the development of skills which can be transferred to different situations to be more important and therefore should be emphasised in teaching biology.*

The controversial issue lesson for example helped to alleviate this difficulty because students were engaged for the most part in small group work, where ideas and information needed to be exchanged. As her comments on hearing student discussion indicate, C highlighted what she valued was appropriate biology learning. This she did using six key comments - "they are asking questions, they seem willing to think, they are using evidence, using the glossary, they are having a crack at it, and they are motivated".

Encouraging students to ask questions and to think critically was thus a further way in which C felt she was able to meet her professional responsibilities as a teacher, and in addition address both propositions of this theme. This goal remained consistent throughout the study, as the following reflections seem to suggest:

> I definitely believe in those two aims and I do believe that they are part of good education. I don't know how well they are reflected in what I do. I don't think that I achieve it particularly well (*all said in a sombre tone*). I think you might be over estimating what I actually achieve there.
>
> C:Prop, 152-155

Clearly as the quotation above illustrates, C's idealised vision of what she would like students to do in her lessons and the view of biology she wished to portray was tempered by her professional concerns. Hence, even though on most occasions C preferred to use practicals where the outcomes were known, what C maintained throughout the research was her belief that students ought to enjoy such activities particularly as they were an opportunity for them to be more actively involved in their own learning. This seemed to be a consistent position for C, as evidenced by the comments which now follow. In this extract C recalls what seemed to be a common occurrence in her more formal practical lessons:

> ... this idea of being able to use practical experimentation more appeals to me a lot. I like that style because I think that kids get a lot more personally involved which I think is a good thing ... like this morning I think that they probably all had a good time. It is so much nicer teaching in that sort of atmosphere ... when the kids are thinking and asking you questions and they are doing things rather than just sitting there and ... information coming in through the ears and coming out through the hand and bypassing the brain completely. I am sure that some of them can go away and look at their notes later on and think ... did I write that?
>
> C:PostPost1, 183-192

Despite the demands of the syllabus and the examinations, and the teaching environment in which she was working, C's vision for students was that they become autonomous thinkers - "I hope that they will recognise that there is not always a right and a wrong or a correct answer, but where there are some things that they can have an opinion on. I mean that is part of my teaching style". Nevertheless, C seemed to suffer considerable tension between her espoused beliefs about what students ought to do, which seem to fit well with much of the rationale for the teaching of STS type issues and, what she was able to do given the professional concerns discussed in the first propositional theme.

6.6: The Teaching of Controversial Issues in Relation to A-Level Biology

Despite being questioned by members of staff as to her involvement in the research, C's position with respect to what she believed was the value for the teaching of controversial issues remained constant.

Two propositional statements summarise what Teacher C saw as the place and educational value of teaching controversial issues given her present A-Level Biology teaching context.

(i) C seemed convinced that controversial issues assisted in the social development of students but was less convinced that they could foster an understanding of biological concepts[18].

(ii) C perceived that the current A-Level Biology syllabus, as reflected in the final examination, constrained the teaching of controversial issues.

Throughout the study C was never diverted or in any way persuaded from her belief that the teaching of controversial issues could be used legitimately for the development of students' social skills despite questioning from her Head Teacher (HT).

> I am not the slightest bit worried about that because I feel that I can defend whatever we are doing whole heartily and if they disagree with me I would not care anyway because I am absolutely convinced that this is okay. There is nothing dodgy about this whatsoever. I have got no problem with that at all ... but it is just playing politics isn't it and that everybody is on your side and that you are never put in a position of having to explain yourself when they are getting aggressive.
>
> C:Pre3, 297-304

[18] This proposition held true for C throughout the study, including the propositions interview. However her written comments (7/6/96) indicated that this had changed to: *I'm surprised that I was not convinced that controversial issues foster an understanding of biological concepts. Perhaps I have changed my mind since the last interview* (referring to the Propositions Interview).

More specifically, for this controversial issue dealing with human reproduction, students needed to be informed. Her considered position was that for controversial issues with moral and ethical dimensions - "there is no room for ignorance in this subject", and therefore she was prepared to - "defend that pretty stoutly. It is there, you don't have to do it, you don't have to take part if you don't want to but they do have to know about it".

Apart from group cohesion, something C believed was necessary especially at the beginning of the year, the main social skill C wanted to develop in the lesson was discussion. Small group discussion she believed would give students the opportunity to share opinions and ideas in an informal manner whilst completing required tasks. Unlike J, C was more willing to allow such discussions to occupy the whole lesson provided both she and the students were well-organised. For C, it was important that students were made aware that opinions and ideas on issues varied. This was made clear by C in her recall of a previous lesson on contraceptives. In this context she comments:

> There were so many different points of view (*referring to controversial issues*) ... I don't know how many of them have the opportunity to talk about things like this ... to realise that not everybody thinks the same way as they do. They may have learnt something I hope about ... this was to do, with contraception ... I hope that they learnt something about the subject as well.
> C:Pre1, 214-220

This notion of active learning was supported by several students who were interviewed after the lesson. For these students the discussion of human infertility had been a positive learning experience because they were sharing information, opinions and ideas with their peers and were developing their problem solving skills. As two students pointed out in their interviews:

> We organised all the materials, shared out the tasks and then put it all together.

> We brain stormed each other, used the folders and wrote down our answers.

These views were endorsed by C:

> It is nice that they are all taking part ... that is kind of a measure I suppose of the amount that they are enjoying it and you won't bother to take part if you are not particularly enjoying it. People actually want to take part and want to make their comments heard. So that is another good reflection.
> C:PostPost 1, 492-503

Such positive student reactions to the lesson were encouraging for C, especially as she reported after the lesson to having felt uneasy in the introduction. As far as she was able to gauge, many students had met the aims of the lesson: they had engaged in the discussion of a biological issue with moral and ethical dimensions using the information provided. This differed from that of Teacher J who viewed the lesson more as a one-off event as well as a surprise since normally complacent students took on active leadership roles.

Nonetheless C still held firm to the belief that the success of any teaching of controversial issues in terms of it developing social skills, depended primarily on students first learning the facts, in her terms the 'nuts and bolts':

> I sort of see the role of these issues as sort of giving interest to the subject but you still have to know the nuts and bolts to investigate them. I think you have to have some time devoted to just getting through the facts (*her emphasis)* and then you apply those facts to dealing with the controversial issues ... I am not really sure about what order that they come into but I do see them as complementary parts of this. You can't do one without the other. You can't do the CI without the biological understanding.
>
> C:Pre1, 230-240

For the most part such an approach was not contemplated by J except possibly for the very able students but then only if the discussion was well-structured. The difference between these two participants was that in a much broader sense, C somehow came to regard controversial issues as being useful for the development of biological understanding, to use her own term, "as complementary parts" (refer to footnote 17).

Juxtaposed was her view that even though class discussion of controversial issues was often a spontaneous one-off event, it could legitimately be integrated into A-Level Biology whenever appropriate, provided that coverage of syllabus content was not threatened. Here, C experienced a tension between what ideally she would like to do, that is, what she believed was educationally valuable and what was indeed possible. The possible integration of controversial issues, seen as being complementary to the biology content of the syllabus, along with the development of social skills was her considered position throughout the study, as typified in remarks such as:

> The content of today's lesson I don't think will get them very far in an exam because when they are asked a whole pile of facts about the reproductive system I don't think they will have picked up a great deal today. But, it might have given them a little bit of inspiration and make them think, when they do that part of the course ... "Oh I remember when we were talking about that". It is almost as if we need a little bit of flexible discussion work to inspire the interest and then the hard graft, you know the boring content bit, to work with it, to complement it.
>
> C:Post, 171-176

Although controversial issues stimulated student interest, as shown above, C was not convinced that alone they could be employed to teach substantial content areas of the biology syllabus - "I am quite keen to sort of nail things so that when they walk out of the room they can say that "I have learnt this, this and this", despite her more personal belief that they were a most appropriate way of assisting and stimulating student learning, and indirectly her own professional development. These sentiments were reflected in her talk as:

> Well basically with this bit if you can get them interested in researching something, then if they are interested enough in a topic, they will read it up and they will get a far better understanding of the biological concepts than if I am at the front lecturing. The last bit I have been interested in, what you have been doing, because I was hoping to pick up some tips and ideas.
>
> C:Prop, 114-115

Despite her own frustrations with teaching, notably those already addressed in the previous section dealing with her professional concerns, and what she thought controversial issues teaching would demand of her as an A-Level Biology teacher, C was never in any doubt that students would enjoy such lessons given appropriate issues.

> As a method of learning it is brilliant ... the discussion ... and as a method of getting them to get through exams I might need some more convincing to do there but I don't know ... if I try to look up some exam papers ... when are they going to be able to use this knowledge to improve their grade at A-Level and I am not sure if it is there. As far as education goes it is brilliant ... get the kids involved and thinking.
>
> C:Post Post1, 150-156

For C the teaching of controversial issues was no doubt educationally valid and deserving of more than what Teacher J termed a five minute chat. However, for the reasons already discussed their inclusion as a significant component of her A-Level Biology teaching practice remained problematic.

However when asked about what sorts of things students could learn from such lessons her response, although hinting at the acquisition of biological content, was couched nevertheless in terms of her concern for content acquisition, and so in many ways her thoughts about the teaching of controversial issues resembled those of Teacher J.

> In fact controversial issues is a better way of understanding biological concepts but (*her emphasis*) as you are passing control over to the kids, you may allow the kids to miss out on certain issues which may be considered by the syllabus to be important.
>
> C:Prop, 132-137

Many of Teacher C's students who were interviewed did not necessarily view discussion and the acquisition of biological knowledge as being separate. In terms of the controversial lesson dealing with human infertility, the issue had caught their imagination and therefore the lesson had been interesting, different and challenging. Others responded by saying that they welcomed the freedom to work on their own as a group by sharing ideas and knowledge rather than simply taking notes. The following student comments typify their perceptions:

> It was different to what we usually do and it was a nice change and I thought it was interesting to refer back to the whole class.
>
> I thought it was great. It was new and I did not recognise most of the words and terms that were used in the folders but that is good.
>
> That was interesting, that was good because **you had to work** (*his emphasis*) ... like read into other people's cases and try to sort out a solution.
>
> You are not taking notes, you are doing it for yourself, finding out for yourself.

However, C remained cautious about the amount of new knowledge acquired by students and the appropriateness of such lessons based on the discussion and presentation of well researched arguments, in terms of examination success, as is demonstrated in the comments which now follow:

> I think in an exam that if the essay questions were based on something controversial where kids could express their opinions and state their own views and would get credit for a well reasoned argument, not for just writing down facts, then you would be encouraging people to practise the skills of discussion and argument ... I don't see any evidence of any essay question requiring that sort of skill. If you look at the questions asked in recent exams they have been content based questions requiring no personal input of the student at all ... So the kids are never expected to give their opinion
>
> C:PostPost2, 404-418

Unlike Teacher J, Teacher C was not totally dismissive of any future use of controversial issues. In her view even though:

> It has not sold it to me 100% but having done it once I will be more tempted to have a go at something specific ... and then I will be more tempted to have a crack at it. I would like to have another go at it ...
>
> C:Post, 287-291

Discussion of such issues although needing further thought on her part was seen to be of educational value but the amount of time needed to repeat such lessons remained problematic[19] - "this is one format which I would be quite happy to try again ... this sort of group discussion ... I'm not sure that this is

[19] For further correspondence refer to Appendix 6.5: Correspondence from Teacher C.

the only way of doing it". Because of time Teacher C preferred to use resources already available for particular issues, rather than develop her own. From her perspective:

> ... this is the BIG full stop (*her emphasis*) because I just do not have the time to do it. It really would be an occasional one-off ... or if I happen to bump into something that I think is appropriate ... if I was to bump into a booklet with a lot of information on a particular topic which would be easier for me to hack at. But I know that to be practical I know that I am not going to go to libraries and writing off to get a lot of information because I do not have the time ... I am a very busy person.
>
> C: Post, 380-387

Discussion has so far concentrated on what C viewed were the possibilities (social skill development) and the problems (acquisition of biological content knowledge, syllabus and examination demands) for the teaching of controversial issues. Throughout the study, C questioned many of her routine pedagogic practices and in so doing began to realise, and subsequently elaborate on, many of the constraints which were causing her anxiety. This was not only evident when she articulated her professional concerns but also when she began to reflect on what she believed was required of her as an A-Level Biology teacher and how this impacted on her wish to provide students with both meaningful learning and alternative approaches, the teaching of controversial issues being one such example. What C sought was time for more thoughtful lesson preparation and assistance with the use of controversial issues. As she explains:

> ... you can be a sounding board. This is what is needed very often, so that you can voice your ideas, and as you are talking about it half the time you think of answers ... but because I am saying out loud the things in my mind as I am talking, I think of answers and ideas. So I need to articulate.
>
> C:PostPost1, 344-353

This was not the case for Teacher J. She believed she was already meeting her prime professional responsibility and therefore did not see the necessity of employing alternative approaches. J never raised the question of employing alternative approaches of her own volition. In contrast to C, such approaches were not on her teaching agenda.

Opportunities for developing ideas about how to view the possible use of controversial issues in order to teach biological concepts were perceived by C as simply unavailable - "What I need is the opportunity (time) and resources to get up and do it". Given the constraints under which she was presently teaching, there was no time adequately to explore the use of controversial issues nor was there the encouragement from more senior members of staff to do so. As already mentioned any opportunities which might arise via INSET days were not available however educationally valuable, if the allocated time for INSET had already been used. More importantly, however, was the fact that even though the syllabus required teachers to place an emphasis on the PEST aspects of science, this was not reflected in the examinations. What C really wanted was first, the opportunity to discuss the general problems she was facing with biology teaching and to seek professional assistance when appropriate:

> Perhaps I don't need any more evidence. I have been ... I guess the reason that I invited you to come and work in this school was that it was something that I wanted to find out about ... that I also believed that this kind of method was a good one ... I wanted to find out a little bit more about it to see if I could put it into the way that I teach ... my problem is now to find the time, effort and inspiration to do it.
>
> C:PostPost2, 383-388

and second, to have available pre-packaged curriculum materials on various controversial issues pertinent to the current A-Level Biology course since time was a limiting factor, a shortcoming reflected in the following comments as:

> What would be nice would be if you could do all the leg work for us, knock together some booklets and pamphlets that we could use as a resource. When do we have the time to do this? Then published that and then sell it to schools. It would be interesting to see how many teachers would use something like that. One of the big problems is that we don't have time to get everything together. Another thing is that we really don't know what we are talking about. One of the things is that as soon as we get off the A-Level syllabus and into the tests then we are stuck. If all that was put on a plate for us, it would be quite interesting to see how much teachers would actually use it. That (CI resources) would get rid of some of the hurdles and find out whether the idea of teaching CI is considered to be useful.
>
> C:Prop, 265-274

C was of the firm belief that social skills together with other important educational goals could be fostered using the teaching of controversial issues. Whether their use could be extended to include the acquisition of biological content knowledge was debatable. Given the way in which the current syllabus was constructed, C could not see any flexibility in the syllabus for this to happen in any significant way, even though some of the views which C held about the nature of science/biology might have facilitated this approach. The manner in which the A-Level Biology course was examined constrained their possible use in areas other than the development of social skills.

To conclude, participation in this research dealing with various aspects of A-Level Biology teaching was a significant professional commitment for C who saw her involvement as useful for three reasons. First, as an opportunity for her own personal professional development on a one-to-one collegial basis. In this way she was able to articulate many of her concerns. Second, as an opportunity to develop a new and potentially exciting alternative approach to introducing the A-Level Biology course to students at the beginning of the school year and third, as an opportunity to develop, implement and assess one aspect of this alternative approach.

Several professional concerns emerged as influencing the manner in which C perceived her teaching and her role as teacher. Foremost was her responsibility for ensuring that students were given the best opportunities for examination success. How she could do this within the allocated time caused her much stress and anxiety. C knew from experience that most A-Level Biology students worked best when the subject matter and its presentation were both exciting and academically challenging, and for the majority of students this meant interesting practical and fieldwork.

However, the combined constraints of the syllabus, which she believed was content driven, the pressure on students to succeed in the final examinations and the time available in which to complete course requirements all meant that her lessons were of two types: traditional lecture-type formats which allowed her quickly to cover content but resulted in passive student learning, and formalised practicals where students merely confirmed established findings. In addition the school climate in which she was currently working, where professional development was not seen as important, constrained her opportunities to develop alternative teaching approaches. Consequently, effective teaching at A-Level was perceived in more traditional modes of lesson delivery. In addition this ensured that her professional reputation and personal integrity as a competent teacher were always maintained. This was for C very important in terms of her self identity as a teacher.

Controversial issues teaching was for C a useful teaching technique to develop social skills but she had reservations about how much biological content could be covered. Rather they were viewed, as for Teacher J, as a bolt-on activity which under no circumstances ought to compromise syllabus coverage and examination success.

Chapter Seven: Teacher R

Participant 3- School C

7.1: Background

Teacher R (known as R) became involved in this research via a chance meeting with a professional colleague who was aware of the proposed research. This colleague contacted the researcher and the necessary arrangements were made.

R has a first degree in biology and had recently been awarded a doctorate in zoology. Throughout the study R appeared to be confident in many aspects of the A-Level Biology syllabus and its pedagogy. R had four years of full time teaching experience, the first year of which had been at a sixth form college. He is currently a biology teacher at a co-educational, 11-18 comprehensive, LEA controlled school.

At the time of the study (November 1994 - January 1995), R taught three A-Level Biology classes and was using the A-Level Biology syllabus developed by the Associated Examination Board[1]. In the lower school, R was teaching Years 7, 8 and 9, and in the upper school two classes in Year 12 and one in Year 13. It was the smaller of R's Year 12 classes (n=9) who participated. Because this class was identified by R as being enthusiastic and academically able - "the current year 12 group in terms of intellectual ... and motivational are streaks ahead", he thought they would enjoy both the discussion of controversial issues and the challenge of a class debate.

The other members of the biology department at School C were the Head of Biology and Teacher S (Participant 4). R described the science faculty as supportive of innovative teaching techniques provided they could be shown to assist in student learning. R enjoyed teaching at this school and would eventually like to be promoted to the position of Head of Science.

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[1] The Associated Examing Board (AEB), A95/03, 1995 Syllabuses, Biology and Human Biology.

7.2: Nature of the Controversy

For R, a controversial issue was considered to be controversial if a diversity of opinion existed about it:

> Well it is a daft thing to say but, it is an issue over which there is a controversy. In other words it is likely that, within a class there will be a division of opinions and also in society there is a division of opinion over it. Controversy to me also means that it is in the upper ... forefront of people's thoughts at the moment and is also topical and it is something ... sometimes that is, historically controversial but it might not be controversial to the students ... that is it.
>
> R:Prop, 2-8

Of all the four teachers who participated, R was the only one who had previously used controversial issues in any formal manner. He had began this in his PGCE year. To date R had included diabetes, contraception and human embryo experimentation as examples of controversial issues. R was particularly interested in further exploring diabetes as a controversial issue for two reasons: first in relation to the control that doctors and drug companies have over patient management and second, to integrate his ideas concerning diabetes into a unit of work on hormonal control which he was currently teaching to the Year 12 class participating in this study.

For R, diabetes and its treatment was an important and complex controversial issue because it involved patients' right of choice between bovine/porcine derived insulin and genetically engineered human insulin known as humalin. This right of choice was something he thought all students ought to be made aware of. The following extract vividly demonstrates R's conceptualisation of this right of choice, what he saw as the complexity of the issue in terms of what students needed as background knowledge, the research and development costs for developing this type of gene technology, patients' concerns and some of the moral/ethical conflicts between the drug companies and consumers:

> They have to know about the protein structure ... the difference between pig and human insulin. The controversy is, with the scientific knowledge ... the restriction enzymes ... you have to know about plasmids, how bacteria work and that ... and then you have the technological application, so you learn how to insert a gene and remove a gene that you want and then insert it into a bacterium and then make the product you want and then extract it and package it and then sell it. Then you have people using it. That from the drug company's point of view is very successful. So this is a lot cheaper once you have covered your R&D costs. You can make as much as you want but as far as the user's point of view, you have this issue that lots of people don't like the human insulin and they know theoretically that it is the same and is suppose to be better and the same as what your pancreatic cells would be producing. They don't like it because they can't tell when they are becoming

hypoglycaemic as they could with the other insulin. **That is the issue** (*his emphasis*). Now you have these companies who have spent all this money developing the insulin and obviously wanting to use the insulin but some of the users are saying ... well no ... and feeling rather that they are being forced into using something that they don't want to. How much control do they then have over the illness ... who has control over the condition? The person who has it or the drug company or the doctor or the hospital?

R:Pre2, 76-94

As will be discussed later in this account such an approach to biology, which emphasised the social, ethical and factual aspects, was the way in which R had come to think about the teaching of the discipline. R's interest in biology education extended beyond that of merely preparing students for the external examination. This was evidenced in the reasons he gave for his participation in this study, and the way in which he talked about diabetes as a controversial issue. What R wanted to do was to exchange ideas about A-Level Biology teaching with a professional colleague outside his school, along with a more in-depth examination of the practicalities of teaching one controversial issue, diabetes, which for him was of personal interest. As with Teacher C, R welcomed the opportunity for critical reflection, even though it would mean time away from other professional activities. These points are supported by the following item of correspondence:

Thanks for the opportunity to comment. I have nothing much to add, except that I enjoyed working with you and found the CI (*controversial issues*) project very helpful. I have taken the liberty of suggesting a few corrections and I have made a few comments too. It was interesting to read about myself - and it will be useful for my teaching. It is not often that one gets such an in-depth analysis of an aspect of one's practice. You have not mentioned that my mother had diabetes and that his was a contributing factor in her death. I remember discussing this with you and it obviously had an effect on my choice of CI.

Fax received from Teacher R as feedback on the
draft of this account sent to him for comment - 21st June 1996.

Such an in-depth approach by R to the discussion and rationale of controversial issues was atypical. What now follows is an outline and an analysis of how this participant worked with the issue of diabetes to develop a number of lessons where students could appreciate not only the biological, social, ethical and moral complexities of this issue, but also a broader appreciation of the nature of science. It is the emphasis on the nature of science that marked R out from Teachers J and C.

At the time of this study, R and his Year 12 students were working on a section of the A-Level Biology course dealing with the concept of homeostasis[2]. Along with previous work on genetic engineering[3], and protein structure and function[4], R believed that diabetes would be an appropriate issue for student discussion, aptly explained by R in the following comments:

> In the syllabus they have to know about hormones and hormonal control and specifically diabetes is the example in the syllabus. They have to learn about diabetes and also in the syllabus is genetic engineering ... so modifying an organism genetically and so producing something for you ... in this case insulin. It is something that they have to learn about and that is a good example because it has gone all the way ... experiment to industrial process and now 80% of the people use human insulin by *E. coli*.
>
> We have just done biological molecules and we have done protein structure as a way in and we have just looked at enzymes and the other teacher who teaches them has done genetic engineering. It would not be too out of sync (*synchronisation*) with what they have been doing, things like that will probably be fresh in their minds. I would start with the background theory and then work up to this ... to the effects of the technology and how people feel.
>
> R: Pre2, 58-63, 113-118

Clearly, the issue of diabetes could be well accommodated into the syllabus and R's current scheme of work. Furthermore, R's participation in this research gave him the opportunity to explore both personally and professionally another controversial issue, and possibly another alternative approach to teaching, where the necessary background information would be collected and collated by someone else.

Given all of the above, R thought that any lesson(s) on diabetes would not only contribute to student discussion and debating skills, but also to their biological understanding of various aspects of biotechnology, the action of hormones (in particular insulin), and an appreciation of the role of patients, doctors and drug companies in the management of diabetes. Each of these is captured in the comment:

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[2] **Section 4 : Homeostatic Mechanisms** - need for a **constant internal environment**, Concept of homeostasis as a dynamic equilibrium, involving receptors and effectors, as shown by water and solute balance, **glucose balance** and temperature control. The modifications of homeostatic mechanisms as exemplified by the use of insulin in the control of **diabetes mellitus**.

[3] **Section 1.8: Genetic Engineering** - gene manipulation to produce recombinant DNA as shown in the production of human insulin.

[4] **Section 1.5: Properties and Identification of Proteins** - the principles of enzyme action. Factors affecting enzyme activity: pH, temperature, enzyme concentration, substrate concentration, inhibitors.

What would they (*students*) get out of it (*controversial issue lesson on diabetes*) ... they would have an example of how a piece of technology (*genetically engineered human insulin and pen devices*) is actually ... well interacts in real life (*people*) ... and they would have practice at thinking about that and thinking about how things actually work and other things like presenting arguments, collecting evidence and things like that.

R:Pre1, 139-142

Therefore R had two specific aims for the lessons on diabetes. First, they were an opportunity for students to rework their biological understanding of the function of insulin and so become more aware of the nature of this particular STS issue. This was achieved by requiring students to prepare a leaflet for a specific patient audience:

I will describe, I mean it will take up a substantial chunk of the lesson and then I will get them to choose the resources and ... NDA[5] and the drug company and what I would like them to do ... this then is the task ... which is to design and produce a leaflet/booklet for new patients.

I was thinking that the main point is to get them to understand ... you could have cards with different ages, they pick one and that is the one that they have to do it for. That is a good idea ... the different ages.

R:Pre3, 61-64, 72-76

The second aim was that the proposed debate would engage students in STS discussion. Diabetes management was something that R found personally interesting and controversial, and therefore wanted to convey this to his students:

I will make up the packages, which will be drawn from the resources, so each side has a package, so they will spend 15 minutes digesting the information and thinking about arguments ... we say that it is a meeting between representatives of the NDA and drug companies about the problem and I chair it. Hopefully they should be able to generate things ... at the end we will ask each group what they thought of the other group's arguments, viewpoints, what did they learn and then we will have a round up of maybe conflicts of the relationship between technology and the users.

R:Pre3, 140-152

The extent to which these aims were achieved within the three lessons is now discussed.

[5] **The National Diabetic Association** (NDA) is a fictitious self-help patient organisation, coined by R.

Lesson 1:

This lesson was planned in two parts. It began with a brief ten minute lecture style introduction where the focus was on the control of blood glucose, the production of humalin and the management of diabetes. Students were invited to ask and answer questions, and to interject when appropriate. The introduction would set the context for the following lesson(s).

The second and major part of the lesson was an opportunity for pairs of students to examine a selection of resource materials on diabetes in order to prepare a leaflet suitable for new diabetics. Patients included an eight year old, a teenager, a pregnant woman, a parent of an adolescent and a retired person. This leaflet was to be completed for homework and presented to the class in the following lesson.

In reality, the introduction occupied all but the last fifteen minutes of the lesson. A content knowledge map for this first part of the lesson, based on the audiotape and lesson transcript, and illustrating both the complexity of the role of insulin in regulating blood glucose as presented by R in the lesson, and the various concepts students needed to acquire in order to gain some understanding of diabetes is located in Appendix 7.1a[6]. In the remainder of the lesson, students examined various resource materials obtained from British diabetic associations, local hospitals, medical centres and major drug manufacturers of animal and human insulin.

Lesson 2:

The original plan was that students present their leaflets to the whole class for comment and that the remaining forty-five minutes be used by them to prepare for and then participate in, a debate dealing with the diversity of opinions concerning the use of various types of insulin. One group of students would represent the views of doctors and drug companies (*Oppenheim Pharmaceuticals*)[7], both of whom favoured the use of humalin: the other student group would represent the views of patients (*National Diabetic Association - NDA*) many of whom were concerned about their inability to detect the symptoms of low blood glucose levels when using humalin.

However before this lesson began, many students had approached R seeking assistance with their understanding of the role of insulin and the exact nature of diabetes. It seemed that for these students clarification of their understanding was important before they could engage with the lesson tasks. Others sought help with the construction of their leaflets and their use of

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[6] All appendices for this chapter are located in Appendix E.

[7] Oppenheim Pharmaceuticals is a fictitious drug company coined by R.

available computer packages to complete this task. The leaflets were submitted at the end of the next lesson.

For these reasons, R decided to postpone his original lesson plan and now concentrate on first, clarifying for students both the function of human insulin and the problems diabetics might face in managing their condition and second, allowing students sufficient time to prepare for the debate. A content knowledge map for this lesson is located in Appendix 7.1b[8]. This map illustrates R's clarification of both student difficulties with the concept of how insulin controls blood sugar levels, and the controversy over the use of humalin, between the doctors/drug companies and patients.

Lesson 3:

Essentially this lesson went as planned. Students were given time to collate their arguments and decide the order of speakers for the debate. The remainder of the lesson was then given over to the debate, with R acting as chairperson[9]. At the end, R summarised each point of view, commented on how he thought the class had addressed the controversy and finally, re-stated to students the links between the controversy regarding the use of humalin, the control of blood glucose by insulin and various other relevant areas of their A-Level Biology course.

In reality students did not share R's interest in the issue, even though he believed many thought the issue controversial as his later remarks seem to indicate:

> I think if you listen to the people who were in the NDA I think particularly they thought it was wrong for instance that the drugs companies did not make the technology like the pen device available for animal insulin and that was a way for persuading people to change to human insulin. They obviously thought that that was wrong and I think that they ... I don't know if they picked up so much the idea of who should be allowed to make the decisions and the choices ... whether it is the patients, the doctors or what have you ... I don't know if they picked that up too much.
>
> R:Post3, 52-59

[8] A content knowledge map for this lesson, similar to that constructed for Lesson 1, is found in Appendix 7.1b: Content Knowledge Map: Lesson 2-History of the use and development of insulin.

[9] A diagrammatic representation is located in Appendix 7.3: Classroom arrangements for the debate on diabetes.

This lack of interest on the part of students, a disappointment for R, was he believed reflected in their sluggish approach to the debate, his need at times to prompt them to talk and their apparently minimal use of the available resources to construct their respective arguments. As R comments and reflects:

> I was not very happy about the discussion. I thought they had actually done more. It sounded like they had from listening to the groups as if they had done more than what you would have thought listening to the discussion. They did not really come forward and they weren't ... they did not use the information very well that they had been given.
>
> R:Post3, 2-6

These sentiments appeared to resonate with some of the comments made by Teacher J, who also reported that for some students their discussion of organ transplantation was more of a social event, a chat, rather than an opportunity to make an informed opinion.

Even though these lessons did not totally meet R's expectations in terms of student interest - "I don't think they got out of it as much as they could have mainly because they did not put as much in as they could have", the teaching of controversial issues remained for R an important addition to this part of the A-Level Biology syllabus independent of this current student cohort - "I am not going to throw the whole thing in the bin and not use it again" and therefore he was not deflected from his goal of diabetes awareness - "I still think that it could work well. I think that it was a shame that it did not on that occasion".

For R the two aims of the lesson had been partially achieved; students had participated in STS discussions and had been made aware of diabetes and its management.

Overview:

Teacher R believed the syllabus to be restrictive in its content and approach to student learning, deficient of current biological research and devoid of any significant emphasis on the social responsibility of science. However despite these perceived difficulties R appeared to enjoy the challenge of testing the limits of the syllabus in terms of what he personally felt were his professional responsibilities to students. His aim was to continue to remain flexible in his thinking about, and general approach to, A-Level Biology teaching and therefore it was important for R that syllabus constraints, final examinations and available time not cloud his professional judgement.

R's view of biological knowledge seemed to suggest that it was open to rigorous intellectual challenge not only from scientists but possibly from students as well, particularly as he appeared to believe that the biological content of the syllabus was, like that of scientific research, also provisional. Such a view of science/biology along with his belief that students ought to become scientifically literate and in the process also become critical, autonomous thinkers, he believed, ought to be reflected in biology teaching at A-Level. As a science teacher R believed he could make a personal contribution towards each of these by providing students with classroom opportunities where scientific evidence could be scrutinised for bias and inaccuracies. It was here that R believed the teaching of controversial issues had potential.

As for the previous two chapters, what now follows is an account of how Teacher R himself viewed and thought about the possibilities and problems for using the teaching of controversial issues as a way to enrich his A-Level Biology teaching practice. Again each of the four propositional themes form the basis of the account with propositions therein specific for Teacher R. Where applicable, additional comments from R, mailed to the researcher after the propositions interview, are noted immediately after each proposition and integrated into the account. Comparisons with Teacher J and Teacher C are found throughout.

7.3: The A-Level Biology Teaching Context

Two propositions encapsulate what for Teacher R appeared to be the essence of A-Level Biology teaching. These were the influence the A-Level Biology syllabus exerted on teachers in terms of the delivery of its content, and the role and responsibility Teacher R believed he had as an A-Level Biology Teacher. Comments received from R in relation to these propositions are noted below in *italics* and subsequently discussed with the proposition.

(i) Teacher R was of the opinion that many of the constraints on both A-Level Biology teaching generally, and on the teaching of controversial issues as a case in point, emanated from the manner in which the current syllabus was constructed.

> *I think this is true to an extent but the revised syllabus is an improvement. The new syllabus is much less content bound, much more emphasis on thinking.*
>
> Unsolicited correspondence from R: 2 April 1996

(ii) From R's perspective, A-Level Biology teachers have a wider educational responsibility than merely to ensure students acquire sufficient biological knowledge in order to attain examination success.

For R, the A-Level Biology teaching context was problematic. R believed that the AEB syllabus he was using at the time of the study was restrictive and out-dated in content, narrow in its approach to biology, and for the most part content driven. In practice this meant that there was often insufficient time to develop and implement teaching techniques more appropriate for student learning, to collect and collate resources for the presentation of an up-to-date view of biology, and to reflect upon one's teaching at A-Level. These were what R referred to as some of the constraints on his teaching. In addition the administrative and assessment demands of the A-Level Biology course often left him with little personal energy to pursue other pedagogic interests. This seemed to be manifested throughout the study as a tension between how he personally believed A-Level Biology ought to be taught, and the constraints he perceived were exerted on him by the syllabus:

> ... what I said about the constraints on teaching controversial issues is still true, that is, that they emanate from the syllabus. You don't have the time to really go off and do something off the syllabus, so yes, that proposition is still true. You can only still pick things which you think are related to the syllabus and you could not go wildly out on a limb no matter how much you might want to. It would not be fair because you would have to miss out on something that the students needed.
>
> R:Prop, 39-46

Despite R's recognition that his teaching was inevitably focused on the need to cover the syllabus in the time available in order to maximise examination success, he remained more flexible in his thinking about both the teaching of A-Level Biology, and the means of achieving his own aims, than either J or C. The resulting tension between syllabus and teacher aims for A-Level students was therefore, different from that experienced by Teachers J and C. For R there was a tension between how the syllabus presented biology as a discipline and how he believed biology ought to be taught at A-Level. For Teacher J the tension was more in terms of her biological knowledge and her need to spend more time on areas beyond her expertise, whilst for Teacher C this tension was seen in how she felt she was perceived by colleagues and students.

Moreover, Teacher R appeared to have the ability to think about his biology teaching in many different ways, most importantly as a way of encouraging students to think for themselves. Unlike Teacher J who thought about her A-Level Biology teaching more in terms of ensuring that students had a comprehensive set of notes and had completed practical tasks, R saw little value in students having a complete set of dictated notes if the syllabus was moving towards a more process type approach. This is evidenced in the following quotation:

> More and more the syllabus is getting away from recall of information but more to techniques, applying and thinking. Thinking is more important. There used to be a time where if you had a good set of notes you could get a good A-Level and I think you can't do that now. You have to have the information but that isn't going to be enough without the understanding and the ability to apply it well. I think that it is going to increase.
>
> R:Pre2, 31-36

This way of thinking about A-Level Biology, something clearly not evident for Teacher J, and aided by his broad biological knowledge base, could be one reason why he was able to so easily contemplate the use of controversial issues as part of his general A-Level Biology teaching repertoire. The discussions of the diabetes lesson were evidence of this.

In addition, R seldom seemed to allow the constraints of the external examination, the predetermined syllabus and the time available adequately to cover the course, to cloud his professional judgement and perspective. This was not to say that R did not have any professional concerns. It was the way in which he viewed and used these constraints to his own professional advantage, which is of interest in gaining an understanding of what for R it meant to be an A-Level Biology teacher in relation to the possibilities and problems of using controversial issues to teach A-Level Biology.

Although R had reservations about the syllabus, he did not feel constrained by it to the extent that he felt it impossible to teach the syllabus and give students what he regarded as a sound biological education, that is one that adequately reflected the nature of science. R believed that even though the syllabus was content dense, he could not legitimise or use this as an excuse for using either poor or inappropriate teaching practices, which he knew from his own teaching experience, led to under performance by students. For R, the syllabus, examinations and time were constraining in terms of what he perceived was an ideal A-Level course but admitted that he had for various reasons, notably that of student examination success, to work within its boundaries (see previous quote, R:Prop,39-46). As with Teacher J and Teacher C, he recognised the existence of the same three constraints - syllabus, available time and examinations, but he seemed either more able or more willing to question these constraints rather than take them for granted. As will become apparent in the discussion, what he actually wanted to do was to test and at times even transgress what he believed were the boundaries of the syllabus.

One instance amongst many where discussion focused on these concerns occurred when R was asked about which current controversial issues could be used in the A-Level Biology course. This tension between R's preferred way of teaching and that afforded by the syllabus, is exemplified in the following quotation dealing with euthanasia and foetal transplant. Asked whether he saw these as suitable issues for student discussion in A-Level Biology he replied:

> Yes I can, but then I have to see a link within the constraints of the syllabus. If it was up to me to teach biology I would. When there is such a lot of content to get through I think you can't. You can justify a lot of things because you are just not teaching content, you have a wider responsibility, and you have to think about those things, you have moral responsibility. I think you can't be justified in going way out on a limb on something that really had no connection with the syllabus and so you can say ... well it is a pity but ... there are things that you can but you are still constrained a bit but then again you are always constrained. You just have less than 2 years.
>
> R:Pre1, 131-140

Even though at first glance the syllabus seemed to have constrained Teacher R, questioning its rationale while working within its boundaries was for him a professional challenge. As for Teacher C who questioned the PEST examination aspects of the syllabus, both R and C appeared to do this more so than did Teacher J. R acknowledged that there were limits set by the syllabus but nonetheless wanted to test these limits and occasionally transgress them but, as the quotation above indicates, opportunities to do this were rare. However, he remained adamant that these constraints should not deter him from critically reflecting upon his own teaching. In spite of these constraints he felt he still ought to undertake activities as an A-Level Biology teacher which allowed students to engage with the nature and complexity of science/biology. These were to:

- create classroom opportunities where a view of science/biology could be presented to students which more accurately reflected the epistemological nature of scientific knowledge, that is, as a provisional, on-going body of ideas rather than what he thought the syllabus was doing which to a large extent, was the transmission of facts. Asked whether, as part of creating classroom opportunities, he introduced new scientific developments to students he replied:

> Well yes I do because they are interested and it makes it more interesting and it helps them to realise that science and things in Biology are just not in text books but is something that is going on **now** (*his emphasis*) and it is also something that they can be a part of should they choose to want to be (*scientific research*). That is good. They very often are interested and it can be an entry point to other things ... things that are in the news now and are going on now. You can then explore other issues through that.
>
> R:Pre1, 73-80

R's view of the biological knowledge presented in the syllabus was different from that expressed by the previous participants. For him, this knowledge was seen as a provisional while for J and C, it was more fixed.

- continue to employ and further develop controversial issues teaching which he said had previously been successful in developing biological understanding, social awareness of science and motivation amongst students. When asked for an example where students themselves raised an issue which was of relevance to them, he recalled:

> It is not biology but the other day in Year 11 they were asking about pollutants in unleaded petrol. There is this idea that in unleaded petrol there is this super unleaded stuff that might have carcinogens and so it is being introduced and encouraged and people have converted their cars and then they are told that the benzene in it is a carcinogen and so they were asking about that and then I used that ... and it just happened to be at the right time that we went into all the pollutant in car fumes which is part of the syllabus.
>
> R:Pre1, 81-93

This example of how controversial issues arose spontaneously in lessons, and therefore unplanned events, was very similar to that described by Teachers J and C. In the following quotation R comments further on how he ought to ensure that students are made aware of the social sensitivity of some issues, citing euthanasia and then diabetes as examples:

> Euthanasia can be a bit of a problem because there will always be people who have recently been bereaved or who have relatives who are ill and are close to dying and it can upset them and I do remember in the past that I did something about euthanasia and again this is in General Studies and somebody got upset and they said afterwards that it was not what you were doing it, it was just that I felt upset at the moment. Nevertheless I felt that I had not taken as much care in introducing the subject as I might have done. Things which can be personal to people can be and diabetes will be one cos there will be people, it is very common now, maybe there will be people who are diabetic or have relatives who are diabetic so we would have to handle that carefully.
>
> R:Pre1, 122-131

Such comments where R talks about what he ought to do, that is, broach such topics with care, taking account of the context in which they were discussed was again no different from those for Teachers J and C.

- undertake a variety of teaching techniques and novel experiences, the purpose of which was to place students in potentially embarrassing and controversial situations. This was something he felt he ought to do as a teacher. The most vivid example came from his recall of an activity he did whilst a certificated PGCE student. Three features about R's teaching are highlighted in the quotation which now follows: first his willingness to tackle these sorts of issues; second, how he was able to correctly choose an issue which would be of interest to most students even though it could cause embarrassment; and third, how he was able successfully to manipulate each of these so that students worked together in a meaningful and social way to produce - "some very good practical write-ups". Even though the incident outlined took place in a GCSE class, nevertheless, it is typical of the alacrity with which R talked about his use of controversial issues.

> I think the most controversial thing that I did was when I was an intern and the teacher I was working with ... I already had my DES number ... we did a practical on condoms and testing condoms and we had written to Durex and we got all the testing of the criteria that they used for testing and then we did a bit of teaching about that and then the students, we got them testing the thing. I think they enjoyed the practical immensely and I think that they got a lot out of it and I think that we got some very good practical write ups. I think we used it as a practical investigation afterwards as an assessment for the GCSE but what that meant was that you had a practical lesson where the

> kids were filling condoms with water, blowing them up and measuring which pressure they burst at ... air burst pressure is one of the criteria ... measuring and doing things. Personally another good thing about that practical was that it meant that you had kids handling condoms, pulling them about and looking at them and working together in groups with boys and girls. It ceased to be embarrassing because at the start they were embarrassed and some of them were quite gob smacked that they were going to be asked to do this ... they couldn't believe it. I thought that was good because that embarrassment had gone.
>
> R:Pre1, 144-162

As shown above even as a beginning teacher, Teacher R was not fazed by alternative modes of lesson preparation and implementation. He reported that he continued to engage with such innovative approaches if, as mentioned, they could foster student learning. R welcomed and was never threatened by alternative modes of lesson preparation and implementation and as suggested, this might well have been sustained by his high level of content knowledge. Evidence to support these notions was found in R's talk during the planning stage of the diabetes lesson discussed later in this theme. Even though such lessons did not guarantee that he would be in control of what students might be learning, he did feel comfortable with such lessons since he was in command both of the subject matter and with a view of science which he would like students to appreciate. The latter was reflected in the presentation of students' practical reports. For Teachers J and C, on the other hand, alternative modes - if contemplated at all - were approached with considerable caution. What Teacher C saw as her need to inform the school senior management of her involvement, bears testimony to this. This difference might be summed up in the following way: for Teacher R it was a question of "I ought to, I do and I will continue to use alternative approaches"; for Teacher C " whilst I might want to use alternative modes of teaching, I ought not to"; and for Teacher J "I don't because I do not feel confident about my subject knowledge".

It seemed then that for Teacher R, the use of controversial issues was one of many different approaches he might use to address the aims of the syllabus.

- continue his reflection on his own professional development and the academic and social development of his students. This was common for all participants and explains their involvement in the study.

> I like the idea that you have more of a chance to make, to get the kids to think about things as well as just learning content and by that stage many more of them have got an idea of what they want to do. They have chosen their A-Level subjects with a view to doing something and you can help them towards those goals.
>
> R:Pre1, 9-18

Whilst such an activity was not necessarily solely a characteristic of Teacher R's professional practice, it seemed that R placed more emphasis on doing this on a more regular basis. Such views were also expressed by the previous participants particularly in relation to the academic and social development of students, with any difference being seen in their talk about students' academic and social development. Whilst each participant would acknowledge that they engage students in thinking, Teacher R appeared not as concerned with asking students to garner facts and pieces of worthwhile information. For R it seemed more important that students be given the skills to apply what they knew to different contexts. This will be further discussed in a later propositional theme.

From R's perspective using controversial issues to teach biological content and scientific method was now seen as a more distinct possibility since syllabus changes had been made. Because unnecessary content clutter had been removed from the syllabus, it now more accurately reflected what for R was the nature of science, and in particular, what he thought was the purpose of A-Level Biology namely, reflecting the nature of science and providing students with the opportunities to think critically and to develop biological understanding. It appeared that the effect of these welcomed syllabus changes allowed R to somehow legitimate the syllabus. This he explains in the following quotation:

> I think the new 1995 AEB syllabus for examination in 1996 I think is a lot better and I don't think that I would be as critical as I was before. They have taken out a lot of the content and they have stressed process and analysis using their knowledge. I will give you an example. In digestion ... just do proteins and cut out the rest of the content. They then have used that bit of content to teach the principles and so by paring down the content, they have got a lot more space to put analysis in. They say that in the next three years the exam paper will go much more away from the recall of content to much more teaching/examining of processes. I think that is very good because I was always thinking that most of the A-Level thing should be about making people think, whatever the subject is.
>
> R:Prop, 27-38

Even though R had always viewed the teaching of controversial issues favourably, that they could now be incorporated in the syllabus, without compromising student examination success was seen as a positive step. In addition the revised syllabus gave support to R's previous belief that it should have as one of its main aims, the development not only of biological understanding but also appropriate research skills. The teaching of controversial issues was thus seen as one way R could achieve his personal aims. The importance of research skills, is illustrated by the following quotation:

> Also the other thing that I agree ... with the new practical element of the syllabus. There is a skill which is researching and it is not data gathering but information gathering and so the students have to gather information on a particular topic from a number of different sources and evaluate how much of that information is relevant and use the relevant information to write a concise piece. So they can do things like they were doing with the diabetes. What they did (*the students*) exactly fits that (*what the syllabus demands*) and then use that for a practical skill. Then S and I hadn't appreciated that when you came. So that was good and now we can see how that (*the study itself and the use of controversial issues*) fitted in. Yes now we can use it as course work towards the exam, that is the animal experimentation and the diabetes. Which is good. This now gives us more justification in doing it.
>
> R:Prop, 78-93

At the end of the study Teacher R reported that the AEB A-Level Biology syllabus had become more streamlined and the biology department had reviewed its scheme of work in order to accommodate the 1995/96 syllabus changes. As a result many of R's previous concerns with syllabus content, style of examination questions and class contact time had to some extent been removed. However constraints still remained with respect to the teaching of controversial issues and other alternative approaches (see R: Prop, 36-46).

As far as external pressure on the delivery of the A-Level Biology syllabus was concerned, R was aware that recent government guidelines could force him to teach in a more didactic way, something he did not welcome:

> ... also it is possible that you might have external agencies. I don't know how an inspection team would react to doing that. They might think it is wonderful or they might think it is a waste of time. I don't know but that is a possibility.
>
> R:PostPost2, 134-141

What R was unsure of was the response he might receive from government inspectors to his teaching of controversial issues and for this reason might now hesitate in using the kind of strategies he had used during his PGCE year.

Discussion will now focus in more detail on the second proposition of this theme, the role and responsibilities Teacher R believed he had as an A-Level Biology Teacher.

The image that emerged of R was as a confident, articulate biology teacher who appeared to have thought through and made explicit many aspects of his pedagogy. R was not personally or professionally threatened by outside interference, or by the interest shown by colleagues in his approach to biology teaching. As mentioned in the previous account, this was a particular concern for Teacher C. R believed that his biological content knowledge was sound and extensive, his view of science up-to-date and appropriately reflected in his teaching, and his teaching techniques and rapport with students well established, all of which afforded him the leeway he needed to explore new and innovative teaching ideas. This was in contrast to Teacher J who frequently mentioned what she perceived were her inadequacies in terms of current biological understandings.

Apart from the responsibility of ensuring that students passed the final examinations - "it has to be a major focus because you have an obligation to them to provide them with the best preparation for that exam", R believed that his other prime responsibility as a teacher of biology was that he present the discipline in such a manner which would enable students to appreciate the ways in which biological knowledge was constructed and how the discipline worked in practice, rather than as already mentioned, in the memorisation of facts. R's interest in biology education therefore extended beyond examination preparation and could be seen in practice, in his testing of its boundaries:

> I would have thought that for some teachers they would not have thought about using controversial issues. The thing that I thought was interesting about your project was that I thought it was an interesting idea and I thought immediately, ooh ... it has got possibilities there.
>
> R:Prop, 199-202

As part of his role as a biology teacher, R saw his participation in this study as an opportunity to explore in more detail what he had previously believed were the possibilities and problems for using the teaching of controversial issues to foster biological understanding, along with his wish to articulate what he perceived were the much needed changes to the syllabus. Despite what he believed about the heavy content load of the syllabus, R was of the opinion that controversial issues or for that matter any other suitable curriculum innovation, could be incorporated provided that teachers allowed themselves to be flexible in the way they conceptualised biology teaching. Meeting this demand was professionally satisfying for R - "I like developing new things, doing new things, thinking about new things and trying them out. The trouble is that sometimes, well usually, you don't have the time". This will be discussed in more detail in the following propositional theme. Suffice to say that from R's perspective, teachers had to be more aware of the inherent flexibility within the syllabus, be familiar with what was currently controversial, be imaginative in their use of such issues and integrate them where appropriate into their scheme of work. Typical of such comments are the following:

> I don't feel that there is a particular constraint. It is not a particular constraint but it is a bit more unusual to try to approach things from a different angle and that in terms of time and gathering resources and

preparation and that makes it more difficult. In that sense it is a constraint but it is not the syllabus as it is that does not rule out the teaching of CI.

R:PostPost2, 158-166

Such challenges were for R not only very welcome but also part of what he viewed were his professional responsibilities. The following passage taken from data concerned with planning the diabetes lessons, shows how R took up this challenge. Here he used the researcher not only to collect resource materials but more importantly as a sounding board for his ideas about the proposed lesson, and in the process gave some indication of how he went about planning lessons:

> I will get them to choose the resources and ... NDA and the drug company and what I would like them to do ... this then is the task ... which is to design and produce a leaflet/booklet for new patients ... It could be their age or younger, that would be quite useful for them to think about ... somebody younger than them because they have to think about the language they use. (*Elaboration of task rationale*) ... What shall we say ... for a 15 year old? Does that sound good? Yes. (*Thinking aloud to himself*) ...
> They must be some little kids who are diabetic who find out that they are diabetic at 8 or 9. There would be young children but I was thinking that the main point is to get them to understand ... you could have cards with different ages, they pick one and that is the one that they have to do it for and that stops copying. That is a good idea ... different (*R thinks of this himself - method of implementation - purpose of the lesson wrt A-Level student learning)*
>
> Let's have an 8 year old, shall we say a 14 and a 17. (*Organise students into what aspects of the task they'll do*) ... and some 60 year old when it is due to obesity. Yes that is fine , that is good. That is fine and I will make the card and they can just pick one.
>
> R:Pre3, 61-76, 84-90

Such a proactive interaction did not take place with the other two participants. Teachers J and C seemed to be more comfortable with commenting on the researcher's suggestions and collated resources, as opposed to indicating to the researcher what they would do in the proposed lesson. This difference can be seen in R's opening statement of the previous quotation - "I will get them to ..."; taking the initiative represented a distinct difference between R and the other two participants.

Because R appeared to be confident in his knowledge of many aspects of biology, his understanding of how biological knowledge was constructed and how it might most appropriately be taught to A-Level Biology students, future changes to the syllabus were seen neither as a personal nor a professional threat to his self-image as an A-Level Biology teacher. This contention was supported both in terms of his apparent lack of professional concern with the teaching of biology via comments such as:

I am enjoying this new syllabus and this year 12 class. This group is enjoying it. I think the changes in the syllabus have been a good thing ... I think it (*the syllabus*) is very good at the moment. So I am pleased with that and I think that they (*exam board*) have done a good job with the new syllabus and of paring the content sensibly and teaching the principles and with specific bits of content through out. I think they did a good job of that.

R:Prop, 165-172

and in particular, what he saw as the possible need for some teachers to rethink their previous approaches to A-Level Biology teaching:

... they (*examining board*) are expecting the students to apply the knowledge now in a more process and analysis basis rather than in the recall of content. I am now wondering if what you would call traditional normal A-Level Biology teaching, I wonder how much that will have to change and if people are stuck with things like ... I did this 10 year ago so I will do it now ... you know what would happen to the results? Do you see what I mean? ... They (*teachers*) have to change the way that they do things ...

R:Prop, 237-247

R also regarded it as important that teachers should be familiar with other A-Level syllabi and their mode of assessment. For example, even though the 1995/96 AEB A-Level Biology syllabus had been favourably received, R was nevertheless interested in investigating alternative approaches (possibly found in other A-Level Biology syllabi), primarily so that more students could experience success both in learning biology and in their final examinations. In his words:

I am conscious of the fact that just because I learn things one way well that might be helpful but that does not mean that that will work for everyone.

R:PostL3, 190-191

For this reason, R and his colleague (Teacher S - Participant 4) were contemplating a move towards modular A-Level Biology as an alternative approach because of its continual assessment component - "It might be another option rather than exams in one hit. They would have some exams in the first summer and then some exams in the second summer". However, several problems with student maturation and administration still needed to be resolved before any changes could occur. As he remarks:

One of the problems with the A-Level is that students mature over the two years and I think that the biggest argument against modular A-Levels is not only is there an increase in administration but that if you test the students too early then they have not gained that maturity and then they do badly in module tests. But if we could do the AEB in each summer that would be good and they would have goals to work to which would be good for the students.

R:Prop, 177-190

Even though this aspect of R's A-Level Biology teaching remained unresolved at the close of the research, nevertheless he continued in his endeavour to find and develop more appropriate ways of presenting biology to students, as seemed to be evident in the following correspondence:

> It is refreshing to think about aspects of your subject in a new way. The diabetes exercise we did was useful and I think the students enjoyed it. It can (and will) be used again as we now have a wealth of resources. The information gathering element which students had to do for themselves is especially useful as a practical skill as part of the new AEB course work assessment. Let me know if you have any other questions.
>
> Unsolicited correspondence received from R
> after the Propositions Interview - 2 April 1996.

To summarise, even though as with J and C, external examinations and adequate time to cover the syllabus remained concerns for R throughout his involvement with the research, he was able to conceptualise both in such a way that they could assist him in his A-Level Biology teaching whilst not compromising what he believed was a sound biological education for all A-Level students. It seemed that Teacher R did not see these limitations in the same way as might Teachers J and C.

For Teachers J and C, the nature of the A-Level Biology syllabus, irrespective of examination boards, was perceived as a control mechanism for the way in which they could conceptualise their aims and objectives for teaching biology at A-Level. For these two participants the boundaries of the syllabus were perceived as restrictive, if not at times rigid, and therefore teaching strategies needed to be strictly housed within such boundaries. This was how Teachers J and C saw their role and responsibilities as biology teachers. For Teacher R the perception was somewhat different. He seemed to be of the view that syllabus boundaries were more flexible. This meant that he could, even if not always test these boundaries by employing alternative teaching strategies, then at least think about such alternatives.

The following propositional theme explores what Teacher R saw as the nature of science/biology with comparisons drawn where appropriate with Teachers J and C.

7.4: Views of Science/Biology

Scientific research for Teacher R was an activity where the emphasis was not only on the development of ideas but also one undertaken in a social context where politics and economics for example often played key roles.

The following propositions deal with R's beliefs concerning the nature of science.

R saw science as a body of knowledge continually undergoing modification in the light of new evidence, interpretation, analysis and criticism. Thus R thought the current A-Level Biology (1994/95) syllabus did not reflect what he thought was the nature of science and as such ought to be reconceptualised and rewritten to take into account, scientific methodology, STS type issues and real, new, innovative biological research. Furthermore, R bemoaned the fact that some of the more traditional areas of biology e.g. taxonomy were no longer on the syllabus or at the forefront of current scientific research and funding.

For R there seemed to be two pervasive aspects concerning the nature of science. First, that science was more than simply a body of knowledge; it was a body of knowledge open to rigorous intellectual challenge, experimentation and the application of technology. Second, that it was important for all members of society to become scientifically literate[10]. By this R meant that scientific evidence could be scrutinised by the general public for bias and inaccuracies. Here R felt he could make a personal contribution through his teaching:

> Society has to make a decision about how scientific discoveries and technological applications are used or whether they are used or not. You need that information base in the population if society is going to make those decisions in any informed way.
>
> R:Pre2, 25-30

Unlike Teacher J, R seemed more at ease with the challenge of using both his broader biological knowledge and what he had come to believe was the nature of science/biology in his classroom teaching. Included in what R saw as the need to foster scientific literacy and the public's understanding of science, was his belief that students ought to be competent in the skills of data collection and analysis along with the distillation of facts, opinion and myth. This for R appeared to be part of his conceptualisation of the scientific method and was further enhanced by his use of correct technical language whenever appropriate, and his need to keep abreast of scientific/biological research.

[10] This is referred to in the literature as the public understanding of science (see Chapter 2).

These were especially important when some of the more able students in his A-Level Biology classes undertook this as a matter of personal interest:

> ... you have all of them wanting a qualification and some of them wanting to use that. Then you have the others, all of them as members of the population in general and having a background in science and being able to use that in the future and being able to think back on some of the information that they know and then being able to take on board more information and to be able to distil the reality from the media if that is where they are picking their information up. Having practised at least some sort of decision making process and weighing up evidence and looking at different points of view and knowing the difference/different agendas that different people have on particular issues.
>
> R:Pre2, 39-45

Practical work at least for Teachers J and C was generally conceived of in terms of verification of existing findings - a situation which sat comfortably for J in particular but at times caused C some tension. For Teacher R, other than his mention of the incident in his PGCE year, practical work did not surface as an important point for discussion. What R wanted to do was comment upon his own conceptualisation of the scientific method and how he had developed this into a viable teaching strategy rather than any direct reference to practical work. Unlike J and C, the notion of 'real biology' in terms of the way in which current scientific research was carried was not on his agenda. R believed that his view of science permeated all aspects of his teaching and therefore did not question whether what was taught in his lessons modelled what occurred in scientific research. Teachers J and C did, and for Teacher J in particular, the idea that students might consider fieldwork and the more interesting aspects of their practical work part of their image of real biology, was a concern. In fact as indicated in her account she seemed to dismiss students' ideas of biology as irrelevant to her own personal and professional agenda.

Along with R's concerns surrounding the AEB syllabus, already referred to earlier in this account, was that despite its positive and substantial update it had, in his opinion, failed to include any mention of some of the more traditional areas of biological research, for example, ethology and taxonomy. R believed that these areas had much to contribute to an overall understanding of biology especially in the field of biodiversity. R appreciated that much of biology in the coming decades would be biochemical in nature but nevertheless thought these and possibly other areas, still needed further research funding and technical support so that current expertise could be maintained. All of this R highlighted in the following extract:

> ... classification (*taxonomy*) is being taken out ... whole groups and phylum just disappear as far as I am concerned. That worries me because it is happening at all levels. The expertise is being lost and species diversity and speciation and is not very well funded and it's going ... it is a problem when species diversity is so important and changes in things could be indicative of other things i.e. climate change like when there are so many habitats being destroyed and we don't even know what is in them. To have that base of expertise go just through lack of funding is wrong I think. If it goes at the school level your A-Level students applying for university won't even know that that is a possibility. By enlarge they do the things they know about.
>
> R:Pre2, 244-260

What the new AEB syllabus was perceived to be doing was in some way reflecting areas of current biological research - "I think this is true to an extent but the revised syllabus is an improvement"[11]. However, a historical context also still seemed important for Teacher R. This, along with his mention of the politics of scientific funding, although given only a brief mention when he referred to the research and development costs for the development of humalin, were features quite peculiar to R in his view of science/biology. These features were helpful in coming to a better understanding of what for R seemed to be a more inclusive view of the nature of science compared with what the other participants seemed to portray.

Presenting a modern view of science/biology to students was a central purpose in R's teaching. This involved presenting new and innovative biological research which took into account STS type issues. These sentiments were expressed by R throughout the study in terms of the way he viewed the A-Level Biology course, the value of employing alternative teaching approaches to enhance student learning, his expectations of students as learners and what he perceived were some of the underlying views of the nature of science as portrayed in the syllabus. Nevertheless, from R's perspective much of the syllabus he believed required him to transmit a body of knowledge to students without substantial alterations or questioning. However, this seemed to cause him tension particularly as he thought some of its content knowledge to be provisional in nature, something which he reported he would ideally like to convey to students.

When asked how he would ideally like to teach biology at A-Level, his response was complex and included a detailed elaboration of what for him was the essence of biological understanding and learning: a move away from an emphasis on examinations and content acquisition, to one where the skills of acquiring knowledge and practical application were more important. What he thought he was presently doing was delivering content to often bored students. From the perspective of Teacher J, it seemed that she was comfortable with her current approaches and had meet her professional

[11] Evidence obtained from R's Propositions Interview.

responsibilities. Even though C questioned some aspects of the syllabus, in particular the PEST aspects, she seemed resigned to its requirements. The following quotation illustrates the complexity of R's teaching ideal and what for him was the purpose of understanding and applying the scientific method. These comments marry with R's concern for fostering a life long interest in biology amongst students:

> No exams and a restricted timetable ... this is quite a difficult concept to get my head around (pause) I think that I would teach less content. I think that is going to happen anyway because if you give someone the skills of acquiring knowledge then you don't have to ... anything they need to know they will obtain for themselves and it is more important to do that then to actually tell them the facts ... if it was ideally then I would probably do it so that there was a lot of self study and a lot of questioning ... the teacher is a facilitator ... to do that, you have to be prepared to do that, and the kids have to get into a position where they are able to do that first, I think, because they may not be use to it. I think that is the way that it would be, and shall we say then that half the time would be learning biology and applications, and half the time would be problem solving and thinking. Practical work is the applications ... ways that bits of Biology are applied say industrially, you could mimic that ... you can discover things through practicals ... you might have to demonstrate things in practical or you could also model things through practical work.
>
> R:Pre2, 210-220

To conclude this propositional theme, R seemed to hold a somewhat more developed rather than a necessarily different epistemological view about the nature of science compared with J and C. For R, bringing such a view into his A-Level Biology lessons was both desirable and possible, whilst to varying degrees for both J and C, even though this was no doubt desirable, was not necessarily possible for various reasons already mentioned in their respective accounts. R seemed to view his teaching of A-Level Biology as more than the transmission of content and seemed to report this more explicitly in the study. From his perspective he wanted students to appreciate that science was a provisional body of knowledge open to change and as such needed to be continually up-dated to reflect changing ideas and interpretations. Whilst R was keen to develop this understanding amongst students, the current A-Level Biology syllabus because of its assessment demands often provided little opportunity for this to become a classroom reality.

7.5: Teaching Student in the A-Level Biology Course

R's view of students centred on his belief that since they had chosen A-Level Biology, then as future citizens they needed to be scientifically literate. Here he felt he could make a positive contribution. In addition R felt he had a professional responsibility to students to ensure that their interest in the subject was maintained and that for those who were seeking a qualification, this expectation be met.

The two propositions which now follow attempt to reflect what R saw as his professional responsibilities towards students.

(i) **R aimed to foster a lively interest and enthusiasm for biology amongst students who as future members of society ought to be scientifically literate.**

(ii) **Teacher R seemed to be of the opinion that the current AEB syllabus had the following limiting affects on students and therefore as one of his professional duties endeavoured to cater for students of all abilities.**

- **Because the syllabus was content dense, those students who found biology conceptually difficult became easily despondent.**
- **Many of the more able students were disadvantaged because the syllabus was so broad in its coverage, that there was not the opportunity for them to come to a deeper understanding of many areas of biology.**

In terms of student success, R's aim was to provide a conducive learning environment where students were encouraged to think for themselves and in the process become scientifically literate as explicated by statements such as:

> But I think it (*teaching and learning*) is more about getting them to think for themselves and getting them to use their brains and to use the knowledge that they have got.
>
> R:Prop, 204-208

Fostering a lively interest in biology amongst students was perceived by R to be possible in two ways: first, by providing opportunities for students to make conceptual links between various areas of biology; and second, by motivating students to think for themselves despite the content load of the syllabus. These will now be discussed in turn and comparisons made where appropriate with the two previous participants.

Assisting students to make conceptual links between biological concepts was done by R in order to present a multi-faceted view of biology, as discussed in a previous propositional theme. R attempted to achieve such an aim through his use of controversial issues, biological models, and his use during lessons of explicit examples drawn from his background biological knowledge.

Making biological models, in the form of molecular models, posters and displays, formed an important part of R's teaching and was unlike that for Teachers J and C who both favoured more traditional approaches. The value of models in terms of assisting students in their learning of biology was seen by R in several ways - building up conceptual understanding based on simple concepts, raising self-esteem through a sense of achievement, and fostering social interactions amongst peers when working together. This seemed for R to be a way in which he was able to encourage students' interest in and enthusiasm for biology - part of his professional responsibility as a teacher. How models assist in student learning is explained by R as follows:

> Making things, somehow making visuals to represent something actually helps you understand it. When we were doing biological molecules with Year 13 I like getting those molecular kits out and making amino acids and making peptide bonds ... I think making them and doing the things helps a lot rather than a flat picture in a book. I think it does. I think that helps. I think the same for displays ... the one going up is on enzymes and they did that themselves ... they did a diagrammatic sequence of a lock and key model, they made that and actually making the things and thinking about communicating it is a good way of learning.
>
> R:Pre3, 231-238

The second way in which R attempted to make conceptual links and in the process make biology more accessible to students was through repetition and reinforcement using examples familiar to students. The following quotation taken from the post lesson phase graphically illustrates his thinking about why he employed such a teaching strategy. Teacher R demonstrates this using as an example from the first lesson, talk about the maintenance of blood glucose.

Context: Stimulated Recall of Lesson[12]

> *If our brains were deprived of glucose we would start to exhibit a number of symptoms like drowsiness or mood changes as the first stages and if our brains were deprived of glucose for long enough we would eventually go into a coma and even die if we weren't treated. The control of blood glucose is very important. Lack of glucose in the blood stream could result in going into a coma(repeated again). We need then to make sure that there is enough glucose in the blood. So you might think well that is all right just make sure that your blood is full of glucose all the time and you will be alight.*
>
> (He reads the following sentence from the transcript) "lipids could respire or even proteins ... okay? But primarily our cells use glucose as the respiratory fuel. Our brain cells can only use glucose so you must have a constant supply of glucose to our brain cells."
>
> Okay now that is a ... if you like a piece of physiology ... it is just a fact (his emphasis) ... the next bit is ... what does that fact mean? Yes! What it would mean to an individual, a real person if that did not happen. That is why I put in the symptoms ... okay ... and then reiterate the: " The control of blood glucose is very important." Here I reiterate again what I have just said. I do do that a lot. I do repeat things.
>
> I consciously repeat things ... or say things in a different way. That was one of the points that I was trying to get at " Lack of glucose in the blood stream ... control of glucose is important ... lack of glucose ... coma." That is where I have reiterated ... and then again, "We need to make sure that there is enough glucose in the blood"
>
> I did not have this verbatim worked out but I had what I wanted to say and I am use to repeating things and reiterating things and I do this ... we have a bit of biochemistry (pointing to that section in the transcript) and "... control of glucose is very important " I keep saying that and I keep putting that sound bite into their heads.
>
> It is something that I do ... to be honest in all the areas. It is something that now I do without thinking about it. Yes?

Reiteration was necessary R felt because students found it difficult to link biological concepts into a meaningful whole, a similar concern supported by students who were interviewed. One student in particular explains this by comparing teachers' expectation of their learning in GCSE and in A-Level:

> In GCSE it is more ... they tell you what to write down and you learn it but here you have to use your knowledge more and apply it and learn some experiments ... sort of ... say find out what is in a substance and you have to apply it to different situations than GSCE where you know it and you just write it down ... now you have to apply it more.
>
> Student A.

[12] R's classroom talk is in *italics*, his response to the audio tape in plain text and transcript annotations and points of clarification made by the researcher in () brackets.

What the preceding two quotations seem to suggest was that for many students the process of making links within and between biological concepts was problematic. For this particular student at least, the application of biological concepts to novel situations remained difficult. The implication of this in terms of the teaching of controversial issues will be addressed in Chapter 9.

Providing classroom opportunities where students were encouraged to be active, challenged, autonomous thinkers willing to learn was the second way in which R believed he could foster biological interest. Essentially at A-Level, teaching and learning was for R a two way process between students and himself. From his perspective A-Level Biology students had made a choice to undertake studies towards the A-Level award - "I view them as people who have now chosen to do what they are doing ... and that then means that I have certain expectations about them", and so ought to be encouraged to make decisions about and feel responsible for their own learning - "there is an atmosphere where people don't sit at the back and just cruise along. I think that that is the best thing for the whole group for learning", although this was difficult in practice.

This belief that students ought to be encouraged to make decisions about their own learning seemed to be a odds with the view of some students who felt that their contributions to lessons were not valued, and so decided to display little motivation and enthusiasm. The next quotation, part of a discussion between two students, depicts how many believed teachers thought they learnt and understood biology, and why they felt somewhat frustrated about their contribution to lessons:

> St B: I don't think that they know much about what we know ... they jump into things which we don't know. We don't know what they are talking about.
>
> St C: They just presume ... I have not noticed it ... if you state something in class I have not noticed that it contributes to what they are saying.
>
> St B: It is not that we don't know anything.
>
> St C: They are there to teach us what we don't know. They have got to assume that we don't know much.
>
> St B: I would like it more ... to see it where you get a lesson where you think about it afterwards and it is not just ... end of the lesson. I feel that I come away from the Biology lesson and that is it.

For all three teachers fostering in students a long-term interest and enthusiasm for biology was an important aspect of their teaching and part of what each had come to believe was a sound education. Differences in participants' perceptions of students was often more a matter of degree. For example Teacher J saw her students more in terms of examination grades, and if student success was achieved then her professional responsibilities had been discharged. Although still important for C, in addition she thought it desirable that students be aware of the moral and ethical implications of science, as reflected in her comments concerning PEST, and that they become critical thinkers.

The second responsibility which R had towards A-Level Biology students, something he wished to pursue throughout his teaching practice, was that they become scientifically literate. What R really wanted to do was to encourage students to question all aspects of the scientific process and in so doing gain an appreciation of how ideas were developed, knowledge was understood and interpreted, and how these in turn were applied to new situations. Ideally this meant that students would begin to think and discuss both critically and rationally, apply new information to various contexts and check for validity and reliability of evidence from the beginning of the A-Level Biology course. It could be that this was the way in which Teacher R saw the role of practical work as part of his teaching practice.

For R public access to scientific understanding was important and for this to be achieved the general population needed to be scientifically literate. Such views seemed to marry with those of Teacher C. From her perspective as an A-Level Biology teacher, it was important that students develop skills in asking searching questions when presented with challenging evidence. Similar beliefs and ideas was articulated by R when he commented:

> Yes I think that is true (*referring to the above proposition*). Yes and when you think about that current thing about BSE, it matters that your are scientifically literate, if you eat meat then you need to know about this. If you don't have some basic knowledge and you have not got the skills of being able to evaluate what different people are telling you, you might just be swayed by whatever is the next thing on the TV rather than being able to make an informed decision and so, being scientifically literate is important. You hear the farmers union saying that it is totally safe and to eat what you want. Others are saying that no it is not and that you are going to have half a million people with CJD in 50 years. Who do you believe? You have got to have some basis on which to make your decision even at a personal level.
>
> R:Prop, 126-135

Even though Teacher J never mentioned scientific literacy *per se*, she might have referred to it indirectly when talking about her concern with the acquisition of content knowledge and her rationale for practical work, although this was difficult to clearly ascertain.

One of the ways R thought students might become scientifically literate was through the teaching of controversial issues (refer to R:Pre1, 73-80 in first theme). Because controversial issues often dealt with topical scientific research, R postulated that student interest would be aroused to such an extent that they would be placed in a better position to ask less superficial questions and so develop a more informed, broader and deeper understanding of biology.

R was of the opinion that A-Level students were now of an age and maturity when they ought to be seriously starting to think about some of the moral, ethical and technological aspects of science/biology, rather than as he believed some of them did, simply view science as a set of neutral, value free facts. Any subtle differences here between participants rested in how they viewed students' background knowledge. For J in particular this was seen as more problematic than for either C or R who both seldom referred to this as an issues for consideration. The challenge of somehow asking students to think independently was where in R's view the teaching of controversial issues had an important contribution to make in terms of student learning and their view of biology. The following comment helps illustrate this:

> What they (*students*) would get out of it (*the controversial issues lesson on diabetes*) ... they would have an example of how a piece of technology (*genetically engineered human insulin, pen devices*) ... well interacts with real life (*people*) ... and they would have practise at thinking about that and thinking about how things actually work and other things like presenting arguments, collecting evidence and things like that?
>
> R:Pre2, 139-142

The second proposition in this theme refers to what Teacher R perceived was the influence the A-Level Biology syllabus had on student achievement.

From R's perspective the main objective of the AEB 1994/95 A-Level Biology syllabus was the acquisition of biological knowledge and mandatory practical skills which would be examined and assessed after two years via formal written examinations. Therefore in his role as an A-Level Biology teacher, it was important that students be given the necessary skills to pass these examinations. What R wanted was not only that students obtain examination success but in addition, they became both scientifically literate and critical thinkers. Balancing the professional requirement that students be adequately prepared for the final examination and his personal belief that students be both scientifically literate and critical thinkers needed his continual attention and given the time constraints under which he was teaching, this often caused him tension. This tension applied when motivation for some students was low, especially when the content was conceptually difficult, or tiresome for those students seeking an academic challenge and deeper biological understanding. Maximising learning for all students, fostering scientific literacy and keeping abreast of scientific reading were all viewed by R as part of his professional responsibilities as an A-Level Biology teacher and thus integral to his teaching practice. What seemed to be the case was that R viewed the A-Level Biology course and A-Level Biology students in terms of three levels. First, the A-Level Biology course provided a means whereby students could gain a qualification which allowed them access into post 18 courses - "They have chosen their A-Level subjects with a view to doing something and you can help them towards those goals". This was supported with evidence from student talk on the many and varied reasons why they chose A-Level Biology:

> I got a good result in science last year and I felt that I did pretty well in biology ... something that I wanted to do.
>
> Student J.

> I wanted a break because I was doing History, Art and English.
>
> Student S.

> Because I am really interested in Science and Biology particularly, and it is really appealing. It is really interesting I suppose.
>
> Student D.

Second, the A-Level Biology course was a way of educating future generations to become scientifically literate and interested in biology in future years, typified in remarks such as - "I do believe that it is important that for society that there is a large proportion of the population who have a good understanding of science".

The third and final level was as a way of developing students' thinking so that they themselves might come to review critically evidence, opinions, beliefs and values:

> More and more the syllabus is getting away from recall of information but more to techniques, applying and thinking. Thinking is more important. There use to be a time when if you had a good set of notes you could get a good A-Level but I think you can't do that now. You have to have the information but that isn't going to be enough without the understanding and the ability to apply it really well ... science is quite a body of knowledge and you have all of them wanting the qualification and some of them wanting to use it.
>
> R:Pre2, 22-38

Clearly then, conceptualisation of teaching and learning for R, was not only about the transmission of factual information. It was also about the need for students to become competent independent critical thinkers. However in the reality of classroom practice, as revealed in R's interviews and those of his students, and lesson observations conducted by the researcher, R's rhetoric and beliefs did not always marry with those of his classroom teaching.

In reference to his lesson, he remarks that in general - "often they are just ... chalk and talk really" but "it varies even though it might seem to be all the same thing".

Often it was because of syllabus and time constraints that R felt he was forced to employ lecture type formats which he knew saved time but did not in any way guarantee students' biological understanding. This was and continued to remain a personal and a professional dilemma for both Teacher C and himself. However, this tension was not as evident for Teacher J for whom there was simply no time to engage in alternative approaches. The tension she experienced was more related to her concern with content acquisition and the final examination. In addition tension for Teacher C was manifested in her concern with her professional image from the perspective of colleagues and those in authority.

By way of summary, R believed he discharged his professional responsibility to students by actively fostering a positive attitude towards the understanding of biology and its STS aspects. By doing this he developed scientifically literate students, something which he valued as part of a sound science/biology teaching practice. Employing alternative teaching strategies was one way in which R thought he could interest all students and in so doing attend to more specific student learning preferences. The following propositional theme deals with the teaching of controversial issues.

7.6: The Teaching of Controversial Issues in relation to A-Level Biology

R was of the belief that the teaching of controversial issues could be viewed in two different ways.

(i) Because controversial issues were often about topics of social and biological interest, R believed that they could stimulate student discussion, articulation of opinions and social development.

(ii) Because controversial issues were by their very nature controversial, they highlighted areas for discussion and debate where often no definitive answers existed. This controversy R believed could foster in students an understanding and an appreciation of the complexity of such issues and thus be valuable for their intellectual growth and maturity.

Throughout the study, R gave an informative account of his views on the teaching of controversial issues and how he had approached such issues in the past. It seemed clear from the ease and depth with which R articulated these views that he had a clear sense of the value of teaching controversial issues, not only for the development of social skills such as discussion, but also as a way of teaching biological concepts. It seemed to be the ways in which R thought about various aspects of his A-Level Biology teaching practice, as previously discussed, which might well have influenced his approach to innovative curriculum ideas. R was the only teacher in this study who indicated any previous planned, formal use of controversial issues as part of his teaching. Such issues had included diabetes, the use of foetal tissue, contraceptives, vegetarianism and green issues. For Teachers J and C any previous use of controversial issues had been more as a spontaneous class discussion of no more that five minutes duration, and as reported by both participants merely raised student interest levels. For R there was the additional possibility that the teaching of controversial issues might assist students' learning provided that syllabus content and examination success were not compromised.

It was for these reasons that R seemed to view the value of teaching controversial issues in two ways. The first related to the need to find an issue which excited students so that the learning of content followed as a matter of course - "if the issue is controversial then they are more likely to be interested and more likely to have an opinion on it, and then if they do, they are more likely to delve more deeply into it". This then seemed to support his idea that the teaching of controversial issues and other alternative approaches, along with more traditional teaching, assisted students' understanding of biology - "that will help in their understanding of the background. They will pick up the background knowledge because they see that there is a purpose to doing, it, not just doing it because they have to learn it. There is a purpose", and in particular, that controversial issues could provide an entry point for some students in coming to an understanding of biology - "controversial issues are an access point for the syllabus content ... an interesting way to access the syllabus". This gave rise to R's believed that students had various approaches to learning. This belief married to some extent those of Teacher C who was of the opinion that for some students the use of controversial issues as an approach to learning could be the only way, if not then another way, to engage them in biology.

This view of controversial issues, where biological knowledge had a sense of purpose in the discussion of the issue, was not evidenced by Teacher J. That students were actively engaged in a meaningful way with the tasks required during the lesson on organ transplantation was somewhat of a surprise particularly for those students whom she perceived were less academically able.

The second view held by Teacher R in relation to the teaching of controversial issues was that addressing controversial issues could provide students with a glimpse of what science might be like outside the confines of the A-Level Biology course. Again it was Teacher C rather that Teacher J who expressed similar ideas. As R goes on to explain:

> It helps them to realise that science and things in biology are not just in text books but is something that is going on **now** (*his emphasis*) and it is also something that they can be a part of should they choose to want to be. That is good. It can be an entry point to other things ... things that are in the news now and are going on now. You can then explore other issues through that.
>
> R:Pre1, 73-82

This painted R in a particular way - quantitatively not qualitatively different from Teachers J and C. The only proviso for R in terms of the A-Level Biology course was that such issues be relevant to the aims and objectives of the course, so as not adversely to affect student examination performance. The following extract typified this concern and was not unlike many of those expressed by the previous two participants:

> You can justify a lot of things because you are just not just teaching content, you have a wider responsibility, and you have moral responsibility. I think you can't be justified in going way out on a limb on something that really had no connection with the syllabus and so you can say ... well, it is a pity but ... there are things that you can do but you are still constrained a bit then, you are always constrained. You just have less than two years.
>
> R:Pre1, 132-140

Even though all participants were of the opinion that controversial issues were valuable educationally, R also believed that there were difficulties. These were first that the issues under consideration had to excite the interest and imagination of most students and second, issues which teachers thought controversial need not be controversial for students and vice versa. Such sentiments were unlike those of Teacher J who was of the opinion that in the reality of classroom practice controversial issues were unable to sustain student interest for a significant length of time.

The first of these difficulties was evidenced in the third diabetes lesson, the debate, when students' interest and motivation had begun to waver, even though according to R, this was unusual. R believed this was because diabetes management was unfamiliar to students and not as intrinsically motivating as other controversial issues[13] might have been. Nevertheless R still thought this issue, and the use of a debate as a teaching strategy, appropriate for A-Level Biology students. In future he would begin with something obviously controversial to students and leave those seemingly less

[13] From the students' perspective, as evidenced in their interviews with the researcher, organ transplantation and animal experimentation were more interesting.

controversial issues to pursue later in the course. This was endorsed by comments such as:

> In fact if there is something else that they could get hot under the collar ... it might be better to do that first and then do diabetes later when they have got the hang of what they are suppose to do.
>
> R:PostL3, 211-213

Thus for R at least, it was very likely that lessons addressing relevant controversial issues would be used in the future. It is interesting to recall that for Teacher J, when asked what she had planned for the following lesson, her response was in terms of completing work which students had missed because of the organ transplantation lesson. Teacher C on the other hand indicated that she needed more convincing evidence that biological concepts could be learnt and more professional assistance in how this could be best achieved. R was in this respect much clearer in what he believed controversial issues could do and how this could be achieved.

The second of these difficulties concerned the difference in opinion between what R and his students thought was a controversial issue, a point aptly exemplified in the next quotation dealing with the theory of evolution:

> First it will be the controversial issues which will interest them, more because they are controversial but then again there is a slight difference as to whether I think that they are controversial or not or if they think it is. Different people in the class might think that it is controversial. Like this RC priest said to me that evolution was a 19th century debate but there would be people who think that it is rubbish. That could be a problem. They could be in the fundamentalist Christian range ... that is the point that I want to make. Yes there are things. On the other hand I might think something is controversial. They might not see it, so there's an issue there. So you have to get it right, something that you think is controversial and you think will be interesting, is interesting, and then it will fire someone's imagination. Usually an A-Level student will be like that ... at least when they get into the core.
>
> R:Pre2, 46-56

For R there was a perception here that students' opinion and interest might be at odds with his own views. This extract also gave a hint of R's beliefs concerning the nature of science albeit for one possible controversial issue that of evolution, a view addressed in a previous theme.

Furthermore, teaching from R's perspective as a biology teacher was not only about ensuring that students were motivated to acquire biological understanding and scientific literacy. Rather it was also about setting up classroom environments which provided educationally valuable situations where students could become responsible, socially-aware thinking individuals. In view of recent syllabus changes he remarks:

> If you are interested, I think the new AEB syllabus (1995/96) does offer other areas where teaching through controversial issues is possible: deforestation, transplantation, vaccination, agricultural management - chemicals, genetic engineering, transgenic animals and drugs (which affect the synapses).
>
> Correspondence received by R after the Propositions Interview.

Now that the syllabus had been changed, the use of controversial issues could potentially at least now play a more significant role. Here he saw opportunities for informing students about the nature of science, in particular how knowledge was constructed, for developing an understanding of biological concepts learned in familiar contexts, for fostering social skills such as group discussion and debate and finally, for developing an awareness of students' moral, ethical and social responsibilities as future citizens.

Such views were evident when R expressed his concern that issues such as contraception and AIDS, along with various other aspects of human reproduction, had been removed from the compulsory GCSE science course and were now part of a course termed personal and social development (PSD). This is attested to in the following typical reflections:

> It is amazing isn't it! They have taken it (*contraceptives*) out of science and put it in PSD which means that science is compulsory, PSD isn't so that was a bone of contention ... so now learning about AIDS and contraception and STD were all part of the compulsory curriculum for everybody. Some people in the House of Lords thought that parents should be able to withdraw their children from those lessons and so it was changed. I don't think that it was a good idea, rather a stupid idea especially if the aim of the government is that sexual relationships would be taught with some sort of moral content so to divide sex up into the mechanics in science and then people's emotions in PSD is a bad idea. But that is what has happened.
>
> R:Pre1, 172-182

What concerned R, in terms of outside influence on his teaching, as illustrated in the above quote, was that he might be placed in a position where from his perspective, he could no longer discharge his professional responsibility by informing students of some of the moral, ethical and societal aspects of science. At a more general level R was aware of and sensitive to the constraints imposed by outsiders on teachers who wished to adopt and use innovatory curriculum approaches in their teaching. The views of inspectors about such innovatory practice and the perceived impact of government policy on the way he should be teaching for example, although a potential reality caused tension, and as such were for various reasons unwelcome and unhelpful. This perceived tension was true for Teacher C who also seemed somewhat ill at ease with outside influences. For Teacher J, this tension was not manifested in the study.

In broader terms, controversial issues teaching was in R's view not solely restricted to science/biology. R believed that they had a wide appeal across various curriculum areas and across various age groups, a belief never immediately evident from the previous participants. His use and elaboration of foetal transplantation in his General Studies classes provided such an example - "we looked at that and the whole issue of foetal tissue and the ethics of it ... I think that they were interested and they did quite well". This broader and more inclusive view of the possibilities for the teaching of controversial issues was a specific feature of Teacher R and not shared with Teachers J and C.

Central then to R's beliefs about the teaching of controversial issues was that many of these issues were both socially and intellectually challenging. Students found themselves in a position where they needed to think on their feet, and formulate and defend an opinion whose boundaries were not necessarily clear, whilst still working within a social group. R believed this was part of his responsibility as a teacher, to broaden students' understanding and to provide such opportunities for intellectual and social growth. Therefore outside directives perceived by R as interference in his classroom practice were not welcomed. R's professional responsibility was thus discharged by providing classroom opportunities where students could explore the issues.

In conclusion, controversial issues teaching was valuable to Teacher R for two important reasons: first as an opportunity to inform students about the nature of science and second, to foster social awareness, social skills and biological understanding. Such detailed and articulated thinking relating to the teaching of controversial issues was found throughout his involvement in the study, no doubt aided by his view of how biology might most appropriately be taught at A-Level. Another reason for this could be that since R had already used the teaching of controversial issues as part of his normal teaching practice and was familiar with its possibilities and problems, he had conceptualised his rationale for the use of controversial issues before the study had begun and therefore his involvement in the study was viewed as an opportunity to further develop that conceptualisation. This did not seem to be the case for both Teachers J and C.

Participation in this research was for R a further opportunity to reflect on his professional practice, something he undertook on a regular basis. For R there seemed to exist a tension between his personal convictions about the teaching of A-Level Biology and the constrains imposed upon him by a content dense syllabus. Some of his concerns - for example those related to time constraints and the final examination - mirrored the concerns of both Teachers J and C.

What characterised the A-Level Biology teaching practice of Teacher R was the manner in which he incorporated his views about teaching generally, his willingness to think about and employ alternative strategies, his expectations of students and his belief about the epistemological nature of science. However, R's primary personal conviction was to make students think. Accordingly he appeared to be continually reflecting on his A-Level Biology teaching practice in order to achieve that purpose.

Despite what R believed was a syllabus rich in content, he was of the view that there were opportunities in the A-Level Biology syllabus where alternative teaching approaches such as the use of controversial issues could be incorporated albeit as an adjunct or bolt-on, rather than as an integrated approach, provided that teachers were imaginative in their approach to biology teaching and student examination success was not compromised. This for R included a move away from the more traditional method of content delivery to one where students were involved and responsible for their own learning. In particular he was keen to emphasise his openness to innovatory practices although the administrative demands of A-Level Biology teaching often left him little time for the necessary planning and preparation for such lessons. In addition, his concern to ensure that students were successful in the A-Level Biology exam constrained him both in the time he felt he could allocate to exploring issues which whilst of interest to him, and perceived as being valuable in terms of his concern with making students think, were nevertheless considered peripheral to the business of covering the syllabus and preparing students for examinations. This was a common concern for all participants.

R believed that he had a comprehensive biological knowledge base which he drew upon when teaching A-Level Biology. Combining this with his pedagogic skills allowed him to present a view of science/biology to students which was not only current but at a level of understanding suitable for their immediate and future needs. Because R was confident in all aspects of his A-Level Biology teaching he did not view the teaching of controversial issues as an imposition on his teaching. For him the teaching of biological controversial issues had many possibilities including social skill development and biological understanding. Moreover since the new syllabus now afforded more opportunities for using alternative approaches R perceived that any further constraints rested on the ability and willingness of teachers to embark on new and innovative teaching practices.

Chapter Eight: Teacher S

Participant 4 - School C

8.1: Background

Teacher S (known as S) became interested in this study through conversations with colleague Teacher R. On a subsequent visit to R by the researcher, arrangements were made with S for an informal meeting. It was at this meeting that some of the general aspects of the research were discussed and S made the decision to become a participant. S has a first degree in biology, several years of experience both as a research scientist and as a teacher in her current school[1]. S enjoyed teaching and had not regrets concerning her change in career from that of research scientist to science teacher. At the time of the study S, like Teacher R, was using the Associated Examination Board A-Level Biology syllabus.

S described the atmosphere in the Biology Department as generally cordial. In contrast to her colleague Teacher R however, S thought this atmosphere was at times restrictive, in the sense of not always encouraging staff to explore different modes of lesson delivery or the examination of alternative syllabuses.

At the time of the study (December 1994 - March 1995), S taught three A-Level Biology classes, the biology components of the Year 10 and Year 11 modular science courses, as well as a Year 8 science class. It was the larger of S's two Year 12 classes who participated in this study. Students in this class, S believed, had sufficient academic ability to cope with the challenges of what controversial issues might offer in terms of their understanding of biology and their skills in presenting well thought out logical arguments.

S appeared confident in all aspects of biology teaching. She reported that thinking about how best students learnt was very much part of her professional practice. What was particularly distinctive about Teacher S was her emphasis on the notion that the complexity of biology could be understood once links were established between its basic concepts. This was part of what she had come to believe was the best manner in which to assist students' biological understanding and formed the core of her pedagogical understanding of how meaning was constructed by students.

[1] Since completion of data collection, S has been promoted to Head of Biology, a post she reported in the Propositions Interview was both professionally and personally rewarding.

8.2: Nature of the Controversy

For S a controversial issue was one where a variety of opinions prevailed:

> It is something where there are two views that are opposed but each one is equally valid and it just depends upon where you personally draw the line. I think that applies across the board, not just in science, with other issues and in other areas. The nature of controversial issues means that there are a huge number of aspects ... a huge number of ways of looking at it and that is why it is controversial. You are then obviously going to have a huge variety of points and resources so putting those together to build up your own argument or your own view about something. You have then naturally got to look at the resources. So all controversial issues would be able to fit into that scheme of things.
>
> S:Prop, 10-18

From S's perspective, participation in this study served several purposes: it allowed her to explore the possibilities for using controversial issues in her teaching, at least for one issue possibly over several lessons; it provided her with an opportunity to examine the possibilities of using controversial issues to teach parts of the current A-Level Biology course without markedly compromising syllabus content coverage; and more generally, it could assist her own professional development.

S decided that if she was to become involved in this study, it was important that the controversial issue chosen be relevant to both the syllabus and students and, in addition, that students had a real choice in the issue to be discussed in any proposed lesson(s). Choice was something which S valued. With this in mind, she presented students with a list of controversial issues which she thought were appropriate[2] given that at the time of her participation in this research, she was working with her Year 12 students on the more general aspects of cell structure and biochemistry[3]. The concept of choice is most appropriately illustrated in the following extract:

> Out of those then they choose ... a better position for them to control what they want to do. It might then be of more interest (*to students*). I think because of the nature of the topics I would be swinging it quite a lot in my direction if I choose something that I was interested in. ... It (*the student vote*) might be more productive in the long run, they might get more out of it.
>
> S:Pre0, 25-31, 39

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[2] All appendices for this chapter are located in Appendix F. For the list of controversial issues refer to Appendix 8.1.

[3] **Associated Examing Board (AEB)**, A95/03, 1995 Syllabuses, Biology and Human Biology; Section 1: Cell Structure and Biochemistry.

The two issues which received equal top vote by students were animal experimentation and cloning and so on the basis of what she thought would sustain their interest, S chose animal experimentation.

For S, animal experimentation, in particular whole animal dissection in schools, was an important ethical and moral issue which she believed ought to be presented to A-Level Biology students for discussion and reflection. This was part of what she believed was the necessity of broadening students' biological understanding. Moreover, she thought this issue would contribute to students' understanding of STS issues[4], its discussion would assist students in their social skills development and, since live animal exports to France were currently topical and receiving media attention, student interest would "no doubt" be aroused. These reasons subsequently proved correct and are discussed later when outlining the rationale for the lessons.

On a more personal level, S had strong and clearly articulated views about the place and purposes of animal dissection and animal experimentation. In essence S believed that student learning was not compromised if dissection was not carried out and, given her personal experience as a scientist, thought many unnecessary experiments were undertaken in the name of science. The quotations below typify her considered position on these issues both in schools and in scientific research:

> I think that it has its place. The school is not the place for dissection and I don't think that you can gain anything from that activity that you can't gain to the level that you are required to know for that particular information ... you are not going to gain from that by cutting the animals up ... Dissection ... I can see its place in trainee doctors, vets work but only if they are in a situation where they are going to handle that tissue and be expected to be proficient in it.
>
> S:Pre4, 272-281

> I don't think that it (*the use of animal experiments in scientific research*) is very well thought out. There is a lot of waste which is not necessary, unnecessary experiments ... I have not had to work on live animals myself but I have worked alongside people who have and it is just cruel ... the techniques where the animals are not anaesthetised properly ... that is horrible ... you don't have to dig very deep and you ... find examples of people misusing animals.
>
> S:Pre4, 293-304

[4] This encompassed **Aim 2** of the current AEB syllabus which was *an appreciation of some of the many applied and technological aspects of biology*. In addition S believed that the issue might be useful for answering some of the essay questions in Paper 1 of the final examination.

She maintained these views throughout the study and indicated she would only disclose them to students when asked. For S disclosing her moral position was thought inappropriate - "it is the moral issues that are involved ... I would not be happy with that".

Initially S wanted students to discuss the issue of animal experimentation over two lessons. However, given the very positive reaction by students during the first lesson, she decided to take full advantage of their interest, and extend the discussion to a third lesson. This would give students time to prepare and present their arguments as well as to answer questions from their peers.

Lesson 1:

This lesson focused on the context of the issue in terms of its place within the syllabus, the difficulties associated with the use of animals for biological research and the tasks which needed to be completed by each group in this and the following lessons.

During the lesson introduction which was led by S, students were invited to comment on the species used in animal research, alternative approaches to animal experimentation, medical advances made with and without the use of animals, and the legal status of animal research in Britain[5]. In the second part of the lesson students assigned themselves to one of three groups where they worked on a presentation for the following lesson and sought assistance from S when needed. The three areas for discussion were arguments for the use of animals in scientific research, arguments against the use of animals in scientific research, and alternative approaches[6].

Lesson transcripts and student interviews indicated that students found the lesson challenging and they quickly organised themselves into teams, some working on arguments with which they did not necessarily agree.

[5] Refer to Appendix 8.2.
[6] Refer to Appendix 8.3.

Lesson 2:

In the first half of this lesson students worked on their presentations. In the second half the group opposed to the use of animals in experiments presented their argument with each member focusing on one aspect. These included the often unknown side effects of many drugs administered to different animal species, the knowledge that some drugs have been developed without the use of animal testing, and the moral argument that using animals for research was an inhumane activity because these species were unable to give consent.

The presentation given by this group raised numerous questions which resulted in a lively, lengthy and interactive discussion involving the whole class. This group of students had used the resources and the available evidence to support their argument.

Lesson 3:

In this lesson the groups supporting the use of animals for research and those advocating the use of alternative methods presented their arguments. As in Lesson 2, each student within the group focused on a particular aspect of their argument. Arguments in favour of animal experiments included the development of modern medicine and the need at times to study the whole animal as a biological system rather than specific organs and tissues in isolation. The group who examined alternatives to animal experimentation focused on ways of refining experiments so that pain and suffering were minimised, reducing the numbers of animals used and the possibility of eventually replacing all animals with the use of computer technology.

Once each group had presented their considered position, S sought questions and comments from the rest of the class. Again this fired a lively and active debate between supporters and opponents of the issue and lasted until the end of the lesson. This was not surprising given that some of the latter group appeared to be ardent antivivisectionists but had nevertheless presented well thought out arguments supporting the use of animal experiments.

As far as all the lessons were concerned S's aims had been successfully achieved. Students had taken the task seriously, presented well thought out arguments using the resource materials presented and had worked well together in their groups, as she indicated to students at the end of the lesson in her summative comments:

> We will bring it to a close there. Just about the talks - I thought they were excellently presented and well researched. You have made good use of the resources and everyone provided a balanced argument to express their point of view. I really felt for the people who had to deal with the extremes of the argument. All three talks were excellently presented and the resources were used to the best of your ability. Well done for that.
>
> S:Lesson 3, 344-348

Overview:

There were two characteristics which highlighted the A-Level Biology teaching practice of Teacher S: the way in which she assisted students in their understanding of biology and the influence of the final examination on her teaching practice. S appeared to teach the A-Level Biology course in a similar way to how she herself, as a student, had come to understand its workings, that is, a discipline which was built from the integration of simple concepts into a complex, holistic picture. The construction of such a mental picture of biology in the minds of students was achieved by S in two seemingly complementary ways - her *de-construction* (break-down) of complex biological ideas into simpler, more meaningful ideas, and her *re-construction* (build-up) of these simple ideas into a more complex picture of biology. In S's view, this mental structuring was best achieved by students through the use of visual imagery and visual materials, both of which she used as tools to aid in student understanding. Even though students had preferred modes of learning, for the most part this approach to the teaching of biology at A-Level had been successful for S in terms of student examination success.

Controversial issues were seen by S as potentially important in her teaching, if they could be used to motivate students and therefore she was interested in exploring their use. In the past, when controversial issues had arisen spontaneously in class, she had dealt with them within the context of the lesson more often as short interludes in her lesson plans. For the most part she was unconcerned if and when they arose, particularly as they were often transient, media topics which required little more than basic biological understanding and for which she believed she was not required to disclose her personal opinion. Moreover, she believed that if they were able to assist in examination success in an effective and efficient manner, without compromising the delivery of the syllabus then they had a place in her teaching. As for the other participants, controversial issues were well suited to the development of students' social skills and certain practical assessment tasks and for the main, given the current A-Level Biology teaching environment, they were at best adjuncts to S's teaching of biological concepts.

The following account[7] outlines the way in which this experienced teacher conceptualised the possibilities and problems for the teaching of controversial issues set within the context of her A-Level Biology teaching practice.

8.3: The A-Level Biology Teaching Context

For Teacher S, the A-Level Biology course was complex in its presentation of concepts and as such was perceived by many students to be problematic. Presenting the A-Level Biology course in a manner which was accessible to all students so that their examination success was not compromised was challenging for this teacher.

Two propositions summarise what for Teacher S was her conceptualisation of A-Level Biology teaching[8].

(i) **Teacher S had a well developed, complex view about how best to teach A-Level Biology so that students could be assisted in their learning. This involved the use of visual materials, visual analogies and practical/fieldwork** *(and detailed analysis of past examination questions[9])* **all of which were significant elements in her current A-Level Biology teaching practice.**

(ii) **The final examinations provided both the necessary and central focus for S's A-Level Biology teaching because they seemed to constrain and contain the content of her biology teaching.**

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[7] Unlike that received from other participants, S did not provide any additional written correspondence on either the propositions or on the draft of her account.

[8] Because it was often difficult to clearly separate each of these propositions and so risk loosing some of the more subtle nuances of the data quoted in this part of the account, these two propositions will be discussed simultaneously with distinctions made where appropriate. This difficulty in separation is not surprising given the complexity of teaching.

[9] This teaching strategy was highlighted by S only in passing in the Propositions Interview and was not found anywhere else on re-examination of the data.

Interpreting the AEB syllabus in such a way as to facilitate maximum student learning outcomes - whether through formal explanation of concepts or via related practical/skills activities - was for S the central and most important challenge to the way she conceptualised and so implemented the syllabus. In order to interpret correctly this syllabus, something which was essential for ensuring student examination success, S seemed to have developed a clear, yet complex, mental picture of its workings and the manner in which it sought to assess students. This interpretation of the syllabus was reflected to a major extent in her beliefs concerning the most appropriate ways to present topics in order that student understanding of biological concepts was built from the integration of simple concepts into a holistic, complex picture of biology[10]. To this end S used visual materials, practical and fieldwork, along with the use of examination questions as tools to complement her teaching of biological content. This way of building students' biological understanding is exemplified in the quotation that follows:

> I enjoy the sixth form work because it is really complicated and you have time to develop it and simplify it and try to spell it out stage by stage. They end up with a complex picture and you have been instrumental in putting that together. That is a challenge and I like that.
>
> S:Pre0, 127-129

For S using visual materials to explain complex biological concepts was an important way of assisting students in their understanding of biology - "I am a very visual learner and I try to imagine the smaller part of how they go together". Her view was that since biology presented many students with conceptual difficulties, one of her professional responsibilities as a teacher must be to unravel this perceived biological complexity in such a way that students were enabled to make sense of the biological content found in the syllabus. S seemed to believe that students were very much like her in terms of their learning. Here her own experiences came into play, as she describes:

> I think of the stages that I learnt things in and what I needed to know for the next part and how I could go into the next part. I tried to start at building it up. So really I go about things the way that I learnt them.
>
> S:Pre0, 136-139

[10] A more detailed analysis of what for Teacher S represented the nature of science/biology is found in the following propositional theme.

The process of unravelling this biological complexity S found exciting and challenging. She addressed this challenge by establishing in her own mind the depth of student knowledge about various biological topics at the beginning of each new unit of work and used this to build in students' minds a complex, richer and deeper understanding of biology to such a level as to meet syllabus requirements. In her words, developing a visual 'image' was important:

> That is why ... one of the things that I wanted to do ... that is why teaching appealed to me because I really liked visualising quite complicated and difficult areas and simplifying these difficult areas into immediate images and that was one of the things that appealed to me in teaching and getting to think about things that were conceptually difficult and try and simplify it and be able to communicate it. That was the appealing thing.
>
> S:Pre1, 110-116

In terms of everyday, more routine procedures this was often heard in her talk concerning lesson planning and usually occurred in lesson introductions. The extract below illustrates S's procedure and shows detailed planning taking place as well as an acknowledgement of students' concepts and understandings. In this way S moulded her teaching and students' learning so that they gained understanding and, as a result of this, were able to answer examination questions:

> I write down the key points that they would need to know from the syllabus and I would look in the text books and I would think about what ... the background that they already have. Talk about things that they already know ... for the introduction. Check the relevant background that they already know about the syllabus ... the bit that we are going to work more on and develop. If it is something that I have already started in the previous lesson and we have just done how the necessary raw materials get into the plant and just give them 2 or 3 key questions which we have done as the conclusion to the past lesson, and go in from there.
>
> S:Pre4, 154-163

Such a visual conceptualisation of biology, where complex ideas were envisaged in terms of smaller, integrated units, was not something S had developed recently and subsequently incorporated into her teaching repertoire. Rather it was, as she often revealed in the interviews, part of the way she as a student herself had learnt biology - "I tried to think about how I learnt it". As she recalls:

> I really needed things clearly set out and I have always tried to work towards that. If that did not happen it was because I was disorganised, not because I did not think that it was important because I was not organised to get it in advance. I always had that in mind. Always in undergraduate and graduate work.
>
> S:Pre1, 105-109

S used visual materials and visual analogies in a variety of ways as observed by the researcher during A-Level Biology lessons and as S herself commented upon during interviews. These included three dimensional models, graphs to illustrate trends in data often displayed on prepared acetate sheets and teacher-assisted student demonstrations of laboratory procedures for practical activities where students were guided in their activities. In a group of lessons dealing with the nature of enzyme action, for example, S used several models to explain how enzymes interact with their substrates. This was complemented with familiar textbook and examination type diagrams which she had reworked into a series of coloured transparencies to indicate the steps involved in catalysis. Field notes at the time indicated little use of a more formal lecture type lesson delivery. Rather lessons centred on teacher and whole class conversations about how the models were thought to explain the action of enzymes on substrates and the limitations of such models generally in order to explain biochemical reactions. As she recalls from these episodes of her teaching:

> When they are doing beta pleated sheets (*protein*), amino acid strands going in the opposite directions, I say it looks like a road, with lots of roads going next to each other or people going on the RHS and people going on the LHS. That is the kind of thing that goes on in my head. It has got to be visual not written down. I can't deal with that!
>
> S:Pre0, 177-180

All four participants stressed the importance of well planned lessons but there were variations in how they thought this was achieved. For example, for J it was important that she record all the key points of the lesson often verbatim; for C it was important that the lesson outline allow for unplanned events; S and R in contrast preferred to write brief lesson outlines, the finer details of which they reported were in the form of mental pictures. Possibly their broader content knowledge facilitated such planning.

Clearly then, visual representation as tools to aid biological understanding and learning was a feature of S's teaching at A-Level, something for which she had developed a strong rationale and sense of purpose. The strength of this techniques might have ultimately rested on her belief that students had few conceptions of, for example, how molecules were thought to interact, and so since biochemistry was a significant component of the course, the use of visuals allowed her to "implant" images into students' minds in order to facilitate their learning, a notion made explicit by:

> ... that is why I like the biochemistry type ... it helps to be able to visualise what is going on. If you can ... have a clean slate really ... they probably don't really know how the molecules interact or have no perception of how enzymes and substrate complexes might form. You can implant the images rather than try to work from something which they see on a regular basis.
>
> S:Pre1, 145-151

For these reasons, S found the conceptualisation of these ideas, their planning and implementation into her A-Level Biology teaching both personally and professionally rewarding. Once trialled and modified these ways of visualising biological concepts were seen as an investment of her expertise and thus became part of her teaching repertoire and resource collection. Asked if this was done in each lesson, she replied:

> Normally yes. I had a view of putting a lot of effort in because I knew that I would use it again with the other A-Level Biology group, so that might have been one of the more polished areas. I had time to look at the resources and sort things out.
>
> S:Pre1, 119-122

In this sense the resources developed for the proposed lessons dealing with animal experimentation were no different. Because the lessons had been successful, they could be used intact or modified for future use as the following comments suggest:

> They are good resources. I would like to have these as sheets and a transparency just in case. If they don't come up with all of them then, I have something to back it up (*referring to the lesson introduction*).
>
> S:Pre4, 96-97

Awareness by S of the potential value of visual materials in terms of assisting student learning extended beyond the classroom. S elaborates on this in the following quotation where she links what she might see in the media, with what was required by the syllabus. In this context, the use of analogies seemed to play a key role in her thinking about the teaching of biology:

> if you see something and you think ... that would be useful for that. You see something on TV ... in the bookshop or you see a poster then it jumps back into your mind ... if I see it I try to use it. If it is a visual thing, the way something looks or that reminds me of how a nerve works or something like that, it might be an analogy that I use in a lesson. If it is like a written piece of information in the newspaper, that doesn't tend to send me off in the same way. I don't process that in the same way, it has to be visual ... an analogy or something that you see, like a poster that you see. Most of it is ... that reminds me about how that works and you could use that analogy if you are trying to explain a concept. It tends to be things like that.
>
> S:Pre0, 164-180

However, there were drawbacks for S as far as her approach to learning was concerned. Even though S was aware of what she perceived were the benefits for using such an approach, that is, as a way of building a complex, rich and integrated view of biology, she was nevertheless concerned that her approach might not always be the most appropriate way of learning for all her A-Level students - "It is probably not a very good approach really because everybody goes about it in different ways". This concern S articulates in the following quote, along with her belief that the use of such an approach aided by visual materials did not necessarily produce of itself autonomous thinkers, something she wished to encourage in her teaching as opposed to "spoon feeding" the student:

> Year 12, they like it (*referring to the visual approach*) but I am aware that I am spoon feeding them a lot and they don't do really as much as they could do by themselves so I try to break from that sometimes and get them to go off on their own way. But there again if I think that there is something really tricky I try to do it how I would have learnt it and then let them go off by themselves again. It is very teacher lead and I am very aware of that. That is not ideal a lot of the time. It is a simple way because I can then explain things and I think that is good for some things.
>
> S:Pre0, 141-147

In order to cater for differences in student learning styles other than through visualisation, S employed two other teaching strategies. These were classroom practicals and field work, and the use of past examination questions. A discussion of these aspects of her practice will illustrate how each complemented S's conceptualisation of A-Level Biology teaching. Although still significant, they did not appear to form the central focus of that conceptualisation. In particular and unlike J and C, S was not interested in building a set of A-Level Biology notes which students could recall in the examination.

Practical and fieldwork experiences were alternative ways in which S believed she could assist students in coming to an understanding of biology. These were seen as activities whereby students could be actively engaged in making decisions, participating in group work and organising their own tasks. Practical and fieldwork experiences were thus regarded by S as valuable activities for both social skills development and for the manipulation of biological ideas - part of her strategy for building more complex concepts. Many of the students who were interviewed by the researcher also shared such a view, as one of them points out:

> Practical work helps you remember. You have to think about it yourself and do it ... so I can remember. It's enjoyable ... and I feel good about it.

S's choice of practical activities centred around what was mandatory on the syllabus, what she herself had trialled and further developed in previous years, and what she was currently working on to improve. As for the other participants, the syllabus and the examination directed S's choice of such activities. Her concern was that planned practical work produce the expected results, a sentiment echoed in particular by Teacher C. In contrast to Teacher C, however, Teacher S seemed more prepared or perhaps more able to think through these difficulties, as is demonstrated in the extract that follows:

> I use the things that have worked in the past. If something did work then I keep it in and if it did not work then I think why didn't it work ... what did they need to know that they didn't know that would have helped the activity to go more smoothly. I am still in the process of doing that. I still don't have it right.
>
> S:Pre0, 158-163

Maybe Teacher S had other ways in which she viewed practical work, but for the purposes of this study, she chose to focus on how she conceptualised her teaching in terms of student learning using visual analogies and materials. In this respect she was similar to Teacher R who also spoke little about practical work preferring to concentrate, for example, on the development of students' scientific literacy. Similar to other participants, S appeared to have no moral or ethical objections to the mandatory practical and field based activities. In theory, whole animal dissection could have caused concern but this did not arise because it was not a syllabus requirement. The following two quotations exemplify these practical requirements, her personal position on dissection, should this procedure become a requirement, and what she believes is the educational value of dissection. Again, compromising student examination success was not entertained as is demonstrated in the following comments:

> I don't do dissection as such. Sometimes if there is something I get from the butcher then I buy bits and pieces. I would never kill anything for the pure lesson.
>
> S:Pre1, 296-297

> It is not a requirement (*whole animal dissection*). It is an inconvenience if we had to do that ... arranging the animals to be here at school and sorting all that out ... if we don't have to do it then I am quite happy not to have to do it. If we had to do it I would not have any qualms about getting on with it for the sake of what they are required to do ... If they are required to do it (syllabus requirement) then I would do it on a small scale but I would not have an animal each or something like that. I would do it on a very small scale if they had to do it and if they had to see it. I would not mind doing it. I would not want to put them at a disadvantage over other people. I wouldn't leap wholeheartedly and get loads of animals in. I could not do that.
>
> S:Pre4, 261-276

In S's opinion whole animal dissection, at least at A-Level, had limited usefulness in terms of students' understanding of mammalian anatomy. S believed that the level of understanding required could be achieved more successfully via other means such as videos or computer simulations.

The second alternative teaching strategy used by S was that of past examination questions[11] - "there are other aspects of the course which need different methods, such as the use of exam questions". During this study, S never alluded to, nor did the researcher observe, her use of examination questions in order to assist students in their understanding of biology. Therefore the inclusion of this aspect of her teaching practice could not have been made in the construction of propositions concerned with S's conceptualisation of her teaching. That the use of visuals and practical/fieldwork activities were an important aspect of her teaching practice was never disputed by S. What S did question was the emphasis placed on the importance of these approaches, especially the use of visual materials, above any others - "at the time that you came, the visual was at the forefront of my mind but it is not a universal method". She supported this notion with an example from her teaching of human reproduction. In the quotation below, taken from the Propositions Interview, she conceptualises the ideas in terms of the construction of complex concepts using visual mental images:

> ... there are better ways of doing things like reproduction for example, looking at hormones and co-ordination of hormones. It does not automatically lend itself to having a visual analogy because there are too many things coming into play. If you are then trying to visualise the whole lot then, you can't pull the whole lot together. ... I think that if you concentrate on small sections and build up the understanding of different sections separately and then, I did this like when I did questions on different areas of the same topic. In reproduction for example, I had questions based on the production of hormones which then went onto questions based on ovulation and the maintenance of the lining of the uterus and things like that. Then after the sections have been broken down I had some questions to draw all of those sections together. That was dealt with differently to that of the visual. I am also trying at the same time to see how I think about it now. I broadly think that I still have these opinions (*referring to the proposition*).
>
> S:Prop, 28-50

Thus for this experienced A-Level Biology teacher, using examination questions to further advance the biological development of her A-Level students, even though initially hidden from the researcher at the time, was from her perspective an important aspect of her teaching.

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[11] Refer to Proposition (ii) of this theme.

Nevertheless, the A-Level Biology examination still served several purposes. It focused her A-Level Biology teaching and so guided the breadth and depth of her choice of content materials. Most importantly, it was used by S as a measure of her success as an A-Level Biology teacher, a purpose similar, for example, to that for Teacher J - "they have passed". Students' examination performance was the measure of that success and, as for all participants, gave her a sense of professional identity. S used the examinations as a tool to drive students forward in terms of motivation - "if you can impart some enthusiasm along the way then that is a bonus" and for herself - "it is very much getting through and jumping through hurdles ... that is how I see it". All of which are aptly encapsulated as:

> I think it (*teaching*) would go down the pan. I think it would disintegrate because that (*exams*) seems to be the focus of everything that I do at the moment. I think...there are certain things that I am interested in and if it was just left to sort of develop their interests and things that I thought were interesting ... I don't think that that is a very satisfactory approach I don't think. You have got to have this goal at the end.
>
> S:Pre1, 223-230

The concern that S had with examinations was also linked with syllabus coverage. In her opinion even though the AEB syllabus had made several modifications, as outlined in the previous account, it remained content dense and examination oriented. And so for S, it was most appropriate in terms of how she saw herself as teacher that examinations be used as a focus for her teaching and as a guide to syllabus coverage. Student examination success was the goal and all aspects of her teaching seemed to be directed towards that goal, one not unlike that for each of the other participants. This is illustrated in the passage below, where S talks about her goals for both her students and for herself in terms of examination success:

> Trying to stimulate further an interest they already have ... trying to develop quite specific skills with regards to answering certain styles of questions ... so I am trying to develop an interest that they already have I think would be ... (*also*) perhaps general study skills ... gathering information and formulating an opinion but I see that as really coming into exam skills which are very very broad and in the end I think that I am concentrating on those. I don't think about other skills that they are going to develop during the course.
>
> S:Pre1, 200-212

Asked if she was indeed driven by the A-Level examinations, she emphatically replied - "Yes!", and seemed at ease with this position.

Essentially the focus of S's A-Level Biology teaching - one not unlike that of the other three participants - was the external examination and its associated syllabus requirements. Moreover, for S, as for Teachers J and C examinations were used as a measure of professional success. In terms of classroom practice, this was translated into a view of learning and a conceptualisation of A-Level Biology teaching built upon the notion that a complex understanding of biology, as seemed to be required by this A-Level Biology course, could best be achieved if it began with the integration of simple concepts. This was a characteristic feature of this teacher. These were then developed into more complex concepts in order to meet syllabus requirements. The use of well-prepared visual materials, fieldwork, practical activities and past examination questions were employed by S in varying degrees to ensure that students acquired the biological knowledge and understanding necessary for examination success. For each and all of these reasons S taught the way that she did.

8.4: Views of Science/Biology

Teacher S appeared to have a strong background knowledge in many areas of biology, in particular that of biochemistry and genetic engineering. However, although she had spent several years working as a research scientist, it was difficult to ascertain a clear, comprehensive overview of what she believed was the nature of science/biology. However, two simultaneous views emerged and are reflected in the following propositions.

(I) Science was a complex, sophisticated body of knowledge which could with intellectual skill be broken-down and re-built from simpler, underlying concepts.

(ii) Although Teacher S recognised that some of the most significant discoveries in science were made occasionally by pure chance, most discoveries in science and hence progress in scientific research were seen by her as painstaking, time consuming, and at times boring and tiresome.

Teacher S seemed to support a view of science as being a complex body of knowledge and ideas which could be unravelled and understood as a series of interlinking, hierarchical steps. Such a view appeared to be supported by the way she conceptualised her A-Level Biology teaching and how she believed students learnt best, the latter assisted by the use of visual representations. As discussed in the previous proposition dealing with S's conception of A-Level Biology, the learning of biology was seen as the acquisition and linkage of simple concepts to form a more complex picture open to further biological research and intellectual challenge. Whether this was S's view of science/biology *per se* or whether this was her view of how science/biology ought to be taught remained somewhat unclear, as the following quotation would seem to indicate:

> Yes I agree broadly with that (*referring to the first propositions above*). To describe some of the concepts as simple ... they are often fairly ... they are not simple concepts really. They can however be broken down into some more fundamental ideas. You can't simplify everything and there are some ideas that are just complex and you can't really break down any further on the whole ...
>
> S:Prop, 210-207

What biology certainly was not for S was a collection of facts; rather it was a complex system of ideas, a notion best reflected in her illustration of meiosis in the next quotation:

> Well you can look at meiosis for example and the stages are fairly simple but to really understand the process but to have a real understanding of how cells do it and where it is done and the consequences and the significance of the process then although what happens, if that is all that you have to study then that is a straight forward process. But trying to see its importance, that is always going to be a difficult concept, and you link it to other ideas and try to build up a bigger picture. It was always a hurdle.
>
> S:Prop, 214-222

Such a view of the complexity of biological understanding and indirectly her own model for learning, was in contrast with Teacher J in particular, who clearly stated on numerous occasions that science/biology was "out there" somehow waiting to be discovered. In this sense her way of thinking about the nature of science was similar to that for R particularly in the belief that science needed continual modification in the light of new evidence and understanding.

In terms of scientific research S seemed to think that most of the work with which scientists were engaged was often routine - "research slog over many years" and so when breakthroughs did occur, they were to a certain extent chance events, to use her turn of phase - "pure chance" or "fortunate mistakes". Associated with this was S's notion that often such discoveries could, potentially at least, irrevocably change the direction of scientific research. This view of science was portrayed in the first of the animal experimentation lessons when S talked to students in the lesson introduction about scientific discoveries generally, and in particular where areas of past and current research involved animal testing:

> Many things in biology ... a small number of things are discovered by pure chance. There are a few examples of important discoveries that are pure chance or, if you like, pure mistakes which then lead to something significant. An example of this might be penicillin. It was not being investigated when it was discovered. It was by pure chance that is was discovered and the repercussions of that were huge. Yet nobody intended to set out to discover penicillin, that was just a fortunate mistake. Another example of something that was a fortunate mistake was the use of dedroxin, a heart disease drug and that was discovered by pure chance, that was a fortunate mistake. Most of the discoveries in biology are brought about by hard slog, research slog over many years. Many of these procedures involve animals. I am sure that you are aware that animals are used for research techniques to bring about huge discoveries that can change the field of biology in a way that can't be reversed.
>
> S:Lesson1, 11-29

A second perception S had about the nature of science, although only alluded to when invited to comment on the propositions of this theme, was that in many ways scientific research was a collegial activity and a melting pot of ideas. In this context, those members of the research community who contribute most would somehow be the most successful in terms of their ideas gaining prominence, as is evidenced in the extract which now follows:

> I think a lot of the time the most successful scientists are the ones that throw in, if you throw in enough ideas into the pot, there is always going to be something that is going to have a grain of truth in it. Probably the people who generate enough ideas will have thrown in a few grains of truth. I think quite often it is like that I would imagine. That would be my view.
>
> S:Prop, 250-257

These were the only two occasions on which S clearly articulated any of her views about the nature of science, a view which remained consistent throughout the research. In her words:

> I still hold that very much so. I think people over estimate the research lust to be like the most fascinating areas of science but I think a lot of time everybody is doing practical research and I think, they think, why are they doing it.
>
> S:Prop, 246-249

Clearly, in terms of these propositions more data would need to be collected in order to unravel what other views S might have about the nature of science/biology and how these were portrayed in the reality of her classroom teaching. Nevertheless, it appeared that her views were more in tune with those of her colleague Teacher R and the second participant Teacher C.

8.5: Teaching Students in the A-Level Biology Course

Teacher S appeared to have an excellent rapport with her A-Level Biology students. She viewed them as individuals who for various reasons had chosen to study biology at A-Level and therefore felt that it was her professional responsibility to ensure that they completed the syllabus and obtained passing grades, whilst presenting the discipline as an exciting area of study.

Two propositions encapsulate how Teacher S viewed her students.

(i) A-Level Biology students were seen by S as generally mature, responsive, motivated individuals who welcomed the opportunity to express their biological understanding and participated in class discussion.

(ii) Even though students had many different ways of learning, S believed most learnt best through the construction of complex ideas using simpler underlying concepts, a process aided by visual representation.

S's articulation dealing with her A-Level Biology students was generally from the perspective of the most appropriate way she believed they learnt, the goals she wanted them to achieve during the two years, in particular that of passing grades in the final examination (a feature of all participants), and what sparked their interest and subsequent motivation to learn biology:

> Trying to stimulate further an interest they already have ... trying to develop quite specific skills with regards to answering certain styles of questions ... so I am trying to develop an interest that they already have I think ... gathering information and formulating an opinion but I see that as really coming into exam skills which are very very broad and in the end I think that I am concentrating on those. I don't think about other skills that they are going to develop during the course.
>
> S:Pre1, 204-212

S's belief that her current Year 12 A-Level group were generally mature, responsive and motivated was reflected throughout the study in two different ways; first, in her wish that students choose as a group the controversial issue they themselves would like to discuss - "they are not time wasters". Her confidence in her background biological knowledge and her belief about herself as a successful A-Level Biology teacher allowed this to happen - "I have no qualms about having to pacify people because that is the reality of the situation". The second way was that she actively sought student comments in terms of clarification when new content material was presented in class. This S reported she did and was observed in her conversations with students who sought her assistance with content or practical work. It appeared that S did not necessarily assume that because she herself had a clear understanding of a concept, students would therefore be able immediately to make the required links in their understanding.

Allowing students to choose the controversial issue for discussion was an important consideration for S in terms of her participation in this study. As mentioned choice was something she valued. She believed that allowing students choice meant that their interest in any one issue would be high. In terms of animal experimentation this proved correct. Students found the issue interesting, highly contentious and for some an opportunity to examine closely a viewpoint with which they were ethically opposed - "it certainly got them thinking and that was my very good impression". Hence, S was not surprised at the overall quality of the ensuing discussion, pointing to her belief that such opportunities fostered not only discussion skills in terms of presenting a mature and balanced argument but also a tolerance for, and an understanding of, alternative perspectives. In this regard her views of students as autonomous thinkers married with those of Teacher C, an opinion S stated before and reconfirmed on reflection of these lessons. This belief about students is typified in her talk as:

> They get on with it ... I think that they are quite adult and they realise that if they have strong views on something there are always going to be different points of view and they are going to have to accept that. Because they think strongly about it they have to listen to the balanced argument and leave people to judge for themselves ... if they want to persuade people ... they are going to have to think coherently and argue strongly against people picking holes in it.
>
> S:Pre4, 243-258

> I thought the people on this table (*against*) and that table (*alternatives*) got geared up about it. This group (*against*) were doing quite well. That group (*pro*) were doing quite well and they could see the benefits of it but they are having a hard time defending it I think. They were all thinking about the task and the different sides of the arguments and being aware that they had to defend theirs.
>
> S:Post, 9-14

S was also aware that her students appreciated her lessons being clear and well presented and so encouraged them to seek clarification if necessary - "they have opted to do the course ... trying to do the course and trying to get some success at the end". Lessons which built up complex understandings, based on the integration of simple concepts and took account of students' background knowledge, achieved this objective of clarification. Given that not all students were confident in biology, it was important for S that student interest remain high, appropriate student skills be developed, examination techniques be mastered and finally that they be able to gather appropriate information to make informed decisions. As for each of the previous participants, this was the way in which professional responsibilities to students could be discharged, epitomised for S as:

> I think at the end of the day the people will need the grades that they get to do something that they are interested in ... and part of it is an interest and providing opportunities to find something that really does set them buzzing. You really think that if they can't carry on with that, the exam grades, they keep that in mind.
>
> S:Pre1, 200-223

In turn students, S believed, had a responsibility towards themselves as maturing individuals to perform well throughout the two years, especially as examination success often led to wider career choices, a sentiment echoed by Teacher R. Since students had made the choice to study A-Level Biology, S believed that it was her professional responsibility to ensure that they received passing grades - "that is what people are there for". The controversial issue lessons, as a case in point, assisted in the achievement of at least the last of the above goals - to use information in order to make informed decisions. As she remarks after the third lesson:

> I felt positive about it. I thought it would be interesting and a good chance for them to share their opinions which they don't get a chance to do very often. In some respects we were digressing but I think that might add to their essay writing and all the other different aspects it might add something to the more general aspects of the course. We are not covering anything in particular, but it is not detrimental to how they think about biology. It certainly got them buzzing.
>
> S:Post, 25-30

Even though A-Level Biology students were responsive to most aspects of the course, many still needed assistance in organising their study skills and to appreciate that an investment in time was an essential aspect for success. Reflecting on her years of A-Level teaching S comments:

> Most students are responsive yes but when it comes to them organising their own time, I would not describe them as mature really. But this was a fairly atypical group. I thought they were a particularly good group. I would yes describe them as mature and responsible but for students in general or at the beginning of the Year 12 course, I think that that would be a bit too broad to describe them as mature and responsible and motivated. They generally are responsive yes, but maturity and motivation seem to go hand in hand. They don't seem to see that whatever they do now is going to reap them benefits in the long term exam ... what enabled them (*referring to this group*) was that I introduced them to different methods of assessment early on and even some of the things that they did in the Year 12 in terms of practical work were going towards their final exam. The sooner you involve them in that the better is their response.
>
> S:Prop, 183-196

To summate for S, students were an essential component of her personal conceptualisation of A-Level Biology teaching. She saw them as often mature, interested individuals, who had chosen for whatever reason to study biology at A-Level. As for the other participants, she felt that one of her professional responsibilities ought to be directed towards students' learning of biological concepts. Assisting students in this understanding was for S both professionally challenging and rewarding. She had come to achieve this through a well thought out approach to student learning which centred on her belief that most students learnt for meaning if difficult concepts were broken down into more simple concepts and subsequently re-built to form a more complex picture of biology. To achieve this aim, S employed the use of visual analogies and materials in similar ways to how she herself had learnt biology as a student. This then helped to explain the way in which she had come to view students and their learning of biology. Therefore for S, students, their success at the A-Level Biology examination and the need to cover the syllabus in the allocated time were all interrelated.

8.6: The Teaching of Controversial Issues in Relation to A-Level Biology

This section of the account elaborates on S's conceptualisation of what she believed were the possibilities and problems for the teaching of controversial issues in the context of her A-Level Biology teaching: a conception which would seem to indicate that S addressed the teaching of controversial issues from a number of differing perspectives.

(i) It was S's belief that the constraints of the syllabus and external examinations did not foster the use of controversial issues and so were not a significant aspect of her teaching practice.

(ii) Controversial issues assisted in the development of students' social and ephemeral skills but had limited value in terms of their developing understanding of biological concepts.

Although it was never the intention of this study to evaluate the effect of this intervention on each participant, in the case of Teacher S, it should be noted that two significant events took place which at the time seemed to extend her thinking about the teaching of controversial issues. These events were specific for Teacher S and thus worthy of special mention. For these reasons part of this section of the account is somewhat narrative in nature.

The first occurred during the Pre-Lesson Interview Phase and concerned S's own re-examination of the syllabus in terms of the teaching of controversial issues generally and her realisation that in fact the use of animal experimentation did indeed fit with what she was currently teaching her A-Level Biology students, despite her previous hesitations:

> Well it was unintentional really but I went to pick apart the syllabus a bit more, I thought ... oh there it is and I did not realise that it was in there ...
>
> S:Pre4, 38-39

The second event occurred during the Post-Lesson Interview Phase as a result of S's attendance at an INSET session when various assessment tasks and examination questions came under review. It was in that session that S realised the value of the three lessons on animal experimentation she had recently undertaken with her Year 12 class, in terms of the mandatory syllabus assessment tasks. The significance of each of these events is now discussed in the light of S's conceptualisation of the possibilities and problems for the teaching of controversial issues.

The last Pre-Lesson Interview proved to be an important insight into S's changing conception of the way in which controversial issues could be located within the syllabus in terms of broadening the way in which S viewed controversial issues and in particular, where the issue of animal experimentation could be located within the syllabus. Since the previous interview[12], S had re-examined the syllabus generally as well as the content of what she was currently teaching her Year 12 Biology class and found, to her surprise, that this issue could be integrated with her current scheme of work. Although S was willing to have students debate this issue, because of its value in developing their social skills, something she never questioned, up until this point of the study, she had been somewhat ambivalent as to how this issue fitted exactly into the course in terms of its ability to address content. What S came to realise was that the issue of animal experimentation could be linked to an understanding of biochemistry, what she was currently teaching and to a future unit on microbes. The extract which now follows illustrates the enthusiasm with which S talks about this realisation:

> I couldn't see it fitting in with what I was doing at the time and I thought it was going to be out on a limb ... drop one thing and then go onto this and then go back to what we were doing. I didn't want that to happen. But that is not the case. It does fit in!
>
> S:Pre4, 45-47

This perceived shift in her thinking about controversial issues, something which seemed to have emanated from S's own thinking and reflection, may have helped to ensure that the forthcoming lessons on animal experimentation were favourably received by students. Asked how students would respond, her reply was always positive. As she comments:

> ... they will get into it right away ... They will have no problem with getting on with ... I think they will be a very good group. They will lap it up. If they get a good introduction then they will be quite buoyant with it and they will be fine.
>
> S:Pre4, 211-215, 227-228

The second shift in S's thinking about using controversial issues occurred after the lessons. The trigger for this apparent shift was, as she explained, her presence at an INSET session where the appropriate use of ephemeral skills in relation to student assessment for the final examination were discussed at length:

[12] Pre-Lesson Interview 3 - this tape was inaudible so interview questions were asked again in Pre-Lesson Interview 4.

> ... if it is something that you can't write down or quantify it easily then that is ephemeral and you don't submit any evidence for that, you just submit the mark ... It is not evidence that they have written down but it is your assessment of the situation and that is taken as evidence.
>
> S:Post Post, 17-22

As S recalls from that session and explains in more detail in the quotation below, what she had not realised was that the tasks students had been required to engage with in the animal experimentation lessons, that is, the examination of resources and the collation of evidence needed to develop a logical argument, were also part of what the syllabus termed ephemeral skills and therefore could legitimately be used as part of their final assessment. This she subsequently did. As S recalls from that session and now explains in more detail:

> I didn't think it was part of the A-Level course work. I didn't think it really figured but I went to an exam board meeting and some of the skills were meant to be assessed as ephemeral skills, like the organisation of equipment or using a wide variety of resources to come up with a final prose or article or argument. They are not the kinds of things that you can judge from a piece of written work. They are more things that you have to judge at the time ... what they are meant to do is have a wide range of resources and put together an argument or an essay or a role play exercise or a debate, using a wide range of resources and that is just what we did really. They had loads of resources and they put together something from it.
>
> S:Post Post, 32-37, 44-47

Accordingly the value of these lessons were seen not only in developing discussion skills but also in terms of their potential contribution to student assessment and examination success and therefore, it would seem to further substantiate her belief that the final examination was the central focus of her A-Level Biology teaching - "I had a note on the activity and I submitted that as one piece of ephemeral evidence".

Given the significance of the two events already mentioned, what now follows is a discussion of S's thinking about the teaching of controversial issues as well as her thoughts and reactions to the preparation, implementation and subsequent reflection on the animal experimentation lessons. This approach was thought appropriate because it helped to explain how various aspects of S's thinking about the teaching of controversial issues appeared to have evolved during the study.

Teacher S believed that there were three distinct possibilities for the teaching of controversial issues. **First**, they could be used to broaden students' general understanding of biology, and along with fostering an increased awareness of the moral and ethical dimensions of such issues, could be used to illustrate to students that biology dealt with relevant issues and concerns.

> I think it (*referring to the issue of animal experimentation*) will be fine on its own as an issue by itself. It just makes things more relevant and real even if it is does not cover anything in particular ... it just makes it come to life.
>
> S:Pre2, 372-376

The moral and ethical dimension was noted in particular by S when referring to past students' reactions to tissue and organ dissection as a case in point:

> ... they say that it is cruel. If you get something from the butcher ... a muscle or a heart ... they say that it is cruel and then you talk about ... well the rest of the animal is being eaten ... those kind of questions come up throughout the school.
>
> S:Pre2, 340-343

When it came to broadening students' outlook and understanding of biology from a more technological and social perspective, S visualised the use of controversial issues in her A-Level teaching as that of "polyfilla" in terms of "filling in the (*syllabus*) gaps", an idiosyncratic feature of S which she mentioned once in the study. In the second half of the following quote S illustrates the metaphor using the example of gene therapy:

> Controversial issues is like filling in the gaps. Like you generate these little distinct areas and difficulties and then by teaching about controversial issues it is like a polyfilla. It is a nice, linking-things-together and also squashing down and filling up the holes, like squashing down the holes, because they (*the students*) have got the gaps. So that gives them a broader understanding. I think it also helps to question ideas. We were doing some things about gene therapy the other day. We were talking about the wonderful idea this was and what the potential could be and then what in reality was going on and, how much success had been seen and, how little what was in comparison to all the talk and hype about its potential. I think the teaching of controversial issues brings in, links the actual realities of biological sciences rather than the more fanciful views and ideas of it.
>
> S:Prop, 301-311

This notion of controversial issues as being likened to "polyfilla" could also be viewed in terms of its limitations to being fully integrated within the A-Level Biology course.

The development of social skills, a common belief across all participants, for S through group discussion particularly at the beginning of the A-Level Biology course, was seen by S as the **second** possibility for using controversial issues in her teaching:

... as a starter especially with a new group of students at A-Level, if you want to get discussion rolling then to build on group cohesion, you are better off sticking to something that is going to generate some discussion.

S:Prop, 103-105

This view was evident also in the planning and development stages of the animal experimentation lessons:

They have to know what they are up against. They need to know how they and the other arguments are going to be slanted ... what sort of questions they are going to have to address. So yes, it is definitely going to be good having the other side in there (*referring to the contents of the student folders for the lessons*).

S:Pre4, 202-204

and later supported in her reflective comments about those lessons:

It certainly got them all thinking and that was my very good initial impression. They were all thinking about the task and the different sides of the argument and being aware that they had to defend theirs.

I thought it would be interesting and a good chance for them to share their opinions which they don't get a chance to very often.

S: Post, 11-14, 25-26

The **third** possibility, another distinctive feature of S, was in relation to the usefulness of controversial issues for the examination. This was where the importance of her INSET attendance became evident in terms of broadening her view of the potentiality of controversial issues. S believed this could be realised by providing students with opportunities throughout the course to work with unfamiliar controversial issues in order to develop skills in data handling and analysis:

I think there is some scope for choosing something that is unfamiliar - like having a blank sheet and letting them develop ideas where they did not initially have an opinion.

S:Prop, 100-102

In S's opinion these skills could then be used either as part of the assessment of students' ephemeral skills as already mentioned, or to answer questions in the final examination where the application of biological concepts to unfamiliar contexts was required:

A lot of the time what they are not good at in the exam situation is looking at the things like comprehensions or pieces of completely novel biological theory where they have an understanding of a concept but here it is being applied to a completely different situation. I think it would help if they had to make sense of something that was totally unfamiliar (*via discussion*), it may develop some skills there and it is something that they would formulate an opinion about from fresh and they would be all in a similar position to start with so that would be good really. It would also be interesting to see which way they sent and why and it would give me an insight into the lines along which they were thinking. Do you see what I mean?

S:Prop, 111-119

In addition, S did see controversial issues as more than simply lesson motivators. They could potentially be useful in essay writing, a task required of students in the examination, but not necessarily in the development of students' understanding of biological concepts. As shown in the following extract, controversial issues could potentially have a place alongside regular syllabus delivery but not as an integral part of how the current syllabus was constructed.

they (*controversial issues, CI*) give a wider view of a certain area that they have to know in depth then yes. If they required people to come to terms with the nuts and bolts before the CI then yes, because they sort of have to do the main parts before they deal with the CI. It is sort of like a motivating factor. I think more directly in essay writing they might be directly relevant and they can then just take pieces of information that they may have heard of or talked about while discussing a CI and basically incorporate that into an unstructured question where they are free to express their opinions.

However, S's position with respect to the possibilities of employing controversial issues in the reality of her classroom practice remained somewhat ambivalent.

S raised two major concerns with respect to the teaching of controversial issues. First the question as to whether they had a significant place within the current syllabus, which she herself was later to resolve and second, the possible request by students to state her personal moral and ethical views on any one particular issue. Although both caused her unease as will be illustrated below, they did not appear to be grounds for the summary dismissal of the teaching of controversial issues which was more the situation for Teacher J who for the most part conceptualised them in terms of five minute motivators. So for S in some sense, the use of controversial issues might serve as an alternative way to explain parts of a concept, as she explains:

I might not use the CI by itself to explain the concept but I think it would be useful to have that as well to develop a concept. I would not use the CI to explain the fundamentals of it or of an idea.

S:Pre1, 240-252

Each of these two concerns will now be addressed. In terms of their place within the current syllabus and within her current A-Level Biology teaching practice, as she points out in the quotation below, controversial issues had little if any status, often only being raised as points of interest by students or herself in the course of the lesson:

I tend to stick to the nuts and bolts of the syllabus and talk about some recent examples when I can think of something that is appropriate but I don't spend a lot of time telling stories about the way that things have developed. That (*controversial issues*) is not part of my teaching.

S:Pre1, 83-88

From S's perspective, the teaching of controversial issues in any significant and realistic way was limited, given the constraints of time, the nature of the syllabus and its assessment of student progress. This was a sentiment common for all participants, typified for S in comments such as:

the thing that I am worried about is the delivery of a chunk of the syllabus ... is it important that we deliver part of the syllabus throughout using controversial issues ... they don't get assessed on anything like that (*social and ethical aspects of technology*) in essay questions ... they are not that type of essay question ... they are not controversial issues, they are more or less summing up of the whole broad spectrum of things such as the use of living things. It isn't really ... I suppose the titles come up now and again which use a controversial issue but they are not the norm.

S:Pre2, 17-28

and reflected in her initial hesitation as to the suitability of animal experimentation to - "deliver a chunk of the syllabus", a concern which as already mentioned was later resolved.

In addition, any more frequent use than perhaps four or five times over the course of two years, would compromise the inherent motivational value of controversial issues, despite their value in broadening the biological outlook of students. In her words:

I don't know how often you would do it before you would have exhausted their ideas or they have got really used to it and feel that it is a bit of a chore ... I don't know ... but certainly I think using it maybe four or five times over the course of the two years could be the limit. Yes it certainly is a good idea to look into the issues because I certainly don't know a lot about various issues and I am aware of that myself in my position.

S: Pre2, 293-298

Constraints also mentioned by the other participants, included time to collect and collate the resources, and the time needed to undertake a number of such lessons:

> It is very time consuming if you are going to do this quite regularly to allow time for debate and preparation for talks. If you choose your moments and don't do that many, a few key issues, then that is not really a constraint.
>
> S: Post, 133-138

However, for S in particular, if she had invested time into the preparation of such lessons, they would be used in the future with adjustments made to suit particular class groups:

> I will use certain examples from many year groups and redo things in slightly different ways. So if I put it together once then I can get a lot of wear out of it.
>
> S:Post, 119-123

Asked where the lesson on animal experimentation and its resources now sat in terms of her schemes of work, she commented:

> I don't know if, I would do this same one again, I would like to tackle something else ...
>
> S:Post, 125-127

It was not that S was uncomfortable about animal experimentation as a controversial issue *per se*, or the manner in which students had responded to the lessons, but rather her wish to continue her own exploration of the variety of ways to teach biology:

> I think that everything is useful as long as you have a variety. Having it there as another string to your bow is a good idea. That is what make it effective as well.
>
> S: Post Post, 282-284

The second major concern expressed by S was the possibility of having to express her personal opinion on some of the more sensitive issues irrespective of her level of content knowledge about the issue. This was something S did not wish to do. For her, such opinions were private and she believed not part of her public role as teacher. Expressing private opinions on matters moral and ethical was not seen by S as discharging her professional responsibility to students. Moreover, S believed that students ought to be given opportunities to formulate their own ideas and opinions without undue influence from her, or other teachers, and so made a point of not overtly articulating to students her personal views concerning sensitive issues.

> I would not be worried about the content but I am not very comfortable about expressing my opinions and ... well it is the moral issues that are involved ... I would not be happy with that. I am happy to talk about the concepts involved and a lot of CI, in my mind, are not always as controversial as first they seem. I would not want to say what my moral stand was ... just giving straight facts fine which I thought were clear cut ... this happens ... can it happen sort of questions ... fine.
>
> S:Pre1, 175-185

The presentation of factual biological information irrespective of the issue, posed no difficulty as reflected in her further remarks:

> I would have no qualms about talking about the information, when it came to saying whether that was the right or the wrong information then that is when I would not be comfortable.
>
> S:Pre1, 175-185, 188-192

However, despite such seemingly strong sentiments S could be persuaded to disclose her views to students, at least for the issue of animal experimentation. The two exchanges quoted below, between Teacher S and a group of her students, bear this out:

> Student: Have you got a specific opinion? (*Seeking a response from S*)
>
> Teacher S: Have I? I think that I am in the middle ground ... I am not strongly in favour of one thing or the other but saying that I don't agree with dissection ... pointless dissection ... that is one thing that I don't agree with ... I am in the middle.
>
> S:Lesson 1, 265-268
>
> Student 1: Are we to bring in that sort of thing as well then (*seeking clarification of the task whilst referring to the exploitation and dissection of animals*)?
>
> Teacher S: I don't know ...
>
> Student 1: It is not educational ...
>
> Teacher S: It is to do with exploiting animals isn't it ... where does our exploitation end. In my opinion and I don't want to impose my opinion, it is barbaric and, if we have this little respect for animals where does it end! Is the animal experimentation just another form of human entertainment, especially if you are looking at the view of where you are just experimenting for the sake of finding out how it responds ... pure scientific research not medical not ...
>
> Student 2: It says here that aspirin affects the birth of baby cats and they would not have done that for medical research to humans.
>
> Teacher S: Maybe they used different organisms to see the effect of aspirin and this is a side effect. This is difficult to imagine isn't it?

Student 3: In animal experimentation and things like that, people can get away with doing barbaric things...they say it is experiments.

Teacher S: Yes that is right and they ...

Student 2: It implies that.

S:Lesson 1, 301-316

When invited to comment about this, S seemed unaware that her stated position outside the context of the classroom differed from that within. In defence of her position, she states:

I don't mind saying what I think really but I don't want to impose anything as correct but maybe at the end of a session on a controversial issue, if somebody asked me what my opinion was then I would be more than happy to say what I felt about it. It would be more as a concluding and passing remark really, at the end ... rather than an introduction to something.

S:Prop, 61-66

It appeared then that S was somewhat ambivalent about stating her personal opinion on controversial issues. However, it appeared that she could be persuaded to do so once she had established a rapport with students, and had considered the issue in question and the context in which the issue would be addressed. It seemed for S that if she personally considered the issue to be too sensitive, she would still provide students with the information needed to discuss the issue but would refrain from directly stating her position. Obviously, the issue of animal experimentation was not of this kind.

Given the above discussion, it would seem appropriate for S to view the teaching of controversial issues as a way of broadening students' general view of biology but limited in terms of the long term acquisition of biological content. This is exemplified in the following quotation:

I think it is good to broaden, it is a good use of all the resources to broaden their outlook on biology and really draw things together but using it frequently to deliver parts of the syllabus ... I think is limited ... controversial issues have limited use. But certainly to really get them thinking about wider issues of biology it is excellent.

S:Pre2, 290-293

Indeed as was shown throughout this phase of the account, some controversial issues, for example animal experimentation, sparked student interest and may well have raised the profile of biology in the minds of some students.

Given the success of the three lessons on animal experimentation, her realisation that this and other controversial issues did have a place within the syllabus and her knowledge that such lessons could legitimately be used as part of student assessment meant for S that the teaching of controversial issues took on a new meaning. This was its relevance to the syllabus and so could be valued as part of the practical work assessment component. Referring to the use of controversial issues in terms of student assessment she comments:

> I was not aware of relevant examples to really deliver a relevant proportion of the syllabus in that way. That was one of my failures and would imagine that there are a lot of people in the same boat. They might know certain things from personal experience for a few things but there are a lot of issues that haven't really become apparent but every issue would enable you to fulfil that type of skill I am sure. I am sure that every syllabus has that somewhere in there.
>
> S:Post Post, 66-72

Nevertheless there still remained significant problems with any further incorporation of controversial issues into S's teaching. For S these included the collection and collation of resources, the lack of sufficient time to undertake these in the normal course of teaching A-Level Biology and their limited usefulness in terms of syllabus coverage. If these could be dealt with adequately then from S's perspective, the gains in terms of widening students' biological perspective and examination performance were an appropriate investment of time:

> The gains to be got from it out weigh the investment of time ... I think that it will link things together if they are looking for a wider view of biological aspects which isn't the nitty gritty piece of the syllabus but it links things together and it does help them to get an overview.
>
> S:Post, 135

> I can definitely see how it would be a real important use and they can get credit for it from the exam board as well. I think that that is a good incentive to do it again.
>
> S:Post Post, 259-261

Chapter Nine: Conclusions of the Study

Possibilities and Problems

9.1: Introduction

The purpose of this final chapter is to move beyond the understanding gained of each participant 'as an individual', to the development of a more general theoretical perspective which aids in the understanding of what other experienced A-Level Biology teachers might perceive are the problems and possibilities for the teaching of controversial issues.

Evidence from the previous four chapters, where both idiosyncratic and more general features were noted between participants, indicated that there were a number of common features which potentially at least, could be useful in coming to an understanding of what experienced A-Level Biology teachers generally might perceive are the problems and possibilities for the teaching of controversial issues. However, considerable care needs to be taken when moving from claims about the specific four cases to claims about A-Level Biology teachers in general. As Hammersley (1990) remarks:

> Assessing the validity of such generalisation is an added task over and above the assessment of the claims themselves. (p. 31)

Nevertheless, the formulation of plausible generalisations can be achieved if the task is approached in terms of the construction of naturalistic generalisations. These generalisations, not of a statistical nature, are meaningful for the intended audience to which they are directed, a point defended by Stake (1995) in his identification of the purposes of such generalisations:

> ... single cases are not as strong a base for generalizing to a population of cases as other research designs. But people can learn much that is general from single cases. They do that partly because they are familiar with other cases and they add this one in, thus making a slightly new group from which to generalize, a new opportunity to modify old generalizations. (p. 85)

Given that this study adopted a phenomenological stance, the work of Stake (1995) has been helpful, especially his development of six useful criteria for the validation of naturalistic generalisations (*ibid.*, p. 87). These along with the three Schutzian postulates of logical consistency, subjective interpretation and adequacy together would suggest that only two types of claims can be made legitimately for this research. These are what Hammersley (1990, p. 41) refers to as definitions and factual claims and of the latter, only descriptions and explanations are pertinent to this research.

Apart from the literature confirming that examinations, syllabus and time impact on A-Level Biology classroom teaching practice (Solomon, 1993; Geddis, 1996), this study has identified a wider range of often more subtle variables which influence what A-Level Biology teachers' believe are the possibilities and problems for the teaching of controversial issues, and in addition has suggested conditions under which these variables might operate. With this in mind, the purpose of the following section is to present a more theoretical account reflecting the complexity of the findings of this research.

9.2: The Possibilities and Problems for the use of Controversial Issues

Of the number of variables which have been identified in this study as contributing to teachers' thinking about the possibilities and problems for using controversial issues to teach A-Level Biology, five emerge as of central importance. These variables are:

- Teachers' perception of their biological content knowledge.

  This refers to the amount, adequacy and confidence these teachers have about their own biological content knowledge in relation to the teaching of A-Level Biology.

- Teachers' perception of their pedagogic skills in relation to the teaching of A-Level Biology.

  This refers to the set of teaching strategies identified as being ones which they employ.

- Teachers' views about the nature of science/biology.

  This refers to the views these teachers have about how science/biology 'works' and the principles and the procedures used to construct and test its knowledge claims.

- Teachers' perceptions of students.

  This refers to these teachers' perceptions of students as learners of biology.

- Personal characteristics of teachers.

  This refers to teachers as individuals and includes their breadth of experience outside of teaching, their understanding of and personal opinions about controversial issues and their perceptions of the constraints on their teaching imposed by their institutional environments.

9.2.1: Teachers' perception of their own biological content knowledge

Shulman (1987) identified the need for teachers to have appropriate levels of subject content knowledge in order to effectively teach their subject. However, evidence from this research suggests that the importance teachers place on their biological content knowledge and the impact of this variable on their perceptions of the problems and possibilities for the teaching of controversial issues, is mediated through three associated conditions - amount of, adequacy of and confidence in one's own biological content knowledge.

Amount - refers to the quantity of biological content knowledge teachers have from which they can draw when teaching A-Level Biology, for example, as facts, principles and experimental procedures. *Adequacy* refers to a feeling of sufficiency teachers perceive they have in both depth and breadth of their biological understanding - an understanding in keeping with the demands of the syllabus. The third condition, *confidence*, refers to the manner and ease with which teachers are able to reconceptualise their subject matter and subsequently make this available to students in a meaningful way.

To illustrate, Teachers R and S, possibly as a result of their experiences in scientific research, had what they considered to be a high level of biological content knowledge in terms of amount, adequacy and confidence in that knowledge. This was evidenced by their willingness to teach all aspects of the course, their apparent ease with the level of understanding required of students and how that understanding might best be achieved by students. Referring to the biological content of the syllabus and his own knowledge base, Teacher R comments:

> You can only still pick things which you think are related to the syllabus and you could not go wildly out on a limb no matter how much you might want to.
>
> R: Prop, 42-44

In terms of enhancing students' understanding of biology, Teacher S remarks:

> I enjoy the sixth form work because it is really complicated and you have time to develop it and simplify it and try and spell it out stage by stage. They end up with a complex picture and you have been instrumental in putting that together.
>
> S: Pre0, 127-129

Even though both participants preferred to teach certain aspects of the course, purely out of personal interest, other topics or controversial issues, posed no threat to their belief that the amount of biological content knowledge they had was adequate.

In contrast, there were many aspects of the current A-Level Biology course about which Teacher J, in particular, felt ill-at-ease. This was clearly portrayed in what she saw as her need to 'mug up' and in so doing maintain a knowledge base of sufficient depth and breadth to meet syllabus requirements. As detailed in her account, this was achieved through her intensive memorisation of facts and in her detailed preparation of lessons prior to teaching this biological content to her students. As she explains:

> ... I have for a very poor memory, my short term memory is okay but my medium to long term memory is non existent so I have to mug up very thoroughly before each batch of lessons ...
>
> J: Pre3, 662-664

On the one hand the contention here is that any lack of confidence in the adequacy and amount of teachers' biological content knowledge results in a classroom environment where learning is both constrained and controlled by the teacher. Even though controversial issues might arise during lessons, it is probable that they would not, indeed could not, be sustained as topics for discussion by teachers over an extended period of time - a situation outlined in the account for Teacher J.

On the other hand, possibilities for the teaching of controversial issues are more likely to be considered as a positive and significant aspect of teaching, when teachers perceive that they have an adequate content knowledge, and a confidence in that knowledge, to engage in the sort of flexible thinking required to push the boundaries of the syllabus and, in so doing, introduce new ways of teaching biology using controversial issues. This was exemplified by Teachers R and S.

What emerges from this study is support for the contention that an adequate amount of biological content knowledge and a confidence in that knowledge, in terms of its various conceptualisations, are all necessary but not of themselves sufficient conditions for using controversial issues.

This suggests, therefore, that when teachers' biological knowledge base is well developed, not only are syllabus requirements met, but the use of controversial issues in teaching becomes an additional possibility. In contrast, if teachers have poor levels of content knowledge and/or lack confidence in that knowledge base, despite that knowledge base being adequate, then what is taught to students may meet minimum syllabus requirements but possibilities for using controversial issues in a substantial way are likely to be severely constrained.

For the most part, teachers in this study believed that they were now, or always had been since beginning their A-Level Biology teaching career, in possession of sufficient biological content knowledge to implement the A-Level Biology syllabus, that is, in possession of a sufficient and adequate amount of biological content knowledge. Presenting teachers with potentially unfamiliar content, as was the case with some controversial issues presented to teachers in this study, revealed that they varied in their confidence with respect to the amount and adequacy of their biological content knowledge base. Such a feeling of unfamiliarity with the biological content of some controversial issues led Teachers J and C to question their own levels of confidence with unfamiliar content and in turn to question both the amount and adequacy of their own biological content knowledge base. For example, in reference to the adequacy of her own biological content knowledge, Teacher C remarks:

> I am worried about whether it is relevant and what I am supposed to be dealing with.... It is a difficult one (*referring to the issue of infertility*). It is looking at it from a different way ... Doing it the other way around, is the bit I need to find more about.
>
> C:Pre1, 95, 310

Empirical studies undertaken by Hashweh (1987) and Carlsen (1991) suggest that when teachers are confronted with unfamiliar topics, they set in motion procedures which close down potential discussion of content. For Hashweh (1987) this is evidenced in the lesson planning strategies used by a group of physics and biology teachers and for Carlsen (1991) in the sociolinguistic interactions between students and teachers and between students themselves. As Hashweh (1987) notes:

> ...when teachers were given a chapter with a detectable but meaningless (in disciplinary terms) theme, the unknowledgeable teachers closely followed the chapter structure while the knowledgeable teachers rejected the theme. Teachers tended to delete "details" they themselves could not remember and concepts that were not essential for the theme used in planning. They added many of the concepts they knew, especially those that were either consistent with or easily related to the theme used. (p. 115-116)

Similarly for Carlsen (1991):

> When teaching unfamiliar topics, the teachers tended to dominate the speaking floor, ask frequent low-level questions requiring brief student responses, ignore student bids to change the topic of discourse, and otherwise discourage student verbal participation. (p. 632)

Such remarks marry with those previously made by Kormondy (1990) in reference to teachers' continued neglect of the application of science to contemporary society:

> Many teachers flounder as they move from the security of the known and teachable to the uncertainty of guiding discussion and clarification of values as they assist students in making ethical choices. (p. 403)

The research of Hashweh (1987), Kormondy (1990) and Carlsen (1991) suggests that teachers, as a consequence of their actions, control the classroom environment, thereby placing limitations on what students are permitted to ask teachers and thus restricting students' meaningful engagement with the content in question. However, these writers offer no explanations/mechanisms as to the rationale teachers have for these actions. What this study has shown is that such mechanisms are mediated through teachers' feelings of inadequacy and lack of confidence with unfamiliar biological content. Lack of biological content knowledge would thus be a limiting and a contributing factor to what teachers themselves see are the possibilities and problems for the teaching of controversial issues.

Another limiting factor for some teachers might be their inability to transfer their biological knowledge base from familiar to unfamiliar contexts (Teachers J and C). Inability to transfer this knowledge could be encountered by teachers who possessed both the biological content found within the parameters of the syllabus and within particular controversial issues but who were unable to link these two knowledge domains. This then leads to a second contention with respect to this variable, that in order to understand the biology associated with any controversial issue, teachers need to have a more holistic conceptual understanding of biology than that necessarily presented by the syllabus.

In essence, if teachers have a holistic view of biology which extends beyond the syllabus and, in addition, are able to conceptualise the links between the two knowledge domains of controversial issues and the syllabus, then this would facilitate the incorporation of controversial issues into their teaching. In contrast, if teachers' biological content knowledge is totally structured by the syllabus and the links between the syllabus and controversial issues are not apparent then this would reduce and constrain the possibility of teachers using controversial issues within their A-Level Biology teaching.

To conclude, this research suggests that *amount* of biological content knowledge and a *confidence* in the *adequacy* of that knowledge along with a conceptualisation of biology (which differs from that presented by the A-Level Biology syllabus) each facilitates the ease with which engage with the possibilities for using controversial issues. For example, Teacher J, as her account details, perceived her content knowledge to be often inadequate and therefore lacked the self-confidence she felt was needed to use controversial issues in her teaching despite their inherent interest to both students and herself. In some sense, she was reducing opportunities for students to engage in the discussion of such issues: a situation not unlike beginning teachers who, as Carlsen (1992) asserts, often close classroom discourse when their levels of content knowledge fell below certain thresholds of confidence.

What is of overall interest and seems to be suggested by the results of this thesis is the importance teachers attach to their own perception of an *adequate amount of*, *confidence in* and *familiarity with* their own biological knowledge base and, what the researcher suggests is, a *degree of flexibility* in thinking with respect to the biology located within controversial issues.

9.2.2: Teachers' perceptions of the nature of science/biology

Advocates of the STS approach to the teaching of science suggest that such an approach requires that teachers have a view of science which is provisional and value-laden in its knowledge claims. In addition, it requires a recognition that science is part of society and therefore can legitimately engage itself with the moral, ethical and social concerns of society. This approach is in contrast to the more traditional view of science as an accepted, value-neutral body of knowledge. Such a traditional view sees science as having neither a responsibility to nor a relationship with society and therefore makes no comment on the moral, ethical and social dilemmas faced by individuals or by society even though the results of scientific activities might raise concerns for society.

However, Matthews (1990), Lederman (1992) and Koulaidis and Ogborn (1995) among others, suggest that experienced teachers have a range of beliefs and philosophical positions about the nature of science/biology - some teachers view science/biology more in terms of accepted, value-neutral facts and concepts [which scientists developed, textbooks stated and students needed to acquire (Gallagher, 1991)] whilst other teachers view biology more as a set of interrelated concepts which are open to scrutiny and modification (an activity more often undertaken by scientists) in the light of new evidence, that is they view science as being provisional. This perception is supported by teachers in this study - Teachers J and at times Teacher C seemed to fit more with the former view of science and Teachers R and S with the latter.

Nevertheless, simply having a view of science as being provisional is not sufficient of itself for the consideration of 'STS' type controversial issues as would be the case for 'Scientific' type controversies. In addition a teacher would need to have a notion of the relationship between science and society and the moral, ethical and social dimensions of that relationship. Even though all four teachers in this study mentioned moral and ethical implications of scientific research, as teachers of A-Level Biology they differed in what they believed was the moral and ethical imperative to include such dimensions into their teaching of biology. These differences might be explained in what participants saw was their role as biology teachers. For example, Teachers R and S had a view of biology as provisional and value-laden and intricately connected with wider moral and ethical values. In contrast, Teacher J had a view of biology as an accepted, value-neutral body of knowledge and saw the ethical and moral dimensions of science/biology not in terms of her professional responsibilities as a biology teacher but rather in terms of her social/civic responsibilities. It was for this latter reason, that she articulated her views about blood and organ donation to her students. For Teacher C, even though she seemed to view science as provisional, it was difficult to identify clearly the extent to which she engaged with the moral and ethical dimensions of science/biology in her teaching other than in her stated concern that the personal, economic, social and technological aspects of science were not examined with any regularity and therefore did not form a significant part of her teaching.

In terms of A-Level Biology teaching, a view of science/biology where knowledge is seen as being value-free does not lend itself to any consideration of 'STS' controversies as opposed to that for 'Scientific' controversies where the veracity of ideas is questioned. This contention is supported partly in this study by Teacher J. For her, 'STS' controversies did not play any role in her teaching other than as short lesson motivators. It was also difficult to locate her use of 'Scientific' type controversies.

A view of science as being provisional, value-laden and embedded within a social context facilitates an examination of the relationship of science and society and thus due consideration of 'STS' controversies in order to illustrate features of that relationship. Such a view of science raises the possibility for the use of controversial issues in classrooms. This contention is supported by Teachers R and S of this study. In outlining what Teacher R believes is both the STS and scientific controversy associated with doctor-patient management of diabetes, he points out:

> The controversy is, with the scientific knowledge ... the restriction enzymes ... you have to know about plasmids, how bacteria work and that ... and then you have the technological application, so you learn how to insert a gene and remove a gene that you want and then insert it into a bacterium and then make the product you want and then extract it and package it and then sell it. Then you have people using it. That from the drug company's point of view is very successful. So this is a lot cheaper once you have covered your R&D costs. You can make as much as you want but as far as the user's point of view, you have this issue that lots of people don't like the human insulin and they know theoretically that it is the same and is suppose to be better and the same as what your pancreatic cells would be producing. They don't like it because they can't tell when they are becoming hypoglycaemic as they could with the other insulin. **That is the issue** (*his emphasis*).
>
> R: Pre2, 77-86

Indeed, Teacher R made frequent mention of the provisional nature of science itself and the impact of social factors such as economics and politics on science. However, despite a willingness on his part to use both types of controversial issues to a more significant extent and despite his belief concerning the educational value of such issues in terms of students' understanding of science in all its facets, any further use of controversial issues in his A-Level Biology teaching was hampered by the controls of the syllabus, time and examinations.

Teacher S illustrated her conceptualisation of the relationship of science with society in terms of animal experimentation and its moral and ethical implications:

> Most of the discoveries in biology are brought about by hard slog, research slog over many years. Many of these procedures involve animals ... to bring about huge discoveries that can change the field of biology in a way that can't be reversed.
>
> S: Lesson 1, 11-19

> I don't think that it (*the use of animals in scientific research*) is very well thought out ... you don't have to dig very deep and you ... find examples of people misusing animals.
>
> S: Pre4, 293, 304

Such a view of science could equally accommodate 'Scientific' type controversies because such activities - seen as part of the social fabric - are integral to both current scientific research and the history of science.

In terms of the possibilities and problems for the use of controversial issues, the above discussion has assumed that the biological content of the syllabus is non-controversial. Discussion now focuses on the possibilities and problems for the use of controversial issues when the biology content of the syllabus is viewed as being problematic both in its scientific content and its moral, ethical and social implications. If the syllabus is viewed from such a perspective, then the central criteria for syllabus implementation must be the exploration, testing and development of biological ideas. Therefore, the use of 'STS' and 'Scientific' type controversies are an inevitable part of that practice along with the testing of syllabus boundaries. The contention here is that possibilities for using controversial issues in A-Level Biology are enhanced further when teachers view the nature of science <u>and</u> the biological content of the syllabus as provisional and value-laden. Moreover, 'Scientific' and 'STS' type controversies would therefore play a significant role in teachers' conceptualisation and implementation of the syllabus.

To date, there is no extant literature to support this position. Evidence from this study would seem to indicate that the present A-Level Biology syllabus is perceived by participants to be non-problematic in terms of its content, despite the belief by some participants that science/biology is provisional and value-laden. This could help explain why the teaching of controversial issues received such scant attention by some teachers in this study. Given the accounts of Teachers J, C and, to a lesser extent Teacher S, it would appear that for these teachers, a syllabus which has as its explicit aim the exploration, testing and development of biological ideas, that is, essentially non-prescriptive and, free of external examinations would, for various professional and personal reasons, be problematic. For as Teacher S remarks, when invited to comment on the impact of the abolition of external examinations:

> I think it (*teaching*) would go down the pan ... disintegrate because that seems to be the focus of everything that I do at the moment ... there are certain things that I am interested in and if it was just left to sort of develop their interests and things that I thought were interesting ... I don't think that that is a very satisfactory approach I don't think. You have got to have this goal at the end.
>
> S:Pre1, 223-230

In contrast, the account of Teacher R suggests, that such an A-Level Biology syllabus would at least be considered. For R, stretching syllabus boundaries was a professional and personal challenge. Given his confidence in the amount and adequacy of his own biological knowledge base, the imperative to include moral, ethical and social dimensions into his teaching and finally, his apparent ability to think flexibly with respect to the incorporation of biological ideas into his teaching, such a syllabus, with its potential emphasis on controversy, would indeed be welcomed. For R, this raises possibilities for the use of controversial issues.

To conclude, the use of 'STS' and 'Scientific' type controversial issues is clearly possible when the nature of science and/or the content of the syllabus are seen as provisional and value-laden but limited to those of a 'Scientific' nature when both science and the contents of the syllabus are viewed as an accepted, value-neutral body of knowledge. In answer to the main research question, what teachers view as the possibilities and problems for using controversial issues is contingent upon their views about the nature of science and how this is seen in relation to their views about the content of the A-Level Biology syllabus.

9.2.3: Teachers' perceptions of their pedagogic skills in relation to the teaching of controversial issues

The results from this study indicated that these experienced A-Level Biology teachers have an organised repertoire of finely tuned teaching approaches and pedagogic skills the purpose of which is to facilitate teaching and learning. In this study the approaches included the use of practical work, field work, discussion, group work, lecture-type presentation and informal talk between teachers and students. Nonetheless, it appeared that the frequency of use of any particular strategy was dependent upon teachers' perceptions of the influences of syllabus, time and examination and the school environment, along with their personal confidence in and commitment to each strategy.

The STS approach to science teaching has favoured the use of group work where students have the opportunity to discuss and debate controversial issues amongst themselves (Solomon and Aikenhead, 1994). However, there is no discussion in the STS literature of any aspect of the use of group work which this study highlights. Namely, the importance teachers themselves place on their own ability to manage classroom discussion and group work. Although the four teachers in this study would agree that such teaching techniques are eminently suitable for any examination of controversial issues, they varied in their confidence in using the skills needed for successful classroom debate and discussion, a confidence often independent of (or removed from) their biological content knowledge. The latter is best illustrated with Teacher C. She believed that her excellent rapport with students and her ability and skill to promote group discussion and debate more than adequately compensated for her limited biological knowledge. When confronted with student questions on infertility, she made use of the resource materials prepared for students and so guided them in their formulation of an appropriate answer.

As discussed previously, possession of high levels of biological content knowledge, confidence in the adequacy of that knowledge and a view of science which is seen as provisional, value-laden and set within a social context do not of themselves make possible the use of controversial issues. In addition, teachers need a degree of confidence in their ability to handle classroom discussion and debate and, a clear rationale for the position(s) (neutrality, commitment and balance) they wish to adopt during such discussions. Lack of confidence leads to avoidance of more formal discussion of controversial issues and therefore a preferred mode of classroom operation more attuned with whole class lecturing (Teacher J).

This does not imply that for these teachers 'control of content' is at issue, as might be the situation for those with inadequate content knowledge. Rather, these teachers appear to lack confidence in the pedagogic skills needed to lead discussion or to elicit student responses to the controversy even though they might be of the opinion that controversial issues are excellent for the development of students' social skills and for the acquisition of biological understanding.

Even though the STS and more general literature on the use of controversial issues has addressed the appropriateness of debate and discussion as suitable teaching strategies, it has as yet not raised the question of whether there are other modes of classroom operation suitable for the teaching of controversial issues which could assist those teachers who lack the pedagogic skills necessary for conducting classroom discussion and debate. Indeed, for Teacher J personally, discussion and debate were problematic.

It is postulated that when alternative and/or potentially novel strategies (e.g. controversial issues) and techniques (e.g. classroom debate) are encounted by teachers which challenge their more usual modes of classroom operation, such alternatives are considered by those teachers who are confident in the amount and adequacy of their content knowledge and in their pedagogic skills.

The STS literature seldom critically addresses the usefulness of discussion and debate for the development of biological concepts - a cause for concern for three of the teachers in this study. The results of this research seem to suggest that there are several compounding reasons as to why teachers might not encourage discussion and debate *per se* or believe it can make no contribution to student understanding of biological concepts. As already indicated two reasons are thought to relate to teachers' confidence in the adequacy of their biological content knowledge, their views of science and therefore (for some teachers) their wish to control lesson content. A third reason is related to their pedagogic skills. To illustrate, even though Teacher J was of the opinion that controversial issues were excellent for the development of students' social skills, she felt they had limited value in terms of the development of students' biological understanding. For her, sustained classroom discussion and debate were difficult because she believed she lacked the pedagogic skills to undertake these teaching strategies. This along with what she perceived to be was her lack of content knowledge meant that discussion/debate were limited to five minute unplanned lesson segment. Indeed, she displayed views similar to those of Kromhout and Good (1983) and Good, Herron, Lawson and Renner (1985) in terms of their concern that social issues, rather than science concepts, might become the basis for science teaching. Her interest too was with the transmission of objective knowledge and the processes of students acquiring that knowledge and, therefore, it is not surprising that J did not employ discussion and debate irrespective of her ability and confidence to engage in such activities. For this teacher there were three reasons for not using discussion/debate in her classroom and therefore her preferred mode of classroom operation was as the transmission of largely uncontested biological knowledge via a lecture-type format.

9.2.4: Teachers' perceptions of students

The literature suggests that in order for the STS approach to be successful in classrooms, it would be helpful for teachers to adopt the following perspectives on students; first, students should be seen as being interested in the moral, ethical and social dimensions of science and are capable of appreciating the nature of the relationship between science and society and second, students should be seen as being capable of and enjoying classroom discussion and debate on such issues (Solomon, 1988, 1992; Geddis, 1991;

Zoller, 1991a, Gayford, 1992, 1993). Results from this study support the STS view that students find engagement with the moral, ethical and social issues associated with science/biology of relevance and interest. This was observed and noted by each of the four teachers during the controversial issue lessons.

However, in addition to the belief that students find the STS approach more relevant than traditional approaches to science (Lock, 1996), the STS literature also suggests that when students are engaged in the discussion of science-related issues thought relevant to students' lives, learning becomes meaningful for students because they have real access to science (Ziman, 1980, 1984). Advocates of the STS approach to teaching and learning provide few arguments or empirical evidence to substantiate this claim, nor do they give any consideration to the beliefs teachers may have about students in terms of students' interests and needs in STS discussions, or in students' capacity to engage in discussion and debate *per se*[1]. Moreover, it is unclear whether the STS approach is conceptualised as being integral to more traditional approaches to teaching science or as an adjunct to them.

Moreover, whilst each of the teachers in this study agreed that students should appreciate the relationship between science and society, they nevertheless differed from each other in their capacities to create and foster the sort of learning environments which would facilitate the sustained use of controversial issues as a learning strategy. The arguments advanced by advocates of STS approaches suggest that in order to facilitate the use of controversial issues as a teaching strategy teachers need to construct a specific type of learning environment. The theoretical framework of Greeno, Collins and Resnick (1996) with regard to the design of learning environments is helpful here since it provides three views dealing with the nature of knowing, learning and transfer: the behaviourist/empiricist view, the cognitive/rationalist view and the situative/pragmatist-sociohistoric view. It seems likely that the latter facilitates the use of controversial issues and the two former constrain the use of controversial issues. Evidence from the four teachers in this study indicated that some teachers are able to employ more than one view depending, it seems, on the teaching context, thereby ensuring the possibilities for constructing appropriate learning environments conducive to the different learning needs of their students, including the use of controversial issues.

[1] For a more detailed discussion refer to pages 33-34.

Embedded within the behaviourist/empiricist view is the belief that students' learning is optimised when teaching and learning are structured and routinised. This is a view of student learning with which Teacher J seems most comfortable and has become her preferred mode of classroom operation. Such a view of students and their learning is reflected in her belief that A-Level Biology students are in need of biological content knowledge which she provides. Transfer of that knowledge to students is done by her and its success is gauged in terms of examination grades. Thus even though students might be mature and socially competent, and therefore able to participate in social discussions, nevertheless in Teacher J's view, students were incapable of either engaging with the construction of their own biological knowledge base or discussing how that knowledge base was constructed. It would appear then that such a view of students, in terms of their learning of science, would not support any sustained discussion of controversial issues other than as short, five minute unplanned events within science lessons.

By the cognitive/rationalist view, students are conceptualised as constructors of 'understanding of concepts and principles through problem solving and reasoning' based on their own initial understandings. As with the previous view, no mention is made of the social context in which this knowledge is constructed. Such a view of students was clearly demonstrated by Teacher S and at times by Teacher R in their descriptions and explanations of how they foster students' understanding of biological concepts, that is, in building up a complex view of biology from simple concepts. Whilst such a view of student learning might not foster consideration of 'STS' type controversial issues, consideration of 'Scientific' type controversial issues is possible if seen from a historical context, that is, in the development of scientific ideas and principles.

In contrast to the previous two views of learning, the situative/pragmatist-sociohistoric view sets student learning within a social context and sees students as being actively engaged in the 'social practices of sense-making and learning' achieved via activities such as problem solving and debate where students are supported in their quest to become confident and independent learners. Such a view assumes that both teachers and students are capable of engaging in these sorts of activities. This perspective on learning and knowledge seems to enhance the possibilities of teachers constructing contexts which encourage the use of controversial issues. In terms of this research, Teacher R sought to create social classroom opportunities where students were able to engage in the discussion of ethical, moral and social issues associated with their current biological understandings. The controversial issues lesson on diabetes was one such example. As part of the lesson students worked in small research groups in order to prepare a pamphlet on diabetes using the resources available in the lessons.

This research has shown that teachers may not necessarily think about knowledge, and students' learning of that knowledge, in the ways needed to construct situative/pragmatist-sociohistoric learning environments. Thus even though all four teachers were of the opinion that A-Level Biology students were generally mature, socially able and capable of becoming independent thinkers - a view of students which would seem to be an essential aspect for any consideration of controversial issues by teachers because such issues involve students engaging not only with a variety of opinions but also in the formulation of their own opinions - differences emerged between teachers with respect to their views concerning students' capacities to engage with the complexity and controversies of science and their role in assisting students in coming to terms with that complexity. Thus for Teacher J, the learning environment she seems to construct was reflective of her view that students needed to acquire biological content knowledge, seen as a static body of factual knowledge, which she had to transmit intact. This view of learning is reinforced by Teacher J through her concern with weaker students and the need for them to obtain passing grades. In contrast, Teacher R seemed to have a more developed view of student learning. He was able to alter his perspective on student learning depending upon the context.

This study has provided a much needed teacher perspective on students in relation to the use of 'STS' type controversies. The research has shown that each of the A-Level Biology teachers in this study have an organised set of beliefs about A-Level Biology students generally and about students as learners of biology in particular. In addition, they have a set of goals which students need to achieve by the end of the course.

In conclusion, possibilities for the use of controversial issues are raised when teachers view their students as independent learners, capable of engaging with the social, moral and ethical complexity of science/biology and in addition see such learning as taking place within a social context.

9.2.5: Personal characteristics of the teacher

Of interest to this study is the question of whether previous work-related or more personal experiences have the potential to at least raise teachers' awareness of the existence of controversial issues along with ways in which such issues could be incorporated into A-Level Biology teaching.

Work-related experiences can be conceived as being of two types - those directly related to science (e.g. scientific research) or science-related (e.g. nursing, environmental consultancy) and those outside of science (e.g. business). In terms of the former, consideration needs to be given to whether the breadth and types of biological understandings necessary for such work, leads to a raising of teachers' awareness of controversial issues.

Clearly for those persons engaged in science and science-related work, a knowledge of current biology is essential. This includes an awareness of scientific controversies and the application of scientific knowledge, for example, in industry and in the community. Indeed, both types of work-related experiences are useful to teachers if the aim of teachers is to increase students' awareness of state of the art scientific research and its application (Henderson and Lally, 1988; Morishita, 1991).

Whilst work experiences outside of science may not increase teachers' general or more specific biological content knowledge, they might well have meant engagement with teaching techniques and strategies thought by the literature [Bybee, 1987; Thier and Nagle in Solomon and Aikenhead (1994)]) to be conducive to the teaching of controversial issues. Group work, discussion and the negotiation of workplace demands are examples of such skills applicable to teaching.

There is no clear support for the notion that science or science-related work experiences either increases teachers' biological content knowledge in order to teach the A-Level Biology syllabus or in any way mediates what teachers see as the possibilities and problems for the use of controversial issues in A-Level Biology classrooms. Indeed, there might well be many A-Level Biology teachers, with no science, science-related or other types of work experiences who, as part of what they perceive to be their professional responsibilities as biology teachers, maintain high levels of biological content knowledge, an up-to-date understanding of the nature of science and the skills in teaching through their own professional activities.

Personal experiences include those family and community settings where controversial issues with moral and ethical implications might need to be considered, for example, local environmental issues. Such personal contexts might heighten teachers' awareness of more specific 'STS' type controversies not only from a biological perspective but also in terms of the skills needed to resolve such issues.

The data available from this study is limited to four teachers, three of whom had previous science or science-related work experiences. It would be inappropriate to, for example, directly link either their work-related or personal experiences with any increase in or confidence with their biological content knowledge, their views concerning the nature of science or their use of controversial issues in teaching. Therefore, this study can make no claims about the influence of teachers' *outside-teaching experiences* on what they would consider are the possibilities and problems for the teaching of controversial issues, other than to say that a link could exist in terms of heightening their awareness of controversial issues.

To summarise, each of these experiences of teachers might simply raise teachers' awareness of such issues but contribute little to their considered opinions for the use or otherwise of controversial issues in their classrooms or the skills required to undertake such activities. That teachers' previous experiences might mediate what they believe are the possibilities and problems for the teaching of controversial issues is not mentioned in the literature, nor directly supported by this study. What this study has done is identify teachers' work-related and personal experiences as a possible variable for understanding how experienced A-Level Biology teachers view the possibilities and problems for the use of controversial issues but it has not been able to explain how this variable operates. This might be worthy of further consideration.

The unanimous stated belief by teachers in this study was that controversial issues in biology were those associated with society's social, ethical and moral dilemmas. Discussion of controversial issues was seen as part of *good* education, that is, an education where such topics were debated with sensitivity to and tolerance of various viewpoints - sentiments which marry with those addressing *The Ethical Line of Argument* and *The Civic and Social Line of Argument* as discussed in the literature review.

Furthermore, the results of this study clearly indicate that teachers believe that the use of controversial issues facilitates the development of students' social skills and therefore are of value within the A-Level Biology teaching context. In addition, such issues highlight for students the social, moral and ethical dimensions of the discipline - a finding in keeping with the work carried out by Solomon and Aikenhead (1994). Clearly, the use of controversial issues is a possibility

The results of this study, in terms of participants' more personal characteristics, are not in full accord with the five possible explanations put forward in the literature for teachers' reluctance to teach controversial issues[2]. Apart from Teacher J, teachers in this study did not avoid classroom unrest and dissent in the discussion of the controversial issues. Rather they actively encouraged it. For Teacher C in particular, student unrest and dissent were not an issue; her concern was with maintaining her professional reputation. In terms of A-Level Biology teaching and what teachers view are the possibilities and problems for the teaching of controversial issues, this study has, in addition to confirming what other writers have discussed (Jennings, 1990; Jungwirth, 1980; Hutchinson, 1983) identified the existence and possible influence of other more subtle variables than syllabus, time and examinations on teaching.

Previous work by Geddis (1991) has highlighted the educational desirability for students to become intellectually independent: a desirability enhanced by students' awareness of the 'epistemological contexts assumed by each protagonists', their ability to accommodate 'multiple perspectives on an issue' and for them to become actively engaged in 'decision making' - that these were desirable educational outcomes and could be fostered though the presentation of controversial issues was not called into question by participants of this study. It appeared that neither these desired educational outcomes nor the requirement that the controversial issue fit with both the A-Level Biology syllabus and with what teachers were engaged with at the time of the intervention necessarily determined teachers' choice of issue. Indeed, there were many controversial issues associated with the particular syllabus topics with which teachers and students were engaged. Teachers' readiness to allow students choice of controversial issue is independent of whether the issue fits with the syllabus, with what students are learning at the time and with Geddis's (1991) educationally desirable outcomes. Rather, teachers' readiness to allow students to choose the issues to be addressed is in part determined by teachers' more personal beliefs about their confidence in the adequacy and amount of their biological knowledge base, their social, moral and ethical position concerning the controversial issue in question, their perceived pedagogic skills in handling the issue in classrooms and finally, what it means for them to be an A-Level Biology teacher.

[2] For this discussion in the literature see page 35.

There are several possible explanations as to why teachers choose the controversial issue independent of whether or not they allow students to make the choice. First, if teachers perceive their biological content knowledge and their pedagogic skills to be adequate and, are confident with each of these then potentially at least, all controversial issues are possible and students' interest in any particular issue can be readily accommodated. Such a position is supported in the account for Teacher S. For her, student choice is important. However, such a position is only partially supported by evidence obtained from Teacher R. His choice of controversial issue was mitigated not by his biological content knowledge or by his pedagogic skills but by his personal interest in diabetes management.

Second, if teachers perceive their pedagogic skills to be inadequate to meet the demands of the debate/discussion but are confident in the adequacy of their biological content knowledge, they may still feel able to conduct the discussion - their biological content knowledge somehow compensating for their under-developed pedagogic skills. Here controversial issues are possible but student choice is limited to those for which the teacher has an adequate and confident biological knowledge base. This was exemplified by Teacher J in her choice of organ transplantation for which she believed she had an adequate knowledge base in order to answer student questions but nevertheless felt ill-at-ease with classroom debate. In contrast, even though Teacher C felt that for some controversial issues her biological knowledge base was under-developed, she believed that if this could be improved then, along with her excellent rapport with students and her ability to accommodate class discussion/debate, potentially at least, not only were all controversial issues possible but in addition students would have a choice in the issue for discussion. This was the rationale she used for her choice of infertility.

Consideration will now be given to teachers' perceptions of the influence the institutional environment has on A-Level Biology teachers' use of controversial issues - an environment seemingly dominated by government policies and directives, in terms of syllabus guidelines and external examinations and, a school senior management team which ensures adherence to those policies and directives.

Even though all teachers in this study believed that in some way the syllabus, time and external examinations influenced their A-Level Biology teaching, as was detailed in their respective accounts, the study also indicates that there are subtle differences in teachers' perception of these constraints. For some teachers institutional constraints were not considered important, either because they were seemingly unaware of their existence or chose to ignore them (Teacher J) or because they had been able to domesticate these and other constraints with their own beliefs about the purposes of A-Level Biology teaching, that is, they have been able to work with the imposed limitations (Teacher S). In contrast, Teacher C whilst recognising the importance of government directives concerning the syllabus and external examinations, regarded school interference in classroom practice as an invasion of teachers' professional expertise and identity. Interestingly, the study also suggests that for some teachers institutional constraints are viewed as a professional challenge (Teacher R). For Teacher R, flexibility of approach to A-Level Biology teaching was important in the maintenance of professional identity.

Given the paucity of literature concerned with A-Level Biology teaching and the small number of participants involved in this study, only tentative assertions can be made in terms of the constraints imposed by the institutional environment on teachers' use of controversial issues. In terms of this research, the net effect of institutional constraints was seen by teachers as *pressures of accountability* to students, their colleagues, themselves, parents and the school - a contention supported by Duschl and Wright (1989) who note in reference to their work dealing with teachers' views of the nature of science:

> Attending to factors within the school seemed to be more important to science teachers at CHS than the factors associated with an accurate portrayal of the discipline they teach. (p.493)

As regards what teachers view are the possibilities and problems for the teaching of controversial issues, evidence from this thesis suggests that there are strong hegemonic pressures on A-Level Biology teachers to adopt a traditional style of teaching - a style thought to facilitate students' acquisition of content and examination success. Such pressures ensure that any alternative approaches to teaching A-Level Biology, which might be perceived to compromise examination success, for example controversial issues, are not used in classrooms.

9.3: Implications of the Study

The STS movement has failed over the years to give due consideration to the perspective of teachers in relation to their philosophical position of science and their views of students as learners. In fact the STS movement has underestimated generally the difficulty of teaching controversial issues not only for A-Level Biology but for science teaching generally. In addition, STS advocates have not appreciated the complexity, nor have they adequately addressed practical issues in terms of teacher education and professional development, with respect to the use of controversial issues as a teaching strategy and the construction of learning environments within which STS approaches can be used.

What the STS movement appears to have promoted is a view of teachers as being deficit in their understanding of the relationship between science and society and the importance of this relationship. It is a view of teachers promoted through a normative agenda of what teachers ought to do in order to meet the STS agenda. It seems that such a view does not raise the potential for the use of controversial issues for normal A-Level Biology teaching. Even given the amount of support provided by the intervention (which attempted to remove, for example, constraints of time to collect resources) some teachers were able to engage only to a limited extent with this teaching approach. By seeking to address the perspective of teachers and attempting to uncover what experienced teachers see as the possibilities and problems for the use of controversial issues, this study has actively sought out and addressed difficulties teachers might experience when using such an approach in their A-Level Biology teaching.

Whilst almost *a priori*, the constraints of syllabus content, assessment procedures and time could have been predicted, what this research has demonstrated is that there are many reasons why teachers might not engage with controversial issues to any significant extent. Some of these relate to constraints imposed by the institutional environment in which they work, whilst others relate to more personal aspects of teaching such as their biological knowledge base and their views of science/biology and students. Teachers in this study had an organised set of beliefs concerning what they considered to be appropriate contexts for the use of controversial issues. The adoption of a deficit model of teachers by the proponents of the STS movement is inappropriate and unhelpful for teachers. In essence, an appreciation of the complexity of the problems teachers might face when implementing STS approaches has not been satisfactorily addressed by the advocates of STS.

The findings of this study suggest a number of implications. Two of these are issues concerning teacher education and professional development and an agenda for further research.

9.3.1: Implications for teacher education and professional development

This study has identified a complex set of variables which are indicative of the well-developed rational (four) experienced A-Level Biology teachers have for their use of controversial issues. These have implications for the design of programs of teacher education and professional development.

Addressing issues of biological content knowledge

Given the findings of this research, what teachers might find useful are opportunities to engage with both their existing biological knowledge base and with new biological ideas in different ways from what they would normally do in their classrooms, in order to gain further confidence in the amount and adequacy of their biological knowledge base. One way that this could be achieved is by making such literature readily available through biology education journals, as is already done in Britain. However, in terms of making a more significant impact on teachers themselves, that is, in terms of building upon their present biological understandings, this would be better achieved through in-service support where teachers were able to engage with current biological ideas as both teachers and learners of that material.

Developing views of science/biology

One way in which the use of controversial issues might be promoted is through an examination by teachers of their own views of science in order to ascertain whether such views facilitate or constrain the use of controversial issues. As was shown in this study, a view of science as provisional, value-laden and set within a social context is favourably disposed towards the use of controversial issues rather than a view of science as accepted and value-neutral. Consideration would here need to be given by teachers as to what they themselves believe is the nature of the relationship between science and society and how their perception of this relationship facilitates or constrains possibilities for the use of controversial issues.

Using personal experiences as a useful resource for teaching

In addition, such program of continuing teacher development as suggested above should provide opportunities for teachers to reflect upon how their more personal experiences might facilitate the use of controversial issues. Such in-service support would need to give due attention to the variety of different ways teachers already conceptualise their biological understanding and biology teaching and with this, guidance as to the flexibility of thinking required by students and themselves in order to move between the biological knowledge associated with a particular controversial issue and that of their own biological knowledge base. A familiar or topical controversial issue might serve as an appropriate exemplar. As this study has demonstrated, flexibility of thinking in terms of the biological content knowledge seems to be one of the necessary prerequisites for any consideration of the use of controversial issues.

Raising awareness of different ways of thinking about knowledge and learning

The fourth implication concerns the possible need to raise teachers' awareness of the different ways in which knowledge is constructed, that is, different ways of knowing and the different learning environments teachers need to construct for student engagement with the particular learning task. This would involve consideration of each of the three philosophical positions with regards to the nature of knowing, learning and transfer previously discussed.

Such in-service support, therefore, would need to have as part of its agenda, provision for discussion by teachers of the sorts of teaching strategies which would facilitate the use of controversial issues, their value in terms of student learning and a possible change of role for teachers themselves as they move between teaching contexts of differing philosophical positions. With regard to the situative/pragmatist-sociohistoric view, for example, recognition would also need to be given to the needs of students in terms of the research skills they require in order to work from a potentially inadequate knowledge base in order to become independent, critical thinkers.

There is a wealth of literature and resource materials developed by curriculum innovators dealing with the STS perspective on science teaching. Teachers in this study were aware of the existence of these but often had not found them to be of assistance either to themselves or to their students - SATIS materials in particular were mentioned. The suspicion here is that teachers did not view such materials as being sufficiently sensitive to their immediate needs. As discussed in the literature review, curriculum planners appeared not to have taken into account the expertise of teachers when developing resources thought suitable for students. However, the biology teachers in this study felt they had the necessary expertise to develop curriculum materials but needed adequate time to develop these materials so that they were suitable for A-Level Biology teaching. Given the constraint of time, what teachers might find helpful are suggested frameworks for curriculum change which they could tailor to meet the needs of their students.

9.3.2: Implications for future research

The findings of this research have identified a number of variables each of which are indicative of the complexity of A-Level Biology teaching and so provide a basis for further research. Further studies might build upon these findings by examining in more detail the contribution of each variable to the teaching of controversial issues or to more general aspects of A-Level Biology teaching. Given the perception that teachers in this study had in regards to the heavy content of the syllabus, further research might explore, for example, teachers' biological content knowledge and views of science in terms of the stated aims and objectives of the A-Level Biology syllabus and how each of these impacts upon day-to-day teaching practice. Since there is a paucity of literature dealing with the thinking of A-Level Biology teachers, indeed science teachers in general, this might well prove a fruitful area of research.

In addition to further research on teachers, two other areas are worthy of consideration.

Studies of A-Level Biology students

This is an area of research as yet unexplored. The results of this part of the study suggest two areas of further research. First, an exploration of students' understanding of the term 'a controversial issue', their levels of interest in the discussion of such issues and an examination of their views about the nature of biology and their understanding of its concepts within the context of controversial issues. The second and broader area of research might examine A-Level Biology students' craft knowledge within the more general context of A-Level Biology. Studies of both A-Level Biology teachers and students would provide a more comprehensive view of A-Level Biology teaching and learning than that which currently exists.

Studies in science/biology teacher education

Research in this area would have as its focus the professional practice of teacher educators engaged in the development and evaluation of programs of pre-service and in-service professional development dealing with the use of controversial issues using, for example, action research strategies. Given the meaning of controversial issues used in this study and the discussions of the previous section, it would seem appropriate to adopt the situative/pragmatist-sociohistoric view of learning for the conduct of such programs.

9.4: The Conduct of the Research

This section critiques and reflects on the research method and the design through an examination of whether judiciously apportioned time and energy were given to each of the four phases of data collection, including the preparation of lesson resources, and subsequent data analysis; whether the skill of the researcher, was such that authentic access to the beliefs, values and attitudes of each participant in relation to the teaching of controversial issues was achieved and finally, whether the qualitative approach to data collection and analysis used in this research was congruent with the desire to adopt a phenomenological stance given that the semi-structured interview was the main research instrument. Finally, the purpose of student interviews will be reviewed.

Inasmuch as this research sought an understanding of experienced biology teachers' views concerning the teaching of controversial issues, the sample chosen was small - four, experienced A-Level Biology teachers with no less than four years of A-Level Biology teaching experience each.

The question of judiciously apportioned time and energy

The collection and collation of resources of sufficient quantity, quality and breadth of source required by each teacher during the early part of the pre-lesson interview phase of data collection was time and labour intensive, but nevertheless a necessary supplementary activity before the study could fully proceed. Given that for three participants, the teaching of controversial issues had not previously been more formalised, it was important that these materials be available early in the pre-lesson interview phase. This ensured teachers had adequate time to familiarise themselves with some of the finer details of each issue. These materials subsequently became the property of each participant and were seen at the time by the researcher as one way to develop appropriate field relations. In the researcher's quest to develop such relations these resources were often over-prepared and thus not always an appropriate investment of time and energy. In addition, one possible outcome of this could have been that the researcher inadvertently provided participants with a reason not to reconsider the use of controversial issues, simply because of the time and effort involved in the collection and collation of resources.

Transcribing semi-structured interviews and lesson dialogues on the day was imperative, particularly when voice nuances, non-verbal language and physical outlay of both the interview room and the laboratory were needed to complete fieldnotes. As for lesson resources, this was a time consuming but nevertheless a necessary investment given the need for sensitivity and attention to detail if the purpose of this study was to be achieved.

The development, trial and modification of data analysis procedures was extraordinarily time consuming, labour intensive and took many months to complete. This was inevitable given the inexperience of the researcher who was unable to often anticipate all the nuances and possible short cuts of qualitative research ahead of time other than from a reading of the literature. Therefore, it was not surprising that the process of data analysis was a time consuming learning activity.

Issues of reliability and validity in relation to participants' beliefs and values concerning the use of controversial issues

The frequency and quality of data checking along with the detailed analysis procedures outlined in the methodology chapters allowed the researcher to remain close to and familiar with the data - a strategy thought to be important in terms of reliability and validity for the purposes of this study. In addition, it suggested that potential difficulties with data reliability and validity arising in qualitative research of this type were addressed and in due course resolved to the satisfaction of each participant. This was evidenced in the feedback given by participants during the Pre-Lesson Interview when points of clarification were sought by the researcher, in the Propositions Interview when participants were invited to comment on teacher-specific theoretical statements devised by the researcher and finally, in written feedback received by the researcher either from the drafts accounts or as unsolicited correspondence. Each of these would seem to indicate that the researcher might well have been successful in her attempts to develop four authentic accounts.

Congruence and the desire to adopt a phenomenological stance.

Consideration needs to be given as to whether the data analysis method developed for this purpose (the desire to adopt a phenomenological stance), and the manner in which draft accounts were written, was helpful. The answer here seems to be yes. Even though data analysis was frustrating in terms of time, it allowed the researcher to become familiar with the process of data analysis and to be sensitive to the data itself. This required the researcher to reread and/or relisten to data segments, in order to develop a conceptualisation of what it meant to be an A-Level Biology teacher in terms of what teachers perceived were the possibilities and problems for the teaching of controversial issues - a conceptualisation sensitive to the perspective of each participant.

Given the favourable response made by participants to their draft accounts, it would seem reasonable to conclude that a phenomenological stance had been achieved and that the researcher could feel a degree of confidence in the claims of each proposition.

The use of semi-structured interviews

Semi-structured interviews were difficult in terms of maintaining a balance between the need on the part of the researcher to provide conditions which facilitated teacher talk as opposed to an informal conversation, and the need to maintain a more formal research perspective. Generally, these interviews were successful in yielding relevant data in order to answer the research questions. However, there were a few situations where interviewing was difficult. This occurred when participants felt strained by and uncomfortable with the substance of some of the questions. When this happened, other less threatening and more general questions were posed. Fortunately, this was not the norm. At other times, it was important that the researcher remain flexible in allowing participants time for informal social talk before the substantive part of the interview began. Often this social talk simply allowed teachers to debrief the researcher about the events of the day.

The role of the researcher

Adopting the role of researcher, rather than sympathetic biology colleague, was difficult at times and especially so when, for example, the time and energy invested in the collection and collation of lesson materials were not utilised to the researcher's perceived potential. Occasionally, it was difficult to divorce this from the real task of the study. The collection of too many resources and their over preparation was not a helpful strategy for the researcher to have adopted and can be explained in terms of her enthusiasm, concern for rapport with participants and a feeling of gratitude to them for their involvement. Fortunately for the researcher, these teachers found the experience professionally rewarding.

The intervention

Even though the intervention for this study was conceptualised as non-aggressive and conducted with the full agreement, co-operation and control of participants, two questions need to be considered. First, whether such an approach could be considered as a viable tool for educational research of this kind and second, more specifically for this study, whether a full account was taken of the effects of this intervention in terms of the distortions to participants' teaching practice. To answer the first question, such an approach might be viable when time to conduct research was not problematic. In terms of this study, it was helpful that the researcher had a background in school biology teaching especially for the initial collection and collation of resources. In answer to the second question, due care was taken to ensure that the controversial issue lesson(s) related to the syllabus and to each participant's current scheme of work. In this sense, the intervention was not seen by teachers as a disruption to what they might normally have done. Rather, it was seen as an alternative teaching strategy the content of which fitted with their current schemes of work.

Student data

This was data in the form of semi-structured interviews obtained from the students of each teacher during the course of the study. Students were interviewed in pairs to ease any discomfort they might have with the researcher or the interview itself, and for the convenience of the researcher in terms of time and student numbers. For ethical reasons, students were informed that neither the audiotapes of their interviews nor their transcripts would be available to their teachers, along with an assurance from the researcher that paraphrasing of their responses would not be forthcoming should teachers request such feedback.

The data collected concerned students' perception of biology, their A-Level lessons and their reactions to the controversial issues lesson. Given the wealth of data already obtained from teachers, decisions had to be made concerning time and for this reason it was decided not to proceed with any detailed analysis of student transcripts. The only student data which appeared in the accounts were points of potential interest thought to enrich the accounts of their teachers.

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APPENDIX A

Chapter 3: Research Methodology 1

Data Collection

Figure 3.1: **The four phases of data collection arranged in chronological order**

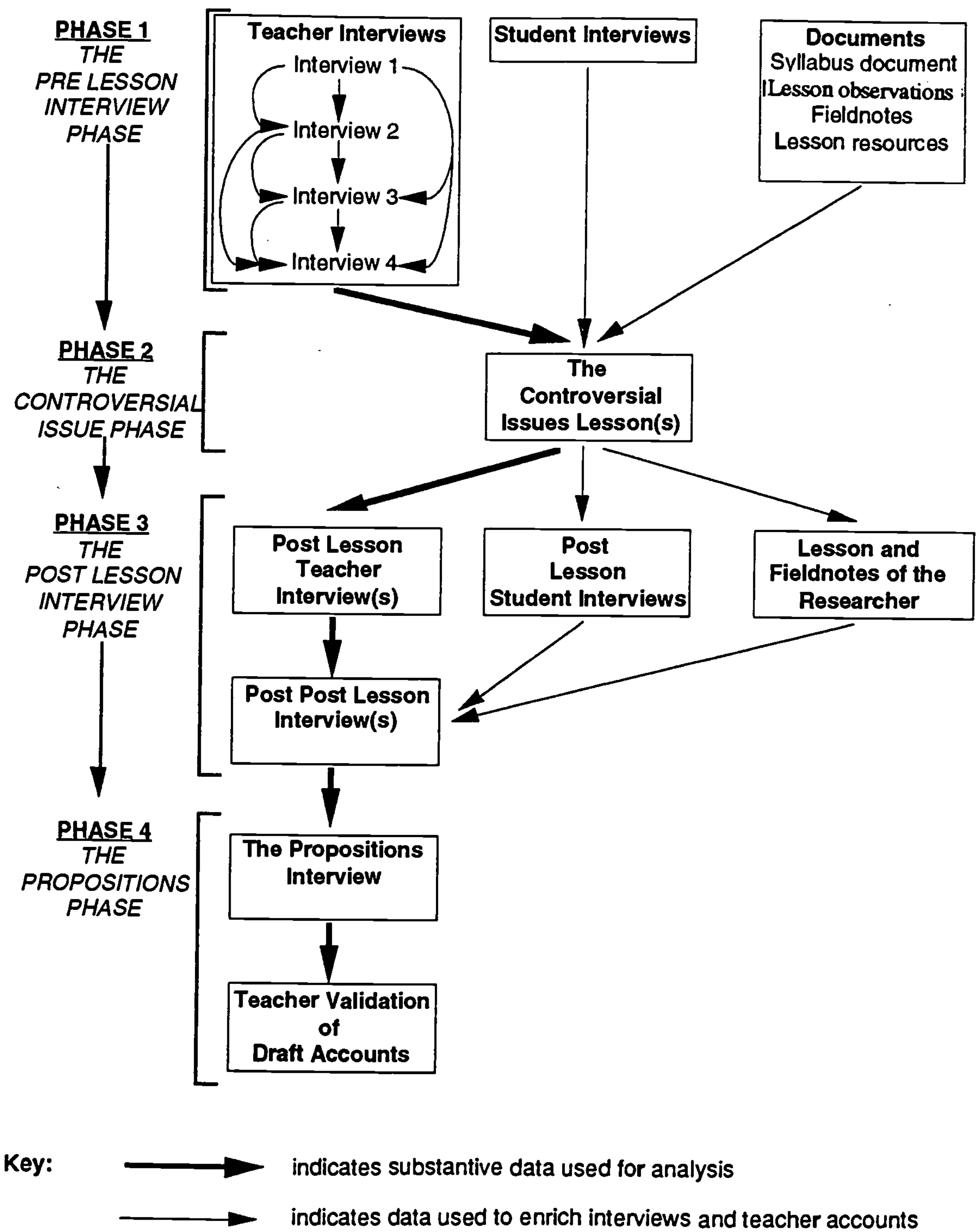

Table 3.1: **Number and duration of interviews within each of the *four* phases of data collection:**

Phase 1 - *Pre-Lesson Interviews*

Phase 2 - *Contoversial Issue Lesson(s)*

Phase 3 - *Post-Post Lesson Interviews*

Phase 4 - *Propositions Interview*

TEACHER	ISSUE	PHASE 1 Pre-Lesson Interviews		PHASE 2 Controversial Issue Lesson(s)	PHASE 3 Post Lesson Interviews			PHASE 4 Propositions Interviews
		Teachers	Students#		Post Lesson Teacher	Post Lesson Student	Post/Post Teacher	
J	Organ Transplantation	4	8	1	1	8	1	1
C	Infertility	4	8	1	1	8	2*	1
R	Diabetes	3 ^	3	3	2	3	2	1
S	Animal Experimentation	4	5	3	2	3	3	1

Key:

\# Students interviewed in groups of two or three.

* A second Post-Post Interview was sought by Teacher C who wanted to comment further on various aspects of the controversial issue lesson addressing infertility.

^ Teacher R had decided on the relevant issue during Pre-Lesson Interview 1.

Table 3.2: **Type and form of data collected**

Sources of Data	Form of Data	Comments
AUDIOTAPES	Teacher Interviews Controversial Issue Lesson(s)	Transcripts of teacher interviews and lessons used for data analysis
	Student Interviews	*Student interviews used to enrich each teacher account*
DOCUMENTS	Lesson plans and notes Resources obtained from U.K. statutary authorities Fieldnotes Syllabus Documents	These documents were used to set the context for each lesson and enrich the controversial issue lesson(s)

Table 3.3: Specific Details for each Controversial Issue

TEACHER	LESSON FORMAT	GROUP DISCUSSION TOPICS
J	*Lesson 1* Introduction - teacher directed Student Group Work Group Work Presentation	*Organ Transplantation* A question of donation Organ Donation and the Law Brain Death Donating a Child's Organs
C	*Lesson 1* Introduction - teacher directed TQPA on OHT Student Group Work Student Presentation to whole class	*Infertility* Female Infertility Male Infertility Frozen Embryos
R	*Lesson 1* Introduction - Teacher directed Students prepare of pamplets and debate *Lesson 2* Introduction - Teacher directed Students preparation for the debate *Lesson 3* The Debate	*Diabetes* OPPENHEIM PHARMACEUTICALS Proponent for the use of humalin NATIONAL DIABETIC ASSOCIATION Proponents against the exclusive use of humalin
S	*Lesson 1* Introduction - Teacher directed Students prepare their presentations *Lesson 2* Students preparing their presentations Anti group presentation *Lesson 3* PRO and ALT group presentation General class discussion	*Animal Experimentation* PRO - animals used ALT - use of alternatives ANTI - no use of animals

Appendix 3.1: Interview schedule for each of the four data collection phases

Pre-Lesson Interview Phase:

Interview 1

- Introduction and purpose of the interviews
- Science courses currently teaching

  What science courses are you involved with this year?
  Who decides which A-Level Biology courses you teach at this school?

- Developments in science

  How do you manage to keep-up-to-date with all the developments in science?
  Do you talk about these developments with your colleagues here or your A-Level Biology students?
  When the more sensational or controversial ones come up in the news, how do these go down with students? Any concerns about their reactions to these? Do you think it is important that A-Level Biology students are exposed to some of these ideas in their course?

- The A-Level Biology syllabus and its teaching.

  Which syllabus are you using at the moment?
  Are there any difficulties with the use of this syllabus?

- The use of controversial issues.

  Can you tell me what a controversial issues means to you?
  Do you use controversial issues in your own teaching? How do you use them? Can you see a way in which you could introduce a controversial issue and then use it to draw out some of the science/biology?

- Thanks to the participant

Interview 2

- Review and clarification of the previous interview
  Do this when appropriate in this interview

- The proposed controversial issue
  Controversial issues to be used and why it is thought to be controversial
  Linkage of the controversial issue with the syllabus and with what is currently being taught by each participant in their A-Level Biology lessons.
  Possible reaction of students to the CI

- Discussion of the proposed lesson
  Introduction, main body and conclusion

- Collection, collation and discussion of lesson resources

Interview 3

- Review of previous interview(s)
  Discussion of the tasks asked by the participant of the researcher
  Discussion of lesson resources

- Detailed lesson organisation and management
  Confirmation of the content of each lesson step

- Elucidation of normal teaching practice in terms of the implementation of the A-Level Biology syllabus

Interview 4

- Review and discussion of the proposed lesson and its resources for both teacher and students

- Identification and elaboration of teaching constraints identified in the previous interviews

- Expectations of each participant to the proposed lesson

- General dialogue dealing with the teaching of A-Level Biology and the possibilities for using controversial issues

- Discussion of the nature of science and its teaching at secondary school

- Future pedagogic goals for each participant

The Controversial Issue Phase:

There were no interviews conducted in this data collection phase. Data in this phase was in the form of a lesson transcript and used to seek participants reactions to classroom events in subsequent phases.

The Post Lesson Interview Phase

The Post-Lesson Interview

- Debriefing of the lesson
  How did you think today went? What about when you first went into the lesson?
  Where there any (immediate) surprises for you during the lesson?
  Would you like to make some comment about the way students responded to the tasks which you had organised for them to do today?

- General comments about this and other upcoming lessons in the current scheme of work

- Comments on the use of controversial issues

- Goals for this group of A-Level Biology students

The Post-Post-Lesson Interview

- Lesson introduction
  Can you recall this event? Would you like to tell me your reaction to what you just heard? What are your thoughts now? What went well in this part of the lesson?

- Main body of the Lesson - students working in groups
  How do you think students responded to this part of the lesson? Did they achieve your lesson aims? Were there some surprises for you here? Can you recall what you might have been thinking during this part of the lesson when students were engaged in the tasks you had set for them?

- Other more general comments
  Can you tell me how have you been thinking about and viewing this sort of lesson(s)? Have students made any comment to you after the lesson?
  What impact if any, has your involvement with this piece of research had for you? Have there been changes in the way you think about your teaching?

The Propositions Phase - the propositions interview

- Explanation of the purpose of this interview

- Explanation of how the propositions were constructed

- Invitation to the participant for them to comment on their specific propositions

    Would you like to comment on each of these statements about your teaching? How relevant were they at the time of the study (if the participant can recall this)? What is your position on these at the present time. Is it necessary to make any alterations to these statements?

- Other comments

Appendix 3.2: List of possible controversial issues used as a probe in Pre-Lesson Interview 1

- The Environment - Green Issues
- Death, Dying and Euthanasia
- Technology
- Organ Transplantation
- Donation of Genetic Material
- Experiments using Animals
- Experiments using Embryos
- Being Vegetarian
- Infertility
- The Cost of Health Care

APPENDIX B

Chapter 4: Research Methodology 11

Data Analysis

Appendix 4.1a: Event 1 (Stage 1) - The Transcription Phase I

A segment from Pre-Lesson Interview 1: Teacher S showing points needing further clarification

Her views about C.I. Ask more.

W: Say that there was a C.I. that you were comfortable with the content and that, would that still be a worry to you or would you then be concerned with other things?

Specific for her - other teachers not at the forefront of their concerns.

S: No, if it was something that I knew a lot about, I would not be worried about the content but I am not very comfortable about expressing my opinions and ... well it is the moral issues that are involved ... I would not be happy with that. I am happy to talk about the concepts involved and a lot of C.I., in my mind, are not always as controversial as first they seem. Sometimes when you read articles or see things on the TV a certain aspect has been emphasised. When you then look at it in depth then it is not as controversial as it first appears. Do you know what I mean?

Clue for question in next interview.

Not elaborated on by other teachers.

W: Do you have any worries if you knew the content ... I was just thinking ... is there a possibility that parents might jump up and down or the school if you wanted to do a C.I. ...

Constraint 5

S: I would not want to say what my moral stand was ... just giving straight facts (fine) which I thought were clear cut ... this happens ... can it happen sort of questions (fine).

Specific personal characteristic for this teacher.

W: There might be some schools where teaching artificial insemination or IVF etc might go down like a lead balloon.

Ask for elaboration.

S: Oh right. If it happened and I had accurate information then I would have no qualms about talking about the information, when it came to saying whether that was the right or the wrong information then that is when I would not be comfortable ... if it happens

Appendix 4.1b: Event 1 (Stage 1) - The Transcription Phase II

The notation of points of interest taken from the field notes of Pre-Lesson Interviews 3: Teacher J.

Preliminary Analysis of Pre-Lesson Interview 3

1. **Overview - this interview accomplished the following**
   - Confirmed the major lesson steps (as discussed in Interview 2)
   - Presented to J possible teacher and student resources for comment.
2. **Points of interest which seemed to have emerged were:-**
   - Review of last interview
   - Aspects of the proposed lesson
     - lesson steps
     - lesson introduction
     - lesson summation
     - group work
   - Personal aspects of J.
   - About A-level Biology teaching
   - About A-level Biology students
   - C.I./biological concepts
   - Research ethics
   - Ethics of organ transplantation
3. **Things to think about**
   - Did J. appear to take on a passive role? Why?
   - Has her thinking about C.I. changed from the previous two interviews?
   - She doesn't always make suggestion?
     Was researcher too overpowering/enthusiastic (Probably)?
   - What did the researcher (was able to) "discover" about her as a teacher of biology and her thinking about C.I.?
   - What can the researcher say about this teacher so far? Why?
   - Think more about -
     - methodology
     - category development
     - interviewing/J's responses
   - A seemingly much more relaxed interview for both J and researcher.
   - J sees the lesson as having some sort of value. Why?

Appendix 4.2: Stage 2 - The Interview Map

Pre-Lesson Interview 1 - Teacher C

Trained in **one** science

subject Year 8 -Key stage 3
Year 9
Year 10- Biol/Phy
Yr 11-Biol

FULL TIME

Has applied for jobs at other schools!

Science Courses this Year.

Decisions about science courses

*Likes those <u>more</u> familiar. but Physics is good after 72 on waves, it's OKAY electronics good Yr9

*Likes to feel secure in her teaching

Head of science

consult'n very brief

Others?

Criterial
you **have** to be happy to teach **all** subjects

Organisation of courses Yr 8, Yr 9 Chem, Biol etc balance for st.'s rather than staff

A-Level Biology

<u>A-Level Biology</u>
*Attracted able/less st.
*School ..... to not only get A/B
*Attractive option; hard work.
*Physics seen as **hard**

<u>Syllabus</u>
1. Up to date? - changes frequently (LEB)
2. Jam packed
3. Not enought time
4. Moving away from contest recall

<u>Personal Aspects</u>
*Driven by syllabus/time
*Concerned about her reputation
***Most** finish course for students
*Good teacher = do we get through syllabus
*Allow interns to do C.I. and give them maximum flexibility
*I question what I do.
*Not fully convinced of C.I.

Keeping up to date

*Weak area,
I'm not up to date
*Modern texts (min source)
*Biol Science Review
*Not New Scientist
*J. Biol Ed'n
*Newspaper - just started

A-Level Student

Normal Biology

1. Uses ideas from J. Biol. Ed'n.
2. C.I. **not** maj part of her teaching
3. She doesn't bring them up unless they **fit** in; if in newspaper & out of context then not necessarily mentioned.
4. Doesn't use anything sensational at start of lesson ► relevance N.B; st. get fidgety.
5. Liberal attitude with respect to what St. can say in class.
6. Drama/role play not done.
7. Doesn't do exciting C.I. to get st.'s involved because it doesn't complete syllabus.
8. Problem solving case St. - a small extent.

Not done
usual A-Level Biology

Drama teach - good
Role play - good
St. reaction -
Student learning
*how to talk/listen
*confidence
*learn from each other
*J. diff. views

*C.I. brought up by st.'s ► Teacher gives time but brief because of syllabus drive
*Don't really bring them up
*Media coverage not high on their adjenda
*I don't know what sparks their interest
*Mixed ability st.'s encourageable/less st.'s
*St.'s tick things off on syllabus
*Thorough enjoy discussion /C.I. ► involved (one instance)
*St. reflect parental views
*Not political; don't read papers "house bound"

C.I.

<u>St. Reactions when T. brings them up</u>

* mixed; same sparkle with interest
*doesn't involve/interest <u>ALL</u>
*Doesn't know <u>who</u> gets excited <u>ie</u> the ones who bring it up!

School

1. No interference if related to syllabus
2. If there's a reason, it must be related to syllabus

Past. C.I. topics GCSE/A-Level

Not done routinely

*Environment - No
*Death/Dying - No
*IVF..... - A-Level -Yes
*Organ T. -Yes
*Genetic Material - Yes
*Exp. with Animals -Yes
*Exp. with Embryo - No
*Vegetarianism - No
*Infertility - Yes
*Cost of Health Care - ....- Yes
Reproach. Tech; - Yes AI?; - Yes Egg donation - Yes
Surrogacy - No; T.Tube....; - Yes A.. of Parents; - Yes ....

Herself & C.I.

1. Not a worry
2. Must be well structured & directional
3. Not good at "ad " discussion
4. Longer lesson must be detailed
5. <u>MUST</u> be related to syllabus (said 3x) before she'll defend J.
6. Educationally, you can't knock it! but syllabus must be covered. ⟶ TIME
7. I question what I do <u>all</u> the time
8. Don't get excited about green issues
9. AI. might give brief passing reference to
10. Idea - good brings biology into the real world, they learn for the future.
11. For teachers -C.I. is difficult
12. Myself - I'm not immaginative, not clever like to follow text;
13. I like PRAC work - FUN

Postulations about C.I.

1. If St. brought them in St. got to make informed choices.
2. I learn from their attidudes.
3. Could learn biology - good
4. How I would/find out what they learnt ----► <u>No</u> answer
5. Roll of C.I. ► to give interest to the subject BUT FACTS then application nuts/bolts are essentials
6. Medical problems ► haven't thought or can thing of that one!
7. Health care wouldn't get them **excited/depends how it's put.**
8. Green issues not that exciting.
9. Vegetarian appeal
10. If A-Level syllabus was more flexible....all NB: Difficult to say.
11. Animal Exp - <u>would get them going</u> Genetic Mat. IVF, embroy
12. Rep Technolgoy - potentiality forbid. I don't know; I must teach biol. st & relate to the C.I.; rather than the other way around.
13. St. might not bring up ethics. ► They're unworldly.
14. Good to see potential of st's.
15. St. don't let on everything ← shy not confident
16. Some of the C.I. should be..... (Must check syllabus)
17. Medical problem --- ► great <u>way</u>
18. Would like st. to use media more for this Biology.
19. C.I. the idea is interesting.

Appendix 4.3: Stage 3 - The Interview Story

Sample taken from Pre-Lesson Interview 2 of Teacher J. showing the four parts of this story and a selection of its contents.

(a) Rationale for this Interview

The purpose of this interview held a fortnight after the Pre-Lesson Interview 1 was to establish:-

- where the proposed lesson on organ transplantation would be placed in relation to what was currently being taught.

At the time of this particular case study, students were involved with a unit of work on animal physiology. Discussion with J. centred around whether this lesson would be best taught within this module or at the end of the module. J. made the decision in Pre-Lesson Interview 3 to place this lesson within the module so as to make it part of her lesson plan/schemata.

- what aspects of organ transplantation might be covered, where the controversy might lie and at what depth students might be required to discuss the issues.

The content aspects alluded to in Pre-Lesson Interview 1 were the kidney, limbs, blood and gamete donation. Social, ethical and moral aspects were also raised by J. These included the carrying donor cards, religious objections to organ donation and the possibility of relatives negating the donation requests of the deceased.

- how the lesson might be organised.

By the end of this interview, she decided that the lesson might involve three steps - Introduction, Group Work, Summation. The finer details would be discussed in the following two interviews - Pre-Lesson Interview 3 and 4.

A second set of aims were specific for this teacher. These were to begin to develop an account from her perspective as to how she:

- rationalises, prepares and manages the teaching of A-Level Biology;
- views her students as learners;
- has used or might use controversial issues as part of her A-Level Biology teaching;
- views biology as a science.

(b) What came from the Previous Interview

The questions for this interview and the proposed lesson plan were based in part on the comments made by J. in Pre-Lesson Interview 1. The proposed lesson plan was used as a focus for discussion for part of this interview. I recorded on this sheet J's comments and suggestions for improvement. This was done throughout the interview as a means of indicating to J. that her comments and suggestions were noted and of value to this study. I hoped that by doing this J. would quickly view the lesson as hers - part of my concern with the notion of lesson ownership.

This interview was transcribed within two days and annotations made within and alongside the transcript about matters to be raised in the following two Pre-Lesson Interviews.

What has emerged so far from Pre-Lesson Interviews 1 and 2 is that for J. there are **two** concerns about her teaching of A-Level Biology: the amount of time available to cover the syllabus, and the amount of content to be covered within the two years of the course, and **two** concerns about the impact of this lesson on her teaching schedule: 'getting the most out of this one off lesson' (her words) and not placing her students or herself in a position whereby coverage of the syllabus content would be compromised.

Given just the analysis of Pre-Lesson Interview 1 and 2, it seems that J. has a well developed rationale for the teaching of A-Level Biology and a clear sense of her professional responsibility towards her students, their parents and the school itself.

(c)Major Ideas which have emerged from this Interview

There were **seven** major ideas that emerged form the preliminary analysis of this interview. These were:

- An Overview of the Proposed Lesson
- Personal Aspects of J.
- Comments about Students
- The Manner of Delivery of the Lesson
- Lesson Concerns/Provisos (exemplified below)
- 'Normal' A-Level Biology as displayed by J.
- Controversial Issues Teaching/Biological Concepts

(d) Lesson Concerns/Provisos

There were four qualitatively different concerns raised by J. in this interview. These were knowledge acquisition, syllabus demands, time available and the proposed lesson itself. Given her concerns about controversial issues as expressed in Pre-Lesson Interview 1, this did not come as a surprise. These concerns are what for her are legitimate, rational constraints on her teaching.

Knowledge Acquisition

This was a familiar and persistent theme throughout the entire interview occurring at nine different instances - some of them being direct and others indirect.

- I think "What is it", is important before you talk, otherwise they are talking above the top of their heads. That is fine.
- (Facts) ... right at the beginning of the introduction that is, in the introductory full frontal bit, What is it? What are they? and Where did they come from?
- Do you have any information on the drugs they need to know ... to keep the organs in place. I must admit I don't (have any information on that).
- I think they need to know what exactly might go wrong with the kidney ... how far gone it has to be before a transplant is merited.
- I see that (which organs are transplanted) as being at the beginning perhaps otherwise they are not going to know. I will have to tell them unless they have some information sheets. They have got to be fed that information don't they ....??
- I want everyone to know everything because it is such a shame if they don't if the opportunity is there. When it comes to structuring a lesson you might end up with a very bitty end.
- I think it is time isn't it . I think the introduction has to be solid and quite well researched because they are a very high achieving group. They do need solid facts and backed up by research. They do not want any airy fairy which you could do with others. It has got to be a solid and stimulating introduction.
- ... and the lungs and things ... definitely. They have got to have all the information...
- (about student groups) ... has done it twice. You could almost do, three 10's, you could almost do that because at the summation you have got three groups prepared and information about key points. I mean that would take the onus off one group actually but that is fine ... it would certainly take the responsibility off one group.

Syllabus Demands

J. commented that there is a lot of dry stuff in the course and that students need a lot of documentation and information for this lesson. The use of visual was thought opportune - technology and fresh specimens.

Time

This was used by J. in **two** differing ways. The first in the sense of there not being enough of it to get things done. For example, there might not be enough time to get everything done in the group work and often there is a lack of time in order to do lesson summations. The second was in the sense of time being acted upon. For example in lessons generally, time is the essence. Time is also acted upon by other constraints such as the syllabus and the science department's demands.

About the Proposed Lesson

Three comments were made here:

- it has no links with any of the lessons in the current module (this view is not always consistent throughout the Pre-Lesson Interviews);
- all aspects of the lesson have knowledge components;
- it is a one-off lesson and it stands on its own.

Appendix 4.4a: Event 2 - The Sorting Matrix

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Appendix 4.4b: Event 2 - Framework of Analysis

Emergent Themes for Teacher J

Emergent Theme 1: What Teacher J likes to teach

Definition

This emergent theme refers to what it is about teaching which for Teacher J is rewarding both professionally and personally. It refers to the content this participant likes to teach, the resources she prefers to use, the students and the classes which she enjoys teaching, the rationale for how she believes science/biology courses have been constructed and the ways of teaching with which she feels most comfortable.

Illustrations

Context: Content knowledge, course structure and students

J: Because I like biology and the modular science (GCSE years) is not always biology. It is a mixture of sciences ... not that that is very fair comment because at the moment I am teaching biology in the modular science but next week I shall be starting to teach energy which goes off the beaten track as far as I am concerned.

W: What is it about A-Level Biology that you like? What are the areas that keep your interest?

J: Mostly I teach the animal side of the syllabus- the structure ... and perhaps the mature attitude ... but mostly because it is the biology and that is my love.

J:Pre1, 7-15

Context: Preferred teaching techniques

J: Environment Issues I don't tend to take on board very much because I don't teach that side of the syllabus. That' s dead narrow but you don't because you haven't got time. Reproductive Technology ... I can't remember ever having used anything from the papers terribly much ... although I have loads of cuttings I don't always remember to fetch them out ... depends if I am teaching the topic at the time ... that 's always the acid test. If I am teaching the topic at the time like I am now with the nervous system ... those happen to be in the papers ... that's brilliant ... I fetch them out and waver them about ... talk about them.

J: Pre-1,84-91

Emergent Theme	Interview 1	Interview 2
What Teacher J likes to teach	Animal physiology - likes the more familiar topics. Likes the A-Level Biology students cos they are more mature. Likes straight content delivery & talk. Exams are important, likes modular science teaching in lower years particularly biology.	
Scientific knowledge and understanding	Lack of time is a major concern. Has collected lots of paper cuttings, many resources, incorporating current biological research. Research appears not at the forefront of her mind wrt biology teaching.	
Routine A-Level Biology teaching practice	Uncomfortable with discussion. Syllabus packed with content. Talks administration with colleagues. Doing anything outside the norm would compromise students' success wrt covering the syllabus & passing the A-Level Biology examination.	There are a lot of facts to cover in he syllabus, frequent use of resources and fresh specimens. There is a lot of dry stuff in the syllabus, she does not do much discussion rather gives them the information, no usual lesson summation.
Past and present uses of controversial issues	Just in passing, too busy to do it, five minute chat if at all. Issues covered to date - green issues and the environment, organ transplantation and some on reproductive issues.	
Constraints for the use of controversial issues	Exams, syllabus and time - all three very much at the forefront of her mind. Don't risk anything to compromise this, don't allow discussion to go too far cos of time. Lack of awareness she says herself about moral/ethical aspects of some controversial issues therefore doesn't want to look silly. Non constraints - parents, school board, not always aware of what goes on in classrooms.	Means group discussion is needed. Doesn't like groups, technique not always of value for teaching cos students miss out on facts. There is not enough time to do what the syllabus says.
Potential uses for controversial issues	Yes for student learning but issues must be interesting and motivating for students, the context is more social. Value/emotive judgements - tolerance/chats, might bring out timid students. Examination/writing skills and learning of biological concepts not mentioned	First glimpse that J might be conceptualising the potential of CI to teach biological concepts cos knowledge acquisition and time pervade her pedagogy. Lesson remains a one off, fits in with the 5 minute chat idea. All fits logically with her view as teacher, views and beliefs about CI teaching. Normal=appropriate for A-Level Biology teaching

Interview 3	Interview 4	Summation (1-4)
	Likes the way the A-Level Biology course is constructed and so likes to teach it. A-Level syllabus needs revision cos there exist students who can study but not necessarily at A-Level but still should be catered for. School science reflects real science	Uses traditional approach - teacher gives the information. Teacher constructs and seems to control the lesson. There are a few practical activities.
	Proper biology is not just practicals and fieldwork but reading as well. Student think prac/fieldwork is real biology but she thinks it peppers it up. It is about finding out and understanding, science is not creative cos all the facts are there even though new ones come up.	Sees lack of biological content knowledge as a concern therefore feels she needs to mug up on this, says she has no long term memory. Science not necessarily a creative activity.
Intro - short, used to give instructions. Lessons are teacher centred & directed, tries to make conceptual links between bio concepts to Sts. Writes up lessons word for word. Syllabus not prescriptive enough.	Proper biology is not just pracs, look for links, team organisation of examinations. Teacher is autonomous to an extent, now more aware of how difficult some topics are, therefore lessons have to be focused, links to be well organised for all lessons.	There are a lot of facts to cover in the syllabus, frequent use of resources and fresh specimens, there is a lot of dry stuff in the syllabus. She does not do much discussion rather give them the information, no usual lesson summation
		There appears to exist no clearly defined significant place in current teaching or in the foreseeable future given the current teaching environment particularly cos it is not a mandatory element of A-Level Biology for all teachers.
Not as prominent as PL2 - content acquisition. Lessons must have value wrt learning. Group work hazard is that they don't get enough information. Time - intro must buzz through, time is the essence.	Not formally discussed but probably alluded to throughout this interview in all other themes (double check this).	Teacher mentions the constraints of time, syllabus and examination. Others not alluded to such as personality, career history, goals for teaching, teaching style, view of biology and its pedagogy and her goals for this, view of students. Non constraints - parents, school board, not always aware of what goes on in classrooms
Difficult to positively establish this in this interview. Maybe questions not clearly put forward to her in this interview - try next interview again. BEST COPY AVAILABLE	CI/biological concepts not taken up. Expects the lesson to be stimulating and first rate and a relief for Sts and something different. Lesson good for social skills not concepts, good for revision. Thinks CI are brilliant. Likes to tell students what is happening and directing students.	Unable to clearly see in any possible way using CI to teach biological concepts. Sees CI as interesting for herself and students but value lies in stimulating student interest say 5 minutes and social group cohesion. This view did not seem to move throughout these Pre -Lesson Interviews.

Post Lesson Interview	Post Post Interview	Students
		(synonymous with what students likes to learn) They like human biology, when it all clicks together and makes sense, good to get a deeper understanding of things, like practicals and fieldwork
		Biology is about dichotomous keys, plants, animals, known facts, it is just not have social/ethical dimension. We don't have enough experience to talk about some of the present theories.
They do discussion and group work more in the lower school than in A-Level Biology. Excursion are good for discussion work, group work and for the interacting. Usually it is the teacher up at the front of the room	Teacher says that she should stop talking and let students talk more. From her perspective this is a typical teacher syndrome.	Day to day biology lessons are enjoyable for most of them. They get a lot of notes, some practical and little fieldwork. Some say notes are tedious and boring, practicals can be useful. Difficult to write up pracs if the equipment is faulty.
		Controversial issues are not a significant part of their lessons. They have done the environment briefly but not done any of the other listed controversial issues on the list
Some items are missing and should be on the syllabus even though syllabus is content laden. Not enough lesson/time to cover the syllabus therefore pressure on teaching, pressure on students and on homework Teacher up to date with the course and keeps a yearly program diary	There is never time enough to let them talk as much as I ought to let them. Yes students are capable and ought to be allowed to do more discussion, then they get more confidence but time is short. Group discussion takes time to do well in terms of preparation Constraints have a prominent place in her thinking, CI possibility - limited	Time - they say they have to rush through the course, need time to think more deeply. Controversial issues would take up too much time, syllabus is heavy, got to get through it and learn it. Lots of preparation is needed for the A-Level Biology examination
Potentiality of CI lesson linked in very much with her value of the lesson but not a direct goal of her biology teaching. It is a side issue which she would have mentioned. Only certain students can pick up knowledge for CI such as problem solving, about 20% of them.	Value in social/group discussion and don't do this normally. There is a danger that students might like them too much. Can't see link with other areas in this biology course. Takes too much time and would have to rethink topics in a big way, couldn't be done that often.	The syllabus should be updated to have 1995 biology in it. Need more opportunities to integrate knowledge. CI are part of biology of 1990's and so should be part of our course. CI are a nice break from boring topics, do at the end of a topic/module, don't do it too often or we won't cover the syllabus, enriches our understanding. CI gives us a more balanced view of biology than what they say they get in the

7. Thoughts about students	A-Level Biology are mature, have a rational approach (62-65), (94-99), (109-114), (274-283)	Reaction to organ transplanted +/- depends on the organ, she thinks students know very little but transcripts will tell, this CI will make them think about - social skills /aspects. High ability, confident articulate group, more girls in group who don't all know each other, so CI is good for social skills
8. Personality traits of the teacher	Doesn't like discussion and group work, says she ought to do more about CI cos it is up to date biology. Has strong view on organ donation and donor cards, content knowledge is OK for her.	OT is not a CI for her but could be for some students. Donation should be free not coercive. Have done kidney donation and drug with that.
9. Particularitites about the proposed lesson and the manner of its delivery		Previous work might be in SATIS at GCSE level, Yr. 12 animal physiology, Intro- overview of the issue of OT. There must be enough content. Groups to rotate, four per group of mixed gender and ability. They could (?) do lesson summation. Student knowledge acquisition in lesson - major concerns this interview. Seems like the lesson might be one off
10. Reflection on the controversial issue lesson		
11. Aspects pertaining to research ethics.		Form her perspective there is no problem with the issue of organ transplantation being used as a focus of discussion in A-Level Biology. No problem with researcher being in the room taking notes. No problem with either herself or the students being taped or observation notes being made by the researcher.

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but they are uncomfortable with eyes or donation - it will get them thinking. They are articulate, assimilate knowledge, adapt to changes in routine, H&C ability and so adapt to what J thinks is expected eg homework. Ideal students persevere, hard working, think about making links, willing to learn.	but depends on what is in the media, good for them to appreciate the ethical Qs. They will want to make informed opinions, they are good at chatting, some have a fund of general knowledge, think proper biology is practical, dissection and fieldwork, some are very high ability, and are determined to do well.	articulate, wide general content knowledge, social in class but for OT they won't know anything cos it is not in the news. Perceived teacher view of students' beliefs about biology different from teacher.
Doctors are in difficult position to ask for donation, civic duty of everyone to have a donor card, next of kin could be a problem. Lesson must be coherent, with lots of links. OT is a fascinating topic Involvement in study appear to be interesting for her, loves the challenge of teaching and A-Level Biology in particular - has meaning for her.	Challenge for her is to get the less able students up a couple of grades, future plans are to keep going teaching A-Level Biology. The more background material she is able to read the better for her for this lesson on OT. Likes to be well organised for all lessons. Tells researcher that 18 yrs for donor and 16 yrs with parental permission. Next of kin on card in important.	Likes what she teaches a lot and this give her meaning in teaching. Extensive use of discussion is not an easy teaching technique. Career aspirations are to keep going as is. Very much exam oriented she says and therefore needs to be organised and focused on that goal.
Reviewed interview 2. Finalised - introduction, organised group work and that students would/might do the summation. General overview of lesson established. Give enough info to Sts but don't bombard them. Value of lesson is that it is useful and varied form the usual.	The whole lesson will get them thinking and links with biological concepts. Previous work on immunity, kidney and circulation. The more facts they have at hand the better. J interested in resources collected. Changes some of the into Qs - happy with what is there for the most part. Tells researcher that content of folders is fine, visually appealing.	Thought the resources collected were good but flexibility in terms of there potential for the lesson on OT not easy to get at. Needed to think about doing group work but still remained sceptical of its content learning.
Form her perspective there is no problem with the issue of organ transplantation being used as a focus of discussion in A-Level Biology. No problem with researcher being in the room taking notes. No problem with either herself or the students being taped or observation ...ing made by the researcher.	Teacher didn't seem concerned that students' permission was not sought for taping. Not concerned that student might object to being taped in the classroom or to being interviewed before and after the lesson - would however state to the class the purpose of the researcher at the beginning of the lesson like she had done in previous observation lessons.	

Some don't do homework, they accept having to stay back which is not really useful for them. Goals In future - keep up the buzz, keep them on task by giving the HW and exam Qs. They mature over 2 yrs but some don't know how to apply themselves to work.	Teacher amazed at who said what comment in the group discussion, says she now sees students in a different light and has new insight to students. They need more practice in discussion, they do a lot of that In Geography. They ought to do more discussion cos they are quite capable. Teacher very positive about some individual student performance and very surprised about this as well.	About Learning Styles: Some say they like rote learning and see this as the way to learn, they believe that some examination questions are often misleading. Some say that they try to make links between all topics/themes if they can. Learning seen as active metal process by some students.
One off event for social skills. Content is questionable really. Some students could use CI for problem solving.	Says she has no career aspirations when comparing her role with other colleagues. Reaffirms her belief about OT and donor card and her concern that nest of kin can veto this. Says she ought to talk less, gets side-tracked easily - I ought to use these vignettes a lot more now that they have been used once.	The role of the teacher is to help us to learn. They should check the equipment that it is working, the course should be updated and experiments should be relevant to us.
Overall it was fine but a few students upset her rhythm which made her feel nervous. Thought they should have spoken more in the intro. Students had limited knowledge and it didn't teach them content, some Sts +ve reaction, others mixed. Would do again but once in a blue moon/not often. Next time- each group the same problem, give more time for knowledge assimilation, OHT Q - fine. New lesson they will do the test they missed., prac schedules and feedback on this lesson.	Surprised a bit, lack of confidence could be. Introduction - fine. Student responses were good but could have got more of them to speak. They seemed to do well given hat they had no knowledge and wandered of task. Sees students in a different light now that she has heard them talking in small groups without her there. They take on different roles which she was not immediately aware of. They are capable she thinks. Socially the lesson was good even though they did not finish everything.	Students thought this was a positive experience - interesting, different, relevant to them. Some thought it was a good way to learn whilst some had reservations wrt teacher bias and content knowledge covered. Being taped made them feel important. Liked group discussion and organising themselves - learnt about which organs could be transplanted, why they are used, why they are rejected and problems with organ requisition. Some said they liked to hone in on content.
	BEST COPY AVAILABLE 326	

Emergent Theme 2: Scientific knowledge and understanding

Definition

For Teacher J this theme deals with any reference to or discussion of scientific/biological knowledge, views of the nature of science and its historical development along with the place and purpose of current scientific research.

Illustrations

Context: Keeping up to date with content knowledge

> J: Reading. The New Scientist which I have weekly and the Biosciences Review which I have quarterly and my AST Journal. I don't know how often that comes. It might be bimonthly I think. I am not sure ... it is a small A5 paperback type thing with lots of articles by science teachers which is quite good. There is a lot of chemistry and physics in it which I ignore and the papers.
>
> J: Pre1, 39-44

Context: A view of biology and its methodology

> J: The majority of them have said that one of the highlights of the course is the practical work and the highlight of the practical work is the dissection ... amazing! They just love seeing the insides. I think it was perhaps the mouse dissection that was the main thing and they also loved the field trip. Again it is the practical aspects, the real aspects of the course- doing proper Biology. They seem to consider that that is proper Biology.
>
> W: So proper Biology for them is....
>
> J: Practical and field trip.
>
> W: So does that go along with your ideas?
>
> J: Well no. It certainly highlights things, it certainly peppers it up.
>
> J:Pre-4, 415-423

Emergent Theme 3: Routine A-Level Biology teaching practice

Definition

This theme refers to those aspects of regular A-Level Biology teaching which Teacher J deals with on a routine basis - daily, weekly, termly or yearly. It includes the use of various teaching techniques, reference to syllabuses, professional interaction with colleagues and ways of preparing lessons.

Illustrations

Context: Teaching Techniques

> J: ... I would much rather have something to look at and for them to look at, rather than them looking at me all the time but I would have just done a quick introduction and I very often try to deflect them from me if I can because if it is a straight lesson where you can't then ... that is fine ... but if you can do that, it is lovely ... that is just the way (to do it) and that brings them out talking.
>
> J:Pre-3,149-154

Context: Professional Interaction with Colleagues

> W: So, who decides which biology courses to teach at this school?
>
> J: The Head of Biology has done in the past. The course we are doing at the moment was decided by the girl who is in-charge of biology and along with the other teachers of biology. They choose AEB as opposed with another which was grim. It was Cambridge, but I am not sure.
>
> W: And you are actively involved with that decision as well?
>
> J: If we choose to change, yes definitely, we are very involved.
>
> J: Pre1,25-31

Context: Common lesson procedures

> W: So do you talk about these developments with your students?
>
> J: Yes.
>
> W: Would you like to elaborate on that?
>
> J: Well I shall flash the articles about and read them to the class. I did that actually yesterday with my one group ... read bits from the articles which were relevant to what we were doing at the moment ... the nervous system and because they were written for the popular person and so they were written quite well so I read chunks.
>
> J:Pre-1,54-61

Context: Lesson Planning

J: I suppose ... I do try to be more aware for them how difficult each topic is and I do try to pre-summarise the topic and then teach the topic and then summarise it so that it is much more structured and I try not to wander off and I try to keep it very precise because there is such a lot , so I do try to keep them well focused on the topics as best as I can.

J:Pre-4,468-473

Emergent Theme 4: Past and present uses of controversial issues

Definition

This theme is defined as any reference to controversial issues that Teacher J has or has not used in the past or is using at present.

This theme does not include any of Teacher J's comments about the potentiality of controversial issues. This is found in the sixth emergent theme dealing with the potential uses for controversial issues.

Illustrations

Context: Controversial issues arising in lessons

W: When these more sensational ones pop up in the news ... how do these go down with the students?

J: Well ... perhaps the most recent one was the one where they think they have discovered the gene for homosexuality. And I think we talked about that and they are fine about that. I think they are quite happy to talk about that. No problem. Very rational really.

J:Pre1,75-80

W: ... have there been incidents there where controversial issues have been brought up by the students?

J: Oh yes, quite often, you will have people who will just say something because it has been in the news and that is fine and I am happy to talk about them as long as it does not detract with what you are doing at the time and it usually something totally different but that is fine ... just a quick chat and then move on.

W: So what is the lessons like at the time? What is the classroom atmosphere like at the time, when the students bring up this controversial issue.

J: It is almost invariably a class that you always get along with lovely characters and it is invariably one of the characters who brings up the topic because they have the nerve and that is fine! It is just that you are doing something totally different other than what they want to discuss and you can have a quick chat.

J: Pre1,167-180

Emergent Theme 5: Constraints for the use of controversial issues

Definition

This theme is defined simply as any aspect of her teaching which from Teacher J's perspective does or might hinder the use of controversial issues in her A-Level Biology lessons. Amongst others this could include time, examinations and syllabus demands.

Illustrations

Context: The demands of the syllabus

J: ... (the) A-Level biology could encompass quite a lot of things and yet ... saying that ... the syllabus is relatively ... not strict ... but it does have its guidelines and really we are pushed for time and so we have very little time for anything like that ... any discussion at any length other than a quick 10 minutes at the beginning of the lesson ... or as you go around the lesson and have a chat.

W: Do you find that the lack of time disconcerting?

J: Yes, it is, it is an ever present burden.

W: And the reason for lack of time is that purely because the syllabus is laden?

J: Yes, it is very heavy.

J:Pre-1,141-152

Context: Non constraints

W: Would this school interfere in any way with your teaching of some of these controversial issues?

J: I don't know, they tend not to know what is going on. I think that I would have to be aware of them after that meeting we had when Cathy mentioned them but I dare say we will have to be a bit wary and tread lightly but I don't think it will have much of an effect on A-Level teaching ...

W: If you took on board some of these new issues in reproductive technology would there be anybody in the school who might disapprove?

J: Well, I suppose the people who are forming this policy document, the Governors might ... I don't know if they would actually! It is hard but I think if you put it in the context of A-Level Biology it could go down very nicely. I don't see any problem ... I really don't.

J: Pre1,126-140

Emergent Theme 6: Potential uses for controversial issues

Definition

This theme encompasses comments which Teacher J makes about what controversial issues teaching might do for student learning and for her own teaching practice.

Illustrations

Context: The value of class discussion in terms of student learning

J: (Value of discussion) ... it gives you a different insight into the students who have become involved in the discussion and they see a different side to you as well. It is quite nice for them to see you doing something else other than straight teaching.

W: Do you think it motivates the students?

J: Possibly indirectly because it gives them the thought that this is a bit more interesting and this could happen again.

W: When these topics have been brought up, what do the students learn ... even if it is only in that small incident when you have brought it up?

J: That is hard to know. I mean ... just that particular topic that has been brought up and often just the chance to chat ... you know the social thing.

J: Pre1,184-197

Context: About controversial issues themselves

J: Excellent all of them. They are all brilliant things. I would love to be able to discuss but I just ... they would have to be just little quickies.

J:Pre-1,434-435

W: Can you see any potential there?

J: Well not in the present not in the way the syllabus demands. That would come into the module Humans as Organisms probably, Maintenance of Life perhaps ... which I have just done and that is so packed with content if you introduce something else I really don't think ... I would feel that they would risk displacing the information they have got in favour of this cos this is more up to date and not do so well in the exam. Organ transplantation we do and that is lovely ... with the kidney.

J: Pre1,313-319

Emergent Theme 7: Thoughts about students

Definition

This theme deals with comments Teacher J makes about both her A-Level Biology students and those in lower year groups. The context for these comments is either in general pedagogical terms or in relation to the teaching of controversial issue .

This theme does not include teachers' preferences about students.
This is found in Emergent Theme 1 - What Teacher J likes to teach.

Illustrations

Context: Student knowledge about organ transplantation

> Well, I think it does depend upon what is on the news at the time and they will know things but have forgotten them unless somebody just had something major done. Last year there was this little girl Laura who was taken to USA to have a bowel transplant and so it is very much in the news then and at that moment in time they were better informed than they might be this time, unless something else comes up. They are very transient things aren't they?
>
> J:Pre-4,364-369

Context: Teacher J's perception of an ideal A-Level Biology student

> W: What do you look for in a good biology student?
>
> J: It is hard...willingness to learn really. They don't have to be the top most bright student but they have to be able to persevere, that is quite a good one with A-level biology. If they can persevere and use the knowledge that they have gained and transfer it to the next bit of information they gradually learn to use what they have got instead of stashing away lots of facts. That is a great joy.
>
> W: So you are looking for a student that makes links?
>
> J: Yes and is flexible and if they are not flexible which they very often are not then you tend to make them more flexible and they thrill themselves with that, that is a great pleasure that they realise they don't need to know everything and they rely on something like that and they can transfer that. I found that very difficult personally.
>
> W: Transferring from one thing to the other?
>
> J: Yes ... the underlying physical principles into the next biological module.
>
> J:Pre3,680-692

Context: Student academic ability

J: ... many of the less able are getting that together (making links) and they are thrilled with themselves and they are realise that , that applies now that they learn before... but I think that is a maturing thing ... There is so much information coming at them that they can't cope with it all and handle it all. As they grow up and go into the 6th form they are able to think deeper into their memory ... I don't know what happens but they just, this is for the less able students, I think that the bright ones are there always.

J: Pre3,697-705

Context: Student academic growth

I think perhaps the able ones haven't changed at all but the ones who are middling to low have risen and that is what I had always hoped to do. You can't do any more for the most able student other than keep them up on the straight and narrow and keep them at their high ability and assume that they will get the A that they would always get anyway. You can't value add ... this thing ... but for the middling to lower you have got to hope to bring them up from the possible fail ... but in the meantime you have got to keep the high ability students highly motivated.

J: Pre3,717-723

Emergent Theme 8: Personality traits of the teacher

Definition

This emergent theme broadly covers any comment made by Teacher J of a more personal nature. It includes for example her personal views on organ transplantation and how this and other controversial issues ought to be taught in schools along with her own career aspirations.

Illustration

Context: Teacher J's personal view on organ transplantation and donor cards

> J: Oh well, I think using controversial issues is brilliant!!!!! because it stimulates them in a way that no other can do. Perhaps the transplant is not something that comes up in a syllabus and it is not directly linked with any specific topic in the syllabus at the moment but I think that any controversial issue is good because it gets them thinking and discussing.
>
> J:Pre-4,353-361
>
> W: ... So it doesn't matter if you carry the card your family have to know.
>
> J: Crumbs and they have to give permission.
>
> W: Yes.
>
> J: Daft. That is daft, because I carry a card and my husband doesn't and he would be quite likely to say no, because he doesn't agree with donation and it gives him the creeps but, that is wrong because I would like to donate them, because they are mine. That is really odd. I did not know that.
>
> J:Pre4,211-216

Context: Personal involvement in this study

> J: It is wonderful, in fact I have since then done so much cutting out of articles and things from all sorts of places (which I have always done) but now I have catalogued them this time and written them into my teaching schemes which is not before time ... and it is really good ... in fact it has inspired them as well. My upper 6th group mentioned just the other day that cartilage had been replaced by artificial cartilage and used for donating. It is wonderful and they always have done that ... what TV programs they have watched ... but that is because I know them better and we have been an a field trip together and that is good.
>
> J:Pre-3,775-782

Emergent Theme 9: Particularities about the proposed lesson and manner of its delivery

Definition

This emergent theme concerns all references about the organisation, value and delivery of the lesson.

This emergent theme does not include any comments about students. The later is found in Emergent Theme 7: Thoughts about students.

Illustrations

Context: Previous related work dealing with organ transplantation

> I am going to do immunity but very briefly with them now, because I am doing circulation because that comes at the end and I shall mention about rejection of the graft. So they will have a little bit of information about immunology ... so for transplantation they will have a little bit of information ... they will need drugs ... so that is all they will know really.
>
> J:Pre4,35-39

Context: Value of this lesson

> I think it is going to be more social actually, they don't mix terribly well. There are lots of biological concepts what will come across unwittingly, a whole vast range because it will revise the heart which they are doing now or have just done, it will redo the kidney which we have done and it will encourage their thinking skills. It will be very good for thinking and social. Some of them are just not very good at doing either of those- thinking and /or chatting about what they thought. They just keep their heads down.
>
> J:Pre4,345-352

Emergent Theme 10: Reflection on the controversial issue lesson

Definition

This theme encompasses all general and specific discussion dealing with the controversial issue lesson after it was taught by Teacher J.

The theme is divided into three types of comments - those concerned with the Teacher J's own performance, those concerned with her students and those of a more general nature.

Illustrations

Context: Immediate response by Teacher J to the lesson

Oh fine, no problems except that I had to do the admin and I knew that I had to do this, it was unpleasant and I knew that three of them had to stay behind to do homework which is tedious. It is due in today and you make them stay behind to hand it in. I knew that was not going to be very nice and we got over that and they seem to accept it. They are useless and they just accept it and do it at lunch time.

J:Post,14-19

Context: Lesson ownership

O yes...in many respects I did because when I looked at the questions the night before last and I went through all the stuff that you had given me I wrote notes, picked up bits that I thought might be nice to mention.

J:Post,226-230

Context: Student performance

They went through the questions on the OHT with their limited knowledge and I think that they did quite well there. I think I lead it too much. I think that I talked too much. I do do that but only because I remember snippets of information which I had not given a second thought to..

J:Post,49-51

Context: General aspects of the lesson, for example follow up work

Well not often but once every blue moon and they would be happy with that once in a while...say once a term.
They will do their test which they missed out on today, half the lesson will be that, I have a question ready for them to do in silence and for the other half I will chat to them about this lesson but that will be in the second half of the lesson along with filing in practical schedules details which we have not done yet and going along a bit with the kidney.

J:Post, 34-38, 158-162

Emergent Theme 11: Aspects pertaining to research ethics

Definition

This category includes any discussion with Teacher J as to how the data will be gathered.

This theme includes audio tapes of students interviews, teacher interviews, classroom conversations in the controversial issue lesson and notes from all lesson observations.

Illustrations

Context: The Presence of the Researcher in the Classroom

> W: ... if you might mention that the reason that I am in the back of the room is that I am there to find out ways of making the A-Level syllabus more interesting.
>
> J: Yes. Absolutely I would hope to put that as one of the main bits because you have put that at the end haven't you ... the conversation between them and the teacher would be taped. Would you like to be introduced formally to the class and then sit at the back, or would you like not... because that makes it very formal which is good.
>
> J: Pre3,89-95

Context: Availability of Research Data

> J: Hm, do you want to take part or do you want to watch?
>
> W: I would just like to sit in the back of the room and take field notes.
>
> J: Right.
>
> W: Which of course you are welcome to look at ... no problem and during the group discussion I would be interested in spending a little bit of time with certain groups ... listening
>
> J:Pre3,347-351

Appendix 4.5: Data Table for Teacher J

This table indicates the location of transcript segment used for this stage of data analysis - the allocation of data to support, refute or modify propositions.

Cluster 2: Teaching Concerns - Propositions: 2, 5(b) and 14

2. This teacher's view of controversial issues teaching did not change throughout the study.
5(b). The value of controversial issues teaching for this teacher is seen in terms of students' social skill development not in terms of developing biological understanding.
14. From her perspective, controversial issues lessons can only be realistically perceived as one- offs whose value lies in the development of students' social skills.

Proposition 2	Proposition 5(b)	Proposition 14
+ Pre1(232-239),(484-492)	+Pre1 (167-180),(203-215), (284-292),(252-253),(467-474) -Pre1(216-229)	+Pre 1 (18-19), (32038), (181-197), (203-215) - Pre 1 (10-11),(43-44),
+ Pre3(680-735)	+ Pre3 (572-585) - Pre3 (774-778)	+Pre 2 (565-567 +Pre3 (572-606), (656-662)
+Pre4 (335-352)*	+Pre4 (335-377)*^ - Pre4 (32-43), (353-361)^	+Pre4 (335-352)*, (378-389), (445-481)
+Post (55-57)	+Post (168-182), (199-211), (243-250), (111-120) - Post (285-301)	+Post (142-167), (212-225)
+Post-Post (30C)*, (31)*, (32)* - Post-Post (24A)*, (23E)*	+Post-Post (30C)*, (31)*, (32)* - Post-Post (24A)*, (23E)*	+Post-Post (30C)*, (31)*, (32)* - Post-Post (24A)*,(23E)*

Key:

+	Data segment supports the proposition.
-	Data segment does not support the proposition.
*	This particular data segment supports more than one proposition.
^	Indicates what might appear to be conflicting evidence and thus needs examination.

Appendix 4.6: Provisional Propositional Themes

Listed below are the clusters of propositions presented to Teacher J for comment in the Propositions Interview. Additional comments were forwarded to the researcher after the interview and are noted in italics.

1. About A-Level Biology

J seemed to enjoy teaching and found it both professionally and personally fulfilling.

You also seemed to have developed your own particular style of teaching which for you has brought many rewards, most notably that your students had been successful in obtaining passing grades at the A-Level Biology examination.

+ very much enjoy the course. I have written a few extra bits here and there as well - Teacher J.

As a teaching technique formal planned discussion was not something you would normally do in your A-Level Biology lessons.

2. Professional Concerns about A-Level Biology Teaching

(a) J's choice of content and the way she conducted her lessons consistently reflected three concerns:

- external examinations
- predetermined syllabus
- available time

Your primary professional responsibility seemed to be that A-Level Biology students should be given the best available opportunities to score passing grades. In order for you to discharge this responsibility you felt that there was no time for anything which might delay syllabus coverage or compromise examination performance.

(b) Often, J found it difficult to apply her wider biological perspective obtained from background reading to her A-Level Biology teaching because of the large amount of time needed to collate resources and to allow for lesson flexibility,

(c) At the time of this study, The A-Level Biology syllabus in use was you thought very dense in its content. There was also important aspects missing which you thought ought to be rectified.

(d) Juggling the syllabus and the external examination with the amount of time available seemed to dominate and pervade your thinking about your A-Level Biology teaching.

3. About Controversial Issues Teaching

(a) J believed that controversial issues teaching was possible within her A-Level Biology teaching but only as one off, short, distinct lesson activities whose value lies within the domain of students' social skill development not in terms of developing biological understanding.

I feel it would help re reasoning skills/thinking before discussions.

(b) J had strongly held views and content knowledge concerning organ transplantation which when the occasion arose she articulated to students. She was aware that this knowledge along with that of other controversial issues needed to be continually updated for controversial issues teaching.

(c) Despite a willingness to invest her professional expertise into the planning and implementation of a controversial issues lesson, conceptualisation of the use of such issues to teach biological concepts remains difficult for a number of reasons.

It needs high ability/highly motivated students

4. About A-Level Biology Students

On the one hand J seemed to think of students as mature, confident, articulate, academically able, interested in controversial issues and debating, and possessing a fund of general knowledge, whilst on the other hand she seemed to think they were often 'content deficient' in areas of basic biology.

J seems to conceptualise learning and teaching as the transmission of knowledge to student using a highly didactic, lecture type format or formal practical activities.

With variety in group work when needed to lighten up the atmosphere.

From your perspective worthwhile lessons seem to be those where students acquire content knowledge or practical skills.

+ *reasoning ability* + *appreciation*

For J an ideal student was one who perseveres with all the required tasks, completes homework and can apply biological knowledge to new or novel situations.

J seems to believe that the more able students succeed despite her teaching and the less able students achieve passing grades if they 'stick at it'.

5. View of Science/Biology

Based on the evidence available for this study, J's view of science/biology seems to be as a body of factual knowledge about the world. Some of this knowledge she employed in her current A-Level Biology teaching.

+ *appreciation of the wonder, structure and function of the natural world.*
+ *problem solving ability encouraged*
+ *understanding of ethical/moral biological problems*
+ *a way of gaining a form of training - scientific ready for use for degree work etc.*

Appendix 4.7: Propositional Themes and Propositions

The propositional themes and their respective propositions used in the development of the account for Teacher J

1. The A-Level Biology Teaching Context

(i) J seemed to enjoy teaching, particularly the A-Level Biology course which she found both professionally and personally fulfilling.

(ii) J believed that her primary professional responsibility was to ensure that A-Level Biology students be given what she considered the best available opportunities to score high examination grades. In order for her to discharge this responsibility, she felt that there was no time for anything which might delay syllabus coverage and so compromise examination performance.

(iii) J's choice of content and the particular ways in which she conducted her lessons consistently reflected three professional concerns:

- external examinations
- the predetermined syllabus
- available time to cover the syllabus

And so as a teaching technique, formal planned discussion was not something J would normally do in her A-Level Biology lessons.

(iv) At the time of this study, J believed the current A-Level Biology syllabus to be content dense. Juggling the syllabus and the external examination with the amount of time available seemed to dominate and pervade J's thinking about A-Level Biology teaching. For this reasons she taught the way that she did.

(v) Often, J found it difficult to apply her wider biological perspective obtained from background reading to her A-Level Biology teaching because of the large amount of time needed to collate resources and so allow for lesson flexibility.

2. The Teaching of Controversial Issues in relation to A-Level Biology

(i) J believed that controversial issues teaching was possible within her A-Level Biology teaching but only as one off, short, distinct lesson activities whose value lies within the domain of students' social skill development not in terms of developing biological understanding

(ii) Despite a willingness to invest her professional expertise into the planning and implementation of a controversial issues lesson, conceptualisation of the potential use of such issues to teach biological concepts remained difficult for reasons such as student academic ability and motivation.

(iii) J had both strongly held views and content knowledge concerning organ transplantation which when the occasion arose, she articulated to students. She was aware that this knowledge along with that of other controversial issues needed to be continually updated for controversial issues teaching.

3. Teaching Students in the A-Level Biology Course

(i) One the one hand J seemed to think of students as mature, confident, articulate, academically able, interested in controversial issues and debating and, possessing a fund of general knowledge, whilst on the other hand she seemed to think that they were often content deficient in areas of basic biology.

(ii) J seemed to conceptualise learning and teaching as the transmission of knowledge to students using a highly didactic, lecture type format or formal practical activities.

(iii) From her perspective worthwhile lessons seem to be those where students acquired content knowledge or mandatory practical skills.

(iv) For J an ideal student was one who persevered with all the required tasks, completed homework and applied their biological knowledge to new or novel situations.

(v) J seems to believe that the more able students succeeded high A-Level Biology examination grades despite her teaching and the less able students achieved passing grades because they undertook the required teacher directed tasks.

4. Views of the Nature of Science/Biology

Based on the evidence available from this study, J's view of the nature of science/biology seemed to be as a body of factual knowledge about the world; some of which she employed in her current A-Level Biology teaching.

APPENDIX C

Chapter 5: Teacher J

Participant 1 - School A

Appendix 5.1: Aspects used in the formulation of interview questions

1. Moral and Philosophical Problems

The overriding problem is:

To what extent is an individual responsible for the provision of the well-being of others?

Some points worthy of consideration are:

- The morality of excising organs from a healthy donor.
- An individual's consent to organ removal.
- Potential benefit to others.
- Cadaveric organ procurement raises problems regarding the definition of death.

Some questions that might be asked are:

- Who authorises organ removal?
- Is there a moral limit to what can be done to a dead body?
- Should appeals to the sanctity of the human body outweigh the interests of those who have an urgent need for bodily parts?
- Should utilitarian or egalitarian principles underpin social policy options for the procurement and allocation of transplantable organs?
- Does a person who needs an organ in order to live have a moral claim to the organs of another being?
- What is the fair distribution of organs to those awaiting transplants?
- Is the human body a marketable commodity?
- What are the physicians obligations to the donor and the recipient?
- Organ transplantation can introduce a third part to the traditional doctor -patient relationship, the next-of-kin . Why is this a consideration?

2. Background notes which guided the formulation of interview questions

Bioethical Considerations:

- Technical skills in transplant surgery have rapidly out paced society's ability, or willingness, to supply adequate resources.
- Some of the ethical dilemmas associated with organ transplants could well be resolved by means of attention to the background principles of utilitarianism and egalitarianism, other dilemmas may be resolved by advances in technology, developments in medical knowledge, or even a shift in societal attitudes towards the allocation of certain resources eg. advances in immunosuppressive therapy, which eliminates a need for a close genetic match between donor and recipient, can resolve ethical dilemmas faced by relatives under pressure to donate organs.

Organ Transplant History:

- This has always been a high risk experiment and/or routine therapy.
- Ethical problems are thus located, and sometimes resolved in the dialectic between experimental research and clinical routine eg. should hopelessly incurable individuals be subjected to experimental methods when benefit is more likely to accrue to others as a result of perfection in technique, just as techniques of transplant surgery were experimental in the early stages, so too were the ethics. Rules evolved so to speak along with the techniques.
- Cadaveric organ transplants highlights the fact that on person's death can offer the hope of life for others but it forces discussion of the mechanism of death and the publicly acceptable definition of death with reliable criteria and tests.
- One of the problems is that organs removed from dead persons must, if they are to be successfully transplanted still retain some life in them and it is therefore apparent that the body of the donor still has some life in it. For many people, this raises problems about the determination of death in cases involving organ donation.
- This is one of the most fundamental ethical considerations associated with organ transplantation and it continues to generate confusion and moral uncertainty.
- Organ transplantation involves fundamental issues concerning human relationships.
- It is a history of anxiety and serious moral questioning, which reflects a dialectical movement between the ethical problems of risky and expansive experiments on the one hand and routine therapy using scarce resources on the other.

- As renal/cardiac transplantation becomes routine, problems of procurement and allocation loom large. Thus the following need to be increased: public awareness, public money, legal, ethical and moral guidelines.

Transplants: Experiments or therapy?

- Blood transfusion-well established once the ABO system was known.
- **Self replacement tissues** such as blood and for some persons sperm, do not address the kind of ethical and philosophical problems associated with the transplantation of **non-regenerative solid organs** such as kidney, heart, liver, pancreas and liver. **Non vital organs** such as the skin, cornea and eye have made good progress during the 20th century.
- Successful transplants depend upon; close genetic match between donor and recipient (in the past), use of immunosuppressive drugs and typing-antibody/antigen.
- There are four different types of transplants: **autografts**-transplants within the some individual eg. bone, skin, **homografts**-transplants between members of the same species or **xenografts**-transplants between different species, and **isografts**-between genetically identical individuals eg twins.
- **Cyclosporin**- immunosuppressant drug
  - selectively inhibits rejection of foreign tissues without damaging their ability to combat viruses/bacteria.
  - synthesised from soil fungus.
  - does not attack white blood cell production in the bone marrow.
  - can forestall rejection without destroying host defences.
  - reduces complications, shortens hospital stay.
  - extends the range of transplants.
  - offers benefit to high risk patients for example, those with high degrees of immunological reactivity.
  - **Side effects**-tremors, convulsions, swelling, inflammation of the gums, abnormal growth of body hair, incidence of lymphoma, toxic side effects which may effect other organs eg. kidney.
- For solid organs, where transplantation has become routine, the ethical problems are bound up with the procurement and allocation of organs, although considerable problems concerning experiments occur as the transplantation programme expands into new fields.

Living and cadaveric donors:

- A government mandate of all citizens to donate a pint of blood, or a kidney would meet a utilitarian requirement for blood and kidneys, but would clearly violate the autonomy of its citizens.
- The problem of live donation may never be fully resolved but the following could help:
  - increasing the size of the donor pool for bone marrow.
  - developments in the technology of organ transplants.
  - advances in immunosuppressive therapy.
  - 1983 with the introduction of cyclosporin-steroid therapy.
- Most European countries restrict live donations to relatives so as not to encourage commercial transactions.
- Most suitable cadaveric donors, 35 for men and 40 for women, must have no previous organic heart disease.
- In the U.K. to avoid potential conflicts between the attending physician and the requirements of the transplant team, practices have been consolidated which ensure that the donor's physician should have no role in the transplantation procedure itself. This ensures that the need for organs never interferes with the objective judgment that the patient was dead.
- Organ procurement
  - buying and selling- UK has legal prohibitions, sale for £'s could benefit the rich at the expense of the poor-slippery slope, sales have been banned.
  - trading, exchange and distribution-computerised data base where there is a registrar of donors and recipients matches to help overcome the rejection problems
  - taking- presumed consent
  - giving
  - requesting

Giving of Organs:

- Donation by prior direction of the deceased or by family responsible for disposal of the person's remains.
- In the U.K. the system is voluntary and donor cards are available.

- The 1961 Human Tissue Act (U.K.): The act endorses the deceased's express view to donate, which means that the element of consent is considerable as an express consent, as opposed to the presumed consent. But in the absence of a view expressed by the deceased, it would seem that a form of presumed consent is operative to a veto by spouse or relative.
- Gallop poll in the Guardian 30.12.1988 in the U.K. gave 85% in favour of donation - British Kidney Patient Association 70% said yes, but only 29% carried cards.

Request

- This is a routine request by doctors/hospitals for organs.
- In the U.K. required request was considered by DHSS but was rejected in favour of a policy involving better information concerning the donor and an extension of the donor card system.

Conclusion

- None of the systems of organ procurement is, at present, satisfactory. The sale and purchase of organs is an affront to human altruism and would, from the start, involve exploitation and degradation.
- Routine salvaging, with presumed consent, might risk overriding an individual's deeply felt objection to post-mortem donation, whilst the operation of a veto by relatives may frustrate a genuine desire to become a donor.
- In fact none of the systems in practice today can guarantee that an individual's wishes will be respected. The wishes of the donor card holder may be frustrated because no one looked for the card, or the family concealed the fact that one was held. A system of presumed consent might go into operation before it is known that the individual did not wish to donate.
- Possible Solution - a national registrar of names of donors who have given express consent and those who have indicated a desire not to donate and then regularly contact to reaffirm (or reconsider) their consent.

Data on Renal Transplants:

- By the mid 1980's the success rate of an average transplant was 80% survival for at least 5 years for those receiving a kidney from a live donor and 60% for one obtained from a cadaveric donor. There was an 8.2 years span before rejection.
- 1985 - 7,452 renal transplants in Europe
  1986 - 8,976 renal transplants in the U.S.A. with 21,000 worldwide.

- The best results - good histocompatibility and antigen matching, identical twins-29.2 years before rejection, 12.1 between parent and child and siblings.

- A kidney transplant offers a better quality of life than dialysis and also the cost of transplant is less than that of dialysis. In the U.S.A., dialysis costs $35,000 per year (1983) compared with a transplant of $5,000 - $8,000 per year with a better quality of life.

- As a general rule the cost of a successful transplant plus one years post-operative therapy amounts to less than the cost of one year of the cheapest form of chronic dialysis. After the first year the costs are negligible.

- There still exist many problems with rejection which often can mean back on the dialysis or another graft or more complications. In the U.S.A., 1500 return to dialysis each year, 80% of kidney recipients develop an infection of whom 25% die, due for the most part to lung infection. Side effects of immunosuppressives are hypertension, hepatitis and cancer.

- Successful renal transplants give a better quality of life for less expense. It is easier to get a new kidney than a new heart.

- One renal transplant surgeon has described renal transplantation when successful, as giving the patient a "holiday from dialysis".

Data on Cardiac Transplant:

- Problems are that it is difficult to obtain a "new" heart and it can't easily be maintained on a life support like dialysis.

- "...a considerable degree of public apathy towards organ donation can be attributed to the publicity followed by poor results, during the early stages of cardiac transplantation, together with the steady improvement in cardiac knowledge over the last 20 years. The survival rate for one year in 1986 in U.S.A. was (75-85)%.

- With near satisfactory immunosuppressive therapy, cardiac transplantation is becoming part of routine therapy and its expansion is inevitable. About 400 cardiac transplants occurred in U.K. in 1991 with 80% success rate for one year.

- Cyclosporin therapy now allows consideration of people over 55 years for cardiac replacement but, it still produces nephrotoxicity in 70-100% of patients. It is also toxic to the liver and the CNS. Multiple drugs with variable doses are now used.

- Other drugs include-azathioprine, low doses of Prednisone and rabbit antithymocyte globulin (RATG).

- Improvement s have now also been made in recipient selection -
  - terminal cardiac condition from which no alternative treatment is available.
  - high tech surgery helped in not giving people transplants who might earlier have needed them.
  - coronary artery bypass surgery.
  - valve replacement.
  - implantation of an automatic defibrillator.
  - steroid therapy

Liver Transplant:

- Since 1990 the success rate has been 70% for one year, helped by new improvements in immunosuppressive drugs.
- In the U.K. in 1982 - 21 transplants
1987 - 172 transplants (900 in the world)
- It is still regarded as a high risk therapy, has life threatening complications and is a very expensive operation usually twice that of the heart, at 1995 prices USA of $75000 - $24000.
- It is now possible to use parts of the liver for transplants eg. the use of adult cadaver donors whose livers are too large for transplantation into infants.

Bone Marrow Transplants:

- These are used for people unable to make white blood cells and who are aplastic anaemic.
- Success has only been with HLA- compatible donors.
- There is still a problem with graft versus host disease
- There is now a registrar of donors.

Appendix 5.2: Lesson Outline

1. Introduction (15 minutes)

- What is an organ transplant?
- What is the technology involved?
- The role of Ethics in any decision making.
- Review of Organ Physiology.

2. The Scene is Set ***(Time: tba)***

- People involved - the medical profession - patient, donor and respective familie.s
- Health Care Costs

3. Individual Group Discussion (3 lots of 10 minutes, student rotation)

Students given any or all of the following:

- general problems to discuss within their own groups
- use made of vignettes ie medical examples
- one main problem and asked to concentrate on the one only
- ethics discussions ie reasons for and against various organ transplants
- donor cards and what they should and should not contain

4. Lesson Summation (15 minutes - students to present this in groups)

Students present their ideas to the whole class

GROUPS:

14 students:

2 groups of three students

2 groups of four students -gender distribution tba.

For the Introduction - *Organ Transplantation*

Questions:

1. What is Organ Transplantation? Consideration - Patient, £, Recipient, Age of donor/recipient
2. Why is it done? Are the reasons justified? Group presentation.
3. Which organs can be transplanted and why? Same as 1 above.
4. Those concerned with the transplant
   - Who donates and why? Introduction /Discussion within the groups
   - " A Free Gift "
   - Recipient
   - Medics
   - Family and friends
   - Medical Costs
   - Religious and Moral reasons

Knowledge:

1. Functions of the kidney, heart, limbs, blood.
2. Medical, ethical etc problems with transplants.
3. Technology-dialysis machines *Bring in pieces of apparatus if possible-* eg. *heart, lung,* kidney- hip joints, pace-maker.
4. Rejection of organs *Tissues, plus immunity, rejection, antibodies*
5. Age of the Donor/Recipient *blood donation, matching of tissues*
6. How 'bad" does it have to be before it is life threatening drugs.
7. Symptoms of malfunction/presentation *Introduction*

Skills:

1. Discussion
2. Group work
3. Openness to ideas of others

Possible Areas of Teacher Input

- What is Organ transplantation?

  Transplantation is a surgical technique in which living tissue or whole organs are removed from a donor and inserted or placed into a recipient.

  The aim of this procedure is to replace the malfunctioning tissue or organ with one that is functioning. The success of the transplantation depends upon numerous factors including:

  - survival and viability of the transplant ie. the source and preservation of the organ to be transplanted.
  - skills of the surgeon.
  - suppression of the immunological defence mechanisms of the body.
  - administration of drugs in order to overcome tissue/organ rejection eg. cyclic polypeptide cyclosporin A.
  - irradiation of the lymph glands of the body where antibodies are concentrated.

- Transplantations are of two types:

  - Organ Transplantations-kidney, heart, liver
  - Tissue Transplantation-cornea, bone, skin, arteries.

  In principle tissue transplantation is much easier to perform because the surgery is less complicated, the blood supply can if needed be interrupted for a brief period unlike that of the heart for example and rejection is not so critical.

  Transplantation of brain tissue is now possible as well to a limited extent.

- Cost -Benefit of Organ Transplantation

  - Surgery
  - Keeping the Organ alive and viable
  - Use of the technology-kidney dialysis machine
  - Community costs-NHS.

- Immunity, antibodies and tissue matching.

  The use of drugs to prepare the patient and the organ/tissue for transplantation - the use of drugs to suppress rejection and the irradiation of the lymph nodes

- Patient symptoms of the malfunction

- Technology available to date-dialysis machine, pacemakers, hip and limb replacement.

- Ethical aspects-Who donates and why?
  - Why are some people not willing to donate?
  - Carrying a donor card-is it a good idea

Possible Question to Students in the Introduction

1. What do you understand by the terms organ transplantation and tissue transplantation?
2. Which organs and tissues are involve with transplantation?
3. What technology is used with transplantation? Do you know how it works?
4. Where do organs and tissues come from?
5. How does the doctor establish the fact that a patient needs a transplant? What are some of the physical symptoms displayed by the patient?
6. How might a doctor approach a grieving family to ask for an organ donation?
7. What medical aspects need to be considered before a transplant is carried out?
8. What ethical aspects need to be considered before a transplant is undertaken?
9. What is the Hippocratic Oath?

Appendix 5.3: Group Vignettes

Group 1: *Parents Solace in Donating Child's Organs*

Lauren Venutti was 31/2 when she was declared brain dead at the Stanford University Medical Centre in 1990, two days after a seizure.

"You're just numb when you're told your child is dying' is brain dead." said her mother, Tina, who, with her husband, Joel, decided to donate the child's organs. "It is a very immediate decision," she said. "Just knowing that through your child's death you're giving hope and dreams to someone else helps tremendously. They (the surgeons) already knew there was a little girl down at Loma Linda who needed a heart and was a perfect match. It's the greatest gift you can give." In a twist of fate about a year later, Mrs Venutti gave birth to a boy , born 10 weeks premature, who had a severe congenital heart defect. He lived only 3 days, but had he survived, the treatment for his condition would have been a heart transplant. "Would there have been a heart for him?" Mrs Venutti said. "Probably not. It was hard to accept this. We have been at both ends.

In December 1991 in the U.K., there were about 5323 people waiting for transplants, 4118 for kidney, 284 for hearts and 219 for both heart and lung. Of the transplants carried out, 1837 were for the kidney, 290 for the heart and 81 for heart and lung.

While dialysis can help those with kidney failure until an organ can be found, there is no temporising measure for patients with severe malfunctions of their hearts or livers. An estimated one in three people who need these organs die while waiting.

Frustrated by low donation rate and the stream of patients dying because no organs can be found, transplant surgeons are lobbing for new legislation that they will hope will tip the balance in organ procurement in the other direction. Instead of asking a bereaved family to consent to donate or produce the patient's donor card, doctors would proceed under the assumption that a brain dead patient has agreed to organ donation, unless the patient or family has specified otherwise. Such "presumed consent" laws, which have been proposed also here in the U.K. have been in place in several European countries for a few years and have sharply improved the organ supply there. But many doctors and other involved in procuring organs feel that the laws must be coupled with a heightened awareness on the part of both doctors and families so that neither will shy away from this agonising decision.

Too often families are approached halfheartedly or in insensitive ways, before they have had time to come to terms with the death. It is important that doctors and others involved with organ donation help families with their denial and anger before bringing up the subject. Otherwise, any chance of donation will be lost.

"One problem is educating people to the issues and the second is that the doctors attending brain-dead individuals don't want to bother," said Dr.Norman Shumway, professor of cardiac surgery at Stanford. "When the patient is finally brain-dead, the last thing they want to do is call an organ donation centre and do more work to give away organs of the person they were trying to save."

Organ donation is not often considered by people for half the people who meet the criteria either because they were never identified as suitable donors or because their families were never asked. In general about 40% of families who are asked say no.

Reference: British Kidney Patient Foundation,1994 from
The New York Times, Tuesday May 11 1993.

Discussion Questions

1. Imagine that you were the parent of Lauren, what might you have done in similar circumstances? How would you feel about the decision you have made? How easy would it be to make decisions like this?
2. Do you think the parents make an informed and sensible decision? Why?
3. Did they have enough information and advice? What additional information and advice might have been useful?
4. Imagine that you were preparing a young child for a heart transplant operation. The only information that you have been given is that a heart has become available from a young girl who has died from a brain seizure.
5. What would you want to say to your child to explain the operation, to prepare them for what might happen and for the possible rejection or failure of the donated organ?

Group 2: The Meaning of Death

In the summer of 1988 John Smith, a 45-year-old computer programmer from London, and his second wife, Lucy, were touring in Cornwall in a car which they had hired for their honeymoon. The motorway accident involved three cars and a truck. Lucy, who was driving, suffered the full impact of the collision and sustained head and chest injuries of such magnitude that it was obvious that she had been killed instantly. John was flung clear of the wreck but sustained massive head injuries and was taken within minutes to the hospital. He required several transfusions and a ventilator to maintain oxygenation, although his heart and kidneys appeared to be undamaged.

After 36 hours John was still unconscious and unable to maintain spontaneous respiration. An EEG brain scan revealed no brain activity and further tests revealed absence of spontaneous motion and no reaction to painful stimuli. It was discovered that John was in possession of a donor card and the transplant team were notified and put on alert whilst a search was undertaken to locate John's next of kin. This proved futile. After consulting two other physicians and conducting tests which revealed complete absence of brainstem functions, the attending doctors declared John dead despite the fact that his heart and lungs were functioning with mechanical assistance. The decision was then made to move John to the operating room where his heart, lungs, and kidney were transplanted into two other patients.

Three days later Joseph Smith, John's son from a previous marriage, arrived at the hospital , followed by Lucy's sister, Mary. Both were overcome with grief which later turned to anger. In due course they initiated legal proceedings. Unbeknown to the medics John was a member of the Jehovah's Witness community a religious organisation which does not agree with organ donation or blood transfusion. The hospital maintained that John's donor card expressed a clear indication of his wishes and that his death had been determined objectively and confirmed by two doctors independent of the transplant surgeons.

The arguments made by the solicitor representing Lucy's sister were directed at John and Lucy's last will and testament. In the event of Lucy predeceasing John, the whole of her estate would go to John. According to the terms of John's will, the whole of his estate would go to his son Joseph. In the event of a simultaneous death the joint estates would be divided between both Joseph and Mary. Mary's solicitor argued that John and Lucy met their death simultaneously and that John's body was artificially maintained until his organs were transplanted. In reply, Joseph's solicitor argued John had survived Lucy until the moment artificial ventilation was terminated and his heart and lungs removed. The ensuing legal battle turned on matters of clinical/medical facts and ethics which were themselves based on the criteria for death: in other words, on what it means to be dead.

Discussion Questions

1. When John's organs were removed, was he dead or alive? What evidence have you used to form the basis of your answer? Would the situation have been different if John was of another religious or ethical tradition or from another country?
2. Who died first, John or Lucy? Upon what evidence should the answer be based?
3. Does anyone own a 'dead' body?
4. Who then decides to go ahead with organ donation and subsequent organ transplantation?
5. Does a person who needs an organ in order to live have a claim to the organs of another being either alive or dead?
6. Should appeals to the sanctity of the human body outweigh the interests of those who have an urgent need for bodily parts?
7. What is it that is lost in death that causes us to regard the person we have known as 'gone'?
8. Is it spontaneous breathing and heartbeat, consciousness, cognition, or characteristics associated with speech, reason, and similar traits that marked him or her as a living person? Or is it an entity such as a spirit or soul that has departed?
9. Which of these should we choose, or which combination should we choose, or what other feature or features might be included?

Group 3: *The Law*

In Britain the law holds that even if people carry donor cards, the relatives must still give permission for the organs to be removed from the deceased relative. This has the possibility that a person's wishes might not be realised due to the family's objection or the donor card not being located in time for the transplant.

The law in this country states that persons wishing to donate organs at the time of death must inform their relatives. Often relatives are unwilling or unable because of grief to allow for the organ(s) donation. In Belgium, this is not the case. People must inform the local health authority if they do not wish their organs to be used for transplantation. This is called "opting out".

Discussion Questions

1. What comments do you have about the differences between Belgium and the U.K.?
2. Should the health interests of the potential recipient override those of the deceased?
3. Would it be wrong of relatives to refuse to donate cadaveric organs (ie. organs from dead bodies)?
4. How ought the law to stand in U.K. with respect to organ donation and the carrying of a donor card?
5. Would the "opting out" option work in this country?

Note: If you did not want to have your organs removed on your death you would have to register your wishes with say the local health authority otherwise your organs would be removed if members of the medical profession considered that they would benefit another individual.

Group 4: The Question of Donation

Discussion Questions

- What might be the difference between the donation of blood and say that of a heart, kidney or other organ.
- Some people donate their sperm or eggs, other people donate blood or even a kidney whilst still alive, is there a difference between the donation of eggs and sperm compared with that of blood, the heart or the kidney?
- Are healthy citizens obliged to offer their body organs as free gifts after death? Is this gift free?
- Some people carry a donor card. Should people above the age of 18 years be asked to carry one? Why? What should or should not be on this card? How does one decide the answer to this question? Would you carry a donor card? Why?

Should people under the age of 18 be able to carry donor cards if they wished? When might parental or guardian permission be necessary?

Appendix 5.4: Correspondence from Teacher J in relation to the draft of Chapter 5

6.6.96

Dear Wil,

Thank you for your letter and initial draft. It all makes for fascinating reading and I'm quire amazed at the things we said.

I suppose I feel a little concerned about the over-use of 'pedagogic' and 'diadactic' and the inference that my lesson are dry and uninteresting. This gives the wrong impression about lessons full of humour and anecdote making heavy content light and accessible.

Apart from that I have made very few comments having written in pencil in the text.

The syllabus has now changed and reduced so the 'Controversial Issues' may well play a larger part in future.

All the best for the future, it has been a pleasure working with you.

Yours,

Teacher J.

APPENDIX D

Chapter 6: Teacher C

Participant 2 - School B

Appendix 6.1: Lesson Plan

Human Infertility

1. Introduction *10-15 mins*

- Review the male and female reproductive system.
- Teacher questions students as to:
  - the names/function of the various parts
  - where things could go wrong- the term 'infertility' introduced here.
  - use of contraceptives

2. Student Group Discussion *40 mins*

The class will be divided into 3 or 4 groups and each group will be given a folder with information and some tasks to complete concerning one aspect of either male or female infertility.

Details will include:

- information about infertility
- technology currently available to assist in solving infertility
- donation of human gametes
- ethical, social and legal aspects
- vignettes-medical case studies

3. Individual Group Presentation *15-20 mins*

Each group will present answers to some of the questions presented in the folder as well as the possible solutions to the medical case study. This will be done on sugar paper, collected at the end of the lesson and typed/redistributed later.

4. Teacher Summary/Whole Lesson Review *5-10 mins*

Review of the major lesson aspects presented as bullet points.

- knowledge aspects
- ethical, social and legal areas

Appendix 6.2: Discussion Points for the Lesson Introduction

1. What is Infertility?

Infertility means that for a number of reasons pregnancy is extremely difficult.

These reasons could include:

- *Anatomical* - parts of the male and female reproductive system are faulty and or absent.
- *Physiological* - levels of sex hormones are inappropriate - diseases eg. STD, AIDS.
- *Psychological* - stress, lifestyle.

2. Reasons for Infertility

Female 57%

- No ovulation
- Fallopian tubes are diseased
- Absence of menstruation (no periods)
- Cervical and uterus abnormalities
- Endometriosis

Male 21%

- Lack of sperm production
- Immobile sperm
- Blockage of the vas deferens
- Ejaculation failure
- Chromosomal or hormonal disorders

Both 18%

Problems with sexual intercourse such as the sperm not being able to meet the egg. Fertilisation cannot occur.

Unknown 4%

Stress, diet, weight gain and loss, chemotherapy

Drugs - both prescription and non-prescription

3. **What can be done about Infertility**

- Avoid situations where either one of the partners is at risk of a sexually transmitted disease for example AIDS.
- Avoid infection after surgery such as birth both vaginal and Caesarean, miscarriage, abortion, appendicitis and pelvic infection. Such infections can cause adhesions in the reproductive organs which can lead to infertility.
- Workplace and lifestyle hazards including environmental chemicals, radioactivity, high stress, smoking and alcohol and, prescription and non-prescription drugs
- Community Education/Healthier Lifestyle.

4. **Social and Cultural Aspects about Infertility**

- How do infertile couples feel about their situation?
- The collection of eggs and sperm is for some people a very stressful procedure. Why might this be so?
- What might be some of the physical and emotional risks involved with infertility treatment? Some people argue that it is not worth it.
- What are the costs to the community in terms of money, emotions and counselling?
- What are the alternatives to assisted reproductive technologies?
- Why is it that society places so much importance on fertility?
- Does our society assist people in coming to terms with their infertility?
- What about the minority groups in our community who do not have the financial resources to contribute to the private health funds, how might these people be assisted?

Appendix 6.3: Group Tasks for the Presentation

Group 1a: Male Infertility

This folder contains information helpful for your group to answer the medical case study below. Read the information in the folder before you attempt to answer the questions. The flow chart and pamphlets contain information that will help you to back up your answers.

Please write down all your thoughts and answers on the sugar paper provided. Your ideas are of interest not whether you have the right answers. This activity is not a test.

The Case Study

Mandy and Robert Menzies have been attempting to conceive their first child for 18 months. Mandy is a 26 year old teacher with regular periods and no significant past medical history. Her husband is a 29 year old bricklayer. He is fit and healthy and the couple have no sexual problems. Examination reveals no problems with Mandy. Robert is 6'2" tall and weights 80 kg. He has a normal male physique, sex drive and hair pattern. His testes appear normal on the outside. Subsequent semen analysis reveals immobile sperm.

Questions

1. What is the likely diagnosis? There might be more than one correct answer here.
2. How could any of the diagnosis be confirmed?
3. What are the treatment choices for the couple?
4. The couple wish to pursue donor insemination. What further investigations and arrangements should be made? Are there any others areas other than medical which need to be taken into consideration?

(This is a very challenging question not only for you but also for doctors, lawyers and others in the community).

Group 1b: Male Infertility

This folder contains information helpful for your group to answer the medical case study below. Read the information in the folder before you attempt to answer the questions. The flow chart and pamphlets contain information that will help you to back up your answers.

Please write down all your thoughts and answers on the sugar paper provided. Your ideas are of interest not whether you have the right answers. This activity is not a test.

The Case Study

Patricia and Michael Frances have just been to an Infertility Clinic on the advice of their doctor. They had been told 2 years earlier at another clinic that there was no cause for their infertility. Both are now 30 years old and they wish to know if any further investigations or treatment might help them to conceive. Both are in excellent physical, sexual and psychological health. Patricia's current investigations reveal no abnormalities or problems. She is ovulating regularly and experiences no severe menstrual pains or problems.

Questions

1. What investigations would you 'as a doctor' suggest for Michael, knowing that his male hormonal levels were normal and that there were no blockages in either the vas deferens or in the epididymis?
2. What treatment is available for this couple?
3. If all these investigations proved fruitless what choices do this couple have in order to start their own family?

Group 2a: Female Infertility

This folder contains information helpful for your group to answer the medical case study below. Read the information in the folder before you attempt to answer the questions. The flow chart and pamphlets contain information that will help you to back up your answers.

Please write down all your thoughts and answers on the sugar paper provided. Your ideas are of interest not whether you have the right answers. This activity is not a test.

The Case Study

Sue Jones is a young 25 year old mother who had her first child Ben 2 years ago. She enjoys breast feeding her son and continues to do this especially before putting Ben down for his sleep at night. For the past 15 months Sue and her husband Tom have been trying for a second child but to date have been unsuccessful. This is causing them some stress. They have not used contraceptives since their son's birth.
Both Sue and Tom are in excellent physical and sexual health.

Questions

1. What questions might you ask this couple when they come into your surgery?
2. What could Sue do to increase her chances of becoming pregnant? Why would you suggest this?
3. If the couple still did not become pregnant what preliminary investigations would you undertake if you were their doctor?

Group 2b: Female Infertility

This folder contains information helpful for your group to answer the medical case study below. Read the information in the folder before you attempt to answer the questions. The flow chart and pamphlets contain information that will help you to back up your answers.

Please write down all your thoughts and answers on the sugar paper provided. Your ideas are of interest not whether you have the right answers. This activity is not a test.

The Case Study

Mary is a fit and healthy 30 year old who is very keen and enthusiastic about physical fitness. She trains about 5 times a week for about 1.5 hours each time. Peter and her own the gym. In order to set up the business they have delayed having children until they were a little more financially secure. Mary has been on the contraceptive pill for 6 of the past 8 years. During the past 2 years the couple have not used any contraceptive and Mary has not become pregnant. As a younger woman her doctor suggested that she should go on the pill in order to help regulate her periods which during her A-Levels and at University caused her much pain and discomfort. Her periods are still very irregular and she has spot bleeding from time to time. Peter has a child from a previous marriage.

Questions

1. What do you think might be the cause(s) of the couple's difficult in starting up their own family?
2. How might they be able to 'help themselves' with out the immediate use of medication?
3. If they returned to the doctor in 6 months what might she suggest as a cause for investigation? Give reasons for your answer.

Group 3: In Vitro Fertilisation and the Freezing of Embryos

A Medical and Ethical Problem involving In Vitro Fertilisation

Mr. and Mrs. C are accepted by an In Vitro Fertilisation Clinic. Mrs. C has blocked fallopian tubes which means that even though her eggs are released from her ovaries every month she is unable to get pregnant. Her husband's sperm are therefore unable to swim up into the fallopian tubes for fertilisation to occur.

The couple agree to have 6 ova(eggs) removed from Mrs. C. Two are fertilised with the sperm of Mr. C in the laboratory and are then implanted into Mrs. C. The others are frozen along with semen from Mr.C. After 2 - 3 weeks the couple are delighted to hear that they can look forward to a set of twins in 9 months and anxiously await their arrival.

On a wet evening the car in which they are travelling is involved in an accident and the couple are killed. They have left no will.

The next of kin (nearest relative) is contacted and asked to indicate what ought to be done with the remaining frozen eggs and semen.

Questions

1. What aspects would you need to consider if you were the next of kin of the couple?
2. You as the next of kin are approached by the research team at the clinic where the eggs and sperm are frozen. The team would like to use the eggs and sperm for research on infertility. How would you answer their request? What things would you be considering in detail before you gave your final answer?
3. Did Mr. and Mrs. C act irresponsibly in not leaving a will covering the future of their eggs and sperm in case of their death? Give reasons for your answer?
4. Freezing of eggs and sperm, and their thawing, is still an area of scientific research and development. What problems do you think might still exist in this area?
5. When does human life begin?

Sample of Student Notes

Male Infertility

On order for a couple to become pregnant the male must produce sperm in the testis and the female must produce eggs in the ovary. These sex cells - sperm, ova (eggs) must interact so that they fuse together and fertilisation occurs. This fusion normally takes place in the fallopian tubes of the female(in vivo) or in certain circumstances such as when the couple are infertile outside the body (in vitro). Once the egg is fertilised subsequent events in the woman's body must occur so that pregnancy and birth follow.

Specific estimates of the number of men who are infertile in our community are difficult to come by. The medical journals often report that **one couple in 10** require advice or treatment for infertility. About **10%-15%** of couples find themselves infertile at sometime. Approximately one man in 25 will need to seek advice/assessment for his infertility(if he wishes to father children).

For a man to be fertile he must:

- produce sperm in his testes(spermatogenesis)
- produce sperm that are mobile ie. able to swim
- have normal sperm ie a tail and a head some sperm lack these.
- produce enough semen
- achieve a normal erection and ejaculation during sexual intercourse
- produce enough sperm in his semen
- have his testes outside his body so that the temperature of his scrotum in 2-3 degrees below body temperature

On average a healthy male ejaculates 34ml of semen containing as a minimum 60 million sperm and sometimes well over 270 million sperm. Of all the sperm produced only a few hundred of all the sperm ejaculated reach the site of fertilisation in the fallopian tubes of the female. The rest die along the way.

Possible Causes of Infertility

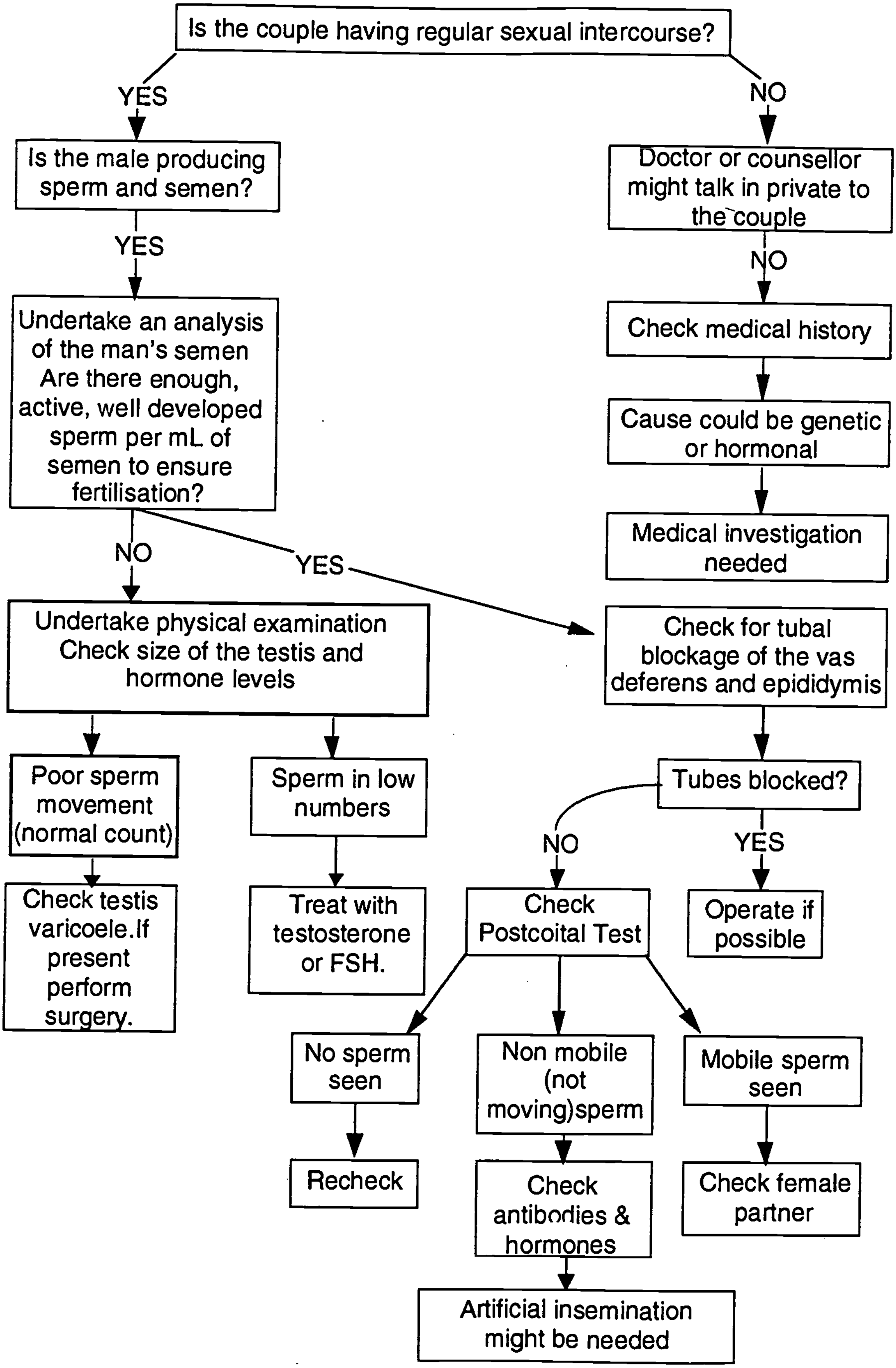
- Chromosomal - instead of the male having XY chromosomes he has XXY and hence very small testes and no sperm.
- Hormonal - imbalance of male sex hormones eg. testosterone.
- Problems with sexual intercourse
- Problems with the testes
- Other areas such as obstructions in the reproductive organs, epididymal hostility - even though normal sperm are produced they are immobilised once they are in the epididymis because their tails are destroyed and, infection of various parts of the reproductive system.

Ways to Investigate the Problem of Infertility

Check the following:

- volume of semen
- % of mobile and normal sperm per semen sample
- hormone levels
- presence of sperm antibodies
- obstructions in the reproductive organs
- sperm and female cervical mucus interaction

Male Infertility



Female Infertility

Approximately 15% of couples who do not use contraceptives fail to achieve a pregnancy within 12 months and more than 10% remain unsuccessful after 2 years. Investigations usually begin after a year of unprotected sexual intercourse. In half of these it is the female who experiences infertility difficulties.

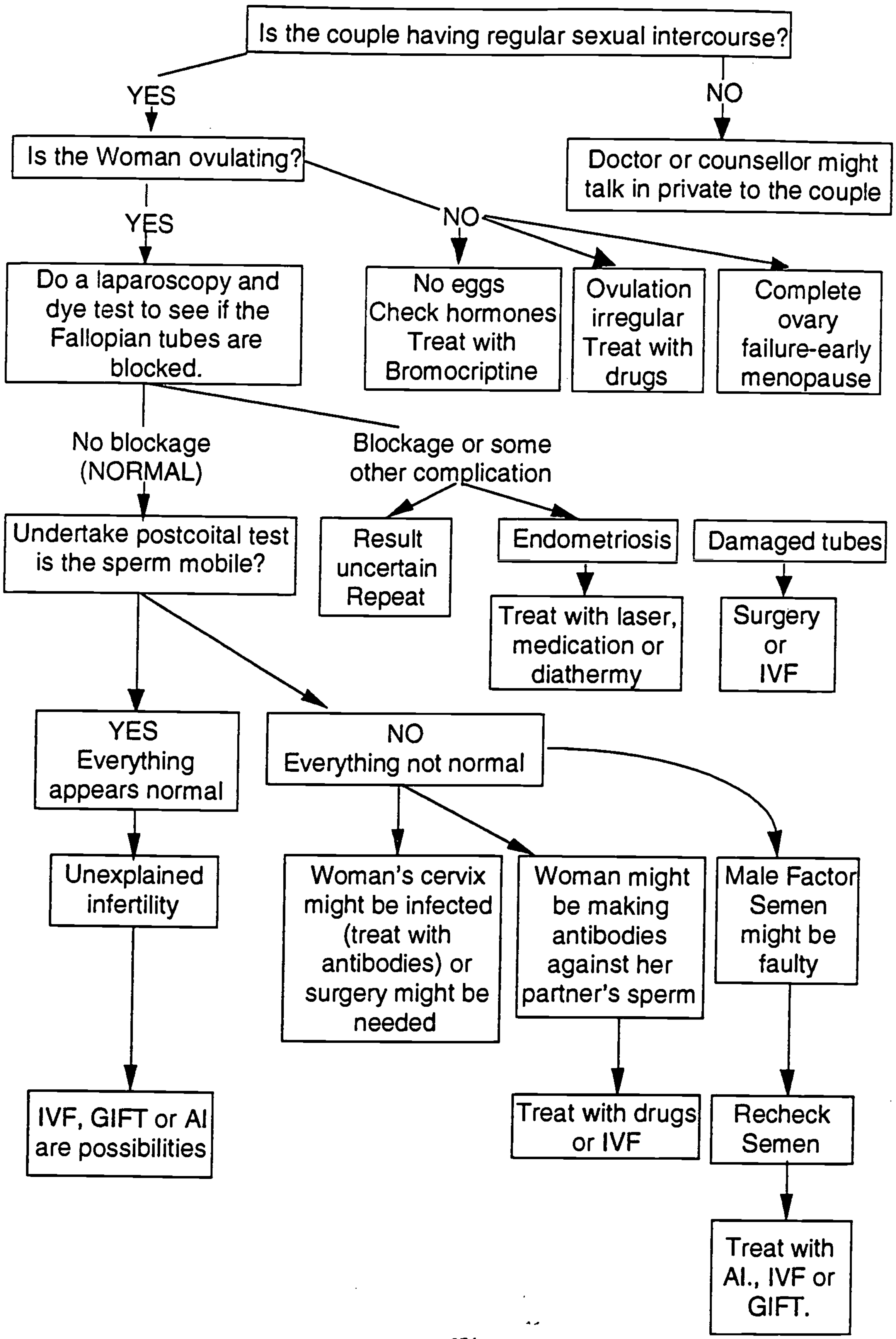
Primary Infertility - mean that the women has never been pregnant.
Secondary Infertility - mean that the woman has had a child but is now unable to conceive.

Infertility is one of the most common health problems experienced by women in the reproductive years. There is no firm evidence that infertility is increasing. Choosing to have children later, pelvic inflammatory disease, weight loss and weight gain as well as weight-or-exercise related anovulation (no ovulation) have all become more common.

Female infertility is usually the result of one of the following:

- **Disorders of the Ovary** such as absence of ovulation (anovulation), high levels of breast-milk producing hormone called prolactin which alters ovulation (hyperprolactinaemia), and imbalance in other hormones affecting ovulation.
- **Blockage of the Fallopian Tube**
- **Hostile Cervical Mucus** - if the mucus becomes acidic sperm are unable to pass through on their way to meet the egg in the fallopian tube.
- **Weight-Related Ovulation** disorders due to both weight gain/loss. Also reduced body fat in some female athletes explains why some have ovulatory disorders but still maintain ideal body weight.
- **Endometriosis**

Female Infertility



Appendix 6.4: Glossary of Related Terms

Artifical Insemination using the husband refers to insemination using the husband's sperm and may be advantageous in those cases of mucous hostility , low sperm count or motility. It does not cure sperm problems but uses it to its maximum efficiency and capability, though the results are not as dramatic as some couples imagine.

Azoospermia refers to the complete absence of sperm in the semen.

Bromocriptine is a drug given to women who have too much of the hormone prolactin in their bodies. Prolactin is the hormone used in the production of breast milk and is thought to be a natural contraceptive.

Cervical Mucus Defects occur when the mucus from the cervical canal prevents the sperm from entering the uterus.

Chlamydia is a micro-organism which can be transmitted through sexual intercourse and may cause pelvic inflammatory disease(PID) in women.

Chlomiphene is a drug given to women undergoing fertility treatment or IVF which stimulates the ovaries to produce multiple follicles and so ripen more eggs.

Clinical Pregnancy refers to the ultrasound evidence that a fetal heart exists.

Diathermy is the electrical burning of blood vessels to stop bleeding.

Donor Insemination is a technique whereby instead of the women's partner's sperm being used sperm from an anonymous donor is used. The donated sperm is placed either at the cervical opening or in the cervical canal.

Ectopic Pregnancy is one which develops outside the uterus, usually in the Fallopian tubes. Early diagnosis and removal of the pregnancy is important to prevent rupture of the tube and life-threatening haemorrhage. Tubal damage may occur as a result and therefore reduce fertility.

Egg Collections refers to the collection of eggs from the ovary.

Embryo Transfer is where fertilised eggs are transferred to a woman's uterus via a fine tube inserted into the vagina and through the cervix.

Endometrium is the lining of the uterus and is particularly rich in blood just before a woman has her periods when it is shed because fertilisation has not occurred.

Endometriosis is a disease in women where the normal lining of the uterus (endometrium) is found in areas other than the uterus, such as the ovaries and the tissue surrounding the uterus and Fallopian tubes, including ligaments, the bladder and bowel. Endometriosis is thought to be caused by fragments of the lining of the uterus escaping into the Fallopian tubes and out into the pelvic areas during menstruation. These tissues respond in the some way as the uterus during menstruation and therefore also bleed. However there is no way that the blood can leave the body as menstrual blood does through the uterus(womb). This causes inflammation and some of the blood and tissue can form cysts. Symptoms might include severe pain during periods, pain at the time of ovulation, pain during or after sexual intercourse, or with bowel movements. Heavy bleeding or irregular bleeding are other possible symptoms.

Epididymis is a tube in the male genital tract which connects the testes to the penis. Blockage in the epididymis prevents the passage of sperm to the penis.

Female Factor is a term referring to any reason why a woman is infertile, such as ovulation failure of damage to the fallopian tubes.

Follicle is a group of cells that surround the ripening egg in the ovary.

Gametes are the reproductive cells. In the female they are the eggs and in the male they are the sperm.

Gamete Intrafallopian Tube Transfer(GIFT) refers to the technique whereby the eggs are sucked up from the ovary and mixed with the man's specially prepared sperm and then this mixture is gently squirted into the fallopian tube. Sperm and a maximum of three eggs are transferred together to one or both of the female's fallopian tube(s).

Human Chorionic Gonadotrophin is a hormone secreted by the placenta in pregnancy. The hormone is extracted from the urine of pregnant women and is given to women undergoing fertility treatment or IVF to induce ovulation.

Human Menopausal Gonadotrophin is a preparation of two hormones, follicle stimulation hormone(FSH) and luteinising hormone(LH). These hormone are obtained from the urine of women usually above 55 years old who no longer have periods. This preparation is given to women undergoing fertility treatments or IVF to stimulate the development of follicles.

Hyperprolactinaemic infertility is a form of infertility where there is too much of the hormone prolactin produced in the body. Prolactin is needed in the production of breast milk and is thought to act as a natural contraceptive.

Hyperstimulation is an overstimulation of the ovaries which may occur after women have been given drugs and hormones to induce the growth and release of multiple eggs from the ovaries.
Hysteroscopy is a fibre optic telescope which is passed up the vagina and then into the uterus in order to inspect the uterine cavity. It allows doctors to see the uterine cavity under direct vision and is able to detect abnormalities that would not normally be picked up by X-rays because they are too small.

Hysterosalpingography is technique where by a dye is placed into the cervix of the women where it is then able to move throughout the Fallopian tubes. This dye can be picked up on an X-ray and so any blockage of the tubes can be seen. Patients can view the results of the X-ray on a TV monitor.

Insemination refers to the procedure whereby fertile semen is placed either around or just inside the cervix of the woman,using a narrow polythene tube. The semen can be from her partner or from an anonymous donor.

IVF (In Vitro Fertilisation) is commonly referred to as test tube babies. It refers to a number of medical techniques whereby women are assisted in becoming pregnant. Fertilisation occurs outside the woman's body. Sperm and eggs are collected and put together to achieves fertilisation outside the body. The fertilised eggs have already begun to divide at transfer into the woman. Up to three of the resulting embryos can be transferred into the uterus at any one time.

Laparoscopy is a surgical investigation of the reproductive or abdominal organs using a laparoscope. A **laparoscope** is a surgical instrument which has a light guided telescope so that the pelvic organs can be seen. A **laparoscopy** is performed under general anaesthetic and the abdomen is filled with carbon monoxide. When the **laparoscope** is used for egg collection, more than one incision is made in the women's abdomen for the insertion of the **laparoscope**, forceps to hold the ovary in place, and a needle to suck (aspirate) ripe eggs from the ovaries.

Live Birth refers to the delivery of one or more babies.

Male Factor covers any reason why the male partner's sperm may be less effective or incapable of fertilisation, ranging from a failed reversal of a vasectomy to the absence of viable sperm.

Miscarriage refers to the spontaneous complete loss of a pregnancy before 24 weeks.

Multiple Births occur when more than one baby is born from a pregnancy eg twins.

Oligospermia is said to occur in men where their sperm count is less than the normal count of 20 million per millilitre.

Patent- no blockage.

Pelvic Inflammatory Disease(PID) is an infection and inflammation of the pelvic organs. The infection may be located in the uterus, Fallopian tubes, ovaries or in tissue surrounding these organs. This can result in scarring and blockage of the tubes. Infection can be the result of sexually transmitted diseases or when other microbes enter the cervix such as after childbirth, abortion, miscarriage and with the use of the intrauterine devise(IUD'S). Most cases of PID occur in young heterosexual women who are sexually active. PID is treated with antibiotics. If you are diagnosed as having PID it is essential that your partner be treated as well.

Postcoital Test is a test done after sexual intercourse to see whether the sperm have been able to move through the mucus of the female. A smear is take of the mucus of the cervix to see if the sperm are still motile ie moving. This is usually done 6 to 8 hours after intercourse. Some women have antibodies in their mucus which immobilises the sperm.

Perinatal Death is the death of a baby either in the uterus after 24 weeks pregnancy(stillborn) or within one week after live birth.

Prolactin is a hormone used in the production of human breast milk.

Semen Analysis is an examination of the semen. Ideally the results should be as follows:-

- Volume: Greater than 1.0 ml.
- Count: 20 million sperm/ml or greater.
- Motility: Greater than 50% motility during the 2 hours after production.

Sperm Antibodies are complex chemicals in the bloodstream or seminal fluid which mistakenly attack the body's own tissues. Men may themselves have high levels of sperm antibodies in their seminal fluids or they may be present in the cervical mucous of the woman. Sperm antibodies in the cervical mucous affects how well the sperm are able to swim within the mucus.

Superovulation involves giving drugs to a woman causing her ovaries to produce more eggs than usual in a menstrual cycle.

Transvaginal Ultrasound Guided Egg Collection is a technique used to collect eggs from women for IVF and for GIFT. A needle attached to an Ultrasound probe is inserted through the back wall of the vagina and into the pelvic cavity. The position of the needle is followed on an ultrasound screen and follicles are aspirated or sucked out from the ovary using the needle. A local anaesthetic or sedation is given to women undergoing this method of egg collection. There is risk of infection or internal bleeding.

Treatment Cycle

a) IVF with fresh eggs:a cycle begins with the administration of drugs for the purpose of superovulation, or if no drugs are used, with the attempt to collect eggs.

b) IVF with frozen-thawed embryos:a cycle begins with the removal of the stored embryos in order to be thawed and then transferred.

For donor insemination a treatment begins when the first insemination with donor sperm takes place.

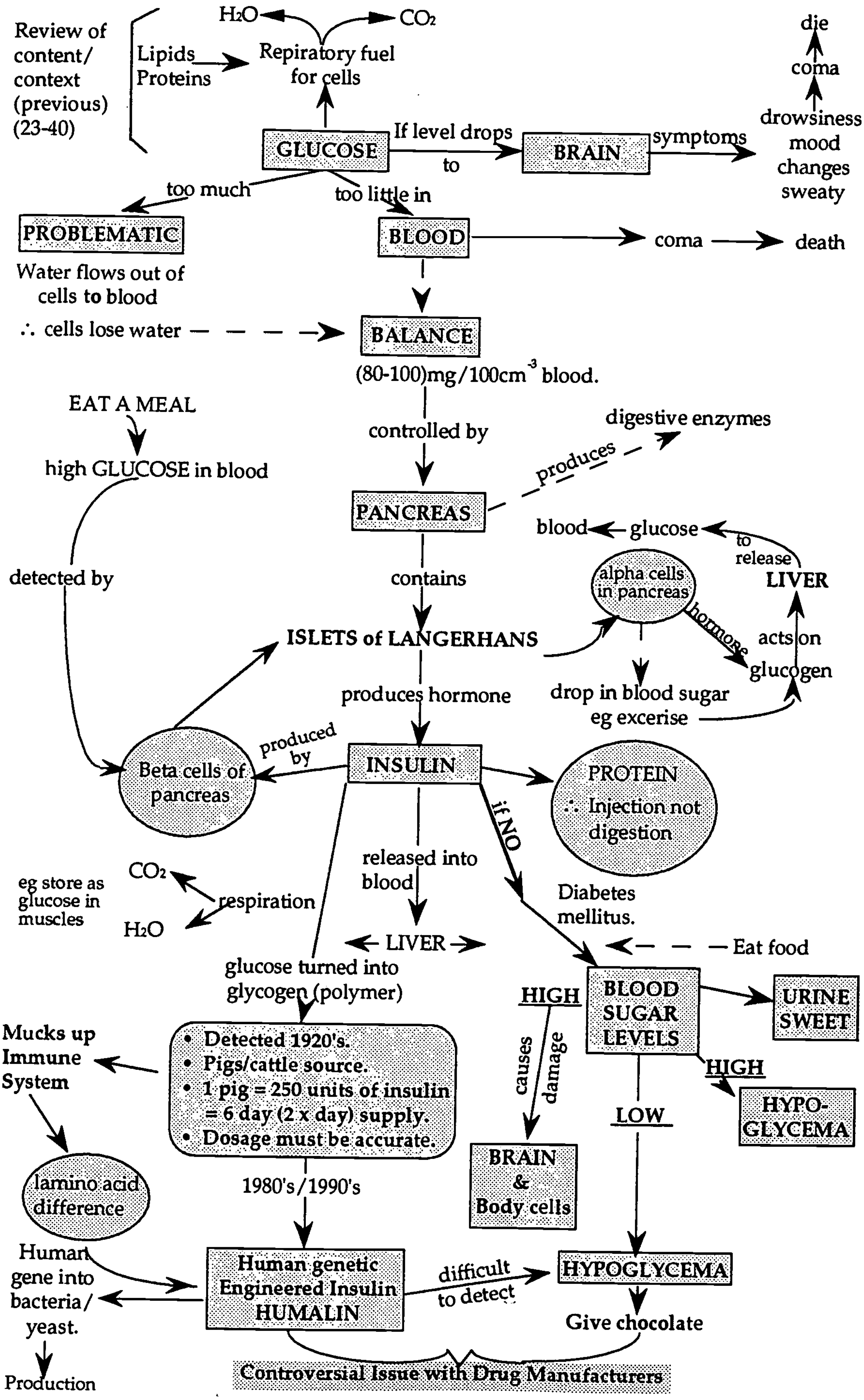
Ultrasound Scanning is the use of high frequency sound waves to look at internal structures or organs within the body on a TV screen. It can be used to monitor when ovulation will occur and in the collection of ripe eggs from a woman's ovaries.

APPENDIX E

Chapter 7: Teacher R

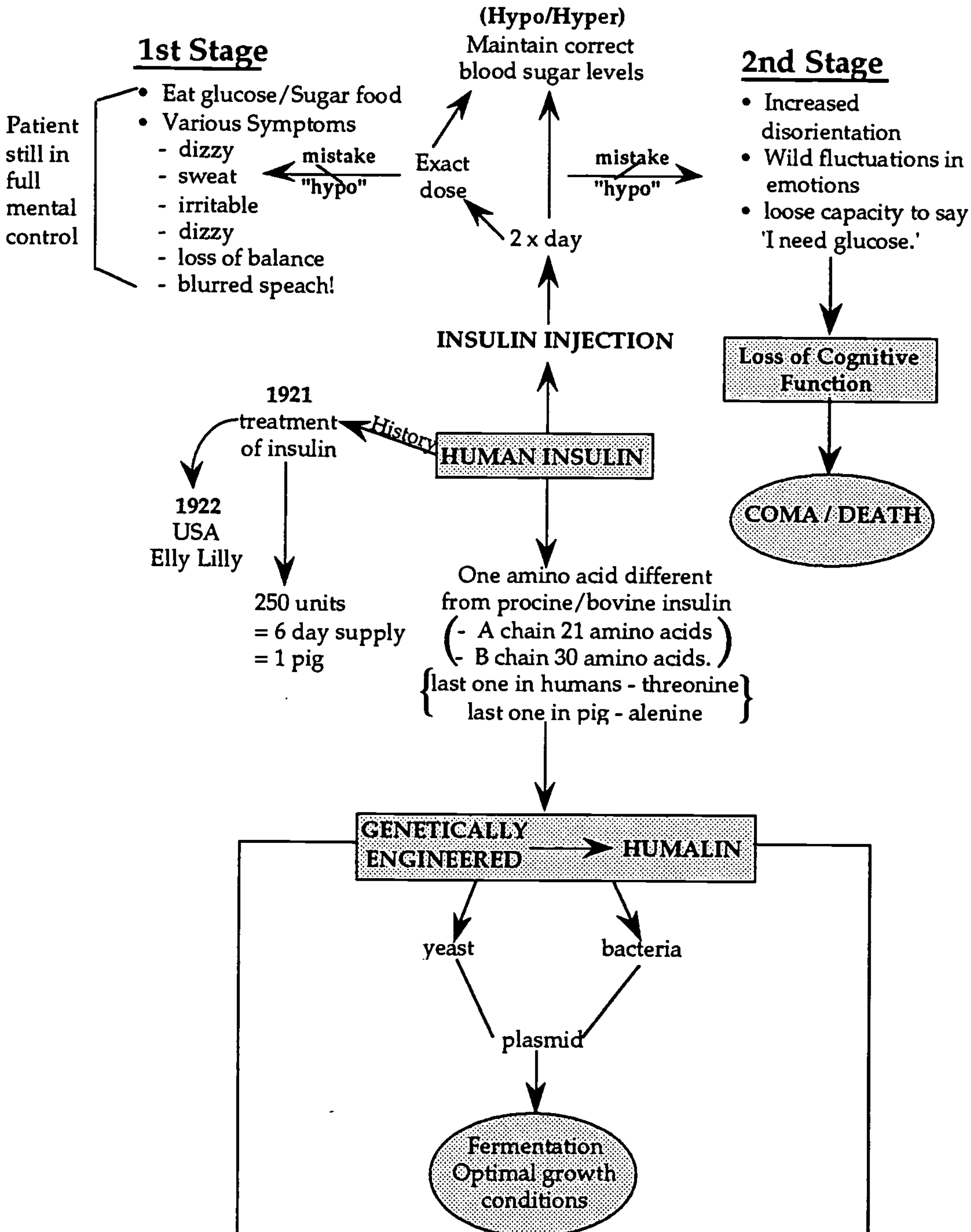
Participant 3 - School C

Appendix 7.1a: Content knowledge *Lesson 1 - Diabetes Management*



Appendix 7.1b: Content knowledge map

Lesson 2 - History of the use and Development of Insulin



Controversy

- Large Research and Development costs for drug companies
- In UK, late 1980's, new diabetic patients put onto humalin (*not* porcine/bovine insulin)
  - benefits ⇨ close immunologically to humin insulin.
  - side effects ⇨ patients couldn't detect *hypo*
    patients weren't being listened to by doctors/drug companies
    patients sought/got help from BDA.
  - patients should be free to manage their diabetes - how they so wish.
- Pen devices only available to humalin users.

Appendix 7.2: Diabetes Management - the debate

Group 1: Oppenheim Pharmaceuticals

You represent this multinational drugs company which operates in a number of fields, one of which is the production of human insulin (humalin). Your company developed the technology (at considerable expense) whereby the human gene for insulin was inserted in yeast cells. These cells produce insulin identical to that produced in the human pancreas. You began marketing this product in the mid 1980's.

You believe human insulin has several advantages over animal insulin:

- No complications with allergic reactions.
- Unlimited supply. The supply of animal insulin relies on the meat trade. This means that supply could dwindle as meat eating declines or with outbreaks of disease in animals.
- Cheaper to produce (after development costs are recovered).

Because of your belief in these benefits and the large investment made in its development, you have encouraged doctors in the U.K. to switch their diabetic patients to human insulin. At the same time technological developments in the administration of insulin (e.g. pen injectors) were only made available for human insulin in the U.K. (although they were available for animal insulins in some other European countries up until 1992).

All new insulin-dependent U.K. diabetics are started on human insulin.

You are aware that there have been reports that some diabetics switching from animal to human insulin lost the ability to detect the early symptoms of hypoglycaemia. However, you know that two separate studies have shown that there is no difference in the awareness of hypoglycaemic symptoms between patients using human and animal insulin.

You are also aware that four laboratory based studies showed a small, but statistically significant reduction in awareness of hypoglycaemia in people taking human insulin. The authors of two of these studies did not regard the results as clinically significant.

In the Netherlands, hospital admissions for severe hypoglycaemia fell following the introduction of human insulin.

The company is willing to concede that there were a few "teething problems" after the introduction of human insulin. You regard this as an inevitable consequence of insulin therapy and consider that the vast majority of diabetics have made the change successfully. You think that changes in the management of diabetes, for instance injecting insulin three of four times a day, rather than once or twice, may have produced problems of symptom awareness - **not** the type of insulin used.

The stance of Oppenheim Pharmaceuticals is that, while it will continue to produce animal insulins for the next few decades, the future of diabetic therapy lies with human insulin.

You will try to ally the worries of the National Diabetic Association and persuade them to encourage their members still using animal insulins to change to human insulins (although you are willing to concede that older diabetics can continue using animal insulin if absolutely necessary).

Group 2: National Diabetic Association (NDA)

The NDA is a charity which supports diabetics in the U.K. It is concerned about possible side effects of human insulin, primarily that patients lose awareness of the early symptoms of hypoglycaemia (eg. sweating, dizziness, irritability) which alert them to take glucose. The absence of these warning signals means that they are more likely to enter a hypoglycaemic coma. All new diabetics are now started on human insulin and most patients have been persuaded to change to it by their doctors.

A 1987 article published in *The Lancet* (a medical journal) reported that diabetics in Switzerland had lost awareness of hypoglycaemia after switching from animal to human insulin.

At around the same time the NDA started to receive letters from its members complaining of the same problem. A survey of members revealed that:

- Some members were not informed by their doctors that their insulin was to be changed.
- Others did not now that their dosages would need to be altered.
- Many complained that their experiences were being ignored by doctors.

You know that four separate studies conducted between 1988 and 1990 showed that patients on human insulin had a reduced awareness of hypoglycaemia compared to patients on animal insulin (although these differences were small).

You believe that the main reason that so many diabetics have been changed to human insulin had been pressure from drug companies not clinical need. Doctors were encouraged to change patients to human insulin. New technology for injecting insulin (e.g. pen devices) was only available for human insulin in the U.K., but was available for animal insulin in Germany.

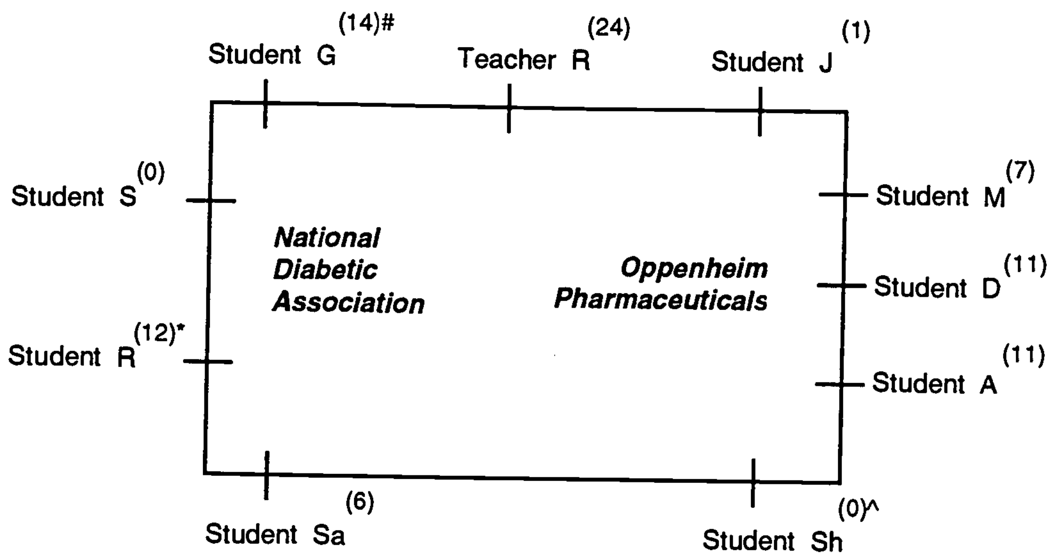
You feel that many doctors regard hypoglycaemia as an irritating but minor consequence of insulin therapy. This is wrong. The symptoms of hypoglycaemia are frightening and incapacitating. If an insulin-dependent diabetic is unsure whether they will be able to detect the early symptoms and respond to them, they may feel unable to lead a normal life.

In response to the concerns of its members, the NDA has adopted the following stance:

1. Nobody should have their insulin changed without a full explanation.
2. They should be warned of the hazards and encouraged to monitor their blood sugar levels carefully.
3. Doctors should have a complete understanding of dosage changes when patients convert to human insulin.
4. The opinions of people experiencing difficulties with human insulin should be respected and, if necessary, they should be changed back to animal insulin.
5. New technology for administering insulin should be available for animal as well as human insulin.

You will be attempting to persuade representatives of the drugs company Oppenheim Pharmaceuticals to accept these provisions.

Appendix 7.3: Classroom Arrangement for the Debate on Diabetes



Key:

# Indicates number of utterances during the debate
* Student names known to the researcher from their interviews
^ Student absent for the preparation of the debate

APPENDIX F

Chapter 8: Teacher S

Participant 4 - School C

Appendix 8.1: Controversial issues presented to students

- The Environment - Green Issues
- Death, Dying and Euthanasia
- Technology
- Organ Transplantation
- Donation of Genetic Material
- Experiments using Animals
- Experiments using Embryos
- Being Vegetarian
- Infertility
- The Cost of Health Care
- Selective Breeding
- Cloning
- Diabetes
- Use of pesticides
- Conservation
- Agricultural development
- Gene therapy
- Genetic Engineering
- Surrogacy
- Age of the mother and father

Appendix 8.2: Discussion Points for the Introduction to Lesson 1

1. Main Species of Animals used in Research and Testing

Mouse	Rat	Rabbit
Beagle	Cattle	Sheep
Guinea-pig	Hamster	Gerbil
Cat	Greyhound	Ferret
Horse	Donkey	Mule
Pig	Goat	

Spider Monkey	Baboon	Prosimian
Marmoset	Tamarin	Macaque
Squirrel monkey		

Various of the following:

Birds	Reptiles
Amphibians	Fish

2. Should Animal Experimentation be Permitted?

YES

Human vs Animal Rights:
In defence of Animal Research

Humans with the capacity for rational thought and action are a superior species

While animals deserve humane treatment, the good consequences of animal research, that is, knowledge that will benefit human beings, outweigh the suffering of individual animals. No other research techniques can substitute for the reactions of live animals.

Animals research can be defended on medical grounds because it would be unethical to deprive humans and animals of advances in medicine

NO Ill- gotten gains

Animals should not be seen as tools for human use and consumption but as beings in their own right

Animal experimentation cannot be taken for granted but must be justified by ethical criteria at least as stringent as those that apply to human research.

Humans practice 'speciesism', that,is we assume that humans are superior and that we are prejudiced in favour of our own kind. All animals including humans are equal and the suffering of an animal is morally equal to the suffering a human.

There is a dispute about the benefit to humans even though there might be some inherent value in the animal experiment. Thus, whatever our gains they are ill-gotten. The ends does not justify the means.

3. The Main Purpose of Using Animals in Teaching

The main types of investigation involve:

- observing.
- selecting relevant observations.
- looking for patterns in observations.
- seeking to explain these patterns by suggesting hypotheses.

The educational reasons for dissection might include:

- gains of knowledge by personal experience.
- an appreciation of the organisation of tissues and organs and their fragility.
- the importance of observation in the process of investigation.
- no model, photograph, computer simulation can equal or be a real substitute.

Appendix 8.3: Group Tasks in Preparation for the Class Debate

Group 1: The Abolition of Animal Testing

This folder contains information from two groups concerned with the use of animals for experiments. These are:

Royal Society for the Prevention of Cruelty to Animals - RSPCA
The British Union for the Abolition of Vivisection - BUAV

Both groups are currently campaigning to end animal experimentation

It is the task of your group to present a coherent, logical argument on the stance of the RSPCA and BUAV using the booklet and leaflets, as to why animals should not be used for scientific experiments. It is important that you not only provide the ethical/emotive side but also the **biological aspects** of their position eg. animals are not humans and so should not be used as human models.

You will be given time to prepare your arguments and then the group will be asked to present its work/thoughts and ideas to the whole class. You might like to do this by using subheadings such as:

- it is cruel.
- there are alternatives.
- nothing has or ever will be learnt.
- it is a waste of animal life, money, time and other resources.

You will need to be prepared to handle arguments from the opposing sides.

Also contained in the folder are the arguments from the opposing side -

The Animals in Medicine Research Information Centre - AMRIC

Sugar paper and pens have been provided to help you gather your ideas together and to use in your presentation.

Group 2: Alternatives to Animal Experiments

This folder contains information from two groups concerned with alternatives to animal testing. These are:

Fund for the Replacement of Animals in Medical Experiments - known as FRAME and **Animal Aid known as AA.**

Both groups are currently seeking waysto find realistic alternatives to the use of animals for experimental purposes.

It is the task of your group to present a coherent, logical argument on the stance of the FRAME and AA using the booklet and leaflets, as to why efforts need to be made into developing non-animal methods for testing chemicals and products and into trying to reduce the number of laboratory animals wherever possible. These groups are of the opinion that many experiments are conducted on animals unnecessarily and, although some animal experiments may still have to be carried out for a while, they are trying to develop alternatives methods that can be used instead.

It is important that you not only provide the ethical/emotive side but also the **biological aspects** of their position eg. the use of animals and testing is being questioned by member of the public.

You will be given time to prepare your arguments and then the group will be asked to present its work, thoughts and ideas to the whole class. You might like to do this by using subheadings such as:

- there are viable and realistic alternatives available.
- the number of animals can be reduced without compromising medical advances.

You will need to be prepared to handle arguments from the opposition.

Also contained in the folder are the arguments from the opposing side -

. The Animals in Medicine Research Information Centre - AMRIC
. British Union for the Abolition of Vivisection - BUAV and
. Royal Society for the Prevention of Cruelty to Animals - RSPCA

Sugar paper and pens have been provided to help you gather your ideas together and to use in your presentation.

Group 3: The Use of Animal in Experiments

This folder contains information from two groups concerned with the positive contribution the use of animal experiments have had in medical and veterinarian research. These are:

Animals in Medicines Research Information Centre - AMRIC
Biomedical Research Education Trust - BRET

Both groups are currently campaigning to continue with the use of animal experimentation on the grounds of basic research and medical benefits.

It is the task of your group to present a coherent, logical argument on the stance of the AMRIC and BRET using the booklet and leaflets, as to why animals should not be used for scientific experiments. It is important that you not only provide the ethical/emotive side but also the **biological aspects** of their position eg. without this research we would not have made many important discoveries in medicine.

You will be given time to prepare your arguments and then the group will be asked to present its work/thoughts and ideas to the whole class. You might like to do this by using subheadings such as:

- human biology is very much like that of other mammals.
- there are often no accurate and legitimate alternatives especially where the use of humans is too dangerous.
- future medical progress should never be put in jeopardy.

Your will need to be prepared to handle arguments from the opposing sides.

Also contained in the folder are the arguments from the opposing side -

Royal Society for the Prevention of Cruelty to Animals - RSPCA
British Union for the Abolition of Vivisection - BUAV

Sugar paper and pens have been provided to help you gather your ideas together and to use in your presentation.

APPENDIX G

Other Items: Letters of Thanks to Participants

University of Oxford

Department of Educational Studies
15 Norham Gardens, Oxford OX2 6PY

Director: Professor Richard A. Pring, M.A., Ph.D.
Tel: (01865) 274024 Fax: (01865) 274027

29th May 1996

Mr/Ms A-Level Biology Teacher
Comprehensive School
16 Norham Gardens
Oxford OX2 6PY

Dear Biology Teacher,

Hope this letter finds you well and at least a little relaxed after the half term holiday. When I last visited you I sought your reactions to a series of statements which I thought summarised your views about A-Level Biology teaching and controversial issues teaching at the time of your involvement in the study. I also said that a copy of what I proposed to submit into my thesis would be forwarded to you as a matter of courtesy and validation. Hence the enclosed account to date.

As part of this validation process of all educational research, it is often advisable that the researcher seek critical comments from participants about the researcher's reporting and interpretation of the data. It would be much appreciated if you could assist me yet again by reading through your account and forwarding me your critical comments and clarifications. Additional comments on the selected interview segments would also be helpful. What I am reporting about your teaching of A-Level Biology may not necessarily be as accurate as you might like, so your comments and reflections would be helpful. Your comments will then be incorporated into the final draft. However, I will still have to make other changes, such as referencing, which will not alter the meaning of your account.

I shall telephone you at school towards the end of the week to ask if the account has arrived and to enquire if written correspondence or an interview concerning your account would be more appropriate. I shall be returning to Australia on 26 June. Many thanks for your professional contribution to my doctorate. I have many happy memories of my days spent gathering data and other materials at the schools involved in my research. This is something that I will be able to share with biology teachers in Sydney on my return.

Yours sincerely

Wilhelmina Van Rooy

30 March 1995

Dear Mr.

I am writing to you to express mv sincere thanks for allowing me to work with two members of your biology staff, I over the last few months. I am most grateful for the support they and yourself have given me in order that I might successfully collect data for my doctoral studies on the teaching of controversial issues in A-Level Biology.

Having been a biology teacher back in Australia, I appreciated the time, effort and openness that both so willingly gave me particularly during the school's examination and marking times. I am currently in the process of transcribing all the audio tapes that were made both as interviews and in the controversial issues lessons. They both know that they have access to these transcripts if they so desire.

I have left in your department all the curriculum materials - booklets, worksheets, videos etc, that were collected for the teaching of Diabetes and Animal Experimentation. I particularly enjoyed talking to and observing your A-Level Biologists at work and so have many positive and happy memories to share with my colleages in the Teacher Education Program at Macquarie University, Sydney.

Finally could I add that the reason I have not further interviewed you or taken up your offer to work with you on a controversial issues is that I am presently working on my doctoral transfer paper and viva for May. If the examiners feel that I need to have data on a fifth teacher I will contact you to discuss the practical possibilities.

Thank you again for your support.

Yours sincerely,

Wilhelmina Van Rooy

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Wilhelmina Van Rooy
20th August 1999.

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