

**Science And Mathematics Education Centre**

**Bioethics education in the science curriculum: evaluation of  
strategies for effective and meaningful implementation**

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## **ABSTRACT**

Although science is viewed by some as objective, analytical and unaffected by morals and values, the practice of science does raise many ethical issues. From an ethical standpoint, science teachers have an obligation to ensure that their students develop the skills to enable them to evaluate and make decisions about ethical issues associated with scientific advances so that they can make informed choices as adults. An appropriate forum for such a pedagogical concern is the subject of bioethics education.

The purpose of this doctoral study was to investigate the teaching of bioethics in science. Specifically, the study attempted to evaluate the effectiveness of a range of innovative pedagogical strategies utilised by teachers who were incorporating bioethics education into their secondary science curricula. Bioethics education is concerned with enabling students, firstly, to appreciate the range of ethical issues associated with the life sciences and, secondly, to develop decision making skills based on ethical theories.

Using an interpretive case study approach underpinned by a constructivist theoretical framework, I examined the teaching practice of three science teachers in different school systems. Each of these teachers taught Year 10 or Year 11 science courses that included a bioethics component. The research process was informed by an ethic of care and the constructivist criteria of credibility, transferability and ontological authenticity.

As a result of the early data generated, I adopted the role of a bricoleur and used alternative research methods to pursue emergent research questions. I developed a survey consisting of four bioethical dilemmas. Bioethics students were asked to resolve each of the dilemmas and provide reasons to support their decisions. Using an ex post facto research design, I compared students who had studied bioethics with a comparison group of students who had not. I also wrote narrative tales in an endeavour to provide an authentic account of the learning of individual students. Commentaries on the tales, by students and teachers, helped to enrich my understanding of students' learning experiences in the bioethics classes.

The research findings are presented as 'inferences', a term which acknowledges the context dependent nature of the data generated. Five themes emerged from the data analysis which, together, indicate (1) the nature of potentially successful teaching strategies for bioethics education and (2) obstacles to students' successful engagement in learning bioethics: teacher attributes; design of bioethics courses; student attributes;

impact on student learning; and physical and social constraints. Another key finding concerns the difficulty facing researchers who wish to 'measure' the impact of bioethics teaching on student learning.

All three teachers displayed potentially successful teaching strategies. They were committed to the inclusion of bioethics education in their science courses. They had clearly articulated pedagogical goals related to bioethics education. They endeavoured to create safe learning environments in which students could clarify and explore their developing ethical values. When students expressed extreme views, the teachers, through careful questioning, challenged them to consider alternative ethical positions.

In relation to the design of bioethics education courses, most of the learning activities in which students participated were based on small group and whole-class discussion (e.g., role plays, oral presentations). These activities provided opportunities for students to examine a topic in depth. Importantly, students were provided with information to help them understand the scientific content area before they could appreciate the associated ethical issues.

In the three cases, it appears that bioethics education had a variable effect on student learning. Attributes were identified that may have influenced student engagement in opportunities to learn bioethics: the students' moral maturity, academic ability, attitude to learning, beliefs about science and ethics, family and religious background.

Evidence suggests that exposure to bioethics education can affect favourably students' attitudes to science. However, the results of the bioethical dilemma survey suggest that, on average, there was no difference in the way that students resolved dilemmas, regardless of whether or not they had been exposed to bioethics education. Although there was considerable variation amongst students, most of the students' responses differed from those of experts in that the students tended to focus solely on the rights of individuals, without considering the long term consequences of their decisions.

Constraints were identified that may adversely affect the impact of bioethics education in science: scarcity of resources, including insufficient teaching time; and, amongst science teachers, lack of expertise in the content areas that raise bioethical issues and lack of experience in the types of learning activities appropriate for bioethics education.

The findings of this research study are significant as they highlight important issues that may need to be considered by curriculum planners and science teachers who wish to incorporate bioethics education into science curricula.

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## **CHAPTER ONE**

### **INTRODUCTION TO THE RESEARCH STUDY**

*What is truth? said jesting Pilate. And would not stay for an answer.*

Francis Bacon, Viscount of St. Albans (1561-1626)

#### **PURPOSE OF THE CHAPTER**

This chapter comprises two parts; an outline of the thesis, and a personal account of events that shaped my values about science and ethics. The outline of the thesis focuses on four key areas; my pedagogical framework; an introduction to the research participants; the rationale of the initial and emergent research questions; and research methodologies and standards. The second part is a reflective account of past experiences which have instilled in me a fundamental belief that all students, regardless of their future career choices, need to have some understanding of the bioethical dilemmas which they as individuals and as members of a community may face. I conclude the chapter with a description of a Year 10 bioethics course that I taught and evaluated as part of a Master's degree. This research experience was crucial in shaping the pedagogical framework with which I began the thesis.

#### **OUTLINE OF THESIS**

##### **Pedagogical Framework**

As this century draws to a close, our students face a rapidly changing and uncertain future. An explosion of advances in science has occurred, often with scant regard for the political, moral and social implications. In particular, within the field of biotechnology, there has been an exponential increase in knowledge and practical applications (e.g., the Human Genome project). As a result, our society needs to be able to evaluate rapidly the potential benefits and risks of scientific and biotechnological advances. Thus, it is my belief that all students need to be informed, not only about the practical applications of science, but they need to appreciate the social and bioethical implications so that they can become informed decision makers in the future. Teachers of science can assist their students by explicitly introducing bioethics education into their teaching programmes.

I came to this study as a biological science teacher with an employment background in medical research (described in detail later this chapter). My previous experience as a medical researcher and more recently as a teacher had led me to believe that science teachers can play an important role in equipping their students with the skills to make appropriate well-considered decisions about bioethical issues.

I believe that many people today have no foundation upon which to make ethical decisions. This is not to say that they are unethical. Rather, they do not have the skills to evaluate issues. Thus, they either avoid making a decision or else default to a shallow/defensive position based on emotions like anger (e.g., bring back capital punishment and public floggings), fear and ignorance (e.g., ban all genetic engineering) or revenge (e.g., an eye for an eye). I would like my children and others to have the opportunity to reflect on ethical dilemmas in a safe and positive environment where they can be guided, not about what to think, but about what questions to ask and how to identify and weigh up alternative solutions.

My views about how to teach bioethics education are elaborated on later in this chapter. These views were influenced by the topic I investigated as part of my Master's degree. In 1994, I completed a Master's project titled 'The development and implementation of a Year 10 bioethics unit based on a constructivist epistemology' (Dawson, 1994). The bioethics unit was developed, taught and evaluated by myself. The research methodology employed in this study was based on an interpretive case study approach (Merriam, 1988) where I adopted the role of a teacher-researcher engaged in action research (Kemmis & McTaggart, 1988).

One of the main findings of this study was that the teaching strategies that seemed to be most effective in enabling students to clarify, reflect critically on and modify their bioethical values were those that were student-centred and underpinned by a constructivist epistemology. These teaching strategies (e.g., role plays and oral presentations) provided students with opportunities to discuss, question and justify their own values and also listen to the views of others. The students were actively engaged in constructing their own understandings. However, the use of a student-centred teaching strategy does not guarantee success. The style of the teacher, the nature of the students and the dynamics of the classroom environment will ultimately determine the learning outcomes of a strategy.

In adopting a constructivist approach I concluded that, as a teacher, I needed to play a multiplicity of roles including that of a provider of information, a facilitator of student-led debate, and a non-critical supporter of students as they attempted to develop their



own understandings. Furthermore, I needed to establish a safe and caring environment where students could interact and express their views.

Since 1994, my views about how bioethics education should be taught were reinforced by my reading of the literature, conference presentations and continued action research in my science classroom. I endeavoured to create opportunities to encourage other science teachers to introduce bioethics to their students. For the past three years I have voluntarily lectured to pre-service science teachers at three of the four universities in Perth. I also presented “how to teach bioethics” sessions at conferences for science teachers, published journal articles and lobbied my teaching colleagues. These experiences helped to mould the pedagogical framework that I brought to the study.

In choosing bioethics education as the focus of this thesis, I hoped that I could contribute to the body of literature about bioethics education. I was aware that the focus of the literature was on the rationale and goals of bioethics education (see Chapter Two). There was (and is) a paucity of evaluative studies, especially at the classroom or individual student level. Thus, the initial purpose of this study was to examine and evaluate the effectiveness of a range of learning activities utilised by secondary science teachers who included bioethics education in their teaching programmes.

### **The Case Study Teachers**

Before I outline the initial research questions and research methodology I wish to introduce briefly the three science teachers (Catherine, Mark and Helen) who participated in this research study. All of the teachers have agreed to have their first names used, but I have not identified their schools nor revealed the identity of any of their students. The students, who made a significant contribution to the research findings, are introduced in subsequent chapters.

#### ***Catherine - Chapters Four to Seven***

Catherine teaches at an independent girls' school. She completed an initial degree in Microbiology and then worked in a Virology laboratory for seven years until she had children. She spent ten years at home with her children before choosing teaching as a career. Catherine is currently in her second year of teaching science. She is teaching, for the first time, a Year 10 Biotechnology course based on human organ and tissue transplantation. Topics covered include brain death, xenografts, types of organs and tissues transplanted and an understanding of disorders treated by transplantation. A

consideration of bioethical issues associated with transplantation is integrated throughout the course. The time allocation is 24 x 55 minute periods spread over six weeks. The two pedagogical goals that are most important to Catherine are that students become aware of and critically evaluate bioethical issues in science and, secondly, that students develop a more positive attitude to science.

### ***Mark - Chapter Eight***

Mark teaches biological science at an independent boys' school. Mark had always been interested in biology and it was his favourite subject at high school. He initially enrolled in biomedical science and although he was enthusiastic about the content of the course, his future job prospects were uncertain. Thus, at the end of his first year he transferred to a Bachelor of Education course majoring in biological science. He initially taught in the state school system for five and a half years before obtaining a job at his present school in 1990. Mark teaches a compulsory Year 10 Biotechnology course comprising 40 x 60 minute periods spread over 10 weeks. The course has been taught at the school since 1990. The Biotechnology course includes three sections: 'Enzymes in Industry', 'Plant Tissue Culture' and 'Recombinant DNA'. The recombinant DNA technology section is designed to expose students to the theory, practice and ethical ramifications of genetic engineering and cloning. Mark's main goals in teaching the recombinant DNA section of the course are to increase students' awareness of ethical issues in science and also to increase the students' knowledge of the terminology and procedures used in DNA technology.

### ***Helen - Chapter Nine***

Helen is an experienced biological science teacher at a Catholic girls' school. Helen initially completed a degree in botany, and before becoming a teacher, worked in the field of plant genetics and tissue culture. She teaches a reproductive technology topic comprising 48 x 45 minute periods spread over eight weeks in a Year 11 Senior Science course. Senior science is an alternative science course for students who do not intend to go to university. In this course students are introduced to genetic diseases, aspects of reproductive technology (e.g., *in vitro* fertilisation, abortion and gamete intra fallopian transfer) and ethical issues raised by the use of this technology. Helen's teaching goals related to bioethics education are to increase her students' awareness of ethical issues associated with reproductive technology, to help them to appreciate the importance of the issues to themselves and society and also to understand that the issues are complex and not easily resolved. She believes that

moral and social issues can not be avoided when teaching about reproductive technology.

## **Rationale of Initial Research Questions**

My pedagogical framework informed the nature of the three initial research questions. These research questions were addressed within an interpretive case study framework underpinned by a constructivist theoretical framework (see Chapter Three).

### ***Initial Research Question 1***

What learning activities are utilised by secondary science teachers who are incorporating bioethics education into their teaching programmes?

I was aware that not all teachers would teach the same way as myself. The method of addressing this research question would, I anticipated, be largely descriptive, based on ethnographic participant observation (Denzin & Lincoln, 1994) and add to the current literature on bioethics education (reviewed in Chapter Two). I hoped to observe a range of learning activities that teachers perceived to be valuable. In this study, I have defined a learning activity as any form of teacher planned interaction that occurs with students in the class room. Examples of learning activities could include oral presentations, portfolios, role plays, debates, library research and guest speakers. The implementation of the learning activities depends on the pedagogical strategies (methods) selected by the teachers which could include group work, whole class discussions, cooperative learning and student centred learning.

### ***Initial Research Question 2***

How effective are these learning activities in enabling students to reflect critically on, articulate and justify their bioethical values?

The skills specified in this question, vis a vis, “reflect critically”, “articulate” and “justify” were those that I considered desirable and achievable products of bioethics education. I attempted to address this question in the first case study (Catherine, see Chapter Five) through an interpretive case study framework. I elicited Catherine’s and the students’ perceptions of the learning activities via classroom observations, multiple interviews and open ended questionnaires. I define perceptions as an individual’s beliefs and judgements. The perceptions of Catherine and her students were overlaid by my interpretation which was influenced by both my pedagogical and constructivist theoretical frameworks (which were not static, but were modified as the research progressed).

### ***Initial Research Question 3***

To what extent did I establish a caring and communicative relationship with the research participants?

This initial research question relates to the ethics of the research process, an issue that I considered important enough to justify a separate question. The perspectives of the teachers and the students were crucial in data generation and interpretation. By establishing a trusting relationship and encouraging open communication, I believe that I was better able to understand the research participants' perspectives. This process helped to prevent my pedagogical framework from dominating and subsuming the participants' perspectives. In addition to the quality of data generated, I felt that I had a moral responsibility to create a meaningful, trusting and mutually rewarding relationship. The manner in which I addressed this research question is described in Chapter Four. In my relationships, I was mindful of the standards that I used to judge the quality of the research process (see Chapter Three).

### **Standards to Judge the Quality of the Research Process**

During the early stages of the study, I reflected on the standards by which the quality of the research process could be judged. I wanted the research findings to be co-constructed by the participants and myself through a *hermeneutic/dialectical* process. The act of interpretation would involve the participants and me together making sense of the research environment. The standards that I adopted included Guba and Lincoln's (1989) trustworthiness criteria of credibility (i.e., extent to which the participants' realities were faithfully portrayed), and transferability (i.e., extent to which findings may be seen to be applicable in other situations), and the authenticity criterion of ontological authenticity (i.e., extent to which the participants' understanding of their classroom environment was enhanced) (see Chapter Three).

I also adopted an ethic of care in my relationships with the teachers and students (Noddings, 1984). I interacted in a relational connected knower way where I was receptive and responsive to the views of the teachers and students (Belenky, Clinchy, Goldberger & Tarule, 1986). Connected knowers endeavour to understand other people's knowledge through empathy. Empathy is about reception, not projection (of my belief systems). Thus, I attempted to understand the participants' points of view by listening to and valuing their views. A connected knower stance enhanced the construction of a shared understanding.

A caring, connected knower approach and the constructivist standards described above were intended to ensure that the research participants and myself had the opportunity to engage in the negotiation of a shared understanding of the research environment. However, I found that in applying the standards there was a dialectical tension between them. For example, my intention to care for and respect the participants conflicted with the standards of credibility and transferability.

Because of this tension and other feasibility constraints associated with the case studies, the degree to which the standards were addressed varied for each of the case studies. The way in which I applied and balanced the standards with Catherine and her students (the most extensive case study) is the focus of Chapter Four.

## **Research Methodology**

### ***Data Generation and Interpretation***

During this research study, I gradually became aware that I was not solely a researcher collecting data to analyse for an external audience. Rather, I adopted the role of 'researcher as learner' where I actively aimed to generate data that would enrich my own understanding of the research environment.

In addressing the initial research questions, data generation methods were compatible with an interpretive case study approach underpinned by a constructivist perspective. Data generation methods included participant observation, multiple interviews, open ended questionnaires, work samples and reflective journal writing (see Chapter Three). These methods enhanced my understanding of the multiple perspectives of the research participants. Data generation and interpretation occurred in a cyclical fashion. Interpretation was informed by grounded theory methods (Glaser & Strauss, 1967; Strauss & Corbin, 1990) as I identified categories and themes within the data.

The process of data generation and interpretation was underpinned by several factors. The incidents and dialogue that I recorded during classroom observations, and the questions I asked during interviews and in questionnaires were filtered through my pedagogical framework, and my *tacit knowledge* (Polanyi, 1969) about how to carry out educational research. They affected the choice of issues that I deemed important enough to pursue and ultimately the choice of data that are presented in this thesis.

## ***Style of Representation***

The style of representation varies throughout the thesis. On occasion, I adopted a narrative style. For example, I used a narrative style when writing about my personal values (later this chapter), when reflecting on the problems with the initial research questions (Chapter Six) and with the use of narrative tales to address emergent research questions (Chapter Seven). A narrative style seemed to me to be the most authentic way of representing these parts of the research process. At other times, I adopted a propositional style; for example, in representing a review of bioethics education literature (Chapter Two); the research methods (Chapter Three); and the final summary of the research findings (Chapter Ten).

## **Emergent Research Design**

Part way through the first case study (Catherine), I began to become aware that research question two (regarding the effectiveness of learning activities) was problematic. I realised that I could not ‘prove’ or ‘measure’ effectiveness. Also, the word ‘effectiveness’ did not fit with my developing constructivist theoretical framework. It implied the existence of a clearly defined boundary between effective and ineffective by which I could weigh up the actions of the teachers. Furthermore, the data generated from Catherine’s case raised issues that I had not anticipated. This led to the development of emergent research questions. I realised that to pursue some of these questions, I would need to modify my research methodology.

## ***Multiple Research Methods***

Still working within a qualitative research paradigm, I employed multiple research methods. In doing so, I adopted the role of a bricoleur (Denzin & Lincoln, 1998, p. 3; see Chapter Three). The alternative research methods I utilised were an ex post facto research design (Crowl, 1996) and a narrative inquiry with fictional stories (Taylor & Geelan, 1998; Van Maanan, 1988). The use of multiple methods was not predicted in advance but emerged as I pondered the most appropriate way to answer the emergent research questions. The flexibility to use different research methods meant that I was not constrained by the types of questions that I asked.

## **Rationale of Emergent Research Questions**

The background of the emergent research questions, listed below, are explained in detail in subsequent chapters.

## ***Resolving Bioethical Issues***

As described above, I realised that I was unable to answer the second initial research question in a satisfactory way. Certainly, Catherine and her students were positive about their experience in the Biotechnology course and the students believed that their understanding of bioethical issues had improved. I was not completely convinced though. I wanted more than their (and my) perceptions. In searching for more conclusive evidence, in a somewhat (I realise now) positivist way, I constructed two emergent research questions that might allow me to determine if Catherine's teaching of bioethics education was 'effective' (see Chapter Six).

### ***Emergent Research Question 1***

Can students be taught to resolve bioethical dilemmas?

I addressed this question by developing a survey containing four bioethical dilemmas. Students were asked to respond to a question about how they would resolve each of the dilemmas and then outline reasons for their responses. Using an ex post facto research method, the survey was completed by the students in Catherine's class and also a comparison group of students who had not studied the course. The responses and the number and types of reasons of each group were compared.

### ***Emergent Research Question 2***

In relation to resolving bioethical dilemmas, how do students differ from experts?

The bioethical dilemma survey was also completed by three experts; a philosopher, a medical ethicist and a medical scientist. The types of responses and reasons provided by the students were compared to the experts. I used Beauchamp and Childress's (1994) four bioethical principles as a framework to evaluate the results.

## ***Exploring the Data***

After addressing the two questions above I began to realise (with my supervisor, Peter's encouragement) that I was unnecessarily constrained by attempting to search for answers to the initial research questions. I needed to examine the data with an open inquiring mind and not be blinded by my a priori view of what bioethics education should achieve. Peter also suggested that rather than view the class as a whole I look for individual variation amongst students.

Therefore, I posed the following five emergent research questions which I address in Chapter Seven.

***Emergent Research Question 3***

What effect does the Biotechnology course have on student's attitude to science?

During our first interview, Catherine had told me that her teaching goal in the course was to improve her students' attitudes to science. Thus, I re-visited the data to determine whether the course had affected the students' views about science.

***Emergent Research Question 4***

Does the Biotechnology course influence the responses, number and types of reasons used by individual students to resolve bioethical dilemmas?

During 1997, I administered the bioethical dilemma survey to a group of students before and after studying the Biotechnology course. I used a paired t-test to determine whether there was any difference in the type of responses and number of reasons offered by individual students.

***Emergent Research Question 5***

What processes do students use to evaluate bioethical dilemmas?

To enhance my understanding of how individual students actually resolved bioethical issues and to determine whether they used a decision making process, I developed another bioethical dilemma (based on euthanasia) and asked students from Catherine's and Helen's cases to describe the process that they used to resolve the dilemma.

***Emergent Research Question 6***

In relation to resolving bioethical dilemmas, is there a range of decision making abilities amongst those students who studied the Biotechnology course?

I re-examined the data from the bioethical dilemma survey to search for differences in the quality of reasons offered by students to justify their responses. The preliminary evidence from this question led me to pursue the emergent issue of variable learning outcomes amongst students. This resulted in the following emergent research question.



***Emergent Research Question 7***

Why did the Biotechnology course enable *some* students to better evaluate bioethical dilemmas?

In order to determine whether there was a range of learning outcomes and why, I wrote two narrative tales based on my classroom observations with Catherine and her students. The tales were intended to represent a student (Holly) who achieved fully the learning outcomes and another (Leanne) who achieved the learning outcomes to a lesser degree. The tale of Holly was written entirely from students' interviews and questionnaire responses, while Leanne's tale was constructed from my observations and perceptions of students' experiences. Five students from Catherine's class, Catherine, and two other teachers at the school who did not teach science, wrote commentaries about the tales. They were asked to address questions about the nature of Holly's and Leanne's learning. The commentaries, especially those of the students, enriched my understanding of the learning outcomes in Catherine's case.

***Quality of Learning Opportunities***

The remaining two case studies of Mark and Helen were not as extensive as Catherine's. This was due to constraints associated with time and access to the research environment. Because of the difficulties I had encountered with initial research question two (see p. 8), with these two cases, the generation of data was guided by the following two emergent research questions.

***Emergent Research Question 8***

To what extent did the teachers achieve their teaching goals related to bioethics education?

***Emergent Research Question 9***

From the multiple perspectives of the students, the teacher and myself, what impact did the learning activities have on student learning?

These questions are addressed in Chapter Eight (Mark), and Chapter Nine (Helen). With these cases, the focus moved away from searching for the outcomes preferred by my a priori pedagogical framework, to an awareness of the extent to which the teachers achieved their vision of bioethics education.

In this introduction to the thesis I have, I hope, provided the reader with an overview of the significant twists and turns of the doctoral study. All of the areas outlined above are elaborated in subsequent chapters.

## **MY INITIAL STANDPOINT**

### **Introduction**

My intention in writing this section is two fold. Firstly, I want to present an image of who I am so that you, the reader, can begin to understand why this research study is important to me. Secondly, I wish to explore and make explicit my own values and beliefs about science, bioethics and research. It would be naive to believe that I was objective or neutral in this research study in relation to my own values and beliefs. I believe that it has been helpful for me to reflect on some of the value-laden assumptions that may have influenced my research decisions. They influenced not only my choice of this research topic and the initial research questions but also the type of data generated, its interpretation and the way that I interacted with the research participants.

When reflecting on how best to write this section I almost decided that the easiest option would be to omit it. There were several problems. The first was one of delineation. Where do I start and end (chronologically) and what do I include (breadth and depth)? If I wanted to record all of the events that shaped my values and beliefs I would need to begin in early childhood and an entire novel might result. Thus, I have chosen to focus on several events that I believe influenced significantly my decision to pursue this thesis topic. Another concern that I have about writing this section is that I don't believe that I can be completely honest and authentic. I am obviously going to be selective about what I write. I am hardly going to write about incidents that I am ashamed of and there are a few of those. There are also some events that, while significant, are too private to recount here. Thus, this is a partially censored version of my history. Nonetheless, I feel that this section forms an essential component of this thesis.

I find also that I am unable to trace my values and beliefs to their source. I can not state that a certain event had a specific outcome or effect. Thus, I have chosen to illustrate aspects of my life that, at this time, I believe, contributed to my values and beliefs about science, ethics and research. In addition to the biographical information below, I have included two stories that were written after troubling events in my life as

a teacher. That I found the issues in these stories compelling enough to write about is also an indication of my values and beliefs.

## **My Science Education**

My earliest awareness that science existed as a subject was in Year 7, my first year as both a high school student and a boarder, when my science teacher wrote on my school report that “Vaille should do well in science”. Occupied with the turmoil of adolescence, my only memory of science that year is a problem which still exists in some science text books. It relates to heat transfer. The problem is that you have just made a cup of tea and added the hot water. The telephone rings. You want your tea to stay hot. Should you add milk? Which will cool faster? The hot tea or the milky tea? I recall answering that I would leave the tea without the milk and then add less milk at the end of the phone call. The teacher said my answer was wrong. According to her, and the text book, you would add milk as this would result in less heat loss.

My only recollection of science in the next three years was entering and gaining a prize in a Science Talent Search for a project on the existence of unidentified flying objects (UFOs). At the time I was an avid reader of science fiction and watched Dr Who, Lost in Space and Star Trek on television. I fervently believed in the existence of extra-terrestrial life. Despite my beliefs, the science project focussed on the falsification of UFO evidence, especially photographs. I postulated terrestrial explanations for reported sightings and demonstrated methods of tampering with photographs. I now have an open mind on their existence.

In Year 11, I studied Chemistry, Physics and Biology in Queensland. I recall a biology excursion to Magnetic Island, squishing through mangrove swamps, but little else. I was a difficult student, cheeky and disruptive according to my school reports. During Year 11, I spent a great deal of lesson time standing outside the classroom. Fortunately, with the aid of good text books, I kept up and obtained good grades.

My final year of secondary school was completed at Leederville Technical College in Perth, Western Australia. At 17, I was intent on having a good time and I regularly skipped classes. George was my Chemistry teacher. He was probably about 40 then, with thinning hair that he carefully combed over his balding patch. He was very keen for me to succeed in Chemistry, a subject which I enjoyed and found quite easy. Aware of my frequent absences he organised for me and several other capable students to attend extra classes after school. He contacted my parents and asked their permission without mentioning why I needed the extra catch up classes. He is the

only teacher whose name I can recall after 12 years of primary and secondary education.

During Year 12, I attended a hospital open day and after touring the laboratories, I decided I wanted to pursue a career in biomedical science. Thus, I completed a degree in applied science. A good memory and assessment by examination in my undergraduate courses meant that I was again able to rely on a good text book. If I had been asked what science was at that stage (which I never was) I would have equated it with knowledge. Thus, my science education at the secondary and tertiary level inculcated a strong notion of the power of science with no consideration of ethical dilemmas.

### **Working in Medical Research**

After graduating, I worked in medical research in the fields of Haematology and Immunology. At one stage, I worked in a children's hospital where I investigated bone marrow transplantation in children with leukaemia (i.e., a cancer of white blood cells). If conventional chemotherapy failed and the child had a compatible sibling (i.e., a similar tissue type), then a bone marrow transplant was performed. It was not always successful due to infection and/or rejection of the transplanted bone marrow. At this hospital, I had far more interaction with patients and their families than in previous research positions. At times this was very stressful. All of the patients that were considered for bone marrow transplantation had not responded to conventional chemotherapy. Most of the patients were young (less than four years old) and had very aggressive forms of leukaemia.

At this stage in my life, I believed that science was objective, analytical and value free. I equated the practice of science with the pursuit of knowledge and truth. I considered objectivity to be an admirable trait in a scientist. I believed that in conducting medical research, one must not become emotionally involved, especially when dealing with patients. Although I acknowledged that some individuals may use scientific knowledge for unscrupulous purposes, I believed that science was inherently good. I felt that with sufficient funding, scientific knowledge could solve all of the world's problems. My work mates, with whom I spent much of my free time, reinforced these beliefs. On reflection I realise that science became like a religion for me. It created certainty and stability in my life.

I had no compunction about any of the duties I carried out and never questioned whether they were right or wrong. For example, in one research position I was

producing antibodies against human leukaemic cells in mice. It was difficult to get large quantities of blood from mice. A colleague taught me how to use a glass capillary tube to pierce the tissue behind the eye and bleed from this site. This procedure could only be done once in each eye and the mouse was left blind. I also injected large numbers (hundreds) of mice intra-peritoneally with leukaemic cells and an adjuvant to enhance the immune response. The mice developed an ascites tumour in the peritoneum from which large quantities of antibody rich fluid could be extracted. I held the mice so that their distended abdomens protruded and using a large bore needle removed as much fluid as possible. If I was fortunate I could repeat the process three to four times before the animal died. Often, knowing that a mouse was close to death I would squeeze their bodies as one would wring a sponge to extract the last few micro litres of fluid. I do not recall ever questioning my actions by wondering about whether the animals suffered or whether the research was of any value.

I worked in medical research for eight years. During this time, I did not have a permanent job. Each November there was a great deal of stress as our department waited on news that research grants had been funded for a further 12 months. For females, combining a career in medical research with a family was very difficult. A career path after completion of a PhD comprised reading, publishing and travelling on the conference circuit hoping to obtain a post-doctoral position in a reputable research institution. Once established, one played the funding game, applying for grants for yourself and your staff. These prospects led to my decision to leave medical research and embark on a career in teaching.

### **Other Influences**

While at home, when my three children were young, I also dabbled in political activism, joining the Australian Labor Party, marching in environmental rallies, lobbying the government about child related issues and attending feminist workshops. I did not become fully involved with these groups mainly because of my work and family commitments. I did however, become involved with a very special group of women, the Nursing Mother's Association of Australia (NMAA), who comprise the largest women's group in Australia, after the Country Women's Association. I began to attend NMAA meetings after the birth of my first child, Sarah. The group offered mother to mother support and free counselling on a range of issues associated with breastfeeding and the care of young children. Two years later when my son Leon was born, I enrolled to train as a counsellor. After six months, I ran my own group and did after hours volunteer telephone counselling.

The act of counselling troubled mothers taught me to be empathic and accepting of others. The emphasis was on listening and helping the mother decide what was best for her and her baby, not telling her what to do. I believe that my involvement with NMAA sowed the seeds of a commitment to equality, caring and empathy. When attending meetings and workshops with other counsellors I was frequently overwhelmed by the kindness and compassion so freely given by many of these women.

### **Post-Graduate Education**

When I had completed my first year of teaching science part-time, I began a Master of Science degree at Curtin University. As a working mother of three young children aged seven, five and two, my main reasons for studying were intellectual stimulation and a desire to become a more effective teacher. I felt that the twelve-month Postgraduate Diploma in Education course that I had completed two years previously had not fully prepared me for the multitude of responsibilities that I faced in my classroom. The Diploma seemed to be a crash course in teaching where only the most basic skills were taught. There were few opportunities to explore anything but the most traditional forms of teaching practice.

My previous experience as a learner was such that I expected that the lecturers would provide me with facts, instructions and sure-fire teaching methods. I believed that I could become a more effective teacher when armed with these procedures. The first unit I studied introduced Jurgan Habermas's *technical*, *practical* and *emancipatory* interests and their effect on school curriculum (Grundy, 1987). I came to understand that my own curricular decisions were overwhelmingly influenced by a technical interest. I believed that my role as a teacher was solely to convey factual information to my students.

In 1993, I enrolled in a unit called *Theories of Teaching and Learning* taught by my future supervisor, Peter Taylor. I had looked forward to studying this unit as the title suggested that I would finally find out how to teach in an exemplary manner. During the unit, we were required to reflect on our teaching practice. I found this concept unusual and challenging. I recall feeling unsure and tentative about what was expected of me.

Peter introduced the notion of constructivism, a term I had never heard previously. On completion of this unit, I arrived at some understanding of what constructivism was

through papers by Bodner (1986), Driver (1990) and von Glasersfeld (1989). I began to realise that knowledge did not exist as a set of facts 'out there' waiting to be discovered by scientists or learnt by students. A sentence from Bodner's paper (1986) reverberated through my mind. "Knowledge is constructed in the mind of the learner." I honed my debating skills introducing the idea of constructivism to my friends in medical research. As I bore the brunt of their anger at my suggestion that science did not represent the universal truth, I realised how markedly my views had changed.

I thought frequently about a constructivist style of teaching and experimented with small innovations in my classroom, encouraged by their success. Given Peter's interest in constructivism and his role as course coordinator, I asked him if he would be my supervisor for the research project component of the Master's degree. He agreed and I began the project in 1994. The project topic was to implement and evaluate a Biotechnology course from a constructivist perspective.

Perhaps, it was a combination of being at home with three small children, or age, or whatever, but Peter had an unparalleled influence on my thinking. He pushed me out of my comfort zone and made me stay there. I thrashed around the notion of constructivism, a concept I had initially baulked at after an education in scientific certainty. In return, I forced Peter to justify and act on his beliefs about constructivism. This process led him to reflect on his own supervisory practice. Our experiences resulted in several papers based on the nature of our student-supervisor relationship (Dawson, 1996a; Taylor & Dawson, 1998).

### **My Experience Teaching Bioethics Education**

During 1992, the year I commenced my Master's degree, I taught science at an independent girls' school. That year a pamphlet was sent to the school advertising a new teaching package called *Transplantation: The Issues* (1992) which was developed and published jointly by the Australian Kidney Foundation and the Science Teachers Association of Victoria. The package, containing a video, teaching program, lesson plans and work sheets was based on human organ and tissue transplantation. There was also a comprehensive section on bioethical issues associated with transplantation. One of the science teachers approached the Head of Science about incorporating some of the transplantation activities into Year 11 Human Biology.

After some consideration, the Head of Science decided that a new course (called Transplantation Technology) would be developed based on the teaching package. When I heard that this course was a possibility I approached the Head of Science and

expressed an interest in teaching it the following year. I was excited about the prospect of developing a course relatively free of constraints and in a format that I thought to be appropriate. Because of my previous employment in medical research in the field of bone marrow transplantation, I had a reasonably good understanding of the theory and practice of organ and tissue transplantation.

In addition, although I had been teaching for a short period of time (less than two years), I had a growing number of concerns related to students' perceptions of the nature of science. I observed that many students who entered Year 8 and who were enthusiastic about science rapidly became disillusioned despite the best efforts of their teachers. They chose to discontinue with science as soon as they were able to, dismissing the subject as boring, irrelevant or too difficult. The Transplantation Technology course was not subject to formal school assessment. I believed that a science course without formal content based assessment might allow students who had previously failed science to experience a feeling of success. I felt that I would be able to adapt the course to suit the range of interests and ability levels of the students.

Also, my perception from teaching science was that some students considered science to be merely a series of facts and short experiments that fitted neatly into a single lesson and that had little to do with their lives outside the science classroom. Some students seemed to believe that school science was not personally relevant. I hoped that a topic such as human organ and tissue transplantation, that affected the lives of a large number of Australians, would help to address this issue. The course would enable students to experience 'real life' science that affected the lives of individuals in our society.

The following year, 1993, I taught Transplantation Technology to all Year 10 students. One of my goals was to introduce students to the role of bioethics in science. The topic of human organ and tissue transplantation raised a number of bioethical issues and thus provided a rich source of dilemmas with which students could discuss, debate and reflect on their own bioethical values (Kries, 1992). I believed that my role was to help students become critically aware of bioethical issues on the basis of their own values and those generally accepted by our society.

During 1994, as part of my Master's degree, I implemented and evaluated the Transplantation Technology course (Dawson, 1994; 1996b). The course was designed to enable students to examine, in depth, ethical issues which arose in transplantation technology. These issues include: the rights of the donor versus the



recipient; the financial cost to the individual and the community; criteria to determine the priority of recipients; and the age of consent for organ donation.

While teaching this course, I adopted the role of a facilitator or guide. I endeavoured to create a learning environment where students felt free to express their views without fear of ridicule. The importance of students' prior knowledge and values was acknowledged by listening to and accepting students' views on transplantation. Students also had frequent opportunities to discuss, debate and reflect on their existing and developing understandings and values through discussion with myself and their peers. This cooperative learning environment provided frequent opportunities for students to clarify, question and modify their own belief systems.

One of the findings was that the most effective learning activities were those that were student-centred (e.g., role plays, debates, conflict maps, small group and whole class discussion); that is, activities that enabled students to be actively engaged and work cooperatively with their peers. These learning activities seemed to be effective as they provided students with opportunities to discuss, question and justify their own values and also listen to the views of others.

However, the use of a particular learning activity in the classroom did not guarantee its success. The results (from observations, questionnaires and student interviews) indicated that there was considerable variation in the degree to which students benefited from the learning activities. Most of the activities required students to speak to each other about their views. Quiet students did not participate in activities to the same extent as other more vocal students. They seemed unwilling to offer an opinion even when addressed directly. A second group of students who did not participate fully comprised those who, although vocal, tended to express their views in a negative or confrontational manner. They were also less likely to listen to and acknowledge the views of their peers (Dawson & Taylor, 1997; 1998).

The following year, I began teaching at another independent girls' school. One of the classes I taught was a low ability Year 10 science class. Based on their Year 9 science grades, the 20 students in this class had been separated from the remaining five Year 10 science classes. Even though it was my first year at the school, I was free to implement a curriculum that I considered to be appropriate for these students. I aimed to develop a science program that would be personally relevant, increase their scientific literacy and improve their attitudes to science but that would not disadvantage any student who elected to continue with biological science in Years 11 and 12. As part of the science program, I expanded the original 10-lesson Transplantation Technology

course into a 24 x 55-minute lesson course that included a range of assessment items such as a library portfolio, oral presentations, design and administration of a transplantation questionnaire, and a formal content-based test. In addition to the goals above, when teaching the course (which was renamed Biotechnology), I also aimed to increase students' awareness of bioethical issues associated with transplantation.

The appointment of an innovative Head of Science in 1995 resulted in substantial changes to the science curriculum, especially in Years 8-10. The curriculum was modified to provide a more inclusive, personally relevant and student-centred programme. Previously, there had been an emphasis on delivery of science content that was aimed primarily at those students who intended to enter university. During 1996, the Year 10 science curriculum at the school was changed to provide a choice of courses to cater for students' various interests and ability levels. The low ability class was removed and the Biotechnology course and a Forensic Science course were offered to all students. These two new courses were designed to provide alternative topics for those students who did not intend to study Physics and Chemistry in Years 11 and 12. In addition to the Biotechnology course and Forensic Science course, students were able to select from Ecology, Genetics, Chemistry, Physics and Physical Science. At the end of Year 9, students selected five of the above science topics. In 1996, 60 students selected the Biotechnology course.

The reason I have detailed the development of this course is that when I discontinued full-time employment and commenced my doctoral studies, Catherine was employed to replace me. Thus, during 1996, she taught the Biotechnology course and became a participant in this research study.

## **Two Tales**

This section (and chapter) concludes with two tales from my life as a teacher. I believe that the tales illustrate my ethical values. Each of the tales began as journal extracts following distressing events at school. In keeping a journal, I frequently wrote tales about my school life. Most of the tales were concerned with events that have affected me on an emotional level. Writing about these events was cathartic. When the words spilled on to the page, the issues could be better dealt with, or at least cast aside. The tales also helped me to reflect on my teaching practice. In the writing of these stories, I was asking myself: how can I be a better teacher/person?; what can I do differently next time? (I have changed some details in both tales to protect the identity of those involved.)

*To Care or Not to Care?*

I taught Shannon last year, when she was in Year 9. She was a sweet girl with an angelic face who responded with a smile and an 'I'm not sure' answer to most questions. As the year progressed I realised that she was absent for all assessment. She continually handed work in late. Part way through the year I asked her to stay behind after class.

'Is there a problem?' I asked. 'You can answer questions in class. Why do you avoid assessment? I'm sorry, but I'm going to have to call your parents.'

Shannon burst in to tears. She sobbed and sobbed. She begged me not to call her parents. She was sorry. She would do all her work from now on. She was just having a few problems and she could handle it.

I was taken aback by how upset she was. I sat her down and tried to call the school counsellor. She wasn't there. I asked Shannon if she would see the counsellor the following day.

Shannon saw the counsellor who subsequently referred her to a psychiatrist. She was diagnosed as a manic depressive. Shannon stayed away for 2 weeks. She wouldn't take her medication and her parents refused to believe there was a problem. When Shannon returned to school she looked like she had been crying for two weeks. The counsellor advised me not to force her to complete work. 'Don't pressure her', she said.

Anyway, back to the present. She is now taught by Gary. I heard him talking about Shannon to Sarah, the Head of our Department, saying she has missed all of her assessment this year and he was sick of her. He was really going to 'stomp on her'. Then he would send her to Sarah to 'straighten her out.' I interrupted their conversation, explained Shannon's background and suggested Gary talk to the counsellor.

'If she can't abide by the rules she shouldn't be here!' he replied.

I said, 'Why hassle her, she's not doing you any harm?'

'She has to learn.'

‘Would you rather she was in an institution?’ I queried.

Ignored, I continued.

‘The counsellor said to go easy on her, don’t pressure her.’

Gary replies. ‘That’s what the counsellor says about all the students. What a namby pamby approach.’

I was very annoyed. Even though she is no longer ‘my’ student I still felt a duty of care towards her. I walk to my Form room and pass the school counsellor’s office who is fortuitously there and not busy. I enter.

‘I probably shouldn’t say this...it’s about Shannon. Gary is going to heavy her.’

Oh’ says the counsellor, ‘I’ve already had students see me about her. She’s getting worse. Getting heavy with her won’t help.’

‘Will you speak to Gary?’

‘Yes, I’ll speak to him’.

I go downstairs to collect the daily newsletter from my pigeon hole. I see Gary enter the staff room and then the counsellor. I hurry, already late, to assembly.

Minutes later I sit in assembly feeling very queasy. What I have done is ethically questionable. I have gone behind Gary’s back to the counsellor. Shannon is his student now. Yes, I have a right to pass relevant information to him but it is up to his professional judgement what he does with it, Maybe he would have gone to the counsellor anyway. Maybe Sarah would have suggested it. I know that I would be absolutely furious if he interfered in a similar way with a student from one of my classes. However, I feel my duty of care outweighed my professional respectfulness regarding his right to exercise his professional judgement to deal with a student as he sees fit.

After several weeks I went back to this journal entry to reflect on my actions. I asked

myself questions. Were my actions ethical? Why did I behave that way? Was I being spiteful? altruistic? Is this story biased? Would I behave in a similar way if I had another chance?

From my perspective, Shannon is a child and I felt a need to protect her from the actions of my colleague. I behaved as I did 'because I care.' We all care about our students, but not everyone would have responded as I did. All my life I have been somewhat impulsive and spoken my mind. It is innate, part of my persona. If I perceive an unjust situation, I have to say something. I can't stop the words bubbling out of me.

On a professional level, I believe that I transgressed one of those unspoken rules of classroom teaching. Although it was never made explicit during my teacher training, or subsequently, there seems to be an unwritten law that teachers do not interfere with another teacher's students. There seems to be a sense of ownership of the students and interference is not permissible. Why is this, I wonder? Why do we close the doors of our classrooms?

Was I being altruistic? or spiteful? Even though I pose this question, I realise that our actions are not so simple and dichotomous. I would like to believe that there was an element of altruism, but perhaps, deeply submerged, there was also a shaft of spitefulness. Yes, there were some personality conflicts between Gary and myself. There were also disagreements about preferred teaching styles and issues related to gender roles. In a subsequent journal entry I wrote that "I despise his autocratic, sexist attitude to students, female staff and myself. He also ridicules my constructivist approach to teaching as an abdication of my teaching responsibilities. He frowns disapprovingly as he walks past my busy, noisy classroom, even closes the door sometimes".

### ***Playing God***

As I wait for my Year 10 science class to arrive, I mentally preview the lesson plan in front of me. We are halfway through a unit called Biotechnology, an innovative unit that in addition to helping students understand a complex scientific topic also raises a number of ethical dilemmas for which there are no right or wrong answers. Most of the students relish the opportunity to engage in rich discussion about ethical issues although some have reacted angrily to the change from their regular science classes.

The students file in and sit down. I recap on the previous lesson. Students had completed a conflict map designed to help them identify the rights, needs and duties of those involved in transplantation. I remind them of some of the conflicts that they identified. Does the donor family have a duty to comply with the wishes of the donor? Also, does the donor family have a right to refuse to donate their kin's organs when a recipient will die without a transplant?

'So, girls, you are aware that 1 in 3 recipients die before they can obtain a transplant. Given a limited number of donors how can we decide who should receive an organ?'

I pause. Caitlin and Sophie raise their hands. 'Caitlin.'

'Well, I think it should be compulsory to donate your organs when you die.'

'Caitlin, we discussed that last week and I think that most of us agreed that the donor and their family have a right to decide what happens. Sophie?'

'Why don't they have a ballot and if your name is picked you get the transplant.'

'Why, Sophie', I reply 'that's an interesting idea and in fact, that is how some states in America select their recipients. Can anyone see any advantages or disadvantages with that system?'

'What if the person was really sick and died after the transplant. Then the organ would be wasted.' says Caitlin.

'Or how about if the person was a criminal in jail.' says Emma.

'So what?' responds Sophie. 'He (sic) has just as much right as anyone else.'

'Okay,' I interrupt. 'If we have time we'll come back to this later. I would like you to make some choices about who receives a transplant. You will need to form groups of about three or four and select 4 patients from this list of 10 patients. All of these patients will die unless they receive a liver transplant in the next 12 months. Large hospitals in Australia often budget to

carry out a set number of transplants. This particular hospital will only carry out 4 transplants this year. You have about 20 minutes to select your patients. I suggest you read the list first and then as a group discuss your choices. There is some information available on the age, sex, occupation and family status of each patient. Any questions? Yes, Maree.'

'I don't think I can do this.' says Maree

'Why not? I query.

'Well, it's a bit like playing God, deciding who will live or die...' her voice trails off.

I walk over and sit down beside her. 'I know it's difficult to choose Maree, but it's only a role play. I can see that you appreciate how it feels. Just do your best. Read the list and discuss it with your friends.'

I return to Maree's group a few minutes later and listen as they discuss Patient A, a four year old Vietnamese orphan who will be adopted by an Australian couple if he has a successful transplant.

### ***Peer Discussion***

'I chose A because he's young and he's got his whole life ahead of him.' says Maree.

'But maybe his life won't be that good.' says Caitlin.

'Yes, but he's got a family that will adopt him.' says Maree.

'He's too young to know any better.' says Caitlin.

'But that's discriminating against him because of his age.' says Maree.

'No, but you don't know that she's doing that, Maree.' said Sophie. 'Patient A is quite a good one, actually, because, you know, he's young. And like he's coming to Australia so he can have a good life.'

‘And - yes’, says Maree, ‘you can just think of his family, who are waiting to adopt him. He can start a new life in Australia with all these opportunities.’

‘We don't really know what his life's going to be like.’ says Caitlin.

‘He's still got the opportunity to make it anything he wants.’ says Maree.  
‘He's only four years old. He hasn't even had a chance.’

Hearing laughter, I turn. Emma, Candy, Janine and Josie are discussing the contents of a Dolly magazine. ‘How are you girls going?’ I ask.

‘We've finished.’ Candy replied.

I inquire as to how they have arrived at a consensus so quickly and Candy says they have let Emma (a popular and forthright student) decide. I stay with this group and through questioning help them to consider each patient in turn.

### ***Debrief Discussion***

At the end of the group discussion, students write on the white board the names of their groups' selected patients. I ask each group to outline why they chose or rejected certain patients. We begin with patient A who has been selected by half of the groups. Maree says he should have a transplant because ‘he hasn't had much of a life’ and ‘deserves a chance’.

‘No’ states Emma emphatically. ‘I don't agree. Who is going to miss him? He has no family. It's no great loss.’

‘I agree,’ says Candy (Emma's best friend). ‘We should not take them. We should look after our own kind first.’

I query, ‘do you think we have an obligation to look after those from other countries who are less fortunate?’

‘No’ says Candy.

‘Definitely not’, says Emma. ‘It won't matter if he dies.’



Maree interjects. 'I actually think everyone has a right to life.'

'Oh yeah!' says Candy sarcastically.

'No they don't!' says Emma.

'It would be nice if every one could get a transplant, but he hasn't paid taxes in our country. What right does he have to our technology?' asks Candy.

In my mind I am weighing up my next move. I view my role in the classroom as one of helping students reflect on and critically evaluate their views through discussion with their peers. It is neither my role, nor my right to impose my ethical values onto students. Rather, I want them to think critically about their own values rather than adopt mine. Yet, last year when students expressed similar views I remained silent and regretted afterwards that I had let the comments pass. Was my silence then interpreted as tacit approval? No, not his time.

'So Emma, do you think those types of views might be interpreted as racist?'

'I'm not a racist.' retorts Emma.

'I didn't say that you were a racist Emma, but I think that some people might think that the comments are. I would have to agree to some extent with Maree. All lives are important. What do the rest of the class think?'

As I read this tale now, I recall immediately that moment in the classroom when I paused for what seemed an interminable period trying to decide how to reply to Emma and Candy's remarks. I had used this role play on many occasions and with each class there was a debate over the suitability of the Vietnamese orphan. Many students agonised over and apologised for their decision. "I don't mean to sound racist but..." I empathise with the difficulty of their arriving at a decision and am heartened that they do experience a moral dilemma. I am encouraged by their reflective comments and tentative decisions.

Although I stated in the story above that 'there are no right or wrong answers to ethical dilemmas' I now believe that there are decisions that are better than others. There are decisions that are just and fair, that respect the rights of the individuals affected and that seek to avoid harm. Decisions should allow for the special treatment of those who

are most disadvantaged in our society, in an effort to achieve some sort of equity. In the case of the Vietnamese orphan, I believe that Australians have a special obligation to assist those in Asian countries who do not have access to our health care and technology. It is part of being humane. Furthermore, I do not believe that individuals should be discriminated against solely because of their race. However, this is my opinion. It is not my role as a teacher to impose my views on students no matter how repugnant I find theirs. However, I did not challenge Emma and Candy because they did not choose the Vietnamese orphan to receive a transplant. Rather I questioned and challenged the reasons for their choice. In respect of students as dogmatic as Emma, I believe that they must be able to justify their decision with valid reasons.

In addition to raising an ethical dilemma for me, this tale illustrates the style of teaching that I adopted when teaching my own class about bioethical dilemmas in science.

The experiences described in this section have resulted in my belief that the teaching of bioethics is a worthwhile topic to research and led me to behave toward the research participants in a caring way where I genuinely valued their input. I hope that can be perceived in the ensuing chapters.

## CHAPTER TWO

### LITERATURE REVIEW OF BIOETHICS EDUCATION

#### INTRODUCTION

The purpose of this Chapter is to introduce the reader to the field of bioethics education. In this review, I have focussed predominantly on literature pertaining to bioethics education in secondary school science, rather than in the tertiary sector or other subject areas (e.g., religious education, social science and philosophy). Firstly, the terms 'ethics', 'bioethics' and 'bioethics education' are defined. Next, a rationale to support the inclusion of bioethics education in secondary school science is presented. The goals of bioethics education in secondary school science are outlined. The types of learning activities utilised by science teachers to introduce their students to aspects of bioethics education are described. This section provides a framework for me to address the initial research questions which relate to the types of learning activities used by the teachers in this study. A discussion is included about some of the constraints that may influence adversely the implementation of bioethics education. I conclude with a summary of how this research study may contribute to the literature on bioethics education.

#### WHAT IS ETHICS? BIOETHICS? BIOETHICS EDUCATION?

##### Ethics

The terms ethics, bioethics and bioethics education are used throughout this thesis and it is appropriate to define what I understand these terms to mean. 'Ethics' can be described as 'a system of moral principles by which human actions may be judged as good or bad, right or wrong' (Macquarie Dictionary, 1990). There are a range of ethical theories that have been developed to guide our behaviour and allow us to reflect on the morality of our actions. These theories about ethics, termed *normative ethics* describe how we ought to behave. They provide a 'framework within which agents can reflect on the acceptability of actions and can evaluate moral judgments and moral character' (Beauchamp & Childress, 1994, p. 44).

Examples of normative ethical theories include natural law, Kantian ethics, egoism, utilitarianism, ethics of care and virtue theory (Singer, 1993; Taylor, 1975). Where these theories differ from each other is the rationale by which ethical decisions are made. For example, Kantian ethics, a type of deontological theory, is based on rules,

duties and obligations. From a Kantian perspective, to behave ethically is to obey these rules or 'categorical imperatives'. The consequences of an act are irrelevant as long as the rules are followed. In contrast, utilitarianism (originally described by Jeremy Bentham (1748-1832) and John Stuart Mill (1806-1873)) is a theory whereby our actions are deemed to be ethical only if the consequences are favourable. Our actions should promote good and avoid harm. Thus, no action is itself morally wrong. Rather, it is the consequences that justify whether an action is right or wrong. Despite this plethora of ethical theories, a closer analysis indicates that there is common agreement that certain actions are wrong. These actions include murder, stealing, lying and discrimination.

In addition to these normative ethical theories, there has evolved theories *about* ethics (i.e., meta ethics) which relate to *how* ethical judgements are made. These theories include realism, intuitionism, naturalism, subjectivism, relativism and universal prescriptivism (Singer, 1993). Meta ethical theories make explicit the principles that individuals follow when they make ethical decisions about an issue.

Although there is some debate about whether ethical values and behaviour are inherited or learnt (Ruse, 1993), it is generally agreed that a person's ethical values are learned. As Taylor (1975) states:

All our moral attitudes and judgments are learned from our social environment. Even our deepest convictions about justice and the rights of man are originally nothing but the "introjected" or "internalised" views of our culture, transmitted to us through our parents and teachers. Our very conscience itself is formed by the internalising of the sanctions used by our society to support its moral norms."

(p. 15)

Thus, ethical decisions are made by individuals based on values which are formed and shaped by their personal experience, family background, education, religious beliefs, ethnic culture and society.

In addition to an individual's personal ethical values, there are frameworks of ethics within which choices and decisions are made by groups. Examples include Christian ethics (Preston, 1993) and the Hippocratic Oath in Western medicine (Veatch, 1989). Many occupations other than medicine have developed codes of ethics to act as guidelines or principles within which decisions or behaviours are specified.

## **Bioethics**

This research study is primarily concerned with the teaching of bioethics. Bioethics can be defined as the ethics associated with living organisms (Macer, 1994). It includes medical ethics and environmental ethics. Bioethics became a separate discipline in the 1960s in response to a growing need by society and the medical profession for guidelines to assist in decision making within an increasingly complex and expensive health care system (Komesaroff, 1996).

Four bioethical principles (respect for autonomy, beneficence, non-maleficence and justice) have been described by Beauchamp and Childress (1994) as a theoretical framework for assisting health practitioners and others to make decisions about bioethical issues (Gillon, 1994). Respect for autonomy relates to the rights of individuals to make decisions about issues that may affect their well being. This principle is based on Immanuel Kant's categorical imperative that individuals be treated as ends in themselves and not as a means to an end. In practice, this principle impinges on ethical decisions related to informed consent (with the emphasis on informed), confidentiality and the right to information.

The principles of non-maleficence (avoidance of harm) and beneficence (promoting good) can be traced back to the Hippocratic Oath (Veatch, 1989) which seeks to ensure benefits to patients with minimal harm. At an institutional level, this may mean the allocation of resources that will provide the greatest benefit to the greatest number. The fourth principle of justice or fairness relates to an equitable distribution of benefits, risks and costs. This does not necessarily mean that everyone should be treated equally because some individuals (e.g. those with chronic health problems) need more resources. Note that respect for autonomy, etc., are principles, not rules, and this leaves scope for their judicious and careful use to resolve bioethical issues.

## **Bioethics Education**

The purpose of bioethics education (education about bioethics) is to enable students, firstly, to appreciate the range of ethical issues associated with the life sciences, health and health care and, secondly, to assist students to develop decision-making skills based on ethical theories. (Macer, Asada, Tsuzuki, Akiyama & Macer, 1996; Reich, 1995). The teaching of decision making skills to resolve bioethical issues is not concerned with defining a 'correct' decision. Rather, it is about understanding and

practising the process of decision making. The four bioethical principles (Beauchamp & Childress, 1994) can be used to assist students in their decision making.

Thus, bioethics education should provide students with opportunities to discuss bioethical issues, consider alternative courses of action, evaluate the potential risks, costs and benefits and finally select a course of action. Bioethics education can enable students to develop, articulate and critically evaluate their personal bioethical values. Bioethics education should occur within a climate of tolerance that recognises the right of the individual student to self-determination and respect. It is important to note that bioethics education should not impose or indoctrinate a particular set of values which may limit student choice and result in a narrow world view. Rather, students should have the opportunity to become aware of the multiplicity of values that exist in our society.

## **BIOETHICS EDUCATION IN SECONDARY SCHOOL SCIENCE**

### **Why Include Bioethics Education in Secondary School Science?**

#### ***Students Need Decision Making Skills***

It is my firm belief that the active encouragement of our students to think critically about bioethical issues will enable them (as adults) to make well-informed political, moral and social decisions about their future and the future of others. Some students will become research scientists, politicians, lawyers and business leaders, all of whom may need to make direct decisions regarding the application of scientific advances. Yet, it is equally important that the nebulous group, often referred to as the 'general public', is also well informed so that they can be better involved in decision making (Frazer & Kornhauser, 1986; Nelson, 1998).

Thus, our school students need to be equipped with appropriate decision-making skills if they are to contribute to public debate about the ethics of problematic issues, such as population growth, food and health resource allocation, genetic testing and engineering, reproductive technology, environmental degradation and control of information technology (Frazer & Kornhauser, 1986; Kormondy, 1990; Rubba & Harkness, 1993).

A lack of understanding of bioethical issues associated with science and technology (by the general community) may lead to feelings of alienation, fear and anger towards the scientific community and their work. Teachers, especially science teachers, whose

content area raises many bioethical dilemmas have an obligation, therefore, to help students develop abilities to evaluate bioethical issues (Armstrong & Weber, 1991; Iozzi, 1982; Mertens & Hendrix, 1990; Skamp, 1986).

### ***Science Raises Bioethical Issues***

The practice of science may be viewed by some as objective, analytical, rational and unaffected by personal morals and values (Charlesworth, Farrall, Stokes & Turnbull, 1989). Yet, science is a social endeavour, and its application is inevitably influenced by our political, cultural, religious and ethical values (Capra, 1983; Kuhn, 1970). It is essential that science students have some understanding of these factors. I am concerned that if science teachers ignore bioethical issues which inevitably arise in science, students are likely to receive the implicit message that there are no ethical issues in science.

It has been argued that bioethics education should be taught by teachers in subject areas such as social science, philosophy or religious education (Mehlinger, 1986). Yet, teachers of these subjects may be unable to present effectively topics of a highly scientific or technological nature (Brinckerhoff, 1985). Also, religion is no longer a guiding force in the lives of many students today. The lack of religious education courses in many secondary schools means that discussion and resolution of ethical dilemmas may not occur (Prager, 1993).

It seems to me that, until recently, the role of bioethics in science has been largely ignored by secondary science educators. A review of the literature on bioethics education in secondary science reveals a paucity of information, particularly in Australia. It is almost as if bioethics is a non-issue in science education. Yet, for example, the Year 11 and 12 Human Biology curriculum set out by the Curriculum Council in Western Australia contains topics related to reproductive technology (e.g., surrogacy), kidney and heart disorders, (e.g., organ transplantation), death and dying (e.g., euthanasia), contraception, (e.g., abortion) and genetics, (e.g., screening of genetic abnormalities) (Syllabus Manual, 1998). All of these topics raise bioethical issues which need to be addressed. However, because Human Biology is assessed primarily through formal examinations, these topics are usually taught in a factual, objective manner and often do not address the bioethical issues.

It is noteworthy that the most recent Syllabus Manual (1998) lists a new objective under the heading of "Working Scientifically". The Human Biology syllabus for Year 11 and 12 now includes "discussion of the ethical issues associated with the use of

new medical technologies” (p. 32, p. 112). Yet, despite its inclusion in the syllabus, some teachers may have difficulties implementing it. The possible reasons for this are discussed later in this section.

There is further evidence that curriculum planners are recognising that bioethics education should be included in the science curriculum. Under the heading “Acting Responsibly” in the Science Learning Area Statement of the draft Western Australian Curriculum Framework is the statement that “students make decisions that include ethical consideration of the impact of the processes and likely products of science on people and the environment” (Curriculum Framework Consultation Draft, 1997, p. 212).

There is also support from science teachers regarding the inclusion of bioethics education in science. In 1993, Macer et al. (1996) conducted an International Education Bioethics Survey of biology teachers (n=1017) and social science teachers (n=593) in Australia, Japan and New Zealand. The purpose of the survey was to determine the teachers’ views on bioethics education. The survey contained 22 questions related to the teaching of bioethics in 15 areas (e.g., *in vitro* fertilisation, biotechnology and nuclear power). The results of this survey indicate that there is widespread support (>90%) amongst teachers for the inclusion of bioethics education in the science and/or social science curriculum. The major reasons stated by Australian teachers were “people face issues in the world” and “science raises issues” (p. 35).

### ***Bioethics Education Can Be Motivating***

The inclusion of bioethics education in science may have a favourable effect on those students who perceive the subject of science to be irrelevant, boring and difficult. As Van Rooy (1994) states:

Here is an opportunity for science teachers to challenge students who all too often view science as a mere collection of undisputed facts which the teacher holds to be true, rather than science being a collection of disputed facts, rich in controversy and in a state of flux. Science might then be seen by more students as dynamic, exciting, controversial and relevant to their world and so worthy of academic study rather than being sterile and of no particular relevance.

(p. 27)



An examination of bioethical issues in science may enable students to view science, not as a fixed set of objective facts and theories, but as a stimulating, controversial, and constantly changing field which is relevant to all humankind.

### **Goals of Bioethics Education**

The goals of bioethics education in secondary school science are similar, but not identical to bioethics education courses in the health sector. In these courses, the emphasis is on increasing the health professional's understanding of and ability to deal with bioethical issues in the work place (Reich, 1995). In secondary school science, the goals of bioethics education are, firstly, to equip students with decision making skills about bioethics so that they can debate controversial issues in our society and, secondly, to help students construct a personal framework so that they can make personal decisions about issues that may affect them (e.g., abortion, transplantation) (Nelson, 1998; Van Rooy, 1994).

The goals of bioethics education in science, cited by authors, range from broad to specific. For example, Allchin (1991) states that bioethics education in secondary science classes can "nurture both morally sensitive scientists and scientifically literate humanists" (p. 44) and "a decision making approach to bioethics would help individuals make informed decisions regarding both personal and community health issues" (Birch, 1986, p. 40). In contrast, Barman and Hendrix (1983) express three specific goals for bioethics education:

1. To present accurate and objective information about specific bioethical issues;
2. To provide opportunities for students to openly and freely discuss the ethical questions surrounding each issue addressed in class;
3. To provide students with a decision making model that would assist them in formulating personal choices about these issues by clarifying their values/ethics and by their consideration of the consequences of their choices.

(p. 23)

## **How Can Bioethics be Taught in Science?**

### ***Introduction***

During the planning phase of this research study, I believed that it would be useful for me to examine the types of learning activities currently utilised by secondary science teachers who were incorporating bioethics education into their science programmes. I felt that an awareness of the types of activities used would inform my role as a researcher. I felt that I could be more focussed in the data generation phase of the study. I would 'know what to look for'. It is important to note that the purpose of my reading was not to construct a yard-stick or checklist on which to compare the case study teachers. Rather, the reading was intended to enrich my understanding of the thesis topic. This section also provides for the reader a framework in which to situate the findings of this study especially those related to the first initial research question on the types of learning activities utilised by teachers.

Bioethics education has been incorporated into a range of science content areas. These programmes, developed to enable students to appreciate bioethical issues in science, include genetic engineering (Armstrong & Weber, 1991), death and dying (Barnum & Hendrix, 1983), reproductive technology (Van Rooy, 1993), animal experimentation, (Allchin, 1991; Radford, 1992), genetic diseases (Hendrix, 1993; Morris, 1994), human organ and tissue transplantation (Dawson, 1994, 1996b; Transplantation, the issues, 1992), environmental issues (Max, 1992) and ionising radiation (Eijkelhof, 1986).

### ***A Model for Bioethics Education***

Regardless of the scientific content area, almost all of the literature related to bioethics education in secondary school science utilises components of a bioethical model described in detail by Burnham and Mitchell (1992). Each of the five stages of the model is outlined and discussed below. Similar formats are recommended by Birch (1986), Barnum and Hendrix (1983), Frazer (1986), Morris (1994), Nelson (1998) and Van Rooy (1994).

#### **1. Observation**

This stage involves presenting students with some information about a bioethical dilemma. Regardless of the source of the material, it is intended to motivate and

engage the student. The content should be of interest to the target group (adolescents) and be in the context of their learning.

## 2. Question/Hypothesis

Questions or hypotheses related to the observations may be generated by the students or the teacher. Questions may be general (e.g., what should be done?) or specific. Woodruff (1992) lists nine questions that students could consider when faced with a bioethical dilemma. They include “what are the facts?”, “who are the stakeholders in the decision?”, “which options are the most compelling?” and “how would you resolve the dilemma?”.

## 3. Gather Information

The collection of information about the issue may be student led or the teacher may supply it. Sources of information include library research, viewing of videos and interviewing of stakeholders. It is important that the information presented to students is accurate, objective and balanced. The teacher should provide resources for and against the issue. This information provides a basis for students to understand the broader social context of the bioethical dilemma (Frazer, 1986; Smith, 1992).

## 4. Analysis and Ethical Deliberation

This is the most important stage, where most of the learning occurs. During this stage, students need, firstly, to describe the issue and then select relevant rules and principles to consider. Ethical deliberation about alternative solutions may result from a consideration of, for example, bioethical principles (Kormondy, 1990). Alternative methods include the use of: ethical theories such as deontology, utilitarianism and virtue theory (Woodruff, 1992); personal values and beliefs that have been made explicit (Smith, 1992); or a cost benefit analysis (Vogel, 1991) where the costs and benefits of alternative solutions are compared. Morris (1994) outlines an ‘ethical reasoning model’ that may be used by students to evaluate ethical issues. The model is guided by four rules (veracity or truthfulness, fidelity, confidentiality and privacy) in addition to the four bioethical principles of Beauchamp and Childress (1994).

## 5. Decision or description of solution

In this final stage, students choose an option from the range of alternatives that have arisen in the previous stage. Students should realise that it is difficult to arrive at a

decision or solution. They should also be aware that no single answer may be correct and that not every one will agree. If using documented cases, students could be informed of the actual outcomes for comparison. The final stage is not conclusive and students may proceed through stages 3 to 5 several times as new information becomes available.

### ***Learning Activities***

There are a range of learning activities that can increase students' understanding of bioethical issues. For example, students could be presented with a case study (Bennet, 1992; Birch, 1986; Brinkerhoff, 1985; Iozzi, 1982). A case study is typically about one page in length and includes some factual information about a bioethical issue and raises some problems for consideration. Case studies may be fictional or documented. Other sources of bioethical issues include video material such as the scenarios depicted in *Transplantation: the issues* (1992) or media articles such as Morrow's (1991) article in *Time* magazine on families who conceive a child to provide transplant tissues for another child, and newspaper articles on controversial topics (e.g., *Ewe clone opens brave new farmyard*, 1997). Other methods of presenting information include expert guest speakers (e.g., genetic counsellor, transplant recipient, environmental activist) and excursions (e.g., to marine management parks or waste treatment plants).

Students can also engage in structured debates (e.g., Armstrong & Weber, 1991) about bioethical issues. Students can prepare to debate for and against an issue (Frazer, 1986). Other strategies used to encourage ethical decision making include discussion forums (Clark, 1997; Nelson, 1998), hypotheticals (Cook, 1998), student-led seminars (Nelson, 1998), drama and simulation games (Frazer, 1986), and role-playing (Reed, 1984). In these activities, students are presented with a scenario and adopt the role of different stakeholders. The activities can be adapted to suit the age, background, interest and ability level of the students.

Another activity involves construction of conflict maps (Dawson, 1994; Pike, 1993; *Transplantation: the issues*, 1992). A conflict map is a chart which is often used in conflict situations (e.g., divorce cases) where the individuals involved have different and often opposing rights, needs and duties within a relationship. It can be used to record the rights, needs and duties of all those involved in a bioethical dilemma, thus enabling the students to discern and weigh up the point of view of all concerned.

Another approach is utilised by Hendrix (1993) in the teaching of genetics to pre-service biology teachers. Students are provided with a table of 27 genetic diseases arranged in a continuum from least to most severe. The defects range from polydactyly (an extra digit on the hand or foot) to a hydatidiform mole (where the sperm fuses with a polar body, rather than the ova, resulting in a mass of undifferentiated cells). Hendrix suggests that a maximum of 15 defects would be suitable for secondary students. After examining the inheritance and resulting defects, students are then asked to draw a line below which they would not “maintain the pregnancy” and also to write a justification of their decision. Thus students have the opportunity to clarify their own values regarding genetic defects (and abortion).

Possibly the most controversial but under-utilised activity to enable students to analyse bioethical issues are community service and social action (Agne, 1986). Thus, students actually engage in activities outside the school that enhance their understanding of an issue. This could range from an analysis of waste management in the local community and writing letters to the Editor of local papers to lobbying politicians, writing petitions, attending protest rallies and even blockading nuclear power plants!

### ***Role of the Teacher***

When teaching students about bioethics in science, the teacher needs to be well informed about the topic. The teacher needs to play a multiplicity of roles including that of a facilitator of student-led debate, a provider of information and a non-critical supporter of students as they attempt to develop their own understandings. It is important that the teacher helps students to realise that participation in bioethics activities should not be viewed as a game or a break from the “real” science. The objective is for students to be able to transfer the decision making skills they learn in the classroom to real life situations.

Discussion in the classroom is the most frequently used method to encourage reflection and ethical deliberation. Discussions may be conducted in small group or whole class formats. Smith (1992) suggests that prior to discussion, students should engage in personal reflection where they think about their own values related to the issue. Students can then share their personal views in small groups. Subsequent whole class discussion can lead into an evaluation of alternative solutions.

During discussion activities, the teacher acts as a facilitator to encourage debate within a positive environment (Allchin, 1991; Smith, 1992; Van Rooy, 1994). The teacher

should maintain a neutral position and encourage respect for a range of opinions. The emphasis is on what the student thinks rather than what the teacher or external ethicists believe to be ethically correct (Prager, 1993). The teacher should ask students to justify unreasonable views and reflect students' questions back to the class. If a range of views is not forthcoming the teacher should play "devils' advocate" to stimulate discussion. The discussion should be open ended. Agreement is not necessary, but an exchange of ideas is. The teacher can extend the discussion by asking questions such as "is this solution fair for all affected parties?"

### **Evaluation of Bioethics Education in Science**

I was also interested in the evaluation of science courses that included aspects of bioethics education. For example, how did teachers (or others) determine the impact of the learning activities? This aspect of my reading related directly to the second initial research question on the effectiveness of learning activities. Unfortunately, most of the literature on bioethics education in secondary school science focuses on the goals and descriptions of learning activities rather than evaluation of the courses. However, several authors do mention evaluation of bioethics education.

Van Rooy (1994) suggests that the following types of questions be used to guide an evaluation process; "can the student defend their view against criticism?" and "can the student incorporate new evidence which may or may not support their current view?" (p. 27). Unfortunately, it may be difficult to measure the acquisition of these skills. Barman and Hendrix (1983) suggest that evaluation of student learning focus on student participation and written assignments. The students should not be judged on their views, but on the extent to which they can analyse an issue and defend their decision.

Armstrong and Weber (1991) taught and evaluated, by questionnaire, a short course on genetic engineering whereby 200 Year 10 Biology students used library research to investigate specific aspects of genetic engineering. Working in groups, students then debated and voted on the pros and cons of genetic engineering. Their questionnaire was designed to assess whether students had increased their knowledge and clarified their own opinions of genetic engineering. It was divided into three sections; 'knowledge of the topic', 'importance of the topic in society', and 'students' values concerning topic'. The results indicated that after completing the course students perceived that they better understood genetic engineering and could state their opinion about it.

Lock, Miles and Hughes (1995) and Lock and Miles (1993) in the United Kingdom used a questionnaire to evaluate the effect of a course of instruction on biotechnology and genetic engineering with 188 14-15 year olds in six schools. They found that after studying the course, students had a more positive attitude to, and an increased understanding of both topics. Students were also able to provide more logical explanations to support their opinions.

Eijkelhof (1986) reports on an evaluation of a physics course on ionising radiation for 17-18 year old students in Holland. After completing the course, questionnaire responses indicated a more favourable attitude to the use of radioactive materials in medicine and industry. Students also seemed to have a greater understanding of the topic, although the authors were concerned that some serious misconceptions persisted (e.g., that irradiation makes food radioactive).

The methods used in these studies to evaluate the impact of bioethics education in secondary school science tend to rely on survey methods where students complete written questionnaires. The results presented are based on whole class data. One of the limitations of these methods is that there is no information about the effects of bioethics education on individual students. The reason for the lack of studies focusing on individual students is unclear.

### **Constraints Affecting Bioethics Education**

When I was planning this study, I became aware (through discussions with other science teachers) that some teachers had reservations about the inclusion of bioethics education in the subject of science. This section discusses some of the reasons for these concerns. One factor may be the lack of appropriate teaching materials. In Macer et al.'s (1996) survey, 72% of biology teachers believed that they did not have sufficient resources to teach bioethics. As a secondary science teacher, I am aware that most text books contain virtually no information relating bioethical issues to content. Although some resources are available to enable science teachers to consider bioethical issues that are associated with science (e.g., Cross & Price, 1992; Frazer & Kornhauser, 1986; Macer, 1994; Transplantation: The issues, 1992; Woodrow Wilson Biology Institute, 1992) they are not widely distributed.

A second problem may relate to teachers' beliefs about the nature of science. Teachers who perceive the nature of science to be a search for truth and knowledge may consider bioethics education, where there is often no clear solution to an issue, to be an inappropriate topic to teach in science (Soloman, 1990). One method of discerning

an individual's view of the nature of science is the VOSTS instrument (Views On Science-Technology-Society) (Aikenhead & Ryan, 1992). The VOSTS is an empirically developed multiple-choice instrument which requires respondents to select statements regarding science that best describe their viewpoint. Using the VOSTS, Fleming (1988) found that undergraduate science students (the pool from which most science teachers come) tend to regard scientific knowledge as fact. It is understandable that teachers who are accustomed to teaching science with certainty may feel uncomfortable when dealing with issues to which there are no definitive answers (Kormondy, 1990).

It is also possible that science teachers may not feel confident when dealing with topics that impinge on their own and their students' religious and moral beliefs (Agne, 1986). Teachers may find themselves forced to justify and evaluate their own strongly held beliefs about issues. This can be an uncomfortable process for the teacher. Furthermore, unlike many science topics, bioethical concepts are difficult to teach in a didactic way using a teacher-centred pedagogy. Even experienced teachers who have built up a repertoire of teaching methods in science (e.g., demonstrations practical work, modelling) may be unfamiliar with the skills needed to implement the types of learning activities described earlier in this chapter (e.g., facilitating debates and forums).

Even when teachers believe that bioethics has a place in the science curriculum as Macer et al.'s (1996) survey suggests, many teachers are already overwhelmed by the large amount of content that they are required to teach. Given that many prescribed science curricula do not contain sections on bioethics, there may not be time to include this topic especially if it is not compulsory. In Britain, for example, recent changes to the Science National Curriculum have resulted in *less* emphasis on ethical issues in science (Lock, 1996).

Another problem may be that pre-service teacher education courses do not equip teachers with the necessary skills to teach bioethics (Mehlinger, 1986; Rubba and Harkness, 1993). Although in the United States there exists in-service bioethics courses at some universities (e.g., Colorado College, Ball State University and San Francisco State University) these courses are limited in their availability (Blake, 1994).

Although Cross and Price (1996) have incorporated discussion about how to teach controversial issues into their science teacher education courses, they have found that "these teachers are confused about when, where, and how to use such skills, and frustrated by a number of organisational difficulties (syllabi and time)" (p. 319). They



sum up the problems faced by teachers when they state that despite a willingness to teach students about issues in science, there are concerns expressed about:

whether in doing this the teaching of traditional scientific concepts will be sacrificed; where they can find resource materials; the effect of destroying the myth of value-free scientific knowledge; the difficulty of teaching evaluation of evidence and making judgments; and the problem of students who wish to become activists as a result of their learning experience.

(p. 322)

### **Significance of This research Study**

Most of the literature related to bioethics education in science is descriptive. There is a paucity of information about course evaluation. There is also little evidence about the nature of student learning. Thus, it is difficult to ascertain the students' views about the quality of their learning or the effect of learning activities described in the literature.

By utilising an interpretive case study approach, I had intended to contribute to the field of bioethics education in science. In this study, there was a major focus on the impact of the learning activities on students' understanding of bioethical issues. The type of data generated from the qualitative research methods that I utilised has the potential to enable insights that were not possible in other types of studies.

## **CHAPTER THREE**

### **A GUIDING INTERPRETIVE FRAMEWORK**

#### **INTRODUCTION**

In the first chapter, I outlined the initial and emergent research questions and described the rationale of this research study. I explained a little about my background and the values and beliefs I bring to this study. I introduced you to the three teachers, Catherine, Mark and Helen, who allowed me to visit their classrooms and work with them and their students. In the previous chapter, I presented a review of the literature on bioethics education and built, I trust, a sound case to support the inclusion of bioethics education into the science curriculum. The purpose of this chapter is to outline the theoretical framework and research method that guided the research process.

This chapter comprises four sections, the first of which explores the ontology and epistemology that underpin this study. A constructivist epistemology is outlined that situates this study within a theoretical framework. I also reflect on some of the limitations and difficulties I encountered with linking constructivist theory to my personal beliefs and values. The second section describes the research method. Initially, I utilised an interpretive case study approach and the types of research strategies and techniques that I adopted are outlined. The data generated led to emergent research questions which were pursued through alternative methods. The third section focuses on the narrative approach that I adopted in the interpretation and reporting of the research process and findings. Finally, I outline a set of standards that I used to judge the quality of the research process.

#### **A QUALITATIVE THEORETICAL FRAMEWORK**

It is appropriate to describe in detail, the theoretical standards that guided the research process and evaluation. As I conducted this research study, my views about what research is and how it is carried out were shaped and reshaped by my experiences as a novice researcher. As a consequence, this chapter was written and rewritten many times as different issues arose while others diminished in importance. Thus, this final version bears little resemblance to the original which was written in the initial months, partly, to satisfy the requirements of the University Graduate Studies Committee.

Most of my early reading had focussed on bioethics education and data collection methods rather than the theory of qualitative research. Although a component of my reading had introduced me to the multifaceted nature and terminology of qualitative research, I must confess that I did not consciously link the theory to my practice until I engaged in the 'writing up' stage. This was partly because the opportunity to visit Catherine's classroom arose soon after I commenced the study. I quickly found that my energy and time were consumed in the process of generating and reflecting on the data.

I read sporadically as I worked with Catherine, but the focus of my reading was related to the questions that arose as I reflected on my research findings. Towards the middle of the research study (after completing two case studies) I wrote a short chapter about theoretical frameworks, ethics in qualitative research and narrative inquiry. I wrote about constructivist theory, feminist theory, critical theory and ethical theory. At the time, what I had written seemed smooth and plausible as though I could merely read about, synthesise and understand the theories and then apply them to my research practices.

Some time later, when I re-read the chapter I could see flaws and contradictions. There was a dissonance between what I had written and my current beliefs which were based on my actual research experience. I discarded most of the chapter, sorted through the pile of papers I had collected over the past two years and began to read. At this stage, I had completed almost all of the data generation, transcribed the interviews, summarised questionnaires, typed up the classroom observations and journal reflections and followed up some of the emergent research questions. I had compiled a "field text" (Clandinin & Connelly, 1994, p. 419) or "case record" (Merriam, 1988, p. 126) for each of the case studies. I had also spent several months reflecting on, and writing the first results chapter (see Chapter Five), referring to the literature when applicable.

Thus, most of the reading for this chapter occurred as I wrote the thesis. The more I read, the more convinced I am (despite brief moments of consternation) that my reliance on intuition and "tacit knowledge" (Polanyi, 1958, 1969) coupled with a connected caring approach ensured a much richer understanding of the research environment and the research participants' experiences than would have been possible if I had been constrained by a pre-existing and unyielding theoretical framework.

Polanyi's tacit or personal knowledge is knowledge that an individual holds a commitment to. It can not easily be made explicit in the way that objective or

externally derived knowledge can. For example, I can state and demonstrate that students were exposed to aspects of bioethics education, yet my understanding of the outcomes of bioethics education is grounded, in part, in personal knowledge. This personal knowledge is not fixed, but has evolved as the study proceeded (and continues to do so).

### **What is Qualitative Research?**

According to Denzin and Lincoln (1994) in their *Handbook of Qualitative Research*, qualitative research or interpretive research makes use of multiple methods to understand the research environment and to acknowledge and make explicit through self critical reflection the effect of the writer's/researcher's personal, cultural, gendered, social and ethnic belief systems. The hallmarks of effective qualitative research include:

- 1) a struggle with a number of theoretical paradigms (e.g., constructivism),
- 2) the use of an appropriate genre (e.g., narrative),
- 3) close engagement between the researcher and the research environment and participants,
- 4) acknowledging the importance of the participants' points of view,
- 5) critical reflection and interpretation,
- 6) rich descriptions,
- 7) awareness of the constraints of the research at all stages,
- 8) appropriate and sensitive forms of data collection/generation (e.g., multiple observations with feedback, unstructured interviews, reflective journal writing.)

I wish, firstly, to focus on the theoretical framework that shaped and guided this research study (i.e., point one). The remaining points are elaborated later in this chapter.

A theoretical framework explains to the reader the underlying paradigm or world view that dictates the aims, design, conduct and interpretation of the research study. Within the field of qualitative research, there are a range of research paradigms that can enable researchers to situate their study within an appropriate theoretical framework. Examples of these paradigms include constructivism, feminism, ethnic models, Marxist models, cultural studies models, positivism and post-positivism (Denzin & Lincoln, 1998, p. 25).

I found reading and writing about theoretical frameworks exceedingly difficult. Some of the papers and books I read seemed impenetrable. I was unfamiliar with the meanings and historical derivations of many of the terms used. Much of the literature on qualitative research originates in the social sciences (e.g. anthropology, sociology) while I was schooled in the quantitative science field.

Each of the theories have their own ontology, epistemology and research methods. Thus, a description of a theoretical framework should encompass statements about ontology (the nature of reality), epistemology (how we come to perceive the world and construct knowledge) and method (the research methodology) (Denzin & Lincoln, 1994, p. 13). Although ontology, epistemology and method need not be viewed in a hierarchical mode, the first two will to a large extent dictate the method. The theoretical framework that underpinned this study was a constructivist theoretical framework.

### **Ontology - What is the Nature of Reality?**

Constructivism is a theoretical paradigm where ontologically there are multiple realities rather than an absolute or universal “truth”. From a constructivist perspective, realities are relativistic, specific and dependent on the individual’s own experiences (Guba & Lincoln, 1994, p. 110). Furthermore, “realities are social constructions of the mind and there exist as many constructions as there are individuals” (Guba & Lincoln, 1989, p. 43). These realities are not fixed. Rather, they are subject to change as individuals encounter and accommodate new experiences.

In relation to this research study, then, I have attempted to record the perceived realities of the research participants and myself. These constructions or interpretations of reality derived from a shared understanding with the participants. The constructions were not fixed or static and were always open to new interpretation as information emerged. Thus, my role as a researcher was not that of a “truth seeker” but rather “researcher as learner” (Tobin & Tippins, 1993, p. 15).

### **Epistemology - What is Knowledge?**

From an epistemological perspective, constructivism is a theory about knowledge where, according to Bodner (1986), “knowledge is constructed in the mind of the learner” (p. 873). The knowledge constructed allows an individual to function and make sense of the world. Constructivism can be related to Piaget’s theory of

intellectual development (Driver, 1990). According to Piaget, the individual learner organises new experiences based on what they already know. Piaget uses the terms 'accommodation' and 'assimilation' to describe how the learner responds to new information. If the new information 'fits' with an individual's schema, then that information is assimilated. However, if there is a conflict between the new information and the learner's schema then accommodation or adjustment of the schema occurs. Knowledge can be considered viable if it 'fits' with the individual's perception of reality (von Glasersfeld, 1989). Thus, knowledge is not a set of extant facts waiting to be discovered. There is no objective knowledge or truth, only perception. As Schwandt (1994) states, "knowledge and truth are created, not discovered" (p. 125).

Although a constructivist epistemology recognises that each individual actively constructs his or her own personal subjectivist meaning based on their own experiences, construction of knowledge is a social transactional process in which individuals interact and develop their own meanings through discourse (Driver, 1990; Tobin, 1993). Thus, from a constructivist perspective, "Knowledge consists of constructions about which there is relative consensus (or at least some movement toward consensus) among those competent to interpret the substance of the construction" (Guba & Lincoln, 1994, p. 113).

I have deliberately avoided wading into the theoretical debate regarding radical constructivism versus social constructivism (and other forms) (Ernest, 1995). For me, such arguments, whilst interesting, are beyond the focus of this research study. Personally, at this point, my perception is that knowledge and understanding are constructed through an interactive process. This interactive process may be with others through discourse (social constructivism) or within the self through reflection (radical constructivism).

### **Relativism Versus Truth**

A constructivist theoretical framework seemed to provide the best 'fit' with my values and beliefs about how we come to understand the world. In addition, the framework also seemed to match well the type of research study I envisaged, that is, one where I valued the views of the participants. Yet, despite the plausibility of a constructivist framework, I still had some misgivings. I recorded my concerns about constructivism in my journal. The following extract relates to my difficulty with the notion of truth.

The relativistic nature of reality and knowledge fills me with trepidation. I wonder how I can possibly write a single sentence of this thesis with

confidence? A different person could ask exactly the same research questions, observe the same classrooms, and their descriptions and interpretation may be completely different. Perhaps, it stems from my objectivist roots but I have concerns about the ‘almost anything goes’ implications of a constructivist paradigm. That everyone’s world view is equally valid. It rather defeats the purpose of research per se. After all, what is the point if my opinion is as valid as anyone else’s?

(Personal Journal, 3/97)

Guba and Lincoln (1989) acknowledge that this lack of an absolute truth is a common criticism made against constructivist research. That is, “If evaluations cannot ferret out the truth, what use can there be in doing them?” (p. 46). They argue that this is only an issue outside a constructivist paradigm. There is no need to search for a universal truth, because none exists. There is no single correct answer. Rather, the researcher aims to be continually sensitive to and adapt their own constructions by accounting for the realities of the participants.

## RESEARCH METHODOLOGY

Denzin and Lincoln (1998) use the metaphor of a “bricoleur” to depict the work of a qualitative researcher. They state that “The multiple methodologies of qualitative research may be viewed as a bricolage and the researcher as a *bricoleur*” (p. 3). A bricoleur is familiar with a range of theoretical frameworks (paradigms). A bricoleur as qualitative researcher uses a range of interpretive research methods to answer their research questions. This is useful as:

The combination of multiple methods, empirical materials, perspectives and observers in a single study is best understood, then, as a strategy that adds rigor, breadth, and depth to any investigation

(p. 4)

The methodologies are not necessarily known in advance but emerge as the most appropriate way to answer whatever questions arise. A bricoleur also understands that the results of research will be influenced by one’s beliefs and values which are in turn shaped by our culture, gender, race, social class and personal experience. The result of a bricoleur’s work is a bricolage, “a complex, dense, reflexive, collagelike creation that represents the researcher’s images, understandings, and interpretations of the world or phenomenon under analysis” (Denzin & Lincoln, 1994, p. 3).

There is much that is appealing about the metaphor of a bricoleur. It describes well my own foray into qualitative research. I struggled with different paradigms. I, too, utilised a range of research methods from different paradigms ranging from participant observation (cultural studies) to an ex post facto research design (positivism) (Denzin & Lincoln, 1994, p. 5, 13). I selected the methods, not because they fitted a particular theoretical framework, but because they seemed the best way to answer the questions I was asking within the context of the study. Some of the methods were selected in advance. Others were developed to address emergent questions. I needed to be sensitive and responsive to unanticipated issues that led to emergent questions. This, in turn, led to the selection and use of appropriate research strategies and techniques.

Research methodologies that are appropriate for qualitative, interpretive and constructivist research are those that account for intersubjectivity between the researcher and the participants (Erikson, 1986; Gallagher, 1991). In this research study, the findings were constructed by both the researcher and the participants as they created meaning and understanding through a hermeneutic/dialectical process. As Guba and Lincoln (1989) state, 'The process is *hermeneutic* in that it is aimed toward developing improved (joint) constructions.... It is *dialectic* in that it involves the juxtaposition of conflicting ideas, forcing reconsideration of previous positions' (pp. 89-90). A primary goal, then, of my research method was to allow the researcher (myself) and the participants (i.e., teachers and students) together to make sense of what is happening in the research environment. A hermeneutic approach can assist the researcher to begin to understand the experiences of the participants (Spector & Glass, 1991).

Thus, one of my aims in this research study was that the participants and I negotiated and renegotiated a shared understanding in the description and interpretation of the research environment. Therefore, critical feedback from the participants was crucial. Only through prolonged and intimate engagement with the participants could I begin to interpret the research environment. The techniques and strategies that promoted this shared understanding are explained below.

### **An Interpretive Case Study Approach**

An interpretive case study approach (Merriam, 1988; Stake, 1994; 1995) can be utilised in this research study. A case study is an intense examination of a specific issue; in this case, the teaching of bioethics education by a science teacher in a biotechnology course. Briefly, the researcher gathers as much data as possible about the research problem (the teaching of bioethics education) and then categorises,



analyses, and develops tentative hypotheses. An interpretive case study is descriptive, interpretive and interactive. Data generated are reflected on and interpretations are co-constructed by the researcher and participants through member checks. By carefully and authentically recording these observations, reflections and interpretations and those of the participants, 'case study researchers assist readers in the construction of knowledge' (Stake, 1994, p. 240).

Stake (1994) asserts that the selection of cases should be those that provide the greatest opportunity to learn about the issue. In this research study, three case studies were conducted in different school systems. However, a factor beyond my control was that there were few science teachers in Western Australia who were incorporating bioethics education into their science programmes. Despite an extensive search via teaching colleagues and the Science Teachers Association of Western Australia, I was unable to include teachers from public schools.

### **Data Generation Methods**

Data generation methods that seemed to be most appropriate when conducting an interpretive case study underpinned by a constructivist theoretical framework included participant observation, unstructured interviews, open-ended questionnaires, work samples and reflective journal writing (Denzin & Lincoln, 1994). The use of these multiple sources of data contributed to the trustworthiness of the findings.

### ***Participant Observation***

Participant observation is an ethnographic method that is commonly used when attempting to understand what is happening in a classroom (Crown, 1996). As a participant observer, I visited and observed the actions of the case study teachers, their students and the classroom environment. When observing in the classroom, I tried to be as receptive as possible. Always mindful of the research questions, I observed and recorded my perceptions of the classroom environment and the responses and emotions of the participants. Details of the observation techniques are outlined in the subsequent chapters about the case studies.

### ***Interviews***

During each of the case studies, I interviewed the teachers and selected students about their understanding of aspects of bioethics education. In relation to the selection of students (who were interviewed) within each case, I used a purposeful sampling

method (Patton, 1990) that allowed for maximum variation so as to perceive a wide range of students' views. The criteria for the selection of students is outlined in subsequent chapters. The length of student and teacher interviews varied from five minutes to 90 minutes. The interviews were almost always audio-taped and transcribed as soon as possible. In addition to recording verbal interaction, I was alert to non-verbal interaction (e.g., facial gestures, body language and hand movements, pauses). I recorded my reactions to these non-verbal signals as soon as possible after each interview. I consciously aimed to be empathic and to listen actively throughout all interviews.

The interviews were unstructured (Fontana & Frey, 1994) in that I did not have a fixed set of questions that I asked. Rather, I initiated interviews with open ended questions, for example, 'how did you feel about the lesson?', 'what do you think the students learnt?', 'would you do anything differently next time?' I paraphrased the participants' responses to determine whether my understanding of what they said approximated what they meant to say. I encouraged the participants to talk not only about what happened in the classroom, but how they felt about what happened. I listened attentively to and affirmed the participants' views of the learning activities.

I found that, on occasion, there was a dialectical tension between seeking information related to the research questions while still being responsive to the needs of the participants. I was always willing to compromise and allow the participants to "set the agenda" during interviews, discussing issues of interest to them rather than those that were related to the research questions.

In conducting an interview or series of interviews, it was important for me to develop a mutually beneficial and trusting relationship with the case study teachers. I found that establishing a rapport with the teachers was not difficult because I was also a science teacher with an interest in teaching bioethics in science education and I empathised with the nature of the innovatory teaching that they were attempting to undertake in their class in relative isolation.

### *Questionnaires and Work Samples*

Work samples including copies of portfolios and written tests were collected from the students. All students completed anonymously two questionnaires at the end of their course (see Appendix A). One of the questionnaires contained open ended questions and was designed to elicit information about the students' perceptions of the learning activities, teaching style, course content and learning outcomes. In the second

questionnaire, students were asked to rank the learning activities in terms of their usefulness in enabling them to understand bioethical issues. These two questionnaires were intended to address the second initial research question about the effectiveness of the learning activities.

### ***Personal Journal***

A personal journal has been shown to be a powerful tool in qualitative research (Connelly & Clandinin, 1988; Hobson, 1996; Holly, 1992). I found that the function of my journal varied during the research study. I used it for developing ideas, reflecting on the actions of myself and others, and catharsis. I also wrote in my journal when analysing data, posing questions, and developing arguments for and against emergent hypotheses. I agree with Cooper (1991) who stated that “Journals allow us to examine our own experiences, to gain a fresh perspective, and by that means begin to transform the experience themselves” (p. 99). The journal also helped me to hear and listen to my own voice. By seeing the written words on the page, the process of journal writing also assisted me in making explicit the personal values and beliefs that influenced my reflections and interpretations.

### ***Ex Post Facto Research Design***

In addressing emergent research questions one and two, which were concerned with whether students could resolve bioethical dilemmas, I utilised an ex post facto research design (Crowl, 1996; Wiersma, 1986). An ex post facto research design allows one to make inferences or infer possible causal relationships in a study. After participating in learning activities related to bioethics education, students in the three cases completed a survey containing four bioethical dilemmas. Students were asked to make a decision and then justify and explain their choice. The types of responses and mean number of reasons were analysed statistically (t-test) and compared to a similar group of students who had not been exposed to bioethics education. The purpose of the survey was to determine whether students who studied bioethics were able to resolve bioethical dilemmas better than students who had not. The students’ results were also compared to the responses of three experts. The development and purpose of the survey is explained, in detail, in Chapter Six.

### ***Narrative Tales***

In addressing emergent research question seven (i.e., why did the Biotechnology course enable *some* students to better evaluate bioethical dilemmas?) I wrote two

narrative tales to illustrate the variable student learning outcomes in Catherine's classroom. The tales were based on student interview data and classroom observations. Catherine and selected students supplied written responses about the learning experiences of the two students represented in the tales. The theoretical rationale for the use of narrative tales is described in Chapter Seven.

### **Interpretation of Data**

According to Eisner (1991), "to interpret is to place in context, to explain, to unwrap, to explicate....If description deals with what is, interpretation focuses upon why or how" (pp. 97-8). The act of interpretation in this thesis was not a value free process. It has been affected by my personal values and beliefs about bioethics education and was also initially constrained by the research questions. It was only later in the study when I moved away from the research questions to viewing the data holistically that new hypotheses emerged.

Interpretive researchers usually begin with research questions which guide the initial data generation. Yet, for me, the act of interpretation began with the actual formulation of these questions. It continued as I designed a research protocol that I believed would best answer them and as I wrote my candidacy proposal. Interpretation was ongoing when I first entered the participants' classrooms and made decisions about what events to record. The written records and my recollections, which formed part of my journal notes, served as the basis for further interpretation. Questions were generated, modified and refined as data was generated and interpreted (Gallagher and Tobin, 1991). Thus, in this study, data generation and interpretation was an ongoing process between myself and the participants whose environment I was investigating.

Briefly, for each of the three case studies, I compiled a case record of classroom observations, interview transcripts, summaries of questionnaire results and journal entries. The initial interpretation occurred in a cyclical fashion at the time of data generation. Guided by the initial research questions, I tried to make sense of the case record, to separate significant data from that which was less significant (although I did not discard data at this early stage). I relied on the case study teachers to help me with this process.

A more comprehensive analysis began as I wrote the thesis. I re-read the case records, identified and categorised themes that recurred through the case studies. I searched for evidence about each theme (confirming and disconfirming) (Erikson, 1986; Merriam, 1988). I reflected on relationships between themes within and between each case. A

comparison of the three case studies allowed an increased opportunity to search for patterns, trends and themes. This process led to emergent hypotheses (and research questions) which required (where possible) returning to the participants. This procedure resulted in the development of grounded theory (Strauss & Corbin, 1990). Further details of the data analysis and interpretation are described in subsequent chapters.

## A NARRATIVE GENRE

A narrative genre (Carter, 1993; Clandinin & Connelly, 1994; Diamond, 1995; Jungck, 1996) seemed to be the most appropriate, ethical and authentic writing style to represent the voices of myself and the research participants. This style of writing is well suited to interpretive research as it acknowledges that fieldwork and writing occur concurrently so that each informs the other (Denzin & Lincoln, 1994).

### What is a Narrative?

What is a narrative? Indeed, what does the word mean? I have read two origins of the term. The first is from Max van Manen's (1990) book *Researching Lived Experience*, which states that "'Narrative, to narrate", derives from the Latin *gnoscere, noscere*, "to know". To narrate is to tell something in narrative or story form" (p.120). Diamond (1995) gives a similar derivation when he states that "The etymology of narrative can be traced to the Latin *narrare*, to relate or to account, which derives from *gnarare* which is related to *gnarus*, knowing or skilled, which in turn is related to "to know"' (p. 82).

Despite the Latin root of "to know", a narrative is not a set of facts that purports to represent knowledge or 'truth'. Rather, a narrative account aims to portray in a rich and compelling way the problematic nature of life (including research). A narrative is an expression of our lived experience. It is concerned, not with facts, but with plausibility.

According to Shulman (1992, p. 21), the characteristics of a narrative are that they have a plot and characters, they deal with specific situations rather than generalisations and they occur within a social and cultural context that is made explicit. A narrative should also reveal a sense of human agency and intention. As Bruner (1986) states, "A narrative deals with the vicissitudes of human intention" (p. 16). A narrative will include, for example, the motives, misconceptions and frustrations of the characters.

A narrative should also affect the reader. It should compel the reader, cause them to reflect, involve them personally and transform them (van Manen, 1990, p. 121). Before I began to write this thesis, I recorded in my journal a list of personal criteria by which I would consider my narrative writing to be effective.

Firstly, my writing needs to be critically self-reflective and result in my own personal growth. It should also move the reader, touch the reader, strike a chord with them. It should be widely understood, not only by an academic audience but by classroom teachers because much of the thesis is about their experiences. The language should not jar or irritate the reader so that the message is subdued. Importantly, the writing content should be ethical to myself and all of the research participants. Finally, I want the reader to travel with me on the roller coaster ride of my research experience.

(Personal Journal, 4/96)

Thus, I agree with Diamond (1995) and Richardson (1994) that the criteria by which a narrative may be judged include verisimilitude (does it ring true? is it plausible?), coherence (does it hang together?) and interest (is it compelling?). These criteria need to be satisfied not only for myself, but also the research participants and the readers of this thesis, that is, the audience. The degree to which these criteria are achieved rests largely in the minds of the reader.

### **Narrative as a Form of Inquiry**

Narrative is a dynamic form of writing that can take us forward in our search for meaning and understanding (Clandinin & Connelly, 1994; van Manen, 1990). Jungck (1996) emphasises that “The dynamic nature of narrative is particularly important in research: if we interpret our experiences through narrative, then we can and often do reinterpret those experiences as well” (p. 117).

Richardson (1994) describes narrative writing as a method of “discovery and analysis” (p. 516). I agree with Richardson that writing is a dynamic and creative process. Writing parts of this thesis as a narrative has empowered me in a way that is difficult to describe. As this study has evolved, writing has enabled me to explore and clarify the research process in a way that would not have been possible with a formal scientific style.

Writing has been an essential component of all stages of this research study. I have been writing since the year prior to officially commencing my doctoral studies, writing about my plans, my possible research questions, my rationale, recording my thoughts, fears and triumphs in a journal, and writing summaries and reflections about every paper or book I read.

My writing proceeded through many stages and at each point I reflected on what I was learning. There were the initial field notes, that were read and typed up. There was critical reflection in the process of journal writing, after member checks of the original data, and peer debriefing. My understanding was enhanced through the selection of data from the field notes and interpretive analysis for journal articles, conference presentations and, finally, the thesis as it progressed through numerous drafts.

So how does a narrative inquiry proceed? I agree with Richardson (1994) that you don't wait for ideas to be fully formed and organised before starting to write. I sat with a pencil and a note book and wrote whatever came into my mind. There was little rubbing out. That came later. The ideas 'flowed out' of my mind onto the paper. Often, I would start a sentence not sure how it would end. Then came a process of reworking and rewriting. As I wrote, ideas, questions and hypotheses arose that I could pursue in subsequent writing. Later drafts were also concerned with grammar, structure of paragraphs, and the consistency and continuity of arguments. I have also heeded Eisner's (1997) warning to writers of narrative to avoid ambiguity and the subsequent backlash by describing in detail the context of the research findings.

I have persisted with a narrative style because I believe that an objective scientific approach would not have conveyed adequately the research process or findings. Eisner (1997) has argued that new forms of representation are needed that can convey a "sense of empathy" while also being sufficiently flexible to allow for "multiple perspectives" even if this complicates the research findings. Eisner asserts that an acceptance of alternative forms of representation such as narratives can expand the types of problems that can be investigated. As Eisner (1997) states, "how one writes shapes what one says" (p. 4). In addition, I would argue that what one wants to say shapes what one writes.

## Issues of Voice

### *My Voice*

This thesis is written partly, but not wholly, in the first person. Yet, the “I” that appears in this thesis is not constant. I am, on occasion, a researcher, a teacher, a learner, a student, a woman. In each of these personas my voice is active. As I move between these roles my writing style shifts from that of description to reflection to interpretation of my actions and the action of others. A narrative genre has helped me to reflect on these multiple roles which at times have been difficult to separate. There are times, also, when my voice is passive or seemingly absent, for example, when referring to the literature on bioethics education (see Chapter Two). Here, the focus is on synthesis and critical analysis of the work of others. Lenzo (1995) considers the use of different authorial voices to be a powerful means of portraying the multiple roles a doctoral student may play in her research study while also addressing the academic standards of a doctoral thesis.

### *The Voices of Others*

By adopting a narrative genre, I have sought to avoid the “crisis of representation” described by Lincoln and Denzin, (1994). This crisis relates to the difficulty of conveying authentically the perspectives of the research participants. This thesis endeavours to represent the views of the many individuals whom I interacted with during the research process. They include the case study teachers and their students, my supervisor, research colleagues, professional scientists, philosophers and fellow students. I have attempted to give each of them a voice in this narrative.

I needed to be particularly sensitive to the extent to which the voices of these participants were expressed. This was a measure of my value of them as individuals and I guarded constantly against taking a superior, outsider position in my writing. The difficulty of representing adequately the voices of those involved in a research study is recognised by Clandinin and Connelly (1994), who explain:

This struggle for research voice is captured by the analogy of living on a knife edge as one struggles to express one’s own voice in the midst of an inquiry designed to capture the participants’ experience and represent their voices, all the while attempting to create a research text that will speak to, and reflect upon, the audience’s voices.

(p. 423)



Narrative is the link between the research experiences (of myself and the participants) and the audience. There has been a continual process of negotiation and renegotiation in order to enable the voices of the participants to be represented fairly while maintaining my own ethical standards. I endeavoured to portray the participants' experiences as authentically and ethically as possible. I always responded to their comments about field notes, interview transcripts and sections of the thesis pertaining to them. Based on the participants' feedback, I modified or deleted what I had written to convey more faithfully their experiences.

I am aware, though, that the final version of this thesis would not sit easily with some of the research participants. Those whose views I wrote about in Chapter Six, although comfortable with my depiction of them and their comments, may not support the writing style I have adopted. For example, Brian, a research scientist, laughingly teased me about my lack of order when I told him I was writing the theory chapter after the results. Michael, a philosopher, cautioned me about adopting anything but an academic style. "Wait until you have tenure," he warned.

However, this thesis must inevitably depict my version of events. Despite 'member checks' and other strategies (e.g., interview quotes) which were intended to give a voice to the participants, I am aware that my voice has projected over that of the participants. The participants can only speak to you, the reader, through me. I decided what data to include, what to emphasise and what to dispense with. The field notes, interviews transcripts, questionnaire responses and personal reflections have been woven into a story with context, comment, critique and interpretation by myself, the narrator.

### ***Heeding the Audience***

In relation to the audience, they are few, but significant. My supervisor is an important reader who has his own set of epistemological/literary standards. There are also the requirements of the University that the results be presented "in a scholarly manner" (Handbook of guidelines and regulations for higher degrees by research, 1995, p. 13). I also needed to consider the criteria used by the external examiners in examining this thesis. The narrative needed to be sufficiently detailed and rigorous to demonstrate the originality of the work, my understanding of the field of study and its contribution to knowledge about the particular field of study (Handbook, 1995, p. 87).

There is a tension within myself in trying to satisfy even this small group of readers. Even though I feel satisfied that I have represented honestly and ethically the experiences of myself and the participants and have addressed the audience I am aware that every reader will interpret the thesis differently. As Bruner (1986) explains:

Obviously, it will always be a moot question whether and how well a reader's interpretation "maps" on an actual story, does justice to the writer's intention in telling the story, or conforms to the repertory of a culture.

(p. 35)

### **Telling the Story**

While considering how best to intertwine the research process (the means) with the research findings (the end), I read John van Maanen's (1988) book, *Tales of the Field*. I derived much pleasure from both his quixotic and humorous writing style and the book's content. Van Maanen writes about different styles of representing research. His chapter on confessional tales struck a chord with me. A confessional tale:

...is an attempt to explicitly demystify fieldwork or participant observation by showing how the technique is practiced in the field. Stories of infiltration, fables of fieldwork rapport, minimelodramas of hardships endured (and overcome), and accounts of what fieldwork did to the fieldworker are prominent features of confessions.

(p. 73)

Like a confessional tale, I have endeavoured to portray in this thesis the research process in addition to the research findings. Although ethnographers tend to write confessional tales separately from their realist tales, I have chosen to intertwine the process and the findings into a narrative. I want to convey a sense of the 'how' as well as the 'what' and the 'why'. Mostly though, I want to write honestly about my "lived experience" over the past three years.

I have been told by colleagues that I am taking a risk by writing in a narrative style and disclosing problematic aspects of the research process. Some readers may surmise that I am inept or foolish to confess my mistakes and my supervisor even more so for allowing me to expose my weaknesses. Peter, my supervisor, said something to me during one of our weekly meetings when we were discussing how to write up a part of

the results. He was probably unaware that it would impact on me the way it did. He told me to 'tell it how it happened'. I have, rightly or wrongly, taken his words at face value.

My values preclude the telling of an unproblematic tale. After all, why bother writing about the research process if I am going to iron out the problems? Thus, this thesis is a narrative of my lived experience as I fumbled about as a novice qualitative researcher. It depicts my journey and those I met along the way who helped me not only to address my research questions but to grow and flourish as a person.

## **CONSTRUCTIVIST STANDARDS IN THIS RESEARCH STUDY**

This section describes the standards that I applied in the research study. A consideration of these standards affected the type of data generated and its interpretation. In adopting a constructivist theoretical framework, the criteria used to guide the research process are based partly on those described by Guba and Lincoln (1989; 1994). They describe two sets of criteria for judging the quality of constructivist research: a set of 'parallel criteria' (based on *trustworthiness*) that mirrors the traditional standards of judging quantitative research (i.e., validity, reliability and objectivity) and a set of constructivist criteria based on the notion of 'authenticity'. The parallel trustworthiness criteria are *credibility*, *transferability*, *dependability* and *confirmability*.

### **Trustworthiness Criteria**

#### ***Credibility***

Credibility is a measure of the extent to which the participants' realities are faithfully portrayed. Credible reporting of the experiential realities of the participants in this study was ensured by prolonged engagement and persistent observation. By spending an extended period of time in the research environments (ranging from three weeks to four months), coupled with sensitive and careful observations, I had an increased opportunity to become aware of and follow up patterns, trends and relationships as they emerged.

Data generated by different techniques allowed triangulation and cross-checking of emergent hypotheses. This was coupled with negative case analysis as I searched for disconfirming evidence of these hypotheses. The practice of peer debriefing, or

talking to others unrelated to the research assisted in developing and discarding emergent hypotheses. I also maintained a record of my prior and existing constructions about the environment and attempted to ensure that undue weight was not given to these *a priori* constructions.

The practice of member checking by seeking continual feedback from participants, demonstrated not only that I valued and respected their interpretations but it was an effective means of checking, clarifying and refining working hypotheses. This process of member checking occurred during the data generation phase and through the initial data analysis to the narrative inquiry.

### ***Transferability***

Transferability is the degree to which the research findings are applicable in other situations. In constructivist research, the onus is on the reader to make that decision. In this study, transferability was optimised by the use of rich descriptions of the participants, events and context. This thesis is intended to be sufficiently detailed to allow the reader to construct their own understanding of the research environment. The thesis includes comprehensive details, not only about the findings, but the school environment (private or public), classroom environment (teacher or student centred), characteristics of students (e.g., gender, academic ability), and curriculum content, all of which may impinge on the generation and interpretation of data.

### ***Dependability and Confirmability***

Dependability and confirmability were maximised by extensive reporting of the data generation methods and interpretation (i.e., an audit trail) so that the reader can link my interpretation to the original data, thus reducing the amount of personal bias. The narrative explicitly maps an audit trail of what was done and why. The reader should be able to track the rationale of the inferences that comprise the final chapter.

### ***Authenticity Criteria***

The criteria of trustworthiness, described above, relate mainly to method and procedure whereas the authenticity criteria relate to my dealings with the participants and the effect of the research study on them. The authenticity criteria emphasise the importance of *fairness* (Guba & Lincoln, 1989, p. 245). Fairness can be ensured by listening actively to, valuing and attempting to understand the different constructions

of the participants. The continual checking of emergent views by myself with the participants occurred through an open process of negotiation and renegotiation.

This process of negotiation and renegotiation meant that there needed to be openness about the purpose of the study, active, honest involvement of the participants and a willingness on my part to continually re-evaluate my own implicit values and emerging hypotheses as the study proceeded. Guba and Lincoln (1989; 1994) describe four types of authenticity. They are “ontological authenticity” (enhancement of participants’ understanding), “educative authenticity” (an understanding by participants of how others outside the research environment perceive them), “catalytic authenticity” (where action results from the research process) and “tactical authenticity” (where participants are empowered to act and improve their environment).

### ***Ontological Authenticity***

A primary focus throughout all parts of the research study was ontological authenticity. Ontological authenticity is the extent to which the participants’ own understandings of their environment are enhanced or improved. I endeavoured to ensure that the participants developed a deeper understanding of their own teaching. I didn’t foist changes upon them, but the level of interaction made it impossible to avoid influencing the participants. Demonstration of the attainment of this criterion comes from the participants themselves when they describe, in subsequent chapters, how the research experience affected them. Thus, there was a reciprocity in the research relationships in that I wasn’t the only one who benefited from the experience.

### **Ethics in this Research Study**

The issue of ethics is important in all qualitative research studies (Brickhouse, 1992; 1993; Flinders, 1992). In research based on a constructivist paradigm, a consideration of values, and more specifically ethics, was paramount to ensure that the participants were treated with respect. Thus, attention to ethics was an especially crucial element in this research study. The use of ontological authenticity implies that ethical standards related to justice and autonomy will be adhered to. Indeed, throughout the study, I endeavoured to act in a way that respected the rights of all involved. That included myself, the teachers, students and others who contributed to this study. Nevertheless, I believed that a further ethical dimension was required.

In formulating a guiding theoretical framework for this study, I was profoundly influenced by the work of Noddings (1984) and Belenky et al. (1986). I adopted

Noddings (1984) caring ethics as a means of guiding and evaluating my actions in this study. Caring ethics is empathic, responsive and concerned with relationships. I believed that I had an ethical responsibility to be receptive to the needs of the participants. I needed to empathise with the participants if we were to develop a relationship based on trust, caring, honesty and respect, that is, to listen actively, and offer support, encouragement, affirmation and resources when required (Flinders, 1992). Only then can a mutually beneficial, collaborative relationship develop. Noddings (1984) states that, "Caring involves stepping out of one's personal frame of reference into the other's." (p. 24) The adoption of a caring ethic helped me to remain constantly alert to the feelings of the participants during the process of data generation and interpretation. It should be noted that an ethic of care was manifested differently in each of the case studies. Specific ethical issues are discussed in subsequent chapters.

An ethic of care acknowledges the importance of the relational aspects of interpretive research. By adopting a caring approach with the research participants I found that I interacted in a relational connected way with the participants. Belenky et al. (1986) use the term 'connected knower' and this describes well how I related to the participants. They explain that "Connected knowers begin with an interest in the facts of other people's lives, but they gradually shift the focus to other people's ways of thinking" (p. 115). Connected knowers attempt to see the world through the eyes of the other. They come to understand other people's knowledge through empathy. They try to share the experience that led to that knowledge. A connected knower approach is congruent with the development of a shared understanding. Erikson (1986) agrees also that "a noncoercive, mutually rewarding relationship with key informants is essential if the researcher is to gain valid insights into the informant's point of view" (p. 142).

When I wrote the initial research proposal for this study, I asserted that a caring approach and Guba and Lincoln's (1989) constructivist criteria would ensure that the research participants and myself had the opportunity to engage in the negotiation of a shared understanding of the research environment. In retrospect, I believe that the achievement of this goal was somewhat ambitious.

Early in the study, when generating data, I considered ways in which I could address the standards. I believed that this could result through continual negotiation of meaning as I shared my reflections and my interpretations of the data with the participants. I could ask them for clarification, affirmation or disconfirmation and be

guided by their comments. Together we could attempt to 'work out' what was happening in their classrooms.

However, the intensive nature of a case study (especially in the data generation phase) raised an ethical issue for me in relation to the degree of participation by the teachers and students. I needed to be continually mindful of my imposition on their time. A search for shared meaning required a considerable amount of time and effort by the participants. This clashed with my goal of adopting an ethic of care. Each of the four teachers willingly gave up their free periods and lunch times as well as their students' class time to allow me to interview them and the students. I felt it would be unethical to increase their workload still further by submitting them to intense scrutiny about their views of the research findings.

Despite aiming for a shared understanding with the participants, they didn't have the same stakeholding in this research as I. Thus, there was a dialectical tension between caring for and respecting the participants and addressing the constructivist criteria. Because of this tension and feasibility constraints associated with each case study, the degree to which the criteria of credibility, transferability and ontological authenticity were addressed varied for each of the case studies. The scope of each criterion within each case study is explicated in subsequent chapters.

## CHAPTER FOUR

### ESTABLISHING CARING RESEARCH RELATIONSHIPS

#### INTRODUCTION

This chapter addresses the third initial research question, that is, *to what extent did I establish a caring and communicative relationship with the participants?* The first part of this chapter is about the research relationship that developed between Catherine, one of the four case study teachers, and myself. The second part of the chapter focuses on the research relationship between myself and a group of five students from Catherine's class whom I interviewed regularly. In writing this chapter, I drew on the work of Guba and Lincoln (1989), Denzin and Lincoln (1994), and Noddings (1984) where they describe the standards or criteria that should be adopted in interpretive research. As described at the end of Chapter Three, the criteria that I focussed on predominantly during this research study were caring, credibility, and ontological authenticity. This chapter documents the way that I attempted to address these criteria and the constraints that effected my endeavours.

Catherine's case study developed into the most intensive and I believe, most fruitful research relationship of all the four cases. There were several reasons for this. Firstly, I had originally developed the Biotechnology course that Catherine taught (see Chapter One) and, thus I was familiar with the structure of the course and the learning activities. Secondly, I knew Catherine from a previous school. Thirdly, during my doctoral studies, I worked part-time at Catherine's school and thus I had frequent opportunities to follow up emergent research questions with Catherine and her students.

#### BUILDING A CARING RELATIONSHIP WITH CATHERINE

In this chapter, I have endeavoured to document the relationship that developed between Catherine and myself. In developing a relationship based on caring, I attempted to empathise with and understand Catherine's perspective. Indeed, I believe that the research relationship that developed between Catherine and myself was a crucial factor in the success of this case study. I hope that the reader will discern that together we created a caring relationship that enhanced not only my understanding of the research environment but enriched Catherine's understanding of her teaching practice and her students (i.e., ontological authenticity).



## **Background**

Before I invited Catherine to participate in this study, I knew her both professionally and personally. I first met Catherine three years ago when I changed from full time to part time employment at my previous school. I was completing my Master's project and found that I had difficulty balancing the demands of full time teaching with study and parenting. Catherine was employed to teach the classes I had given up. Although I saw little of Catherine at that time, because our timetables differed, we found that we shared common interests and work backgrounds and had similar aged children. She has a great sense of humour and she helped me to appreciate the lighter side of teaching.

Eighteen months later, when I commenced my doctoral studies and again changed from full time to part time employment I rang Catherine to urge her to apply for the available classes. I was now teaching at a different school. I approached my Head of Department and recommended Catherine to him. She was subsequently employed. Catherine and I worked well together. For example, if she or I had commitments with our respective children, we would cover each other's classes.

When I realised that Catherine would be teaching the Year 10 Biotechnology course (developed as part of my Master's degree), I had no hesitation in asking her to participate in the study. I asked Catherine if she would be willing to assist me with my research and she readily agreed. I was pleased because I considered her to be a 'good' teacher. She was very organised and cared about the progress of her students.

## **The First Interview**

Prior to teaching the course, I interviewed Catherine to determine her perceptions of the role of bioethics in science. When I asked if she had ever thought about whether she had a responsibility to teach students about bioethical issues she replied:

No, but sometimes when I teach certain topics like genetics, issues come up. The students want to discuss them. I'm quite happy to stop the class and listen to their comments.

( Interview, 18/7/96)

I asked Catherine how she felt about teaching a course that aimed to increase students' understanding of bioethical issues. Catherine stated that it is important that "students

can take a moral stand on issues and that they know how to make ethical decisions” (Interview, 18/7/96). Although her preservice teacher training did not prepare her to teach about bioethical issues, and they were never discussed in her science degree, she felt confident about her ability to teach the course. Thus, despite Catherine’s lack of experience with teaching students about bioethics she responded favourably to the proposition.

Because I had previously taught the course, I offered Catherine my teaching package which included a teaching programme, student booklet, resources and assessment items. She chose not to use the teaching program and student booklet, but rather to plan her lessons from week to week depending on the needs and interests of her students. (See Appendix B for a copy of the teaching program used by Catherine.) The course comprised 24 x 55 minute lessons spread over six weeks. Catherine used *Transplantation: the issues* (1992) as her main resource. Some of the learning activities used by Catherine utilised class and group discussion of case studies that raised bioethical dilemmas, role plays, design and administration of a questionnaire to determine the views of friends and relatives towards transplantation, and preparation of a library portfolio. Chapter Five describes the learning activities in more detail.

Although I did not hesitate to ask Catherine to help me with my research, I was concerned about how I should interact with her in a research setting. Before the study commenced, I recorded my qualms in my personal journal.

I have a major problem to reflect on - the nature of the research relationship between Catherine and I. Am I to be a participant-observer, or do I actively coach her about how to teach bioethics or should I just help her to reflect on her teaching? Which is the most ethical, the most authentic using Guba and Lincoln’s criteria? Whose interests are being served here? She is doing me a favour. She is my friend. I will offer to take her Form class. She hasn’t asked for help. Should I offer it? How explicit shall I be about what I hope to achieve? Do I have the expertise to do this? I need to think seriously about these issues in the next few days.

(Personal Journal, 4/7/96)

On reflection I have three choices.

1/ I act as a participant observer. I have given Catherine my teaching package with the assessment, teaching program, student booklet and resources. I could just let her go for it. This doesn’t meet the criteria of ontological

authenticity. Catherine would gain little from me being there and might end up feeling negative if I stand back and the course doesn't 'work'.

2/ I could try and assist as much as possible, discuss the rationale related to the material -ethics- and the style of teaching -constructivism- and keep in close contact. I could tell her what I did, what worked and what didn't. This may avoid problems but is a bit paternal for one adult to another.

3/ The third possibility and my preference is to encourage Catherine to be reflective, to answer the questions she asks, to let her set her own goals, (like action research). The advantage of this approach is that I avoid imposing my agenda. Catherine makes her own choices. To compensate for imposing on Catherine's time with interviews, etc., I have offered to take morning Form class on a day she doesn't have any morning classes, but she doesn't seem keen.

(Personal Journal, 10/7/96)

In these journal entries, I reflected on what would be the most ethical way to behave. I realised that I needed to make decisions about what data to collect, but uppermost in my mind was how to treat Catherine with respect and care. I did not want to impose on her time which is why I offered to take her Form as a payback for giving up her free time for interviews. The reason for wanting to treat Catherine ethically was not to ensure that I could collect as much data as possible. It was because I valued Catherine as a person and a friend.

After the last journal entry, I telephoned Catherine and explained my concerns and also outlined the three choices regarding the depth of my involvement with her class. She (being my friend and agreeable) told me that she didn't mind what I did. So I decided to try the third alternative. I would endeavour to encourage Catherine to reflect on her teaching practice as she taught the course (ontological authenticity). I had developed the course and also taught it previously so I could share with her my perspective of potentially problematic areas. When I reflect on this decision now, I believe it would have been dishonest and unfair to allow Catherine to 'plough through' the course making the same mistakes as I had. At the time I wondered if 'encouraging Catherine to be reflective' was too nebulous a goal. After all, what expertise did I have in this area? However, although I had not explicitly helped a teacher to be reflective, I had frequently listened to teachers discuss their work and asked them questions to deepen their understanding of their teaching practice. I had also carried out action research in my classroom.

I decided that during our interviews I would seek from Catherine her perceptions of the learning activities, and ask her whether she had any concerns. I would encourage her to discuss whatever she felt was important. Although, from my experience, I believed that a student-centred approach would work best, I didn't want her to adopt a particular style of teaching that she felt uncomfortable with.

### **Enhancing Ontological Authenticity**

Early in the case study, when generating data with Catherine and her students, I considered ways in which I could enhance ontological authenticity. I believed that this would result through continual negotiation of meaning as I shared with her my reflections and my interpretations of classroom observations and interview data.

I asked Catherine if she would agree to be interviewed twice a week while she taught the course to discuss her perceptions of what was happening in her class. Over the six weeks, we spoke many times, both formally and informally. During the interviews, most of which were audiotaped, I strived to encourage Catherine to reflect on her practice by asking open questions. I always endeavoured to support and affirm her actions and to share with her my previous teaching experience. The following three interview extracts typify these aspects of my role.

The first extract indicates how, by questioning Catherine about her actions I endeavoured to encourage her to be reflective and articulate her concerns, and how I drew on my past experience to alert her to possible difficulties.

- Vaille: How about the portfolio? How do you think it went?
- Catherine: Yes. They are a bit confused at this stage. They were keen. They did quite a lot in the library. I said they need to get information from different sources, for example, magazines, CD ROMs, science journals and books so that they can appreciate the different media.
- Vaille: Did they choose an issue?
- Catherine: Yes. I said to stick with one. I made a few suggestions. Some are finding their area is too narrow, so I suggested they broaden it. For example, one student wanted to do surrogacy. There is not much information so I suggested she look at IVF. They need to give one A4 page for each article, a half page summary and a half page opinion.

- Vaille: They will find the opinion the hardest.
- Catherine: It's hard to put your opinion down on paper.
- Vaille: It is a good idea to make it clear like that, because I didn't and they tended to have nearly a page on the article and one sentence of opinion.

(Interview, 31/7/96)

The second extract illustrates an attempt to empathise with Catherine's concerns about the problem of students not listening to each other in a large class. Here, I make tentative suggestions about how to ameliorate the problem, and I affirm her positive experiences with a student-centred approach.

- Catherine: They don't seem to listen to each other.
- Vaille: It's hard with 30 students as it is a course with lots of talking. Ten would be an ideal number.
- Catherine: 30 is too many.
- Vaille: Yes. I had 30 students too. I found with whole-class discussions, I could only have about ten minutes at the start of the lesson. For the rest of the time I got them to work in small groups. Then they talk to each other.
- Catherine: I liked the way the pairs worked on Monday. I walked around and helped them.
- Vaille: Yes, my observation was that they were very excited. Although they lost it in the last ten minutes, before that, they were on task. Another thing for later is maybe to get them to work with different partners as sometimes like attracts like and they just confirm each other's views.
- Catherine: Yes, I'll try that.

(Interview 31/7/96)

The third extract refers to a questionnaire on transplantation that students designed and administered. It is an assessment item, but Catherine had forgotten to tell them to also write a summary and discussion, the completion of which comprised most of the marks. Here, I provide Catherine with a possible solution.

- Catherine: The students designed the questionnaire. They are interviewing ten people and then handing it in.
- Vaille: So, you didn't get them to write a summary and discussion.
- Catherine: No, I guess I should have done.

Vaile: Maybe when it's handed in, have a look and then give it back to them to write a summary and discussion in class and use that as part of their assessment.

Catherine: Yes, that's a good idea.

(Interview 13/8/96)

As part of this study, I was also interviewing regularly a group of five students (see later). With their permission, I was able to alert Catherine to problematic issues about which she was unaware. For example, one of the assessment requirements was that students collect a portfolio of ten articles related to a controversial issue in science (e.g., abortion, euthanasia). Students were free to choose their own issue. They were required to comment on each of the articles and state their views. During an interview with the students, they expressed their dissatisfaction in carrying out this task. Many of the articles were similar and the students were finding it difficult to write a range of comments. They thought it would be better (and easier) to write one final comment.

I spoke to Catherine about the students' dissatisfaction with the portfolios. She was surprised as she was unaware of any discontent. She was concerned about changing the structure of the portfolios as some students had already submitted them. I suggested that, perhaps, students could have the option of one final extended discussion at the end of the portfolio or a short discussion at the end of each article. There would be no penalty whatever method they chose. Catherine agreed that this was fair and informed the students about this option.

### **Enhancing Care Within the Relationship**

I endeavoured to ensure that an ethic of care underpinned my relationship with Catherine. Implicitly and explicitly I acknowledged and valued Catherine's contribution in this research study. I demonstrated empathy and care for Catherine and she reciprocated.

The data that I generated included classroom observation notes, interview transcripts and my reflections and questions recorded in my personal journal. In relation to the interviews, I found it beneficial to transcribe the tapes or write about our informal conversations as soon as possible. I recorded in my journal the advantages of doing this.

As I write I am posing questions and hypotheses to guide my data collection. I am finding that, as I transcribe the interviews, questions arise for me to take

up with the students or Catherine. I am trying to keep my mind as open as possible. I want to observe as much as I can, follow every strand in our conversations as well as ensuring I am empathetic and caring. It's like a fishing expedition. I'm fishing around but I don't really know what I'm looking for.

Also, listening to the interviews, I am glad that I am transcribing the tapes myself, rather than paying someone. The words and the tone of our voices reminds me of my feelings at the time. During the interview, I don't think I was fully aware of the emotions because I was focussed on maintaining the conversation, the affirmation, the empathy, the seeking of clarification, the checking of interpretation, even watching the clock.

Also in transcribing the tapes, I notice the laughter, the pauses and the change in intonation. These are absent from most transcripts and yet, for me, seem to add an essential rich dimension. Listening to Catherine and I speak to each other, even finishing each other's sentences, I am reminded of Dale Spender's (1980) book, 'Man made language', where she examines and compares the conversations among groups of men and groups of women. Listening to the students' interviews I note the same affirmations, completion of sentences and respect.

(Personal Journal, 10/8/96)

Spender (1980) asserts that in conversations women tend to take a supportive role, propping up the other by listening and providing, on cue, reassuring phrases (p. 48). I believe that active listening and positive feedback are an essential component of meaningful, caring conversation. The ability to listen is not easy to measure or to record. Active listening can't be heard on a tape. Yet, it is probably more demanding to actively listen than to speak. There seemed to be a connectedness, of relationships and responsibility in the interviews between Catherine and me. This relates well to Belenky et al.'s (1986) description of the importance of connectedness. At no stage in the research study did I ever perceive that Catherine was dissatisfied or unhappy with her involvement.

In adopting a caring approach, during our interviews, I encouraged Catherine to discuss areas of interest to her. On occasion, we drifted off into topics that were virtually unrelated to the course, as shown in the following extract of a discussion on abortion.

- Catherine: Did you watch that fabulous documentary 'True Lives'? It was on the ABC the other night. It was about this woman. There is a photograph of her crouched almost in a foetal position on the floor surrounded by blood. She had died during a back yard abortion.
- Vaille: Oh, my God!
- Catherine: And Ms magazine had done a feature article.
- Vaille: I've seen the photo.
- Catherine: Yes. You would have. It's very well known.
- Vaille: Is it an old photo?
- Catherine: Yes, very old. It's from 1969. It happened before abortion was legalised and they used the photo to give the other side, that women die of backyard abortions, as opposed to the pro abortion lobby who were showing photographs of foetuses. And I was telling the students about the two sides of the story in the abortion issue. It was so interesting. They interviewed her two daughters who were little at the time and are adults now. They asked them what they thought of it. They said how shocked they were. They were never told their mother died from an abortion. They were always told she died in a car crash. It was awful.
- Vaille: So sad.
- Catherine: It was very moving.

(Interview, 2/9/96)

### **Enhancing Credibility**

In order to enhance the credibility of the study, through member checking, I regularly gave Catherine a copy of the case record. Prior to the first occasion, I wondered what Catherine would make of my journal entries, classroom observation notes and interview transcripts. In behaving ethically, I wanted to give her the opportunity to contribute to what I had written. However, I wondered if she might be offended or disturbed by what I had written. Catherine had never been involved in this type of research. It may have been disconcerting for her to read about herself in such detail. From a constructivist perspective, she may well have interpreted the classroom events quite differently from me. Nevertheless, I needed to give her the opportunity to have a say. When I first gave Catherine what I had written I asked her to consider the following questions.



- 1/ Have I fairly represented you?
- 2/ Are there important issues that I have missed out?
- 3/ Can you clarify or add to any of the points I have written about?
- 4/ Does what I have written help you to think about your teaching practice?

At our next interview, I asked Catherine what she thought of what I'd written. She replied, "Yes, it was good. I thought it was very accurate. You've summarised it really well" (Interview, 5/8/96). I asked her if she felt that she had been represented fairly, to which she replied "Yes". I explained that I had felt a little embarrassed about what I'd written as I was not sure what she would think. She said that she was not concerned. She told me that the most difficult aspect was being watched in the classroom. It made her feel nervous and very careful about what she was saying and doing. I reassured her that I was not there to judge her or look at issues related to classroom management. I was there to determine how she chose to teach the course and to observe the students' reactions. She felt that what I had written did help her to think about her teaching practice.

The next time I gave Catherine the case record, she had been too busy to read it. On the next occasion her only written comment was, "It's fine". She asked me if it was really necessary for her to read it. After all, what I'd done so far was fine. I explained that I wanted to give her the opportunity to have an input. She said that it wasn't important to her. Because I was reluctant to impose further on Catherine's time, I subsequently gave her a copy of the interview transcripts and classroom observation notes and after asking her if she thought they were a fair representation, I didn't pursue the issue further.

Finally, what did Catherine think of her involvement in this study? I posed these questions during our final interview.

Vaile: I want to ask you how you feel having taught the course.  
What is your overall impression?

Catherine: I found it extremely difficult at first. I was very nervous as it is quite nebulous. You can't just pick up the teaching package and start wading through the information. But as it's developed I found it so enjoyable to teach. It's been about getting their feedback and still giving some information. Not too much so that they are swamped. I would probably make a few changes.

- Vaille: So. What do you think you've learnt from teaching the course?
- Catherine: I've learnt a lot. I learnt about transplantation. I guess what I've really learnt is that I can teach a non-structured course.
- Vaille: How about being involved in the research?
- Catherine: I'm actually sad it's over.

(Interview, 2/9/97)

### **Catherine's Perspective**

After writing this section, I asked Catherine if she would be willing to read what I had written about our relationship. In seeking credibility, I felt it was important for Catherine to have the opportunity to provide feedback on my interpretation of the relationship between myself and her. One of the difficulties Catherine experienced in providing feedback was her lack of experience with both the writing style and the language. Her first comment (accompanied by laughter) was "I found it horrible to read. I don't even know what ontological authenticity means" (Interview, 3/98). She was also embarrassed about reading a text that focused on herself. As she explained, "you never read about yourself really or how other people think about you. So I actually find this really quite strange". I acknowledged that it was "full of jargon". I explained to Catherine why I had written this part of the thesis and why I had felt compelled to seek her input. Catherine then told me that, she felt that her participation in the research study had been beneficial. She explained:

I suppose it makes you more reflective. About how you are doing something because you are having to discuss what you do every lesson and normally you wouldn't. You would still probably make certain changes. It probably helps you to make those changes more quickly. You really do have to stop at each thing and think was that very successful? How can I do that better next time? And I must admit I have done that. I have changed things.

In a sense, [during the interviews] half the time I was asking you how you taught it. I wanted to know for my benefit how things worked. Like the business with the portfolio. It works so much better now. It was too long before. I don't think we would have found out so quickly. I don't think I would have known to make that change.

(Interview, 3/98)

Catherine's comments help to confirm my perception that I did have a positive influence on her teaching and that we did establish (and maintain) a relationship based on care and respect.

## **Conclusion**

From the commencement of this study, I endeavoured to act in a way that was ethically caring and that would enhance credibility and ontological authenticity. I found though, that there was a continuing tension about which I strived to find a balance, in addressing these criteria. To enhance credibility, I needed to observe as many classes as possible and frequently seek Catherine's perspective on my description and interpretation of events. This required frequent interviews with Catherine. As the case study continued I realised that Catherine was not particularly interested in making extensive comments on the case record. I believed that it was essential to be constantly alert to Catherine's needs and sensitive to the extent to which she wanted to be involved in this study. Thus, I chose not to seek the level of credibility that might have been possible if I had asked Catherine for extensive feedback on all aspects of the research. By maintaining a flexible approach, I believe that I was able to achieve a balance between my needs and Catherine's (surely the basis of a successful caring relationship)!

## **BUILDING A CARING RELATIONSHIP WITH STUDENTS**

This section describes the nature of the relationship that developed between myself and a group of five students in Catherine's class. The students were interviewed regularly (once a week) for the duration of the Biotechnology course. In adopting an 'ethic of care', I endeavoured to establish a caring relationship. I have documented our interactions below to demonstrate that the students and I developed a relationship that fostered mutual inquiry, care, trust and respect. I needed to remember, however, that as a teacher at the school, I was in a position of authority. I could not pretend that the students were my equals. However, as in all relationships we aimed to treat each other with empathy and respect.

At the commencement of this case study, I gave serious consideration to the type of data that would be most useful in enabling me to assess the impact of student learning of Catherine's teaching. I had recorded my observations and perceptions of student behaviours in the classroom and during interviews with Catherine I had obtained her perspective on students' reactions to the learning activities. But, I realised that I needed to obtain also the students' perceptions of the learning activities. After all, the

students were the recipients of pedagogical decisions and were thus ideally placed to provide an important perspective. I felt that it would not be sufficient to merely ask the students to complete a questionnaire at the end of the course (although I did do this, as well). I believed that the credibility and transferability of this study were enhanced by seeking the students' perceptions as the course progressed.

### **Planning the Interviews**

In order to establish (quickly) a trusting and caring relationship, I planned to interview a group of five students whom I had taught previously. I elected to interview five students, in total, because I wanted to allow for a wide range of views. This may not have been possible if I had interviewed fewer students. Also, it was logistically difficult to have regularly interviewed a greater number.

There was only one student in the class (Frances, a pseudonym) whom I had taught previously. Frances is an articulate student of average academic ability. In order to interview a representative sample, I selected students of average ability rather than the most able students in the class. From the class list, I chose Amber, because I knew that she was a friend of Frances. I felt that the students would be more comfortable with their friends. Then, I asked Catherine to recommend some students. She suggested Sarah who was also a friend of Frances. Through discussion with other teachers, I also chose Corinne and Katie who are friends with each other and also of average academic ability. The selection of students who were friends would, I hoped, ensure that they felt comfortable during the interviews because they were with their friends. Although I deliberately selected students of average ability, I cannot claim with certainty that they were representative of the class cohort.

The students were interviewed as a single group. There were three reasons for this. Firstly, I believed that the students would be able to listen to and build on each other's comments and, secondly, it saved time. Thirdly, in reflecting on the interviews, I believe that the students felt more secure as a group than they would have if I had interviewed them separately. I believed that if the students felt safe in each other's presence they would be more willing to divulge their thoughts.

Prior to the first interview, I read a number of articles related to conducting interviews (e.g., Denzin & Lincoln, 1994; Fontana & Frey, 1994; Merriam, 1988). Based on these readings, I chose to adopt an unstructured interview style. In advance, I prepared open questions based on my classroom observations and prior interviews with Catherine and the students. During the interviews, depending on the students'

answers to these questions, I asked further questions to clarify their comments. I also rephrased their replies to check that I understood them. Except for the first interview, I audio recorded the interviews, as this enabled me to listen actively and also to ensure that all students participated.

### **The First Interview**

During the first interview (26/7/97), which was conducted during class time, I endeavoured to ensure that the students were comfortable about participating by providing as much information as possible about the purpose of the research study. My manner was relaxed and friendly rather than authoritarian.

I took the five students from their class to a nearby seminar room and I think that initially they were nervous and thought that they may have been in trouble. I assured them that this was not the case. I explained to the students that I was studying at Curtin University and that as part of my studies I was collecting data about the Biotechnology course. I explained that I would not be testing or judging them. It was the course that was important to me. I said that I was interested in their views, and that although I was interviewing Catherine, her viewpoint was that of the teacher. Even when I observed the class, my view was that of an external observer. I wanted to know how they, as students, felt about the course content and the learning activities. I said that I had chosen them as they had been recommended to me, or I knew them. I asked them if they would agree to be interviewed once a week for the duration of the course (i.e., six weeks). I said that I would use the last 20 minutes of the weekly lesson they spent in the library carrying out research for their portfolios. I felt that this arrangement would have a minimal impact on their learning and would not require them to give up their free time. The students agreed. I asked them if they would mind me audiotaping future interviews because I found it difficult to listen, talk and write. Again, they said they didn't mind.

I also raised the issue of confidentiality and said that I would use pseudonyms when I wrote up the interviews, and also maintain the anonymity of the school. I informed the students that I was interviewing Catherine regularly. I asked them how they would feel if I discussed what I learnt from them with Catherine. They all agreed that it was not a problem. I said that if they changed their minds they must let me know.

The students seemed keen to participate. I said that they could withdraw at any time if the interviews became a problem for them. I gave each of them a copy of a permission letter to take home to their parents (see Appendix C). The permission letter explained

that I was a doctoral student at Curtin University and that I was evaluating the learning activities used in the Biotechnology course. I provided a contact number in case any of the parents required further information.

Later that evening I recorded in my journal my first impressions of the students.

The students were all very agreeable and able to express themselves well. One possible concern is that they are 'nice' girls and might always agree with each other. They also might not be able to raise negative issues with me. I'll wait and see.

(Personal Journal, 26/7/96)

As it turned out, I was wrong. They did not always agree with one another and they were able to raise problematic issues with me.

### **Establishing Trust and Empathy**

During the second interview (the first to be taped), the students were somewhat reticent about speaking. I was not sure whether this was due to the presence of the tape recorder (which was small and unobtrusive) or because my questions were difficult, or alternatively, because the students were not sure what I wanted from them. For example, I asked Frances, whom I had taught previously, what she hoped to learn from the course. When I probed her understanding she paused. As the following interview extract demonstrates, I used this situation to reassure all of the students that whatever they said was valuable.

Vaille: I'm going to ask some general questions about how you're going. I know you haven't had many lessons but I'd like to ask you, what do you hope to learn? Frances, can I start with you?

Frances: I'm not really sure what we're meant to learn. About social issues, about what society accepts.

Vaille: So why would you want to learn about these things?

Frances: To find out other peoples' point of view.

Vaille: Do you think that's important?

*A pause, and then Frances laughs nervously. I sense her insecurity.*

Vaille: Whenever I ask a question, there's no right or wrong answer. If I ask more questions its just that I want to understand what you think. Is that okay?

Frances: Yes.

(Interview, 31/7/96)

At subsequent interviews, the students became increasingly relaxed and open. On no occasion did I sense that the students did not want to be involved or interviewed. When I arrived in their class, they always packed up quickly and went to the seminar room where they chatted for a few minutes before the interview started.

Despite endeavouring to involve all students, I noticed from the interview transcripts that three of the students, Frances, Corinne and Katie, did most of the talking. Amber and Sarah seemed to be silent in the transcripts. Yet, I believe they were mentally engaged during the interviews. This seemed obvious from their 'body language'. They were, at times, smiling, nodding and laughing. When I gave the students a copy of the interview transcripts they were surprised that they had said so little. Amber commented on her seeming lack of participation.

Amber: I only said three things and I thought I said more than that.

Vaille: Sometimes in a class you think lots of people talk but when you see a record you may find out that only a few people do. I was aware that you were quiet, but I would have estimated that you spoke more than that. Does it bother you?

Amber: No.

(Interview, 21/8/96)

### **Respect for Students' Views**

Although the main purpose of the interviews was to investigate the students' perceptions of the learning activities, during each interview, I asked the students if they had any questions or comments to make. Thus, I provided them with the opportunity to raise issues of interest or concern to them. It was on one of these occasions that Frances and Katie expressed their reservations about the portfolio which comprised 30% of their assessment. Near the end of the interview, I asked the students if they had any comments about the course.

Vaille: So thank you for everything you've done so far. Is there anything else.

*I reach to turn the tape off as Katie says quickly and quietly*

Katie: I think the portfolio is a waste of time.

Frances: Yes, so do I.

- Vaille: Why?
- Katie: Well, I'm doing abortion. I've got ten articles and I've got to write an opinion for each one. The articles are similar and my opinion is the same each time.
- Vaille: Why don't you talk to Mrs [M] about that? I think it's a valid point that you are raising. Why don't you ask if you can write an overall opinion at the end?
- Katie: We sort of did and she said no.
- Frances: Maybe we could write an overall opinion at the end.
- Katie: Mm. I don't know.
- Vaille: I'll talk to her about it today. We have spoken about the portfolio and we are aware that it is difficult.

(Interview, 21/8/96)

I realised that the students were genuinely concerned about this major assessment. After the interview I spoke with Catherine about the students' difficulty completing their portfolios. Alerted to the difficulty, Catherine modified the assessment requirements. I believe that because the students trusted me, they felt that their concerns would be accepted empathically by me.

### **Enhancing Students' Ontological Authenticity**

By encouraging the students to talk about their perceptions of what was happening in the course, their discussions often diverged into a continuation of their classroom discussions. To increase their understanding of the course (i.e., ontological authenticity), I was quite willing to facilitate these discussions as the following extract demonstrates.

- Vaille: So what have you been doing?
- Katie: We watched the video on transplantation about the man who lost his two sons.
- Vaille: Oh yes, *Sharing yourself around*. It has Roy Knudson talking to the school students about transplantation and asking for their opinions.
- Vaille: So what did you think of it?
- Corinne: It was really good. I thought if you had a heart transplant it would last forever, but it doesn't.
- Vaille: So what did you learn? Did you listen to the students' views on the video?



Corinne: Their ideas were like ours except for that one girl. She was really annoying.

*One of the students in the video says that she would refuse a transplant even if it would save her life.*

Corinne: I know it's her opinion. I don't know. She might have had her reasons.

Vaille: Why? What was her opinion?

Corinne: She was like, we're gonna die anyway so why bother?

Vaille: So why did you disagree with her?

Corinne: Well, if you have a chance you should take it.

Sarah: Someone's gonna die anyway. You may as well save a life.

Frances: Maybe it's God's will that you should save lives.

Vaille: That's a good point Frances, very good. We have the technology. Maybe it's God's will that if we have the technology we should use it.

Katie: I think if you have a transplant, it's God's will. Its not tampering with nature. You should use the technology.

Vaille: What about you Amber? Any thoughts?

Amber: Yeah, take it if you get the chance. I'd take it if I had to.

Vaille: Would you force other people?

Amber: No, but I'd tell them they should.

Vaille: Do you understand the point of view if the family doesn't want to donate organs?

Katie: Yes, it is like tearing a person apart. I can understand that people might want their family members to be buried whole.

(Interview, 5/8/96)

The discussions that the students engaged in during the interviews helped me to become aware that the students held differing viewpoints on issues related to transplantation.

Because I had developed and taught the course previously, I was able to assist the students when they had difficulties with aspects of the course. For example, in the following extract, the students are describing their difficulties finding information for their portfolios.

Vaille: So how are things?

- Frances: I haven't done much work today. I can't find any information.
- Vaille: What's your topic.
- Frances: Abortion.
- Vaille: Have you checked the vertical files?
- Frances: Yes, I couldn't find it.
- Corinne: Oh, I've got it.
- Frances: Have you?
- Corinne: It's not much help. The articles are long and they all say the same thing.
- Vaille: You can use the CD Rom perhaps or ring up the Family Planning Association. They will send out information. Either that or you could broaden the topic to contraception.
- (Interview, 5/8/96)

### Enhancing Credibility and Valuing the Students' Input

Halfway through the course, I gave each of the five students a copy of their interview transcripts. I wanted to seek feedback from the students to act as a 'member check'. By showing them what I had written, I also hoped to demonstrate that I valued their opinion. I asked them if they would read the transcript of the interviews before I met with them again. When I gave them the transcripts, they seemed to be amused, as demonstrated in the following interview extract.

- Vaille: I'm going to give you the write ups of your past interviews.  
*I pass them around.*
- ?: Oh God. Look at this!
- Vaille: I've written up what you said.
- Fiona: Are you V?
- Vaille: Yes. There's a few question marks where I'm not sure who said what. So if it was you, write your name there. I'd also like you to read it and tell me what you think?
- Fiona: I never said that.
- Sarah: No, I said that.
- They are all laughing now.*
- Vaille: Remember what I have written is confidential as far as other people are concerned. So don't be embarrassed. It's not that funny.

*They were now laughing hilariously as they read each other's comments.*

(Interview, 13/8/96)

At our next interview, I asked the students to comment on the transcripts.

- Vaille: What did you think of the interview stuff?  
?: It's good.  
Vaille: Sarah, how did you find it?  
Sarah: Good.  
Vaille: Did you learn anything?  
Sarah: No, not really.  
Vaille: Was it accurate?  
Sarah: Yes.  
Vaille: Do you think it has been useful for you to read it?  
Amber: Well, not really as we all basically have the same views.  
Vaille: Katie, do you have any comments on what I've written.  
Katie: I thought it was pretty accurate as far as I remember.

(Interview, 21/8/96)

The main reason for showing the students what I had written was to determine whether they felt that I had fairly represented their views (i.e., a member check). I believe that by giving the students the transcripts to comment on, I not only enhanced the credibility of the findings, but I demonstrated that I valued their viewpoint.

## **Conclusion**

It is impossible to state and provide irrefutable evidence that I established a caring and trusting relationship with the five students. However, the 'objective' evidence that I have presented here supports my tacit understanding that I did succeed in achieving this goal to a satisfactory degree. Despite providing examples of conversations between us, you, the reader can only guess at the friendly tone of our voices, the warm laughs and the empathetic nods.

The input from the students was essential in enabling me to understand the nature of Catherine's classroom. I also believe that the interviews served to increase the students' understanding of transplantation and bioethical issues (i.e., ontological authenticity). At the end of the course, Catherine spoke to the five students about their involvement in this research study. They told her that although it was inhibiting at first, overall they enjoyed the experience. They felt that they had had some input into

the way the course was taught. I believe the depth and the quality of the relationships that developed between myself, Catherine and the students enriched my own and their understanding of the research environment.

## CHAPTER FIVE

### CATHERINE AND THE BIOTECHNOLOGY COURSE

#### INTRODUCTION

In the previous chapter, I illustrated the type of research relationships that developed between myself and Catherine and her students. The focus of this chapter is the Biotechnology course taught by Catherine. In this chapter, I focus on the initial research questions; *what learning activities are utilised by secondary science teachers who are incorporating bioethics education into their teaching programmes?*; and *how effective are the learning activities in enabling students to reflect critically on, articulate and justify their bioethical values?* In addressing the first question, I have selected five vignettes, extracted from the case record which, for me, typify the range of learning activities that Catherine used to introduce her students to aspects of bioethics education. For the second research question, I describe Catherine's and the students' perceptions of the effectiveness of the Biotechnology course in enabling the students to explore bioethical issues.

#### THE BIOTECHNOLOGY COURSE

##### Context of Course

Catherine teaches in an independent girls' school in Perth, Western Australia. In Term 3, 1996, she was teaching, for the first time, a Year 10 Biotechnology course. The Biotechnology teaching programme was initially developed by myself as part of a Master's degree (see Chapter One, p. 19). The primary resource was *Transplantation: The issues* (1992). The learning activities listed in the teaching programme (see Appendix B) were intended to increase students' understanding of human tissue and organ transplantation and also to introduce students to bioethics education. As described in Chapter Two, bioethics education aims to help students to develop, articulate and critically evaluate their own bioethical values within a climate of respect and tolerance. Bioethics education can also enable students to develop and enhance their decision-making skills in the resolution of bioethical dilemmas (Macer, 1994a; Reich, 1995).

There were 30 students in Catherine's class. When asked by Catherine (and myself during student interviews) why they had chosen the course, students' reasons

included: an alternative to Physics and Chemistry, subjects which they perceived they had neither the ability or interest to succeed in; an interest or intention to study Human Biology in Years 11 and 12 or pursue a career in a related field, and a belief that the course would assist their later studies; and an interest in a new topic offered by the school.

### **Data Sources**

Throughout this case study, I applied the standard of credibility. Credibility was enhanced by prolonged observation and continual member checks with the main stakeholders (i.e., Catherine and the students). Sources of data included multiple classroom observations, semi-structured teacher interviews (after each lesson) and semi-structured interviews with a group of five students (weekly). As I wrote the thesis, I conducted follow up interviews with Catherine and her students. Other data sources included students' work samples, (e.g., library portfolios, written tests), journal reflections (Holly, 1992) recorded after interviews and observations, and two questionnaires completed by all students at the end of the course (see Appendix A for a copy of the questionnaires). The questionnaires were designed to obtain measures of students' perceptions of the learning activities, course content and learning outcomes related to bioethics education.

### **Catherine's Teaching Goal**

During an early interview with Catherine, I asked her what she hoped to achieve as part of her teaching role. Catherine's primary teaching goal was "getting students to think". She wanted her students to become more critical and to question information. She articulated this goal after the first lesson from which she emerged, somewhat frustrated, to tell me:

The students haven't got a clue. They accept unquestioningly everything they read. The only issue that they object to is the use of animals in research.

(Interview, 25/7/96)

During the first lesson, Catherine had discussed the movie, *Junior*, in which the male lead character steals a frozen ova which is fertilised and implanted in his peritoneal cavity. She believed that the movie raised many ethical issues and that she and the students would be able to discuss them. She found though, that although almost all of the students had seen the movie, they were unaware that there were any ethical problems. She explained further:

For me, the taking of the egg was unbelievably wrong, whereas for most of the students they just accepted it. The big issue was interfering with Nature. In Junior, the man is having a baby. “Is this right?”, I asked them, “Do you want to give up your unique role?” They hadn’t thought about it. I kept saying, “Well, what do you think?” They just looked at me.

In fact, after seeing their lack of reaction, one of my objectives in this course is to make them aware of the implications of what they read or see instead of just accepting everything at face value.

(Interview 25/7/96)

In this lesson, Catherine had also discussed with her class the case of Baby Fae, a newborn infant who received a baboon heart transplant and died within 12 days. She related her experience:

Not one student was concerned about the baby and her parents. The only issue raised by the students related to the baboon. “Did the baboon die?” asked one. Those who objected to the surgery were against the baboon dying. They did not consider the pain of the child or the parent’s trauma. Their response was, “well, the baby is going to die anyway”. They seem to think it is acceptable to experiment on humans, but not on animals. So, at this stage of the course they know nothing. *My aim is to get the students to think, to question.* For the first time in their lives they are being asked to think about issues.

(Interview, 25/7/96)

The students’ lack of response to these two cases, which for Catherine seem fraught with bioethical issues, resulted in her articulating clearly her teaching goal.

## DESCRIPTION OF LEARNING ACTIVITIES

In addressing the first research question, I present five vignettes to illustrate the types of learning activities that students participated in. The first two vignettes were based on learning activities that were intended to increase students’ understanding of the topic of transplantation. These vignettes are taken from classroom observations early in the course. The latter three vignettes relate to aspects of bioethics education. When I designed the teaching programme, I believed that it was essential that students

understood the topic of transplantation if they were to appreciate the complexity of the issues.

### **Body Drawing**

When I enter the classroom there are eight girls lying on the floor on six foot long sheets of butchers paper. Their group partners are tracing their body shape. The students, in groups of three, are going to draw internal organs on their 'body'. The classroom is noisier than usual, but the students are on task, discussing which organs to include. Some groups decide, firstly, to write down the names of the organs, while other groups begin to draw in the skeleton and abdominal organs. In some groups, one student draws, while another labels, and another names the structures. In other groups, all the students are drawing and labelling, beginning on different sections of the body. There is no single correct way to do this activity.

There is much laughter as the drawings develop and students realise there are large empty spaces. For example, some groups position the lungs high in the chest cavity and the abdominal organs in the pelvic area. There is more laughter as groups view the bodies of those nearby. At the conclusion, each group gives a brief presentation about their 'body'. This section is amusing as Catherine asks them about the location of significant structures such as the reproductive organs and brain.

(Classroom Observation 31/7/96)

When I observed the lesson where students participated in this activity, I was struck by how much they were talking. There was a lot of noise. However, as I walked from group to group, listening to conversations, I realised that the students were talking about the activity, pooling their collective wisdom about the names and positions of organs. My perception was that this activity provided the students with opportunities to interact with each other and to share their ideas.

This vignette is from the fourth lesson of the course. Catherine told me that she thought the activity was important because it helped the students to understand the position of the body organs and consequently the position of transplanted organs. She explained that "I can see from the activity that they don't know where most of the organs are, especially the size of organs. I use the torso to help them see" (Interview, 9/98). Also, the activity was "meant to be fun and more exciting than just copying down an overhead" (Interview, 13/8/96). Thus, Catherine intended that this activity



would inform as well as motivate her students and encourage them to work co-operatively with their peers. When interviewed nine months later, for one student, this was the only activity she could recall. "I don't remember much but I do remember lying on the floor being traced. I didn't have any idea where the organs were before then." (Interview, 7/97).

### **Brain Death**

Catherine began the lesson on brain death by asking the students to write a definition of brain death. She then asked students to read aloud what they had written.

'When the spirit leaves the body.'

'No sign of life.'

'Pronounced dead.'

'Heart stops beating.'

'Organs stop working.'

'Brain, heart and lungs won't work unless there is artificial respiration.'

'State of consciousness where body ceases to respond.'

Catherine defines death from a medical perspective and displays the definition on an overhead. There is 'cardiac death' which is the cessation of heart beat and 'brain death' which is the irreversible cessation of all functions of the brain stem.

The students read a handout on brain death. The handout defines brain death, the function of the brain stem and describes the types of tests used to determine brain death. The students are listening intently, asking questions occasionally. Catherine calls on students to read aloud and the rest of the class follow. At intervals, she stops and explains difficult terms or concepts. She explains how the brain stem controls breathing and heart rate and reflexes. There are a series of a tests which are performed two hours apart by two different physicians. The tests include the pupil reflex where a bright light is shone in the eyes, the blink reflex where a cotton bud is pressed on to the open eyes and the gag reflex where a cotton bud is pressed on to the pharynx. Ice cold water is syringed into the ears and a pencil is pressed onto the fingernails. Finally, the respirator is turned off for 30 seconds to determine if the person can breathe unassisted. If the brain stem is destroyed, then there will be no response to any of these intense stimuli.

A student asks, 'If you were shot in the head, would you feel it before you die?' Catherine says she doesn't know. Another student says she read in a Dolly magazine that you do feel it. Catherine replies, 'Well if it's in Dolly it must be true.' The class laughs. Dolly is a teenage magazine aimed at 12 to 16 year old girls.

The class then watches a video that demonstrates the medical tests used to determine brain death. Catherine asks the students to summarise the steps used to diagnose brain death for homework.

(Classroom observation, 13/8/96)

This vignette was also taken from a lesson early in the course. The activity was included in the teaching programme to allay any fears that students may hold about their organs being removed while they are still alive. One way to reassure students is to familiarise them with the concept of brain death. Catherine believed that it was useful for students to be aware of the procedures used to diagnose brain death for a different reason. She explained that:

They find it very interesting, but more importantly with this activity, it shows them that you will never ever get enough transplants. For brain death to occur is very rare. Thus, we will never achieve the situation of having enough organs to transplant. Therefore, we need to make decisions about who gets a chance to live and who doesn't. It is an unsatisfactory area. I try to stress to them that someone has to play God to decide who will live or die.

(Interview, 9/98)

I believe that both of these vignettes illustrate examples of activities that provide students with background information that will help them to consider bioethical issues in a meaningful way.

### **Catherine's Teaching of Bioethics Education**

Catherine was explicit in her teaching about bioethics. Early in the teaching of the course, Catherine chose deliberately to attempt to increase students' understanding of bioethical dilemmas. For example, during the first four lessons, students were introduced to the terms, "issue", "social" and "bioethics". Catherine also emphasised that when addressing bioethical issues, "there is no right or wrong but it is important to be able to defend your decision or choices eloquently and clearly" (Interview

25/7/96). In the first lesson, Catherine introduced students to bioethical principles and a decision making process for resolving bioethical issues. The decision making process involves understanding the issue, identifying a range of options, weighing up the potential risks and benefits of each and then selection of an option. Catherine taught students that the bioethical principles of autonomy (the 'right to choose'), justice (fairness), beneficence (promote good) and non-maleficence (avoidance of harm) can be used to weight up the options (Beauchamp & Childress, 1994). She used the example of abortion to demonstrate how a decision making process and a consideration of bioethical principles can be used to resolve bioethical dilemmas.

Almost every lesson, Catherine raised bioethical issues and challenged the students to articulate and reflect on their views in whole-class or group discussions. The three vignettes below illustrate the types of learning activities that students participated in.

### **Sharing Yourself Around**

Sharing Yourself Around is the title of a 30-minute video starring Roy Knudson, National Education Officer for the Australian Kidney Foundation. Roy, previously a school teacher, is involved full-time with transplantation education. Roy has a personal interest in transplantation which he relates on the video.

Several years ago, his two young sons (aged seven and four) and a 16-year old neighbour were involved in a level train crossing crash which left his neighbour and four year old son dead. His seven year old son, Chad, was fatally injured. While he and his wife were waiting at the hospital, they were informed that Chad was brain dead and asked if they would consider donating his organs. Roy was deeply shocked, but his wife recalled a television programme Chad had watched the year before about a five year old girl who received a liver transplant. Chad had told his mother that he would like to donate his organs when he died because God would give him a new body in heaven. Chad's organs were subsequently transplanted into five children.

In the video, Roy is speaking to a group of Sydney secondary school students. He explains the procedure of transplantation. That is, under what circumstances transplants are performed, who is involved, what organs are donated and why, success rates and the limitation of transplantation as a form of treatment. Throughout the video, he asks the students questions about, for

example, the rights of the recipient, the use of animal organs, and the age of consent for donation.

Classroom Observation 1/8/96)

When I interviewed the students the following day they told me that they were deeply affected by the video. Corinne told me that she learnt about the process of organ transplantation. She had thought that a transplant would last forever. She hadn't realised that the recipient may possibly die or need another organ within a few years. The students told me that they found it useful to listen to the views of the school students, although they didn't necessarily agree with their views.

The video, *Sharing Yourself Around*, was shown to students early in the course. The video presents factual information and also raises bioethical issues related to transplantation. By viewing the video, students had the opportunity to listen to the views of other adolescents. Catherine stopped the video after each of Roy's questions and asked her students for their opinions. Thus, students had the opportunity to listen to their class mates and also to think about and articulate their views.

### **Liver Transplant Activity**

This cooperative learning activity called the *Liver Transplant Activity* was produced originally as a values clarification activity for secondary school science (Hildebrand, 1989). In groups of six, students role play members of a Hospital Ethics Committee who need to select four patients out of ten to receive a liver transplant.

Catherine began the lesson by explaining to the students that at this particular hospital, only four liver transplants are performed each year. Liver transplants are expensive, and livers are difficult to obtain. Yet, there are ten patients who need a transplant. All of the patients will die within 12 months unless they receive a liver. Thus choices need to be made.

To assist the students in their decision making, they are supplied with biographical information about the patients, including age, occupation, marital status, and number of dependent children.

After Catherine's introduction, the students spend about 20 minutes discussing the patients, so that they can select four transplant recipients.

Each of the groups write their choices on the white board. The choices are remarkably similar, in that the patients tend to be young with dependents.

Catherine asks the students how they decided who would be chosen. She also asks them how it feels to make a decision.

(Classroom observation, 13/8/96)

Students participated in this activity about halfway through the course. At this stage, students are aware of some of the issues associated with transplantation. They understand who is involved and they have some sense of their rights and duties. They also are aware that usually someone must die for an organ to be donated and that there are more potential recipients than donors.

The students needed to negotiate in their groups to reach a consensus. I observed that the level of engagement varied from group to group. Most students seemed to take the activity seriously and I heard students argue forcibly with their group members. In this activity, students were required not only to select patients and outline reasons for their decisions, but to make explicit the criteria they use to decide the value of a person. Thus, students needed to articulate and justify their values.

Catherine told me that she believes the Liver transplant activity “is an excellent exercise”. She explains:

They learn it is not an easy decision to make and that other groups are different from theirs. Depending on what people think, they come up with different people. I want them to understand that it would be fairly frightening if it was you they had to decide about.

(Interview, 9/98)

## **Portfolio**

One of the major pieces of assessment, comprising 30% of the students’ assessment, was the preparation of a library portfolio. This activity provided students with the opportunity to select and explore a topic of personal interest to them. Students were asked to select and investigate a science topic that raises bioethical issues. The students visited the library for two 55-minute periods a week for the duration of the six-week course (12 periods) where they had access to the World Wide Web, CD ROMs, newspaper articles, scientific journals and books. They were required to collect and read ten

articles about their topic and to write a summary and their opinion about each article. The most common topic chosen was abortion with euthanasia, surrogate motherhood, animal experimentation and in vitro fertilisation popular choices also. Most of these topics were potentially personally relevant to the students.

The completion of a library portfolio provided students with the opportunity to articulate and justify their views about a bioethical issue. The following excerpts from two students' portfolios (Katie and Sarah) indicate that they were attempting to consider carefully and critically the arguments for and against the issue. They endeavoured to articulate and defend their view point.

Katie focussed on abortion in her portfolio. The articles that she summarised presented a range of views related to abortion and the use of the drug RU 486. After reading and reflecting on these articles, Katie wrote:

I think that abortion should be an option for women with unwanted pregnancies. It would be better to terminate the pregnancy than to bring the child into a world where it's not wanted. But I don't think that women should not worry about contraception at all and just get pregnant. And then pop down to the clinic to abort it. That is morally unacceptable in my opinion.

I believe that in some cases abortion is genuinely a good option. But if women just can't be bothered I can't agree with that. I think hospitals and clinics should provide abortion procedures because some women have no choice.

With abortion, I feel it should definitely be performed in the first six weeks. Pregnancies like in the Internet article that are more than three months old are like murder. At this stage the baby has a heart beat and moves around. I think the method used in some abortions is disgusting. The scissors in the back of the skull is absolutely cruel and should not be allowed. The baby flinches so can feel it.

(extracted from Katie's portfolio)

Sarah chose to read and comment on ten articles related to controversial aspects of organ transplantation ranging from the involuntary donation of prisoners' organs to

transplantation of animal organs to humans (xenotransplants). In part of her final commentary she wrote:

Some of the issues raised in the articles included xenotransplants, the next of kin overruling donor's wishes, sharing organs amongst different countries and using the death penalty as a way of getting tissues/organs.

People should not be forced to make a spur of the moment decision to have a relative donate their organs. Parents are given little time to discuss this once they find their child is brain dead. Therefore, I agree with the scheme to have whether you would like to be an organ donor on your Medicare card. By having this information on your Medicare card it cancels out the possibility of a family member going against their relative's wishes. Going against someone's wishes when they have made their wishes quite clear is wrong. This is why a permanent record should be made of the donor's wishes. The donor's families should have no say at all if they are speaking against their relative's wishes.

Most people receiving the death penalty in China have their organs automatically donated. These people have no say in the matter. I think people should have the choice on whether to become a donor or not. I feel it is wrong to use this punishment in order to obtain organs for rich business men who are dying and need an organ to survive. Their only hope would be to get organs from a prisoner receiving the death penalty. If I was badly in need of a transplant and killing someone was my only hope, I would refuse to take the organ.

Xenotransplants (transplants done from animals to humans) are cruel. In order to save a life, an innocent animal has to be sacrificed. The success rates for these operations are not high. Therefore the animals should be left to live and the recipient should wait for a donor. Transplantation is a wonderful thing, but I think scientists should draw a line to xenotransplants. I feel that technology is going too far when matters like xenotransplants are considered.

(extracted from Sarah's portfolio)

Katie and Sarah have presented arguments both in favour of and against their issue. They have articulated the advantages and disadvantages of the issue. Katie and Sarah stated clearly their views about abortion and transplantation respectively. They made a

decision. Both Katie and Sarah qualified their decision. Katie agrees with abortion, but not after six weeks gestation or if the mother is careless with contraception. Sarah agrees with organ transplantation, but only with donor consent. She is opposed to xenotransplantation and the use of executed prisoners' organs.

Many of the students stated (in questionnaires and interviews) that they enjoyed learning about one issue, in depth and they felt that they were more informed about the particular topic they had investigated. As Corinne stated:

I did my portfolio on euthanasia and I never knew what it meant. When people said euthanasia I thought they meant 'youth in Asia' I never understood it until now.

(Interview, 2/9/96)

and Felicity:

Yes, I researched it and I found out about it. After doing the research and reading about it I agree with Euthanasia. I can make a decision about it and justify my decision. Before I did not know about it. Now I do.

(Interview, 7/97)

## **EFFECTIVENESS OF THE BIOTECHNOLOGY COURSE**

### **Catherine's Perspective**

As outlined at the beginning of this section, my intention in presenting the five vignettes was to provide the reader with a brief overview of the types of learning activities that the students participated in (i.e., initial research question one). I interviewed Catherine (3/98) after she had read this section to determine whether she felt that the students' experiences portrayed in the vignettes were representative of the Biotechnology course. She affirmed that they were.

Did Catherine achieve her goal of "getting students to think"? By the end of the course, Catherine felt that many of her students had made progress in being able to think about bioethical dilemmas. In an interview, in the middle of the course, she told me:

I guess I feel intuitively there has been a change. When I did that first exercise on the movie, *Junior*, I went through all the issues and they didn't



think any of them were issues. Now, they are more curious and ask more questions.

(Interview, 13/8/96)

At the end of the course, I asked Catherine what she thought the students had learnt in relation to bioethics education. She said that:

The kids got a lot out of it. It has opened their eyes to the fact that they do have to think about issues. I said to them that I hope when they read articles that they don't just accept what's written, that they do stop and think; where is this leading us? do we want to do this? what are the issues involved?

(Interview, 2/9/96)

When I interviewed Catherine near the end of this study she was more cautious in her claims. After reading this section of the thesis and reflecting on her experiences, in particular the extent to which she achieved her teaching goal, she told me that "whether you get them to think, I think the answer is you do a bit, but I don't think you get them to think as much as you would like them to" (Interview, 9/98).

### **Students' Perspectives**

During an early interview with the five students whom I interviewed regularly (31/7/96), it seemed that all five were aware that a consideration of bioethical issues was one of the course objectives. When I asked them what they were meant to learn in the course, Sarah replied "about social issues, about what society accepts and to find out other people's points of view". When I asked them how they would decide what to do if they faced a dilemma, Frances said, "I'd look at the advantages and disadvantages and weigh them up".

Toward the end of the Biotechnology course, I asked the students how the course had affected the way they thought about bioethical issues. Corinne said that by listening to the views of others she was presented with alternative solutions that she had not considered previously. Sarah stated that the course "hasn't changed my views, but it has helped me to know the reasons for my views and to understand what other people think". Amber explained that she thought "more logically" now. Frances said that "it [the course] made me think more carefully instead of deciding straight away" and "I know you can be wrong, but most of it is your decision, and as long as you can explain your decision, it's okay". Katie told me that the course had affected the way that she made a decision about bioethical issues. She stated that before she did the

course she did not know about transplantation and her opinion was her “first impression”. She added that “Now, I tend to think more about all sides of an argument. Like with transplantation, I think about the recipient, the donor and others involved” (Interviews 21/8/96, 2/9/96, 7/97).

At the conclusion of the course, all students completed a questionnaire that required them to comment on what they had learnt during the course (see Appendix A for a copy of the questionnaire). Most of the students’ comments (70%, 20/29) referred to aspects of bioethics education rather than the factual content of the course (i.e., organ transplantation). Seventeen percent (5/29) mentioned using the decision making process, weighing up risks and benefits, and thinking logically and laterally to resolve bioethical issues, e.g., “analyse ethical situations by weighing up the pros and cons to get an outcome”. Fourteen percent (4/29) stated that they were better able to think about their own values and express their views, e.g., “I learnt that I can express my feelings about these things”. Forty percent (11/29) commented about the importance of respect and tolerance and acknowledging different values and opinions. They emphasised the importance of listening to the views of others, e.g., “everyone has different opinions and we should respect their views”.

### **My Perspective**

I agree with Catherine’s perception (regarding her teaching goal) that some of the students were more thoughtful. My perception from observing Catherine’s class is that many of the students were asking more probing questions of themselves and their peers, and generally trying to grapple with issues. Later in the course, when Catherine spoke about transplantation, for example, some of the students did not accept at face value what she told them. They questioned her assumptions and provided alternative solutions. Towards the end of the course, each student gave an oral presentation based on a newspaper article. They were required to summarise the article and present and explain their opinion. During this lesson, many of the students, when challenged by the questions of their peers were aware of the need to proffer a range of arguments to defend their position.

I had believed that the student interviews, classroom observations and questionnaire responses would yield sufficient information to answer the second initial research question about the effectiveness of the course in relation to bioethics education. My overall perception from the data generated, is that the students were provided with numerous opportunities to identify and evaluate bioethical issues. However, did this mean that the learning activities were effective? One issue for me was that, despite

Catherine's assertion that the students were more thoughtful about bioethical issues and the students' claims that they "thought more logically" and could "use the decision making process", could they actually apply what they had learnt? This issue is pursued in the Chapter Six.

## CHAPTER SIX

### RESOLVING BIOETHICAL DILEMMAS

#### INTRODUCTION

This chapter explores my attempts to elucidate the effect of the bioethics education component of the Biotechnology course. This process led me to construct and pursue two emergent research questions. *Can students be taught to resolve bioethical dilemmas?*; and *in relation to resolving bioethical dilemmas, how do students differ from experts?* In the first part of this chapter, I outline the reflective research process which I embarked on as I grappled for understanding and meaning of the data. In the second part of the chapter, I present the results of a bioethical dilemma survey developed to address the emergent research questions.

#### THE BIOETHICAL DILEMMA SURVEY

After I had transcribed the final interviews and read carefully the questionnaire responses completed at the conclusion of the course, I felt that I needed to pursue the issue of the extent to which the course had had an effect on, firstly, the students' ability to make a decision about a bioethical dilemma and, secondly, their ability to justify their decision. Data collected from Catherine and the students seemed to indicate (from their perspective) that the course had had a positive effect on the students' ability to identify and evaluate bioethical issues. However, I felt that their perceptions should be investigated further. I faced a number of unanswered questions.

One problem was that I had not tested the students prior to studying the course. Thus, in the absence of a pre/post test, how could I determine whether the students actually did learn what they claimed to have learnt in relation to bioethics education? I know that the students said they learnt how to be more aware of bioethical issues, but were they any different from their peers who had not studied the Biotechnology course? Were these students 'better' able to evaluate bioethical issues? Could they use the decision making process without the teacher explicitly telling them to? Do they really respect, tolerate or acknowledge different opinions? Can they even identify a bioethical dilemma? How could I measure this?

I wondered if a 'test' existed that would be able to measure a student's ability to evaluate bioethical issues in science. As described in Chapter Two, the focus of the literature about bioethics education tended to be on the process and content of the courses, with little attention given to a consideration of the effect of the learning activities on students. It seemed to be taken for granted that if students studied bioethics, then they would be able to understand and apply what they had learnt.

### Seeking Information

Unsure of how to measure whether a student could evaluate a bioethical issue, I emailed a number of professionals whom I knew had experience in bioethics education. These people had helped me previously while planning this research study. Firstly, I emailed Dr. Darryl Macer who is a Bioethicist and Director of the Eubios Bioethics Institute at the University of Tsukuba in Ibaraki, Japan. He is also Editor of the *Eubios Journal of Asian and International Bioethics* (EJAIB).

Darryl had conducted several large scale surveys in Japan and New Zealand to ascertain the views of people regarding the use of biotechnology in our society and their understanding of associated ethical issues (Macer, 1994a). He also had surveyed science and social science teachers in Japan, New Zealand and Australia regarding their views of biotechnology and bioethics education (Macer et al., 1996). I had participated in this survey (in 1994) and, because of my interest in this area, began to correspond with him. In addition, Darryl had published a set of bioethics teaching notes that are designed to assist teachers who wish to teach their students about bioethical issues (Macer, 1994b).

I sent Darryl a short summary of the students' questionnaire responses and asked him if he was aware of any questionnaires that would measure a student's ability to identify and evaluate bioethical issues. He replied:

It is still a result, and I would think the individual responses would be useful to include in the appendix of your thesis in the future. As you say the problem is that it relies on student's self reporting of the change in their decision-making. I still think it has a place in assessment.

The studies I have seen, briefly, use case studies and questions. I can only suggest the J. Medical Ethics papers I gave before for specific examples. I have not done anything on it yet myself so I cannot recommend which one.

I do not think it is worth doing a control group, rather before and after as this means the number of students does not need to be so large in order to be reliable.

If you want to seek more comments, send an open letter on it to my journal, EJAIB.

(D. Macer, personal communication, October 12th, 1996)

As requested, I sent a short letter to the Eubios Journal of Asian and International Bioethics (EJAIB) and it was published in the November 1996 issue. The letter described briefly the purpose of my study and requested assistance regarding the existence of questionnaires to evaluate the effectiveness of bioethics education. I did not receive any replies.

I also emailed Professor Jon Hendrix who is Professor of Biology at Ball State University, Indiana, USA. Professor Hendrix conducts an annual summer school on biology and ethics for science teachers. He was previously a biology teacher and has published articles on the teaching of bioethical decision making in high school biology (Hendrix, 1993; Mertens & Hendrix, 1990). He replied:

I think that observational data is the best for high school bioethical decision-making growth. That is, can they make and defend a position out of an ethical/moral stance? Can they recognise an ethical problem? These data done pre/post would be more effective in my way of thinking. To measure true moral growth is to measure moral developmental levels and I think they (high school students) are at a fairly static level during this time of their development.

(J. Hendrix, personal communication, October 9th, 1996)

I agree with Jon's statement regarding moral development. In searching the literature for tests of ethical development, I encountered several references to James Rest (1986) and his book, *Moral development: Advances in research and theory*. James Rest is the Research Director of the Center for the Study of Ethical Development at the University of Minnesota in Minneapolis. He developed the Defining Issues Test (DIT) which is widely used in the field of moral development. The DIT contains six ethical dilemmas. Respondents are asked to read the dilemma, select an outcome, and then rank a range of reasons for their choice. I obtained a copy of the DIT from the Center. I decided that this test would not be appropriate in helping me to determine whether

students who had studied Catherine's Biotechnology course were better able to evaluate bioethical issues than those who hadn't. Firstly, only one of the dilemmas is related to bioethics. The remainder are general moral issues (e.g., treatment of prisoners). Secondly, 14-15 year old students would be expected to be at a similar moral development stage. It is unlikely that a single six-week course would cause a significant change in their moral development. The DIT is designed to measure changes in moral development over months and years, rather than the effect of small scale interventions such as the Biotechnology course.

I then contacted Dr. Roger Lock in the School of Education at the University of Birmingham, in the United Kingdom. Roger Lock has an interest in incorporating the teaching of biotechnology into secondary school science and has published a range of papers regarding the teaching of, and attitudes of students to biotechnology (Lock & Miles, 1993; Lock, Miles & Hughes, 1995). In my email, I had asked Roger whether in the absence of a pretest, it might be appropriate to use the Year 10 students who had not studied biotechnology as a control group. He replied:

I don't really have any ideas other than that you suggest, i.e., using the members of the cohort that have not been exposed to the materials that you are investigating.

(R. Lock, personal communication, October 9th, 1996)

Finally, I contacted Professor Michael Levine, who is Head of the Philosophy Department at the University of Western Australia in Perth. Michael teaches philosophy and ethics. I had met Michael while preparing my candidacy proposal and he had recommended some ethics-related reading for me. He replied:

It seems what you need is a questionnaire with specific questions about bioethical issues (and approaches to ethical questions) that you can administer before and then after the course.

(M. Levine, personal communication, October 9th, 1996)

I agreed with Darryl, Jon and Michael that it would have been preferable to test the students before and after studying the course. A pre/post test would have eliminated a number of uncontrolled variables in relation to students' previous experience, academic ability and interest in bioethics. However, the students had already completed the course and a pre/post test was not possible. As I explained in Chapter Three, with interpretive case study research, it is impossible to predict in advance, the issues that will arise from a case study.

In a previous email, Darryl Macer had suggested that I read some papers from the *Journal of Medical Ethics*. These papers concern the teaching of medical ethics to medical students and evaluations of such courses (Mitchell, Myser & Kerridge, 1993; Self, Wolinsky & Baldwin, 1989; Stevens & McCormick, 1994). The medical ethics courses were assessed by the use of case studies. Students were asked to respond to a series of bioethical dilemmas, determine an outcome, and justify their reasons by using bioethical principles.

During this search, I read an article called *Measuring the ethical sensitivity of medical students at the University of Toronto* (Hebert, Meslin & Dunn, 1992). The authors of this article (two medical professors and a bioethicist) had developed an instrument to measure “ethical sensitivity” (i.e., the ability to identify an ethical issue). Medical students were presented with four vignettes and asked to identify the ethical issues in each. The number of issues raised by respondents was recorded, compared to a “gold standard” answer, and analysed statistically. The issues were also classified as to whether they were concerned with autonomy, beneficence or justice.

Their study indicated that ethical sensitivity (i.e., the ability to identify an ethical issue) was unrelated to gender and academic ability. However, they were re-evaluating the data to examine the issue of gender. It is interesting to note that, in this study, the medical students’ ethical sensitivity decreased with each year of medical training. The authors stated that, despite time and resources being allocated in medical schools to bioethics courses, there was little data available regarding evaluation of these courses. They also raise some thought-provoking questions. Is it possible to ‘measure’ ethical sensitivity? Is a person who scores highly on ethical sensitivity (i.e., knowledge) more likely to behave ethically in practice (i.e., action)?

Two issues arose from this paper that assisted me in designing a survey to determine whether the Biotechnology course actually had an effect on the students’ ability to identify and resolve a bioethical issue. Firstly, I decided to search for bioethical dilemmas that would be suitable for adolescents. Unfortunately, the examples of bioethical dilemmas in the literature were inappropriate for adolescents. They were too difficult because the language and style of the dilemmas were designed for medical students, rather than 14-15 year olds. In many cases, the content was related to clinical situations where students need a medical background to appreciate the complexity of the issue.



Initially, I was hoping to develop a method of evaluating students' use of the decision making process. I now realised that it would probably be impossible to do this because of the multiple skills it entailed. The skills include: identifying the bioethical dilemmas in a situation; stating the arguments for and against (risks and benefits); and deciding what should be done. I decided that my original plan was somewhat ambitious. I decided that a survey which required students to make and justify a decision regarding a bioethical issue would be appropriate.

I needed to find dilemmas that were brief, did not require background knowledge, and did not impinge on content covered in the Biotechnology course. I intended to compare the responses of students who had studied the Biotechnology course with a similar group of students who hadn't. Those students who had studied the Biotechnology course may have been advantaged if presented with issues they had discussed in class, e.g., transplantation topics, abortion, euthanasia. I also believed that it was important that the bioethical dilemmas should be realistic, from the students perspective, rather than esoteric and unresolvable. The dilemmas should also be clear, concise and contain an obvious specific conflict.

### **Development of the Bioethical Dilemma Survey**

Using 'bioethics' as a key word, I searched the World Wide Web for suitable bioethical dilemmas. I found two bioethical dilemmas on the Web page of the San Francisco Exploratorium (Diving in the gene pool Scenario #1, 1996; Diving in the gene pool Scenario #3, 1996). The issues were presented as part of an interactive display for members of the public. The topics both related to genetics but did not require any background knowledge. I chose a third dilemma from a set of bioethics resources in the Woodrow Wilson Activities Collection (Haynes, 1992). The topic concerns care of the environment. I modified this dilemma slightly to make it shorter and easier to understand. The fourth dilemma, which I wrote, relates to reproductive technology. (See Appendix A for a copy of the bioethical dilemma survey.)

The survey asked students to state whether they had studied the Biotechnology course and to record their Year 9 Science grade. Although a student's science grade was only a rough indicator of academic ability, I wanted to see if there were any significant differences between those students who had studied Biotechnology and those who had not. Students were directed to read each dilemma and then respond to a question about what they would do to resolve the situation. There were three choices, "yes", "no" and "I can't decide". Students were asked to "list as many reasons as you can to explain your answer". I avoided the use of ethical jargon (e.g., what are the ethical

issues?, state the risks and benefits in this situation, use the decision-making process), as this may have advantaged those students who had studied Biotechnology and were familiar with the terminology.

The survey was administered to 23 students who had studied Biotechnology and 38 students who had not. Prior to examining the survey results, I considered how I would analyse the data. If the course had had any effect there may be differences in the responses (yes, no, I can't decide), and the number and types of reasons. It was possible that students who had studied Biotechnology may be better able to resolve the bioethical dilemma and present sound reasons for their decision.

In relation to evaluating the students' responses and reasons, I considered several alternatives, none of which seemed entirely satisfactory. One possibility was to construct a 'gold standard' answer by asking an 'expert' to complete the survey. I could then compare this to the students' answers and rate them in some way. A second possibility was to categorise the students' responses, as Hebert, Meslin and Dunn (1992) did, according to the bioethical principles of justice, autonomy, and beneficence.

A third method was to code the reasons based on the principles of justice or caring (Gilligan, Ward & Taylor, 1988). They found that when examining the moral reasoning of people, there seems to be two contrasting world views. The first is a 'justice approach' that focuses on rights, fairness and equality, and the second is a 'caring approach' that emphasises responsiveness, connectedness and relationships. Gilligan et al. (1988) conclude that girls and women are more likely than boys and men to use a caring approach. I was curious as to whether I would obtain similar results. In subsequent case studies, I would have the opportunity to survey boys.

The fourth possibility was to utilise an ex post facto design (Crowl, 1996) and compare the results of students who had studied Biotechnology with a comparison group of students who had not. Using this method, the responses given by students to resolve the bioethical dilemma, and the number and types of reasons could be compared.

After reflecting on the alternatives above, I decided to use a combination of the first and fourth possibilities. I compared the responses, number and types of reasons given by those students who studied Biotechnology to a comparison group of students who had not. I also compared the responses of both groups to those of three experts (Dr Andy Wilson, Dr Brian McDonald and Dr Jan Crosthwaite). Andy (a medical

practitioner) taught medical ethics at the University of Western Australia for a number of years. He is now retired although he works on a volunteer basis at the Kingswood Centre for Applied Ethics in Perth. Brian (a medical scientist) is the Director of a parentage and specialist genetic testing centre in Sydney. Jan (a philosopher) is a senior lecturer in philosophy at the University of Auckland where she teaches medical ethics.

### **Results of the Bioethical Dilemma Survey**

Below, each of the four bioethical dilemmas is presented. The responses of the group of 23 students (who studied Biotechnology) and the comparison group of 38 students from the same school and year group are compared. At the time that the survey was administered, some of the students were on work experience programmes and were absent from school. Thus, the survey was completed by only 23 of the 30 students who studied the Biotechnology course with Catherine.

Data related to the types of responses were coded (yes=3, I can't decide=2, no=1) and analysed statistically using SPSS to determine if there were any significant differences in the mean responses of students who had studied the Biotechnology course and those who had not. Using a t-test there was no significant difference in the mean responses of each group for any of the dilemmas. The mean responses and t-test results are summarised in Table 9 in Appendix E. The average number of reasons stated to justify the students' responses was not markedly different. On average, the Biotechnology students wrote 2.6 reasons and the comparison group wrote 3.4 reasons.

The focus of the remainder of this section is on the qualitative responses of the students; the types of student responses; the types of reasons provided to justify their decision; and the degree of similarity with the experts.

#### ***Cystic Fibrosis Dilemma***

Mr. and Mrs. C come to a genetics clinic for prenatal diagnosis. They have each been tested to determine whether they carry the gene for cystic fibrosis, a hereditary lung disease that causes severe breathing problems. The cystic fibrosis gene is recessive, so a child must inherit a copy from each parent to get the disease. In this case, both Mr. and Mrs. C are carriers for the cystic fibrosis gene. The specific mutations for each parent were identified in earlier tests.

Mrs. C, who is pregnant, undergoes prenatal diagnosis to determine if the foetus is affected. DNA analysis indicates that the foetus does have two copies of the cystic fibrosis gene, but one of the mutations it carries is different from that of either Mr. or Mrs. C. That makes it virtually certain that Mr. C is not the baby's father.

*Should the genetics counsellor tell both Mr. and Mrs. C about the test results?*

The bioethical issue relates to the paternity of the child. Do both parents have a right to know the paternity of the child? The types of responses of the students in both groups are summarised in Table 1.

Table 1 Student Responses to Cystic Fibrosis Dilemma (Catherine)

| Response       | Studied Bioethics n=23 | No Bioethics n=38 |
|----------------|------------------------|-------------------|
| Yes            | 17 (74%)               | 24 (63%)          |
| I can't decide | 4 (17%)                | 9 (24%)           |
| No             | 2 (9%)                 | 5 (13%)           |

The majority of the students in both groups (74%, 67%) stated that they would inform both parents about the test results. Of those students who said that they would tell both parents about the test results, the types of reasons and frequencies are summarised in Table 2.

Four (17%) of the 23 students who studied the Biotechnology course could not decide whether or not to tell both parents. Of the four students who said they did not know what to do, two did not give any reasons for their answer. One student said that although Mr C has a right to know, Mrs C may not want him to know. The other student said that the counsellor should take the mother aside and tell her, but not the father. One of the students who said no argued that it was not up to the counsellor to interfere in private matters. She said that Mr C should not be told, but Mrs C could be told and allowed to decide what to do. The other student who said no argued that Mrs C should be told and it is then her decision as to whether or not the husband is informed. This student commented that the information may have a harmful effect on the baby's future.

Table 2 Types of Reasons Provided to Justify a 'yes' Response for Cystic Fibrosis Dilemma (Catherine)

| Reason   | Studied Bioethics n=17 | No Bioethics n=24 |
|--|------------------------|-------------------|
| Both Mr and Mrs C have a right to the information.                             | 12 (71%)               | 16 (67%)          |
| Both Mr and Mrs C need to know whether the baby has cystic fibrosis.           | 4 (23%)                | 6 (25%)           |
| The father has a right to know he is not the real father.                      | 4 (23%)                | 11 (46%)          |
| The baby has a right to know who his/her real father is.                       | 2 (12%)                | 2 (8%)            |
| Tell Mrs C, but not Mr C.  | 2 (12%)                | 0                 |
| The mother needs to know as she may decide to abort the baby.                  | 1 (6%)                 | 3 (13%)           |
| The baby may be affected at a later time if he/she finds out about the father. | 1 (6%)                 | 4 (17%)           |
| The genetics counsellor should not withhold information.                       | 1 (6%)                 | 4 (17%)           |
| The baby's real father has a right to know.                                    | 1 (6%)                 | 1 (4%)            |
| It is Mrs C's fault for not telling her husband she slept with someone else.   | 1 (6%)                 | 0                 |
| No reason  | 1 (6%)                 | 0                 |

Note that some students offered more than one type of reason.

Of the students who did not study Biotechnology, nine (24%) could not decide and five (13%) of the students said no. The reasons stated by the students who could not decide were that the genetics counsellor has no right to expose Mrs C (two students), and that Mrs C should be told and then it is her decision whether or not to tell Mr C

(three students). Two students stated that although Mr C has a right to know it may harm the relationship. Three students did not give any reasons for their response.

All of the five students (13%) who said 'no' stated that it was up to Mrs C to decide whether to tell her husband or not. Three students said that Mr C. may not want to know that he is not the father. Two students said that the counsellor has no right to interfere in the relationship. One student said that it is not important who the father is. The issue is whether the baby has cystic fibrosis.

### *Discussion*

There does not appear to be any notable difference between the two groups of students in relation to whether or not to inform the parents about the test results. The types of reasons given, and their frequency, also did not appear to differ to a large degree. Two-thirds of the students, in both groups, stated that the parents needed to know the test results with more than two-thirds of them stating that Mr and Mrs C. have the 'right to know so that they can decide what to do'. In both groups, most of the reasons stated by students related to the rights of individuals to information (i.e., both parents, the baby, the genetic father).

Only the small proportion of students who said 'no' or 'I can't decide' seemed to appreciate the effect that the test results may have on the couple's relationship. Some of these students stated that the counsellor should not interfere in the relationship and that it was Mrs C's responsibility to inform her husband.

Overall, the students views differed from those presented by three 'experts'. In response to this issue Andy wrote:

My professional bias here stems from the knowledge of the misery of cystic fibrosis; I must recognise that this will influence my response. The counsellor needs to tell the parents that the foetus will almost certainly have cystic fibrosis and spend time explaining the full significance of the disease. The matter of paternity need not arise at this time; indeed it must not for reasons of confidentiality. The counsellor may later have a word with the mother regarding the details of the test results and raise the matter of paternity.

(A. Wilson, personal communication, 11th December, 1996)

Brian told me that prior to prenatal testing, the parents would be counselled by a genetics counsellor about the possible test results. They would be informed that the test, as well as diagnosing cystic fibrosis, would also determine the paternity of the child. The parents would be asked to sign a consent form indicating whether they wanted to know the paternity results. Brian said that in the situation above, both parents would be told that the baby would have cystic fibrosis, and information about paternity would depend on the pre-counselling decision. If paternity was not discussed during counselling, it would depend on the circumstances as to whether the mother would be informed about the paternity.

Jan wrote a 'no' response in answer to the question of whether both parents should be informed about the test results. She stated that "both parents should be told about the cystic fibrosis result, but only Mrs C should be made aware of the question about paternity". She explains that "parents ask for the test for a certain purpose. Information beyond this purpose, which is not relevant to their aim, should not be divulged. It becomes a case of "unsought" information. Mrs C has a right to know about paternity of her child. Mr C should be told only by Mrs C, not third parties. The risk of harm to parents, and hence to the child as well, through disclosure, outweighs any moral consideration in favour of full disclosure." (J. Crosthwaite, personal communication, 11th December 1997)

It seems that those students who answered yes applied the bioethical principle of autonomy, but did so with no apparent consideration of any deleterious consequences. They seemed to be unaware of, or unable to consider, the effect that the paternity information may have on the couple's relationship. Where future consequences were considered, they related to the baby (finding out later) or the counsellor (who may be sued). Thus, it seems that most students adopted a rights based approach to resolve and justify their decision. In contrast, the responses and reasons stated by the experts seem to indicate that, in addition to autonomy, they also considered the bioethical principles of non-maleficence and beneficence.

### *Huntington's Disease Dilemma*

Mr. F, a 42-year-old man and his 21-year-old son George come to a genetic testing centre for advice. George wants to be tested for Huntington's disease, a progressive, fatal inherited brain disorder that usually strikes its victims in their 30s, 40s and 50s.

There is a 50% chance that Mr. F has inherited the gene for Huntington's disease and, if so, a 50% chance he has passed it along to his son George. Mr. F doesn't yet show symptoms of the disease and he doesn't want to be tested. He prefers to live his life and make decisions without knowing whether or not he has the gene. George, on the other hand, wants to know if he has inherited the gene so he can plan his life accordingly.

If George gets tested and is found to carry the gene for Huntington's disease, his father, Mr. F, must also carry the gene. The two men agree that, given their close relationship, it would be impossible for George to keep his test result a secret from his father.

*Does George have a right to know whether or not he carries a disease gene even if it interferes with his father's wish not to know his genetic status?*

In this dilemma there is a conflict between George's right to information about a fatal disease and his father's right not to know. If George does carry the gene for Huntington's disease, then so does George's father.

The responses of the two groups of students are summarised in Table 3. The majority of the students in both groups (91%, 84%) stated that George has the right to know whether or not he carries the gene for Huntington's Disease.

Table 3 Student Responses to Huntington's Disease Dilemma (Catherine)

| Response       | Studied Bioethics n=23 | No Bioethics n=38 |
|----------------|------------------------|-------------------|
| Yes            | 21 (91%)               | 32 (84%)          |
| I can't decide | 1 (4.5%)               | 6 (14%)           |
| No             | 1 (4.5%)               | 0                 |

The types of reasons proposed by the students who said 'yes' are summarised in Table 4.

Of the students who studied Biotechnology, one student could not decide, but stated that George has a right to know. The student who said no stated that 'the father has a right not to be told. The father has decided not to have the test and George should respect his wishes'.



Six (14%) of the students who did not study Biotechnology could not decide. Their reasons are encapsulated in the following quote from one of the students. 'I can't decide because although George has the right to find out his genetic status, I also believe that because of his father's wishes not to know that he doesn't have the right, as it will affect not only himself but his father. If he cares for his father's wishes he wouldn't, but if he wants a family of his own, he should.'

Table 4 Types of Reasons Provided to Justify a 'yes' Response For Huntington's Disease Dilemma (Catherine)

| Reason   | Studied Bioethics n=21 | No Bioethics n=32 |
|--|------------------------|-------------------|
| George has a right to know if he has the disease.    | 17 (81%)               | 20 (63%)          |
| George needs to plan his life.                       | 12 (57%)               | 17 (53%)          |
| It is George's life/body/decision.                   | 7 (33%)                | 11 (34%)          |
| Father doesn't have to be told.                      | 5 (24%)                | 9 (28%)           |
| George can take precautions.                         | 2 (10%)                | 6 (19%)           |
| George may decide not to have children.              | 2 (10%)                | 5 (16%)           |
| George needs to know if he is going to die.          | 3 (14%)                | 0                 |
| Father's wishes don't count.                         | 2 (10%)                | 1 (3%)            |
| If he finds out now, it won't be such a shock later. | 0                      | 4 (13%)           |
| George may find out he doesn't carry the gene.       | 1 (5%)                 | 2 (6%)            |
| It may harm the father-son relationship.             | 1 (5%)                 | 1 (3%)            |
| Gene may be passed onto George's children.           | 0                      | 6 (19%)           |
| George's family can prepare to care for him.         | 2 (10%)                | 0                 |
| No reason  | 1 (6%)                 | 0                 |

Note that some students offered more than one type of reason.

### *Discussion*

Almost all of the students in both groups (91%, 84%) agreed that George has a right to know whether or not he carries the gene for Huntington's Disease. The reasons offered by both groups were similar. The information will allow him to plan his life accordingly and make informed life style decisions about having children and career choice. A significant proportion of the students pointed out that it is George's body and thus, he has a right to information that may affect his life.

The students' decisions and reasons are congruent with those of Andy Wilson and Brian McDonald. Andy wrote the following:

If he is unaware of his genetic predisposition to a fatal disease he will be living in a fool's paradise and make some significant error in his planning, bringing some severe problems on himself. For example, in the knowledge of his genetic abnormality he may sensibly wish to avoid parenthood. The principle that applies here is 'Autonomy' especially George's autonomy. Whether this compromises the father's autonomy it seems reasonable for George to know even under the 'freedom of information' principle.

If George wishes to apply for a job in which he must answer questions about his health, he would be unable to tell the entire truth unless he knew about his genetic defect. He needs to be able to tell the whole story.

Honest and frank discussion between George and his father, preferably with the whole family and its 'support group' present would almost certainly answer the question in the affirmative.

(A. Wilson, personal communication, 11th December, 1996)

Brian stated that, legally, when a person is over 18, they are entitled to be tested for any genetic disease without parental consent. Thus, his laboratory would have no hesitation in testing George regardless of his father's concerns. He also said that George's father does not have to be told the results although he agreed that this would be difficult. As with cystic fibrosis, George would be counselled about Huntington's Disease and the possible outcomes of testing.

Jan, however, could not decide whether George should be tested. Unlike Andy and Brian (and most of the students), she placed a greater emphasis on George's father's right to autonomy. She explained her reasoning.

Rights (including rights to knowledge) must be moderated by conflicting rights (and costs/harms) to others. In this case, I think that there is a small harm in depriving G of knowledge he wants against a probability (50%) of his father suffering from knowledge he doesn't want. But on the other hand, it seems that G's father's view of how to live his life is determining G's options, which seems quite a harm in terms of the value of autonomy. I don't think one can decide in terms of views about human relationships either, in that if G is tested, the relationship with his father will suffer and if he isn't, then it is also likely to suffer. So, I don't know.

(J. Crosthwaite, personal communication, 11th December, 1997)

Most of the students stated that George had a right to information which would affect him. They appeared to be applying the bioethical principle of 'autonomy' (right of the individual). It is of some concern, however, that they did not consider how to deal with George's father. Only one student from each groups mentioned the potentially damaging effect that the information may have on him. Use of the bioethical principle of non-maleficence would dictate that no harm (or minimum harm) should be done to any person.

### ***The Environment Dilemma***

Ms. Franklin is a member of the town council in a small community. She is also co-owner with her brother of a sporting goods store. The community in which Ms. Franklin and her brother live has endured a depressed economy recently. Thus, one of Ms. Franklin's most important personal goals as Council person is to enhance the economy of her community.

At tonight's council meeting a developer is proposing to construct a hydroelectric dam in the canyon of a nearby river. Although the electrical energy generated by the dam is not needed in the community, it can be sold to a regional power grid and during times of need sent hundreds, even thousands, of kilometres away where it can be used. Although the developer and his associates will receive all profits from sale of the power, the dam will mean construction jobs and the huge reservoir created by damming the river can be used by the community for its own recreational (swimming, fishing,

boating, camping) and economic interests (a hunting and fishing lodge, marina). The developer asks that the council pass a motion in favour of the hydroelectric project.

Following the developer's proposal a scientist from the State University informs the council that an endangered fish species lives in the canyon just downstream of the proposed dam site. The fish, called the "drimp", grows to about a foot in length and is a dull greenish-brown in colour. Because of its secretive nature and muddy water habitat, few people have or will ever see one in their lifetimes. It is an Endangered Species. The scientist informs the council that the water used to turn the energy generating turbines and then released from the base of the dam will cause the drimp's downriver habitat to be icy cold and, consequently destroy its ability to reproduce. Without young, adult drimps will grow old and die and the canyon's population will become extinct. There is in the world only one other population of these fish known - it is several hundred miles to the south downstream of a rapidly growing city. The scientist asks that the council reject the water developer's resolution and vote instead for the continued existence of the endangered drimp.

*Should Ms. Franklin vote in favour of the hydroelectric project?*

The ethical dilemma in this case study relates to the deliberate potential destruction of a species for the sake of the economy.

In contrast to the two previous dilemmas, where most students in each group were in agreement about what to do, students offered a range of responses which are summarised in Table 5. Approximately half of the students, in both groups, were unable to decide whether Ms Franklin should vote in favour of the hydroelectric project. There does not appear to be any difference in the responses of each group.

Table 5 Student Responses to Environment Dilemma (Catherine)

| Response       | Studied Bioethics n=23 | No Bioethics n=38 |
|----------------|------------------------|-------------------|
| Yes            | 7 (30%)                | 9 (24%)           |
| I can't decide | 14(61%)                | 18 (47%)          |
| No             | 2 (9%)                 | 11(29%)           |

For each of the responses, students offered a range of reasons which are summarised in Table 6.

Table 6 Types of Reasons Provided By Students to Justify Response For Environment Dilemma (Catherine)

| Response       | Reason   | Studied<br>Bioethics | No<br>Bioethics |
|----------------|--|----------------------|-----------------|
| Yes            |  | n=7                  | n=9             |
|                | The economy and people are more important than the fish.   | 2                    | 8               |
|                | They can relocate the fish.  | 2                    | 5               |
|                | It is Ms Franklin's decision to make.  | 2                    | 9               |
|                | There will always be people who disagree with development.                                       | 1                    | 7               |
|                | The fish are of no use.  | 0                    | 2               |
|                | Recreation areas will attract tourists and improve the economy.                                  | 0                    | 2               |
|                | No reason  | 2                    | 0               |
| I can't decide |  | n=14                 | n=18            |
|                | The hydroelectricity project will benefit the community, but it is important that the fish live. | 5                    | 8               |
|                | It is very difficult to decide as both arguments are well presented.                             | 1                    | 2               |
|                | No reason  | 7                    | 10              |
| No             |  | n=2                  | n=11            |
|                | It is wrong to destroy an endangered species.  | 2                    | 9               |
|                | There might be a better way to enhance the economy.  | 1                    | 5               |
|                | Destroying the fish may adversely affect other species.  | 1                    | 3               |
|                | Money/jobs won't bring the fish back.  | 1                    | 1               |
|                | The dam is not needed.   | 0                    | 3               |
|                | She should be thinking of future generations rather than herself.                                | 0                    | 1               |
|                | The developer may be lying about the benefits.   | 0                    | 1               |

|   |   |   |
|---|---|---|
| The fish may have potential benefits<br>(e.g. medical) that are better than the<br>hydroelectric project. | 0 | 1 |
|---|---|---|

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Note that some students offered more than one type of reason.

### *Discussion*

In both groups, approximately half of the students were unable to decide whether Ms Franklin should vote in favour of the hydroelectric project. Regardless of whether or not the students had studied bioethics, for each of the responses (yes, I can't decide, no), there does not appear to be any difference in the types of reasons offered by students to justify their decision.

In response to this dilemma Andy Wilson wrote that:

This is a good example of a question which needs to be read right through for the purpose of discerning where there is and where there is not a need for application of formal ethical principles. The only part that requires ethical emphasis is the dilemma of "luxurious production of more electrical power - versus- conservation of an endangered species of fish". I would give a lot of credit to a student who recognised that timing alone could solve the problem as follows: 1) submit a reasonable sized culture of the 'drimp' to the nearest suitable 'fish farm' for appropriate animal husbandry ensuring the progeny are going to survive. Then identify a new home for the fish and transfer them forthwith. 2) Reconsider the new potential source of hydro-power at leisure.

(A. Wilson, personal communication, 11th December, 1996)

Jan interpreted the question as one of how Ms Franklin would vote in order to be consistent with her beliefs. Thus, she gave a 'yes' vote for the following reason.

I have taken this as a question of how Ms F. should vote, given her views and not what view she should hold. It would be inconsistent with her personal goals and values not to vote in favour. On the point of what she should think, I don't think that environmental values are overriding. Human costs have to be measured as well. Economic issues can be life and death issues for human communities (and ways of life). Though I am not convinced here that they are this great. And I think that the value of preserving the drimp has been set up to make it seem inconsequential and not

very appealing as a creature. (Suppose it were a small furry creature which has very cute babies instead.)

(J. Crosthwaite, personal communication, 11/11/97)

This dilemma represents, on a small scale, a perennial debate in our modern society. That is, the preservation of species and maintenance of biodiversity in our environment versus growth of the economy through development and employment. It would be expected that a range of views would be held by individuals regarding this complex issue. Thus, the views of the students are not surprising. The students seemed to be evenly divided in their responses depending on whether they considered the fish or jobs to be more important. A proportion of students recognised the dilemma that exists between saving a species and providing jobs for the community. It is also encouraging that a small proportion of students have considered alternative options to those offered in the dilemma. For example, it may be possible to move the fish or to find alternative methods of boosting the economy.

### ***Reproductive Technology Dilemma***

A husband wishes to remove eggs from his wife's dying body to be fertilised by his sperm in vitro and then implanted in to a surrogate mother.

*Would you allow this request?*

The ethical dilemma relates to the right of the husband to remove eggs from his wife's dying body.

Like the previous dilemma, there was a range of responses and reasons offered by the students in both groups.

Table 7 Student Responses to Reproductive Technology Dilemma (Catherine)

| Response       | Studied Bioethics n=23 | No Bioethics n=38 |
|----------------|------------------------|-------------------|
| Yes            | 12 (52%)               | 22 (58%)          |
| I can't decide | 7 (30%)                | 10 (26%)          |
| No             | 4 (18%)                | 6 (16%)           |

Approximately half of the students would allow the request. Almost a third of the students were undecided, while only a small proportion would not agree with this

request. The types of reasons stated by students to justify their responses are summarised in Table 8.

Table 8 Types of Reasons Provided By Students to Justify Response For Reproductive Technology Dilemma (Catherine)

| Response       | Reason  | Studied<br>Bioethics | No<br>Bioethics |
|----------------|---|----------------------|-----------------|
| Yes            |   | n=12                 | n=22            |
|                | Only if his wife has agreed.                              | 8                    | 9               |
|                | The father has a right to have a child with his wife.     | 4                    | 6               |
|                | He can have something to remind him of his wife.          | 3                    | 13              |
|                | It is his decision to make.                               | 4                    | 7               |
|                | The eggs are no use to her.                               | 1                    | 1               |
|                | It will help the husband to cope.                         | 1                    | 3               |
|                | The eggs can help another woman to become pregnant.       | 1                    | 0               |
|                | There is no reason not to.                                | 0                    | 3               |
|                | Every person has a right to a child.                      | 0                    | 3               |
|                | The father's name continues.                              | 0                    | 1               |
|                | It means the wife can have a child.                       | 0                    | 1               |
|                | The husband may not want to remarry, but want children.   | 0                    | 1               |
|                | No reason   | 2                    | 0               |
| I can't decide |   | n=7                  | n=10            |
|                | It depends on who will care for the child.                | 2                    | 2               |
|                | It depends on the wife's wishes.                          | 1                    | 3               |
|                | The child may find it difficult without a mother.         | 1                    | 2               |
|                | No reason   | 5                    | 0               |
|                | It is too difficult to decide                             | 0                    | 3               |
|                | He has a right to children but it should be both of them. | 0                    | 1               |
|                | The surrogate mother may want to keep the baby.           | 0                    | 1               |
|                | There is not enough information                           | 0                    | 1               |



|    | It is disgusting   | 0   | 1   |
|----|--|-----|-----|
| No |  | n=4 | n=6 |
|    | The child may be confused about who its mother is.                     | 1   | 4   |
|    | He has no right without her consent.                                   | 1   | 1   |
|    | It does not agree with my ethics. A dying person should be left alone. | 1   | 0   |
|    | The father wouldn't feel like it was really his baby.                  | 1   | 0   |
|    | The surrogate mother may want to keep the child.                       | 0   | 4   |
|    | Although scientifically possible it is against human nature.           | 1   | 1   |

Note that some students offered more than one type of reason.

### *Discussion*

This dilemma is difficult to resolve because there is no information regarding the views of the dying wife. It would be useful to have some more information about, for example, whether the couple have other children, the availability of support for the husband to raise a child, financial circumstances, the situation that led to the wife dying, the age of the husband and wife, the laws related to surrogacy and, most importantly, whether the wife has given consent to have eggs removed for her husband.

When asked to respond to this dilemma, Andy Wilson replied that:

The vast majority of people, I believe, who are older than 55 years would be almost certain to vote 'reflexly' against such a procedure because of the unfamiliarity of the whole scene. This might, by family influences, move the teenagers to vote no. Despite the science which supports such procedures, there is no guarantee that they will always work and they are very costly in time and money. A subsidiary question which arises here is 'the ethical justification for the manner in which we spend the Health Dollar'. Leading on from this, it would seem reasonable to find out if the prospective parents have already produced offspring. If the answer to this is no, we have further cause to disallow the request. Also, finding a totally cooperative surrogate

mother is no simple task. The surrogacy may not be entirely without problems because the surrogate mother will not know until the end of the pregnancy how much of a bond she will have established with the unborn child. Even if the pregnancy reaches a joyful termination, how is the presumably single father going to care for this child?

(A. Wilson, personal communication, 11th December, 1996)

When I asked Brian McDonald about this dilemma he said that he would not allow the request, although he stated that the issue was being debated from a legal point of view. There was a recent case in the United Kingdom where a wife applied for access to her husband's frozen sperm after he was killed in a motor vehicle accident. Her application was unsuccessful.

He stated that, firstly, surrogacy for financial gain is illegal in most States of Australia and secondly, eggs do not store well. He felt that the husband's request was bordering on self indulgence and suggested instead that grief counselling might be more appropriate to help the husband cope with his loss, rather than producing a child. He believed that the husband would have difficulty finding an obstetrician who would remove the eggs under these circumstances and certainly his laboratory would not be involved in this procedure.

Similarly, Jan argued that the request should not be allowed because:

There is no information about the wife's wishes in this respect, and the situation sounds like using her for someone else's purposes. There are many problems with surrogacy, and particularly using it to meet an emotional need in this way. I think that the decision in such emotionally laden circumstances is likely not to be well thought out, and the consequences for any child are unlikely to be properly addressed in such a case. The child is being created in a situation in which the sort of family relationships which presumably it is meant to represent (bring about?) for the grieving husband are precisely not achievable.

(J. Crosthwaite, personal communication, 11/11/97)

Overall, more than half of the students in both groups stated that the husband should be able to remove his dying wife's eggs. Their reasons suggest that they have a rather romantic view of parenting and seem to consider that the husband will have part of his wife living forever rather than consider the status of the child as an individual. Thus, in this dilemma, the views of the students differed from the 'experts'. Some of the

students seem to overemphasise the rights of the husband without considering the future consequences of their decision.

### **Discussion of the Bioethical Dilemma Findings**

The initial reason for conducting this survey was to examine whether students who had studied the Biotechnology course and participated in a range of learning activities designed to provide students with the opportunity to resolve bioethical dilemmas (e.g., the liver transplant activity) would perform differently than students who had not (i.e., emergent research question one). It would appear, from this survey, that there were no differences in the student's responses and reasons about the four bioethical dilemmas, regardless of whether they had studied the Biotechnology course.

Thus, I find that I am unable to claim that bioethics education can influence a student's ability to resolve bioethical dilemmas. It is possible that the survey was not discriminating enough to measure any effect that the course may have had. I would speculate that it is likely that other factors, such as age, ethical maturity, life experiences and the influence of family, peers and the media can have a significant effect on a student's bioethical decision making skills, an effect that outweighs a single course of study.

A second outcome of the survey results is the difference between the students and the experts in relation to the resolution of bioethical dilemmas (i.e., emergent research question two). Most of the students seemed to adopt a 'rights based' approach to resolve and justify their decision. Many of the reasons stated by students in justifying their responses related to the rights of individuals, that is, the students' justification of their decision seemed to be based largely on the principle of autonomy. In contrast, the responses and reasons stated by the experts seemed to indicate that, in addition to autonomy, they also considered the principles of non-maleficence, justice and beneficence.

The students did not appear to be able to extrapolate about the long term consequences of their decisions. Compared to the experts, it would appear that the majority of the students held a 'naive' or 'romantic' view of life that influenced the way they resolved bioethical dilemmas. This is not unexpected, given the age of the students. I must stress that I am not stating that the students 'got it wrong' and the experts 'got it right'. Rather, the experts were able to draw on their relevant past experiences and deeper understanding of the consequences of these dilemmas in making their decisions.

These findings raise an important issue for me in relation to conducting interpretive research. By pursuing the emergent research question of whether the students really learnt to resolve bioethical issues, I am now faced with data that seem to give conflicting results. Despite Catherine's and the students' assertion that they are better able to resolve bioethical issues, I am unable to 'measure' any difference between these students and those who have not studied the course. It would have been less problematic for me to have accepted the views of the Catherine and her students.

## **CHAPTER SEVEN**

### **WHERE TO NOW?**

#### **INTRODUCTION**

The purpose of this chapter is to address some of the issues which arose after reflecting on the data from Catherine's case study. The chapter is divided into three sections. The first section focuses on the effect of the Biotechnology course on students' attitudes to science. The second section explores the ethical decision-making ability of individual students. The third section presents two narrative tales, based on data from the case record, that are designed to illustrate the experiences and variable learning outcomes of students participating in the Biotechnology course. Interpretive commentary was obtained from Catherine, other teachers and the students themselves. Their feedback increased my awareness of factors that may adversely affect student learning.

#### **RE-EXAMINING THE DATA**

As I re-read the previous chapter on the results of the bioethical dilemma survey, I found myself facing a conundrum. Qualitative evidence based on classroom observations, interviews and questionnaires suggested that Catherine and her students perceived that the course did enable the students to better identify and resolve bioethical issues (see Chapter Five). Thus, I had felt a degree of confidence in being able to demonstrate some measurable effect via the bioethical dilemma survey. On finding that there were no obvious differences in the survey data between the students who had studied the Biotechnology course and those who had not, I felt somewhat as if I had 'hit a brick wall'. Is the conclusion, I thought, to this case study (or indeed the whole thesis) to be that bioethics education cannot be shown to have a demonstrable effect on students' abilities to resolve bioethical dilemmas? If there was a statement that best summarised my research experience at this point, it would be something like, "the more closely you look at something, the less clear it becomes".

As I pondered on the findings, several events occurred. Firstly, I had innumerable discussions with my supervisor, Peter. I lamented the seeming lack of difference between the students who had studied the Biotechnology course and those who hadn't. With Peter's guidance, I began to realise that the initial research questions held me in a 'mental strait jacket'. While generating data and during my initial analysis of Catherine's case study, I had searched for evidence to answer the second initial

research question. *How effective are the learning activities in enabling students to reflect critically on, articulate and justify their bioethical values?* Although there was evidence that some of the students did articulate and justify their values, the impact of the learning activities on this process was unclear. I realised that my efforts to “prove” or “measure” effectiveness were flawed. I recognise now that I was searching for outcomes that fitted my a priori views of what bioethics education should achieve. Rather than searching for outcomes to match the initial research question, I needed to listen to the participants’ stories. I needed to focus, not on my predicted outcomes, but on what the course did appear to achieve.

### **Enhancing Students’ Attitude to Science**

#### ***Emergent Research Question Three***

What effect did the Biotechnology course have on student’s attitude to science?

One of the themes that emerged as I re-examined the data was an unexpected positive influence in relation to the students’ attitude to science. During my first interview with Catherine, she had told me that one of her goals as a science teacher was to:

make it as interesting as possible. Some students have a negative attitude to science. I want to get their attention. I want them to see that if they listen, work and try, then they will achieve in science.

(Teacher Interview, 18/7/96).

I must confess that I was so focused on the initial research questions that were related to bioethics education that I ignored this comment at the time. Thus, I was surprised at the fervour expressed by some of the students in their written responses in a questionnaire asking them to comment on their experiences in the Biotechnology course. All of the 29 students wrote at least one positive comment about the course. Their comments included:

I used to hate science, but I understand Biotechnology because there is lots of discussion. It suited my style of learning.

It has persuaded me to take up Human Biology in Year 11 and 12.

Science doesn't have to be about chemistry and physics, but about everyday problems.

I always thought science was hard.

I never knew this stuff was part of science and it has been the best one yet.

Mrs M knows what she is talking about and can tell us things without looking through notes all the time. She got us involved and expressing our opinion. It was very interactive.

(Questionnaire, 2/9/96)

Although I was aware from my classroom observations that the students seemed to be enjoying the course, I was unaware, that for a number of them, this was the first science topic that they had enjoyed or experienced success in. As the following student explained:

Before, I thought science was hard and irrelevant. I used to dread a double period in science or any science period because I was afraid of having to answer questions, but now I look forward to it.

(Questionnaire, 2/9/96)

During the final student interview, I asked the five students who I had interviewed regularly how they would rank the Biotechnology course compared to their previous experience in science.

- Vaille: If you looked at the course as a whole and you compared it to other science courses you have done. And you gave those courses a ranking of five, how would you rate this course?  
Katie?
- Katie: A nine. I think it's a lot better than the other ones. It's so much more interesting. Not just facts. It's more worldly.
- Vaille: Corinne?
- Corinne: Probably about 8.5. All the other ones were really boring until I got to this one. I've never enjoyed science.
- Vaille: You've never enjoyed science before?
- Corinne: No. I've never enjoyed science. Until I did this course. Now I'm going to do Human Biology next year.

Amber: I'm going to do Human Biology as well because I liked the course. Probably 8.5 to 9 because it was good learning about the body.

Frances: I would give it a 10 because I really liked it and I haven't been bored. It's good.

Sarah: I would give it about 9.5. I agree with what everyone else says.

(Interview, 2/9/96)

So, how did the course differ from their previous experience with science? What did the students like about the course? Many of the learning activities centred around whole class and group discussions. The following comments indicate that students recognised and appreciated alternative opportunities to learn.

It was not something you were told and then had to regurgitate.

It was mainly your opinion.

We got to find out things by means other than the teacher telling us and us having to learn it.

It is more of a discussion topic, not where you have to memorise knowledge.

Less rote learning.

(Questionnaire, 2/9/96)

Ten months after the completion of the Biotechnology course (July, 1997), I interviewed 22 out of the 30 students who studied the course. The other eight students had left the school. The purpose of this interview was to ask the students whether the Biotechnology course had influenced their attitude to science. The students were in Year 11 where science is not a compulsory subject. It is noteworthy that *every* student who studied Biotechnology had chosen to continue with science and was studying either Human Biology, Senior Science or Biology. While I am not asserting that they had chosen to continue with science solely because of studying Biotechnology, one of the issues I raised with students during this interview was whether the course had had any influence on their decision to continue with science. Many of the students I interviewed echoed the following sentiments. When I asked Gemma what she thought of the course she told me:



Well, it was really good. I had never liked science. I thought science was hard and was only for students who were smart. And Biotechnology wasn't. You didn't feel dumb. It was really practical. You could ask questions if you didn't understand. It was like, if I can do this then maybe I can do it in Year 11 and maybe even at University. I couldn't believe I could study science.

(Interview, 7/97)

Kirsten's comments were similar:

It didn't have to be all the hard Chemistry. My mum had said "science can be fun" and I finally believed her. I got my first 'A' grade in science. It gave me confidence. It made me think, "Hey I can do that." When I did Chemistry, it went right over my head. I didn't get it.

(Interview, 7/97)

In searching for disconfirming evidence, there was only one student for whom the course did not seem to have a long term positive effect on her attitude to science. When interviewed, Amanda told me that she liked Biotechnology because "it wasn't hard like the other science subjects" (Interview, 7/97). However, she described the Biotechnology course as a "one-off". "I know that other science subjects are not like that", she explained. "I don't like science much." Thus, with the exception of Amanda, all of the remaining students seemed to experience a positive effect of the course on their attitude to science.

When I re-interviewed Catherine recently about the extent to which she achieved her teaching goals, she told me that the course:

definitely gets them to enjoy science more. You know that because they actually tell you. I teach some of the girls now and they all tell me how much they liked Biotechnology.

(Interview, 9/98)

From the students' questionnaire and interview responses, I would conclude that the Biotechnology course had a positive effect on almost all of the student's attitudes to science. Many of the student's initial perceptions of science as a difficult subject seem to have been modified. Furthermore, the positive learning experience seemed to be one factor that encouraged some of the students to continue with science.

## **Variable Learning Experiences**

During one of our discussions, Peter pointed out to me that one of the weaknesses of presenting the bioethical dilemma survey data (i.e., responses and types of reasons) as an average for each group of students was that this may mask those students whose ability to resolve bioethical issues was enhanced by their participation in the course.

He suggested that the students who studied Biotechnology might be divided into at least three groups. Firstly, there could be students who, before they studied the course, were already quite reflective, aware of their values, and able to carry out a decision making process without being explicitly taught. Their past life experiences and the influence of family and peers may already have equipped them with the skills to weigh up the advantages and disadvantages of alternative solutions to a dilemma. A second group of students could be those who are less reflective and remain so despite studying the course. The course does little to enhance their ability to resolve and justify bioethical dilemmas. Indeed, Catherine had commented to me that the course didn't seem to affect some students. They refused or were unable to postulate or accept alternative solutions to problems. A third group of students may comprise those who were unreflective prior to studying the course, but for whom the course raised their awareness of bioethical dilemmas and provided them with a framework for resolving and justifying their decision. They became aware of, and able to utilise bioethical principles and a decision making process.

The comparison group of students who didn't study Biotechnology might also have included a broad spectrum of students, some of whom were unreflective and others who could have intuitively applied a decision making process. The *ex post facto* research method that I employed to evaluate the results of the bioethical dilemmas did not allow me to discriminate between the different types of students.

When I presented my findings about the bioethical dilemma results at a conference, one of the participants suggested that it might be helpful to probe the 'process' by which students resolve bioethical issues. That is, focus less on the students responses ('yes', 'no', 'I can't decide') and the reasons (mostly based on the principle of autonomy) and more on the process that students use to arrive at their decisions.

The constructive advice from Peter and the conference participants, coupled with several more readings of the entire case record and some reflective journal writing, resulted in me posing four emergent research questions.

***Emergent Research Question Four***

Does the Biotechnology course influence the responses, number and types of reasons used by individual students to resolve bioethical dilemmas?

The bioethical dilemma survey completed by the students who studied the course with Catherine in 1996 was completed at the end of the course. In the absence of a pre-test, I was unable to make any assessment of the degree of change in individual students. In the following year (1997), I administered the survey to a group of 31 students, both before and after studying the Biotechnology course. The reason for administering the survey to students before and after they studied the course was to examine the consistency of individual student's responses and reasons, that is, did studying the course alter a student's responses or types of reasons? When I approached the Head of Science about conducting the survey, he agreed on the condition that the survey be anonymous. Thus, although Catherine kept a record for comparison of pre/post responses, I was unaware of the identity of individual students.

The surveys were numbered so that individual student responses and reasons could be compared before and after studying the course. Using a paired t-test, there was no statistical difference between the pre test and post test for the mean responses (yes=3, I can't decide=2, no=1). The t-test results are summarised Table 10 (Appendix E.) Secondly, there was no statistical difference in the number of reasons for any of the four bioethical dilemmas. Were any of the students able to offer 'better' reasons after studying the course? When I examined the types of reasons presented by students to support their responses, there did not appear to be any difference. Interestingly, if there was any difference, the reasons presented in the post test tended to be briefer. Perhaps this is because the students had already responded to the same bioethical dilemmas.

When I communicated these findings to Jan Crosthwaite (a philosopher who teaches bioethics) she was not surprised that I couldn't demonstrate any differences. She informed me that:

My impression, in teaching about [bioethical] principles is that people take from them what helps to underpin the judgements they are already inclined to make - and that most people work with a pretty pluralistic set of principles/intuitions. I think that success in this area of teaching is less in changing peoples' views than in extending their awareness of the dimensions that need to be considered.

(J. Crosthwaite, personal communication, December 3, 1997)

Bioethics education is not intended to alter the bioethical values an individual holds, but rather to encourage them to weigh up alternative solutions. Data presented in the previous Chapter seemed to support the assertion that the course did achieve this for some students. For example, see Katie's comments from the previous chapter where she stated that before she did the course her opinion was her "first impression" whereas afterwards she tended to "think more about all sides of an argument". Also, see Melanie's comments later in this section.

### ***Emergent Research Question Five***

What processes do students use to evaluate bioethical dilemmas?

In 1997, I interviewed eight students who had studied the Biotechnology course and completed the bioethical dilemma survey. I asked them why they had responded as they had and what they thought about when deciding on their reasons. Most of the students could not answer this question. They seemed to find it very difficult to make explicit the underlying process that they use to actually decide on their responses and reasons. A typical answer was, "I don't know. It is just what I think/believe?" They also tended to restate their reasons for their response. In the final case study (see Helen, Chapter Nine) I was generating data at the same time as I initially wrote this section. I interviewed four students from Helen's class about the survey. One of the students, Janice, was very articulate. She was able to explain the process that she went through to decide on her response and justify her decision. Janice told me that, as a result of studying bioethics, if she had to make a decision about an ethical issue she would seek information from her parents and friends. She would also find out the Catholic Church's view (she is a Catholic), think about what she believes is the most moral decision, think about the short and long term consequences, and then select a choice that best fits her values and that she feels comfortable with (Interview, 17/11/97).

I also reinterviewed four students who studied the Biotechnology course with Catherine (17/11/97). I selected Sarah, Melanie, Amanda and Gemma. Sarah was one of the five students who I had interviewed regularly. Although a very quiet student, she seemed to be quite reflective. Melanie is a highly articulate student who, when I interviewed her about her attitude to science, impressed me with her confidence. Amanda and Gemma were two students who, when interviewed earlier in the year, could not remember very much about the course. From these interviews and my classroom observations, I considered that these four students had different experiences in the Biotechnology course.

My intention during these interviews was to address the emergent research question above. I wanted to determine whether they could explain how they resolved a bioethical dilemma and also determine the extent to which they felt that the course had influenced how they made their decision. I gave each student a new bioethical dilemma which I asked them to resolve. I thought that this was preferable to asking them to try and recall their reasoning for the bioethical dilemma survey they had completed in the previous year. I asked the students firstly to write about their decision and then to verbally explain their reasoning. I audio-taped each of the interviews. The bioethical dilemma that I gave the students related to euthanasia.

### *Active Euthanasia*

Joan Johnson is 58 years old and has terminal cancer of the stomach. She is not expected to live more than six months. Joan has completed a Living Will where she states that she would like to end her life. Mrs Johnson has asked her doctor if he will assist her in administering a lethal injection using a computer program that slowly administers an increasing dose of morphine.

*If you were Mrs Johnson's doctor would you allow this request?*

I asked Melanie what she would do in this situation and also to explain her answer. She told me that:

If I was Mrs Johnson's doctor I would allow her to die.

My reasons are quality of life, compared to quantity of life. She has had a reasonably long life. She is almost 60 years old. So it's not as if she hasn't done anything. She is not expected to live more than six months and with terminal cancer you would expect it to be painful. To die before it gets too painful is better and while you are in full control of all your senses and knowing that you want to die, not sort of just being a vegetable and unable to decide. Also having full control of your bodily functions like being able to go to the toilet and not having tubes stuck in you.

She has a family and it would probably be easier if she died while she was reasonably healthy. And for them not to have to see her go through it all until in the end being helped to do things.

It is also her own choice. As long as the family isn't pressuring her to die so they can get money or something like that. As long as it is her own choice and she really does want to die before the pain gets too bad then yes I think she should be allowed to have the lethal injection.

(Interview, 17/11/97)

I thought that this was a well-considered answer and told Melanie so. I then asked her how she decided what to do. She told me that she thought in her mind about all the reasons for and against a particular response and then she decided which response had the best reasons. I asked whether she made her choice and then thought of the reasons or whether she thought of the reasons first and then made her choice. She said she thought of the reasons first. I told Melanie that she was obviously a very intelligent student and very good at expressing her views. I explained my difficulty about determining to what extent students like her, who could resolve and present sound reasons for their decisions, were affected by the Biotechnology course. She explained that she believes the course did have an effect.

Yes, I think I can make a better choice having done Biotech., because in Biotech. we explored all the possible circumstances, for all the different moral dilemmas and so on. And so knowing what parts of the body are affected and how cancer affects you makes it easier to make a decision. You are better informed.

I think, had I not done the course I still would have said yes because I believed in her own choice but I don't think I would have been able to back it up as well. Like about the pain and the effects of cancer. The Biotech. course showed me that I have to be able to back up my decision. So if I hadn't done Biotech., I would have said yes, but not been able to back it up. I wouldn't have been able to find the reasons.

(Interview, 17/11/97)

Thus, according to Melanie, the course did provide her with an appreciation of the need, and also the skills, to justify her decision.

Gemma said that she would not allow Mrs Johnson to die without obtaining information from other people involved (e.g., her family). She told me that, in making a decision, she had tried to look at the dilemma from other peoples' points of view. I asked Gemma whether what she learnt in the Biotechnology course helped her to resolve problems like this? She replied:

Yes, although I don't remember much we got taught to look at different views and originally I would have thought well if that's what she wants, let her have what she wants. When you make a decision you should think about other people who would be affected, like your family.

(Interview 17/11/97)

Thus, Gemma, Melanie (and Janice from Helen's case) seemed to be using components of a decision-making process to make and justify a decision about a bioethical dilemma. They considered the advantages and disadvantages in terms of their own values and then decided what to do. They all asserted that this was as a result of having studied bioethics.

It would seem that, within a group of individuals, there are a range of factors that may have an effect on a person's bioethical values and their receptivity to learning activities that may modify or influence their values. Although I can present the impressions of individual students (i.e., Melanie, Gemma and Janice), I am hesitant about drawing any generalisations about their assertions. Nor can I quantify how typical their experience was.

#### ***Emergent Research Question Six***

In relation to resolving bioethical dilemmas is there a range of decision making abilities amongst those students who studied the Biotechnology course?

It is my perception that, in terms of resolving and justifying decisions, within the Biotechnology class, there were students with a wide range of abilities. Certainly the survey results revealed a variation in the number and quality of reasons offered by students to justify their responses. The number of reasons offered by students for all four dilemmas ranged from none to 25. Furthermore, the complexity of the reasons varied considerably. For example, in relation to the Huntington's Disease dilemma, a number of students who responded "yes" simply wrote, "he has a right to know". In contrast, one student wrote:

George has a right to know whether his life will be affected by the genetic disorder. Mr F must live with the decision that George makes because although he doesn't wish to know whether he has that gene, George does wish to know. George may be in a position or job (e.g., surgeon) that if he gets the disease it will have a serious effect on other people (e.g., performing

life determining operations or making life affecting decisions). George may wish to have a family and he has the right to know whether he will pass the gene on to his children. George might wish to end his life as soon as he shows signs of the disease and must provide for those who depend on him.

The coding method that I used initially to summarise the reasons does not distinguish the degree of complexity of the student's reasons presented, thus masking individual students' abilities. The variation in learning outcomes is pursued in the third and final section of this chapter.

## **NARRATIVE TALES TO ILLUSTRATE LEARNING OUTCOMES**

Notwithstanding the purpose of the course or Catherine's teaching goals, or the rationale of learning activities that the students engaged in (see Chapter Five), what did the students actually gain from their participation in the course? On reading the case record, there were four learning outcomes related to bioethics education that were raised frequently by Catherine and her students. They were:

1. An awareness that bioethical issues associated with biotechnology and transplantation, in particular, do exist.
2. An awareness that a group of individuals will hold a wide range of bioethical values.
3. An awareness that students need to listen to and respect the bioethical values of others.
4. An awareness that bioethical principles and a decision making process exists.

Based on my observations and analysis of the case record, I believe that there were a range of learning experiences amongst students within the Biotechnology class and that the extent to which these four learning outcomes were achieved varied between students. This led to the development of emergent research question seven.

### ***Emergent Research Question Seven***

Why did the Biotechnology course enable *some* students to better evaluate bioethical dilemmas?

In what way did students differ in their learning and why? Also, what factors influenced their learning? After a considerable amount of thought and discussion with Peter, I decided to address this emergent research question by writing two narrative tales (Connelly & Clandinin, 1988; Taylor & Geelan, 1998; Van Maanen, 1988) that



represent the experiences and learning outcomes of two students. It is my perception that the degree to which individual students achieved the four learning outcomes varied. The purpose of the two narrative tales is to present a credible and authentic account of students' learning experiences and variable outcomes. The extent to which the tales are credible and authentic is explored later in this section through the use of commentaries from teachers and students.

I have chosen to portray the experiences of two students, Holly and Leanne, each of whom achieved the learning outcomes to differing degrees. The tales are fictionalised in that Holly and Leanne do not actually exist. Holly's tale represents the experience of a student who achieved the four learning outcome to a greater extent than did Leanne.

### **Development of the Narrative Tales**

Data from multiple students were combined to write Holly's tale. Excerpts from student interviews, written questionnaire comments and students' work samples that were relevant to aspects of bioethics education were extracted and ordered to construct a narrative that I felt was cohesive and representative of some of the students in the Biotechnology class. The construction of a composite character, like Holly, is not unique in science education research. For example, McRobbie & Tobin (1995) created a composite character of a student, Gayle, to illustrate the experience of a Year 11 Chemistry student. They used interview data from several students to portray the voice of Gayle. The authors used a narrative account about Gayle to demonstrate the interaction between teacher and students in relation to teaching and learning. They felt that this genre allowed the voices of the teacher and the students to be heard in an authentic way. The resulting vignette was given to students (and others) who provided feedback. This process reassured the authors that the vignette was credible and authentic.

Leanne's tale represents the experience of a student who achieved the outcomes to a lesser degree than Holly. Leanne's tale is far more difficult to write. Her voice is not heard in the interview and questionnaire data. Also, the absence of a learning outcome is difficult to represent. Does this type of student exist? There are a few clues that emerge from my classroom observations and discussions with Catherine. There are also some student interviews and questionnaire responses whose brevity suggests a lack of engagement with the learning activities. It is these constraints and hints and my tacit understanding of different types of students that I have fleshed out to develop Leanne's character. The events described in Leanne's tale were extracted from classroom observations.

Leanne is a fictional character. A fictional character is utilised by Tippins, Tobin and Nichols (1995). They created a composite fictional character, called Ms Halfaday to write a narrative about a constructivist teacher. The authors developed the character of Ms Halfaday to illustrate how a teacher would use constructivism as a referent in their teaching practice. The character was based on the authors' collective experience. They wrote that:

...we were unsure of the extent to which the community of science educators would accept our narrative approach to communicating what we had learned from a program of research. To us, it no longer mattered whether Ms Halfaday was a "real" person, whether she was a composite character, or whether she was entirely imaginative. Through this narrative account of her teaching and her classroom she was as real to us as any other teacher we had written about. We had decided that, just as in any case study, the significance and meaningfulness of this paper would be gauged by the reader....We do see it as a powerful tool to communicate to practitioners, a tool that has greater application in science education than we perceive at the present time.

(Tippin, Tobin & Nichols, 1995; p. 148)

I concur with the sentiments expressed in this quote. In constructing the characters of Leanne and also Holly, I have drawn on my own experience as a teacher at the school in this study, a past teacher of the Biotechnology course and a researcher in Catherine's classroom. Later in this section, I address further the question of whether students like Holly and Leanne might exist.

### **Holly's Tale**

Holly is a slightly built student with long, dark hair pulled back with a green ribbon. She is a quiet and shy student who, in class, rarely asks questions. Although not an 'A' grade student, Holly works hard in all of her school subjects. If she doesn't understand a concept, she will approach her teachers at recess or lunch time. Her assignment work is always done meticulously. Even though she studies hard, she doesn't do as well as she wishes. It is written tests that she finds most difficult. Even though she rewrites all of her notes and reads her text book, when she does the test she can't always understand the questions.

Holly wants to do well in science. Her two older sisters attended the school and both studied Physics and Chemistry in their final two years. One is currently studying medicine, the other physiotherapy. Holly, too, wants to go to university and study nursing. She will need to study Human Biology next year and she is a little worried. Last year, in Year 9, she gained a 'C' grade for science. Her main problem areas were balancing chemical equations and understanding energy.

At the end of Year 9, Holly had to select her Year 10 science topics. She had to choose five topics out of seven. In consultation with her parents, who privately spoke to the Head of Science, Holly selected Genetics, Ecology, Physical Science, Forensic Science, and Biotechnology. It is the first year that Biotechnology has been offered. A science teacher spoke to her Year 9 class and told them it was about organ transplantation and issues. Holly doesn't know what an issue is, but she hopes that learning about organs will help her when she studies Human Biology the following year.

In her English class, this term, Holly has been given an assignment on journal writing. Her teacher has explained to the class that keeping a journal is an effective way of recording what you have learnt and reflecting on it. For the assignment, the students need to keep a journal based on one aspect of their school life. Holly decides to write a journal based on her experience in the Biotechnology course.

The following is her journal.

### *Entry 1*

We just had our first lesson with Mrs M. She is a good, clear, loud teacher. She seems to know what she is talking about and can tell us things without looking through notes all the time. This is not how science is usually taught. It is more like social science. She got us involved and expressing our opinion.

She told us about the movie, *Junior*, and Baby Fae, where the baboon's heart is put in the baby. I think it's really cruel. To save a life, an innocent animal has to be sacrificed.

I'm not sure what we're meant to learn. About social issues, about what society accepts. I've never really thought about issues before. I didn't know there were any.

Mrs M also explained about the decision making process. She said we had to weigh up the advantages and disadvantages to get an outcome. Then she told us about using bioethical principles to make a decision. She told us about rights based and consequentialist theories.

Amber asked about abortion and Mrs M told us about two men who shot and killed an abortionist. Candice said he probably thinks he is killing to save many lives, so he is right. I don't know what I think. I've never thought about these things before.

### ***Entry 2***

Today, we learnt about transplantation. Mrs M gave us notes on organs and tissues. We had to work with a partner and put the organs and tissues in order of how often they are transplanted and how much they cost. I said to Mrs M, it was too hard to do, and she said it doesn't matter if we get it wrong. I didn't know that heart/lung transplants were so rare. I thought the kidney was really common, but it is rarer than the tissues.

### ***Entry 3***

We have had three lessons since I last wrote. We did a cool activity where we lay on the floor and traced our bodies. I learnt the names of different organs and where they were. Then we did an activity called "The Transplant Equation". We read an article and watched a video about transplantation. Mrs M. told us the meaning of hard words. We talked about who is involved in a transplantation, the donor, recipient, their families and the doctors and their rights, needs and duties. This is complicated for me. I didn't realise how rare organ donors are.

Last lesson we watched a video called "Sharing Yourself Around". It was really good. It made me think about whether to donate my organs when I die. Their ideas were like ours except for one girl. She was really annoying. She was like, we're going to die anyway, so why bother? I guess she had her reasons. If you have a chance you should take it. You may as well save a life. When we discussed the video in class I learnt how others feel. Everyone has different opinions and we should respect their views.

***Entry 4***

What I like about Biotech. is it's not too intense. It's easy to learn because of the teacher and the way it's taught. I prefer people teaching me by talking to me and me talking back, not just being told what's what. Before I thought science was hard and irrelevant. This course has changed and informed my views on many topics I hadn't considered before. I am thinking about what my ethical views are.

I am doing a portfolio on abortion. I was shocked when I read about the procedure. One of the articles I down loaded from the Internet describes in graphic detail "partial birth abortions" that are performed in the last four months of pregnancy. The article states 'The doctor turns the unborn child into the breech position and pulls the child from the mother until all but the head is delivered. He or she then forces scissors into the base of the skull and inserts a catheter to suction out the child's brain.' There is also a photograph.

With this portfolio we have to write our opinion. This has been the hardest part of the course. This is what I ended up writing. I think that abortion should be an option for women with unwanted pregnancies. It would be better to terminate the pregnancy than to bring the child into a world where it's not wanted. But I don't think that women should not worry about contraception at all and just get pregnant. And then pop down to the clinic to abort it. That is morally unacceptable in my opinion. I believe that in some cases abortion is genuinely a good option. But if women just can't be bothered I can't agree with that. I think hospitals and clinics should provide abortion procedures because some women have no choice. With abortion, I feel it should definitely be performed in the first six weeks. Pregnancies like in the Internet article that are more than three months old are like murder. At this stage the baby has a heart beat and moves around. I think the method used in some abortions is disgusting. The scissors in the back of the skull is absolutely cruel and should not be allowed. The baby flinches so can feel it.

***Entry 5***

Today we handed in our transplant questionnaire. We had to interview 10 people to find out what their views on transplantation were. I found that compared to other people I know a lot about transplantation. Most people didn't know anything about transplantation. When I did the questionnaire I asked my mum and she said she would take the organ even if it only lasted a

few years. That way she could watch her children grow up. I learnt from my questionnaire about what my mum would do if one of my brothers, or sisters or myself died. They would donate our organs. I learnt my family's views on a lot of things to do with transplantation and my family also learnt a lot about each other.

We also did an activity called the Liver Transplant Activity. We had to agree on who would get a transplant. It was difficult. We couldn't agree on who was going to get a transplant. Samantha said that the Vietnamese kid should get a transplant and she wasn't going to bend. It really made me think. I hadn't realised there were so many issues. I got to listen to other people's opinions and they listened to me. You hear people say things and you think, oh yes.

### ***Entry 6***

I think I have changed since I did this course. I think more before I give my opinion. Before I did Biotech. I didn't know anything about transplantation or other issues, so what I thought was my first impression. Now I would talk about an issue and research the problem. I would think it through logically and I have a better understanding of how to do this. I also think I have learnt how to express myself. I didn't know how to before. When teachers asked me what I thought about something, I couldn't answer. Now I can. Last week, in English, we had to write about an issue and I chose transplantation. I gave a talk about it. I said there should be an opting out process where unless you say no it is assumed you will donate.

### **Leanne's Tale**

Leanne is a vivacious and spirited girl. She is somewhat disorganised and often has difficulty meeting assessment deadlines. On several occasions this year, Leanne has turned up to class to find there is a test which she has forgotten to study for. Although students use a homework diary Leanne prefers to spend her study time decorating the pages with fluorescent pens, and gluing in photos of her friends and favourite rock stars. In class, Leanne is a student who participates actively in discussions, but she finds note taking boring. She especially likes group work because it means that she can chat with her friends.

Leanne is studying the topic of Biotechnology in science. She likes the way the subject is taught. She doesn't have to take notes and there are plenty of discussions. Leanne also likes the discussions because she can give her opinion. But last lesson, when she called out, Mrs M told the whole class that they needed to listen to each other, rather than just talking. However, Leanne doesn't seem to want to hear other peoples' opinions. She just wants to talk about hers.

What has Leanne learnt in this course? She has learnt about organ transplantation and the types of organs that can be transplanted and why. She realises that there are problems with transplantation in that there are not enough donors. She has decided to donate her organs when she dies. After all, what use will they be to me, she thinks. Mrs M has presented convincing arguments to support organ transplantation.

Leanne did her portfolio assignment on animal experimentation. She is vehemently opposed to killing animals. She buys all her make up from the 'Body Shop' because their products are not tested on animals. Leanne collected 10 articles on animal experimentation that were written by an anti-vivisectionist organisation. These articles, with photographs of shaved cats, blind rabbits, and monkeys with electrodes inserted in their heads reinforced her opposition to animal testing. She can't understand why anyone could be so cruel. She thinks about becoming a vegetarian.

Leanne had to give an oral presentation on a newspaper article about a woman who received a kidney transplant from her brother. She also had to talk about some of the issues the article raised and state her opinion. She had forgotten about the presentation until the lesson it was due. While other students gave their talks, Leanne highlighted sections of the article with one of her fluorescent pens. Leanne read directly from the article and concluded by saying transplantation was a good idea because the woman's life was saved. Mrs M asked her if she had thought about what may have happened if the transplant had failed, and should family members be allowed to donate their organs? Leanne wasn't sure. She hadn't thought about it.

Last week, the class did the Liver Transplant Activity. Leanne had a maths assignment to complete, so she worked on that while her friends decided which patients should receive a liver transplant.

Leanne decides that the best thing about the Biotechnology course is it's about giving your opinion. It doesn't matter what your opinion is, as long as you can back it up.

### **What Do These Tales Tell Us?**

The focus of this section is the extent to which the tales about Holly and Leanne are credible and authentic. When I told Catherine that I was writing tales about the students, she told me that "it didn't sound very scientific". I explained that it wasn't meant to be. I am not using scientific method as a research methodology. Thus, the standards of objectivity and truthfulness do not apply here. Rather, in writing these tales, the criteria I am using to judge whether the tales are credible and authentic are verisimilitude (i.e., do the tales ring true for the research participants?) and usefulness (i.e., do the tales portray authentically the learning experiences of some of the students in the Biotechnology class and does feedback from the participants enrich my understanding of the research environment?)

I asked Catherine and five of the students who studied the course (Sarah, Katie, Melanie, Gemma and Amanda) to read the tales and provide written feedback (commentaries) on the extent to which their reality is portrayed. Shulman (1992) states that "commentaries 'layer' cases by providing additional perspectives or lenses through which to view the events of the case" (p. 12). I asked them, firstly, whether students like this exist? To what extent do Leanne's and Holly's tales ring true? Are they plausible? To what extent do the tales 'resonate' with their own experience? Secondly, I asked them what they thought Holly and Leanne had learnt in the Biotechnology course. Finally, I asked what factors may have constrained Holly's and Leanne's achievement of the learning outcomes.

I also sought feedback from individuals other than the research participants. It was possible that Catherine and her students may have been unable to separate the tales from their own personal experiences. When the students read the tales and wrote about what they thought Holly and Leanne learnt, they may also have been recalling and writing about their own learning experiences. Similarly, Catherine may well have written down what she thought the students should have learnt.

The criterion of verisimilitude was uppermost in my mind when I asked two colleagues of Catherine (Pat and Carolyn) if they would comment on the tales. Both Pat (a mathematics teacher) and Carolyn (a physics teacher) teach at the school and are



familiar with the types of students who attend the school, but are unaware of the nature of the Biotechnology course and its goals.

The comments of Pat and Carolyn have helped me in an unexpected way to reflect on the tales I wrote. For example, Pat raised a pertinent point to be considered when combining data from multiple students. She felt that, even though I had described Holly as average to below average, some of the language (e.g. “morally unacceptable”, “consequentialist theories”) Holly used in her journal implied an above average student. I acknowledge that care needs to be taken with combining dialogue so as to construct a story that doesn’t ‘jar’. There is also a difficulty with combining oral and written comments. The oral interview data tended to be more casual than written comments.

### *Do Students Like Holly and Leanne Exist?*

All of those who wrote comments (three teachers and five students) stated that students like Holly and Leanne do exist. As Gemma wrote, “to me, Holly was the average student that attended the Biotechnology course”. When Catherine read the tale she asked me, “Is this meant to be Sarah?” “No!” I exclaimed, mortified. (Sarah is one of the students who commented on the tales.) “It sounds like Sarah,” she replied. I had endeavoured not to write about any particular student. Yet, I understood Catherine’s question. If I ask myself which students in Catherine’s class had an experience similar to Holly, I would name Sarah and Katie (whom I interviewed regularly) and Melanie (see previous section). Carolyn described Holly as “an anxious, serious, neat student with tendencies to over achieving. She needs clarity and order, so the teacher is important to help her reduce her anxiety and help her to do well.”

Do students like Leanne exist? Carolyn described her as “a lively girl, somewhat opinionated and disruptive. She does not take school, science or learning as seriously as Holly. The aim for Leanne is just to get through the day.” If I reflect on students in Catherine’s class who were similar to Leanne, Amanda and Gemma immediately spring to mind. I have taught Amanda and Gemma this year and their level of participation during classroom discussions and group work is not dissimilar to Leanne.

Interestingly, although Amanda agreed that students like Leanne do exist, she distanced herself from her and explicitly identified with Holly. In response to Holly’s tale, Amanda wrote that:

Holly learnt lots in the Biotech. course. After reading this I remember it was exactly how I felt. Every thought and sentence expressed here sounds a lot like myself. There are students like this and they do exist which is great.

Although all five students agreed that students like Leanne exist, they were relatively unsympathetic towards her. Melanie stated that “there are students like Leanne and they usually make it difficult for the rest of the class to function to its full potential”. Amanda was particularly scathing:

Leanne didn't learn much at all and that's all her fault. If she had given the course a chance, she may have found it rewarding. Leanne didn't learn half the information that Holly did. She didn't ever consider other peoples' opinions. She never thought deeply and involved herself in class activities like the oral presentation. Leanne never gave any thought to the issues or consequences of the issues. Unfortunately, Leanne gained nothing from the course.

### *What did Holly and Leanne Learn?*

#### *Teachers' Perspective*

In writing the tales, it was my intention to demonstrate that Holly achieved the outcomes related to bioethics education to a greater extent than did Leanne. Catherine felt that the most telling statements that Holly made were that “I would talk about an issue and research it” and that “issues are complicated”. Catherine also stated that Holly had a better understanding of how to express herself and more confidence than Leanne. Also she had developed skills that she could use in other subjects and finally she had enjoyed the course and linked that enjoyment to science. Pat wrote that “Holly learnt about issues related to organ transplantation and abortion and also that a resolution of the issues is a personal thing although talking and research are part of forming your opinion. Holly also learnt about her preferred style of learning”.

In contrast, Leanne was intended to represent a student who did not achieve the outcomes to the same extent as Holly. Even though Leanne was present in the classroom she did not participate fully in the learning activities. Catherine felt that whereas Holly had learnt to think, Leanne had not. Catherine described Leanne as the type of student for whom school is “a social event”. Pat wrote that:

Leanne appears to be more aware of organ transplantation but not to the same extent as Holly. The portfolio reinforced her bias against animal experimentation. Leanne is typical of some students but I don't think her experience in the class was necessarily less worthwhile than Holly's experience. Any small step forward (e.g. becoming aware that she has to back up her opinion and that she could help someone by donating organs) is important for the Leannes of this world to help them learn to moderate their self centred (?insecure) behaviour.

### *Students' Perspective*

The students' responses to the question about what Holly learnt were similar to each other. The three quotes below are representative of their responses.

Through the Biotechnology course, Holly has learnt to express her opinion and think more before making a decision. Not only has Biotechnology helped her in decision making, but has also made her more confident in other subjects and respect other class members' decisions. (Sarah)

Holly learnt a lot in the course. She learnt how to make decisions and express her opinion. Holly learnt that everybody was different and thought differently, accepting them for who they are. Holly found out how many issues were concerned when making a decision and had to think for herself. (Amanda)

Holly learnt that in matters of life and death there is no real right or wrong. Because of this, she was forced to think and explore a case from every angle and to make a decision that is not necessarily 'right', but is the best choice. (Melanie)

When asked what Leanne had learnt, students wrote that:

Leanne's knowledge was limited compared to Holly's. Leanne learnt the very basics about transplantation taught. (Gemma)

Leanne didn't learn much from this subject. Leanne already had strong opinions on animal testing and not many of her opinions seemed to change after the course. However she did learn more about transplantation and decided to donate her organs and considered becoming a vegetarian. (Sarah)

### ***What Factors Inhibited Leanne's Learning?***

The students identified a range of factors that they felt inhibited Leanne's learning. Some of these factors related to the types of learning activities that students engaged in. For example:

Many students like classes where there is no note taking and lots of discussion. Unfortunately some students take advantage of this and fail to complete tasks. (Sarah)

The small minority of students like Leanne learn as little as they do because they don't get involved with class discussions. (Gemma)

However, most of the constraints mentioned by the students related to characteristics of Leanne herself.

She was distracted with her friends and personal interests. (Gemma)

Perhaps this is due to her lack of organisation. (Melanie)

She hardly ever paid attention in class and didn't listen to others' opinions. (Katie)

Leanne's poor use of time and concentration inhibited her learning. If Leanne used her time studying, doing homework, assignments and paying attention in class instead of decorating her diary and chatting to her best friends she might find she has learnt more at the end of the course. (Sarah)

### **Discussion**

In this section, I have used narrative tales as a means of demonstrating the variable experiences and learning outcomes of students who studied the Biotechnology course. My perception is that Holly and Leanne's experiences represent two ends of the learning spectrum. I would also argue, from my classroom observations and student questionnaire and interview data, that Holly's experience was more typical than Leanne's. The comments from the teachers and students indicate that, from their perspective, Holly achieved the four learning outcomes mentioned at the start of this section. She developed an awareness that the variable bioethical values of individuals

should be respected and that bioethical dilemmas can be resolved by a decision making process. In contrast, Leanne learnt about the mechanics of organ transplantation, but little else.

The commentaries, especially those of the students have served not only to make credible the tales, but have enriched my understanding of factors influencing the learning outcomes. In reflecting on the teachers' and students' comments, there are a number of factors that seem to have inhibited Leanne's learning. The first of these factors is maturity. Leanne may not have been morally or emotionally ready to consider the importance of ethical issues. The degree of motivation and attitude to science and school life in general may have been significant. It may not have mattered what the subject material was, Leanne's attitude may have been one of disinterest. Parental influence and expectations may also have adversely affected Leanne's attitude. An image of science as a difficult subject, coupled with previous failure in science (and other subjects) may have resulted in Leanne adopting behaviours and strategies that were not conducive to learning although they may have served as a means of coping with the demands of school life.

The types of learning activities in the Biotechnology course may not have suited Leanne's learning style. Despite participating in the course, Leanne did not seem to engage in the learning activities to the same extent as Holly. Classroom discussion and group work formed the basis of many of the learning activities. Although Leanne enjoyed classroom discussions, she did not seem to appreciate that the purpose of discussion is two-fold. Classroom discussion is about talking *and* listening. Leanne liked to talk and express her opinion but was unable or unwilling to listen to her peers.

Thus, it appears that a combination of intrinsic factors (e.g., maturity, attitude to school, preferred learning style) and extrinsic factors (e.g., types of learning activities) influenced the learning outcomes of bioethics education amongst students in Catherine's Biotechnology course. In summary, I conclude that the attainment of learning outcomes were due, in large part, to the course's personally relevant content (organ transplantation), the types of learning activities employed (student centred, active and cooperative) and also to characteristics of the students themselves.

In the previous four chapters, I have explored, at length, the Biotechnology course taught by Catherine, focusing primarily on areas related to bioethics education. Catherine taught in an independent girls school and I realised that her case was not necessarily representative. In an endeavour to further enhance my understanding of bioethics education, I also visited the classrooms of Mark and Helen, each of whom

were teaching science courses that included aspects of bioethics education. The courses taught by Mark and Helen are the focus of Chapters Eight and Nine respectively.

## CHAPTER EIGHT

### MARK AND THE DNA TECHNOLOGY COURSE

#### INTRODUCTION

This chapter focuses on Mark, an experienced biology teacher at an independent boys' school in Perth, Western Australia. One of the courses that Mark teaches is a Year 10 Biotechnology course. The course, which is compulsory for all Year 10 science students, comprises three sections; 'Plant Tissue Culture', 'Enzymes in Industry' and 'DNA Technology'. The third section on DNA technology exposes students to the theory, practice and bioethical ramifications of genetic engineering and cloning. The purpose of this chapter is an interpretive account of the types of learning activities related to bioethics education that Mark offered to his students.

In this chapter, I address the first initial research question, that is, *what learning activities are utilised by secondary science teachers who are incorporating bioethics education into their teaching programmes?* Because of the problems associated with initial research question two, in this case, I have addressed the following two emergent research questions. *To what extent did the teachers achieve their teaching goals related to bioethics education? From the multiple perspectives of the students, the teacher and myself, what impact did the learning activities have on student learning?*

The first part of this chapter, introduces Mark and outlines the context and structure of the DNA technology course. I describe Mark's teaching goals and the methods that he employs to achieve his goals. In the second part, I present two vignettes, compiled from classroom observations, that illustrate learning activities related to aspects of bioethics education. In addressing the emergent research questions, the quality of the learning activities are interpreted from the perspective of myself (based on my pedagogical framework), Mark (based on his pedagogical goals) and the students.

#### INTRODUCING MARK'S CASE

I was pleased to have the opportunity to visit Mark's class because the topic of DNA technology is not normally taught in secondary schools in Western Australia. Yet, the area raises many bioethical issues as the vignettes (later) demonstrate. From my own experience as a teacher in Western Australia, I would suggest several reasons why

science teachers do not normally cover this topic. Firstly, most schools teach genetics and ecology as the biological components of Year 10 science. The content material from these topics is a prerequisite for students who choose to study upper school biological science. Secondly, the equipment and reagents needed to carry out practical work related to DNA technology is expensive and beyond the budgets of most schools. Also, some teachers may not have the expertise to teach this relatively new topic. Furthermore, there are few resources (e.g., text books) available for secondary school teachers. The way in which Mark's school overcame these difficulties is outlined below.

Before visiting Mark, I wrote to the school principal requesting permission to observe Mark's class. I received a welcoming reply. (See Appendix C.) Prior to observing Mark's class, I interviewed him about his teaching background, his teaching goals and the structure of the DNA technology component of the course.

Although I had spoken to Mark on the telephone, I met him for the first time at our initial interview. Mark met me at the school's administration building. He welcomed me warmly and we shook hands. He was younger than I expected (he is 34). He was neatly dressed, wearing a shirt and tie and appeared very comfortable within the school environment. I commented on this and he explained that he used to be a student at the College and his father is the Head of Science.

When I asked Mark why he became a teacher he told me that he had always been interested in biology and it was his favourite subject at high school. After he left high school, he initially enrolled in a biomedical science degree and although he was enthusiastic about the content of the course, he felt that his future job prospects were uncertain. Thus, at the end of his first year he transferred to a Bachelor of Education course majoring in biological science. He was familiar with the demands of teaching as a profession because both his parents were teachers. He initially taught in the state school system for five and a half years before obtaining a job at his present school in 1990. Mark teaches upper school biology and lower school science. He is currently acting Head of Biological Science.

When I asked Mark why he thought that the teaching of bioethics was important, he told me it was "because of my experience as an individual". That is, "my life experiences have moulded my world view". Those experiences which were most important to Mark were "a Christian upbringing, an interest in biology and nature, and positive life experiences" (Interview, 23/3/97).



## Data Sources

Over a period of six weeks (February-March, 1997) I visited Mark and observed his DNA technology class on five occasions. I interviewed Mark prior to each of the lessons I observed. Recently, I re-interviewed Mark after he had read the two vignettes that are presented in this chapter. The interview questions are in Appendix A. In order to address the criteria of credibility, each time I visited Mark (except for the first visit) I gave him a copy of the case record which included classroom observations, interview transcripts and journal extracts. I asked him if he would read it and make comments. I asked him whether he felt that the sections I wrote that were based on classroom observations were a fair representation of what happened in his classroom? Mark agreed that they were. He told me that he liked what I had written and also the style of presentation. He also said that my presence in his class had helped him to crystallise his thoughts about what he wanted to achieve with his students. More recently, Mark has read and spoken with me about his interpretation of the vignettes that appears in this chapter.

At the end of the course, four students, Sam, Cary, Josh and Ken (pseudonyms) were interviewed about their impressions of the learning activities related to bioethics education. Mark selected these four boys based on his view of the extent to which they engaged with the learning material. Sam and Cary were very articulate and seemed interested during classroom discussions about bioethical issues, whereas Josh and Ken appeared to be less interested. I reinterviewed Cary six months later about some of the issues that arose as I reflected on the data. All students (20) in the class completed a written questionnaire (the same as in Catherine's case) related to their impressions of the learning activities (see Appendix A). The students also completed the bioethical dilemma survey, the results of which were compared to those of a similar group of students from the same school. The students' responses and statistical analysis are summarised in Table 11 and 12 (Appendix E). The results obtained from the bioethical dilemma survey were similar to Catherine's. As with Catherine's students, the reasons offered by Mark's students to support their responses tended to focus on the rights of individuals. For example, Table 13 (Appendix E) summarises the reasons provided by Mark's students to justify a 'yes' response to the cystic fibrosis dilemma.

Compared to Catherine, I observed Mark's class for a relatively brief period of time. Although the course covers three areas of biotechnology; plant tissue culture, enzymes and recombinant DNA technology, my classroom observations, teacher and student

interviews and questionnaires focussed on the final section (the DNA technology section). This was because the bioethical issues component comprised the final four lessons of the DNA technology section.

### **The School Environment**

The school that Mark teaches at is situated in an affluent coastal suburb. The boys attending the school pay substantial tuition fees, although the school does offer scholarships for academically and musically talented students who would not otherwise be able to attend. The following extract from my personal journal describes my initial impressions of the school.

The school buildings and grounds are well maintained. The main administration building where I met Mark appears similar to the independent school where I teach. The administrative staff are mostly female and everyone seems very formal and efficient. The woman at the front desk telephoned Mark while I sat in the reception area and read the school English magazine. I did not see any students.

As Mark took me over to the science department, I noted that the school, although old, has been rebuilt. All of the facilities seem modern and expensive. The science building was no exception. There was a large central preparation room with ample storage space and laboratories connected. When comparing the facilities to my school, I could see that the preparation room was very well resourced and maintained. Mark led me to a staff room for the biological science teachers. It was cool and air conditioned. (The temperature today was 42 degrees Celsius.)

When Mark showed me his teaching laboratory, I noticed that there were windows along the outside and inner walls. The other two walls were covered with notice boards containing laminated posters of the Great Barrier Reef, Marmion Marine Park, posters from Geo (a nature magazine), surfing posters and photographs of birds and fish. The room had a definite 'marine feel' to it. Through the outdoor windows were tall green trees that shaded the building, while through the inner wall windows, there was an indoor arboretum. They gave the laboratory a calm, verdant atmosphere.

(Personal Journal, 13/2/97)

## **Development and Structure of the Biotechnology Course**

The Biotechnology course was originally developed by the previous head of Biological Science who was awarded a Fellowship to travel to America to obtain information about existing biotechnology courses, especially those related to DNA technology. The science department then obtained a grant which enabled them to buy the initial (expensive) equipment and reagents to set up the course. Ongoing costs are offset by the science department conducting professional development sessions for science teachers from other schools who wish to teach aspects of the course. The course has been modified by Mark to include a consideration of ethical issues arising from the use of DNA technology.

In 1990, the Biotechnology course replaced a standard Year 10 Biology course of genetics and ecology. The science teachers had felt that their Year 10 students seemed to be in limbo. By the end of Year 9, the students had studied biology for two years, yet were not developmentally ready for the more conceptually difficult upper school biology. The science department was committed to changing the Year 10 science curriculum and all Year 10 students now study the Biotechnology course rather than the traditional genetics and ecology courses offered in most schools.

When I asked Mark if the science staff experienced any difficulties with changing the curriculum, he told me:

No, the Biotechnology course is more valuable than another year of standard biology. Our students are confronting issues in their daily life in newspapers etc. These issues will have more and more of an impact. Students need to be exposed so that they will be well informed. The course is also very practical which helps with student motivation.

(Interview, 10/3/97)

The DNA technology component comprises the final third part of the 10 week Biotechnology course. For each of the three sections, the students are provided with a booklet, developed by the science department that contains theory, practical work and work sheets. (See Appendix B for a copy of part of the DNA technology booklet.)

The contents of the DNA technology booklet introduces students to cell theory, cell microstructure, the nucleus and chromosomes. Students then examine the double helix structure of DNA and the genetic code. During the next lesson, students isolate DNA from onion cells. DNA prepared in this way looks like thick, white saliva.

Students then prepare a gel (a type of jelly) that can be used to separate broken pieces of DNA. The DNA is broken up with special enzymes called restriction enzymes. This process of separating the fragments of DNA, known as electrophoresis, involves passing an electric current through the DNA in the gel. DNA is negatively charged and will move towards the positive electrode. The smaller the piece of DNA, the faster it will move. The pieces of DNA can then be visualised by staining the gel with a dye such as methylene blue. The DNA stains intensely. Students are taught about the method of gene manipulation through the use of restriction enzymes. They are also exposed to some of the practical applications (e.g., slow ripening tomatoes). In the final section, students are introduced to the concept of ethics and investigate some of the ethical questions that arise from the use of DNA technology.

Assessment includes a final written test, brief comprehension exercises and a series of homework sheets. Students also complete a written assignment about *in vitro* fertilisation and the use of recombinant DNA in pesticide resistant plants. There is no formal assessment on the ethics part of the course. The reason for this, explains Mark, “is test comparability between classes. The ethics section is flexible and it depends on the individual teacher how far they take it. There are two other teachers teaching it, one for the first time. Thus, the degree of time spent exploring ethical issues depends on the teacher’s comfort level” (10/3/97).

To date, Mark has been very pleased with the positive feedback from the students about the course. He believes that the emphasis on practical work and discussion seems to appeal to the students. Since Mark began teaching the course in 1992, the number of upper school biology classes has increased from two to four. This pattern of enrolment is against the State trend where the number of students studying upper school biology is decreasing.

### **Mark’s Teaching Goals**

When teaching science, Mark tries to impart to his students that science is “the study of life and how things work and how that impacts on our daily life”. The impact of science on the lives of students is a theme that Mark brings to his teaching of the DNA technology course. He believes that through teaching science he can “get kids to work out how things work” and also “to realise there is some miracle to life” (Interview 13/2/97).

Mark's main goals in teaching the recombinant DNA section of the course is to help his students to acquire the skills to understand new technology and to increase their awareness of ethical issues as he believes that:

the more informed the students are, the more likely it is that they will become well-informed community members. You want to be a valuable contributor to society. You can't deny the momentum of society. If you can keep up with ethical issues, you can make some informed comments.

(Interview, 13/2/97)

In addition:

they need to have a broad understanding of the issues so that they realise when they are being manipulated. They need to learn that newspaper articles may be biased and sensational. I want my students to look past the sensationalism and look at the facts and issues without the bias. I believe their knee jerk reactions are due to their lack of understanding.

(Interview, 23/3/97)

### **How Mark Aims to Achieve his Goals**

Like Catherine, Mark has no particular expertise in teaching students about bioethical issues. "I certainly wasn't taught it in teacher training," he states. However, he believes that "I think it [expertise] comes through life experience, looking at issues and making judgements myself" (13/2/97). Thus, he does not perceive his lack of education about bioethics to be a drawback as long as he keeps himself informed.

I asked Mark how he achieves his teaching goals. He shows me some of the newspaper articles and videos that he has used previously to stimulate discussion about ethical issues in class. He encourages students to ask questions and express their opinion. Discussion about ethical issues involves the whole class and tends to occur in an ad hoc way, depending on the students' interests and ability. He has used videos from a BBC series (narrated by David Suzuki) that includes *Cracking the Code* and *Designer Babies* (1994). Mark believes that using the media as a source of information is more "real life" and "gives the stories more credibility than using text books". In the past, they have discussed the human genome project (where every human gene is to be mapped) and the potential ramifications for employment and life insurance; for example, if you carry a gene that predisposes you to cancer, should you

be given life insurance with the same premiums as someone who does not have the gene? He also encourages students to bring in articles of interest to them and explains that he will forego his lesson plan to allow the students time for discussion.

When I asked Mark how he helps his students to understand ethical issues he told me that the best activities are those “where they get involved in discussion. I just let the discussion diverge” (10/3/97). He explains that:

because I interact with students in this and other classes, I build on their ideas and modify them. The students are not sponges who absorb knowledge. I need to draw their ideas together and reflect them back.

And:

my role is to make them informed, but not to pass judgement. Expose them to content and let them make up their mind. If you ram your judgement down their throat, it can have a negative effect. I expose them to issues and let them make judgements which they will anyway. If you give a hard and fast opinion then that can be a block to their learning. If you are open, they are more likely to be receptive to the content. And one of your roles is to communicate the content.

(Interview, 23/3/97)

I asked Mark how he would lead a discussion about an ethical issues? He explains that:

I would discuss what the article was about, what are the biological concepts behind the article? Explore those. Not put judgement on it. Very open ended. It is hard to make a conclusion. You can discuss it to highlight areas that you understand. Only sometimes through exploring the issue, can you come to a conclusion. Sometimes it aligns with the morals and values of society. Sometimes it is outside it. I don't tend to put conclusions on ethical discussions. It is really exploring the issue, looking at the factual knowledge that has been applied. Is it valid? Like gene screening. And then get the students' opinions. They can see how other people view issues.

(Interview, 10/3/97)

From my interviews with Mark, my perception was that he has a clear understanding of his pedagogical goals and has articulated a sound rationale about how he will

achieve his goals. That is, Mark aims to increase the students' knowledge of the terminology and procedures used in DNA technology and through discussion increase students' awareness of ethical issues in science.

From what Mark has told me, I anticipated that classroom discussion (whole class and small group) would be a central feature of his teaching. That is, discussion where he challenged the students' beliefs, provided alternative viewpoints and provided opportunities for them to listen to each other.

## **LEARNING ACTIVITIES**

The purpose of the two vignettes below is to illustrate the types of learning activities that Mark used to achieve his teaching goals of increasing his students' understanding of the processes of DNA technology and associated ethical issues. At the end of the two vignettes is a discussion of the extent to which Mark achieved these goals. Vignette One entitled 'Cells, Cows and Cave Men' is based on classroom observations of the first lesson of the DNA technology course. Vignette Two, 'Questions about Ethics' is based on classroom observations from the final three lessons of the course.

### **Vignette One**

Mark told me that during the lesson on which this vignette is based, he intended to revise the structure and function of animal and plant cells and cell theory, a topic most of the boys had previously studied in Year 8. He wanted to focus on the nucleus and DNA and then show a video about cells that the boys could take notes from.

As I wrote this vignette, I took the liberty of adding in some relevant background information on DNA technology. These sections are indented. I hope that as you read this vignette, you learn something, not only about how ethics was introduced in this particular classroom environment, but that you come to appreciate that DNA technology represents a fascinating field of biology that will have an increasing impact on our society.

#### ***Cells, Cows and Cave Men***

The boys are waiting outside the laboratory. They enter chatting, but quieten down when Mark starts to talk to them. Mark begins by asking a question. "Over the last fortnight, what has been one of the big issues discussed in this class?" Two boys answer immediately, "the cloning of Dolly", "the cloning of the Rhesus monkeys".

Both of these issues featured on the front page of the local newspapers. 'Dolly', a Finn Dorset sheep was created by turning a single cell from the udder of an adult sheep into an embryo and growing it in the uterus of another sheep. Thus, Dolly is genetically identical to the female sheep from which the udder cell was taken. The lead story was followed by a series of issue articles, editorials and letters to the editor mostly related to the ethics of this type of research and the possibility of cloning humans. Most authors found the notion of cloning humans repugnant and unethical. Indeed, Ian Wilmut, director of the Roslin Institute near Edinburgh where 'Dolly' was cloned stated before the House of Commons Science and Technology Select Committee that he found the concept of human cloning "distressing and offensive" (The West Australian, 1997, p.9). Nevertheless, he stated that it may be possible to clone humans within two years.

The weekend paper then published a front page article about the cloning of two Rhesus monkeys. Given our genetic and evolutionary closeness, this may have seemed quite amazing except that the monkeys were cloned from embryos. That is, the embryo was split at the 4-8 cell stage. Thus, even though the Rhesus monkeys were genetically identical to each other, they were genetically different from their parents. This process is similar to the natural process of 'twinning' where identical twins are produced. Each split embryo develops into an individual. Cloning of embryos is difficult and many of them may be sacrificed before the procedure is successful. (That is, there is a high fatality rate with mammals). Research involving cloning of this type in cows and sheep to produce consistently high quality animals has been under way for more than ten years, although the general public may be oblivious to this.

My experience with students is that although they are familiar with terms like 'cloning' and 'genetic engineering' they don't necessarily understand the terms. The term cloning means 'to make a copy'. Thus, when genes are cloned, multiple copies are made. When embryos are cloned, an embryo is split and because the cells at that stage contain all of the necessary genes to develop in to an individual, two identical embryos develop. Within the laboratory, cells have been successfully cloned since the 1950s.

What was remarkable about Dolly is that she was formed from an adult cell. Normally, adult cells are differentiated or mature. During this process of differentiation, most of the genes are switched off so that the cell produces only



a limited range of proteins. It is possible (although difficult) to demethylate the DNA in an adult cell so that all of the genes are switched back on. This cell can be fused with an ova that has been emptied of DNA. The ova then develops into an embryo. The technique is fraught with difficulty and in the case of Dolly, 277 eggs were used.

It is my view that because of medical advances of this type that students need to be well informed not only about the science behind such breakthroughs but the ethical implications.

Mark states that both of these situations utilised methods of DNA manipulation and also raise a range of moral and ethical implications. At this stage Mark does not pursue what these implications are. Rather, he alerts students that they exist.

He asks the students where DNA is found. A student says that it is found “in the nucleus of every living cell”. Mark asks, “why is DNA present?” Another student replies that it is a “code for how the cell functions”.

He goes on to ask, “what are two cell types?”

A student answers without hesitation, “plant and animal”.

“How are they different?” Mark asks.

“Plants have rigid cell walls and chloroplasts.” “Both have a cell membrane.”

As the students respond, Mark draws a rectangular cell with a round nucleus and chloroplasts. Mark calls on a wide range of students, at least half the class, as they raise their hands to respond to his questions. These questions require factual information to be recalled and I believe Mark is using this question and answer session as an opportunity to remind students about their Year 8 work on cells. Mark continues asking similar questions.

“Anything else?” A student mentions a vacuole.

Mark moves on and asks the boys. “How did we find out about cells and their structure?”

“The microscope.”

“How long ago?” he queries.

A student replies, “the 1970’s.”

“No, earlier.”

“The 1960’s.”

“No.”

“1870’s.”

“No.”

“Was it Galileo?”

“No.”

“1400’s.”

“No.”

“It was during the 1600’s. Does anyone know the name of the scientist? No. Robert Hooke first observed dead cells in cork. Several years later, Antony van Leewenhoek placed a ground lens in a tube and observed living cells, small organisms. Does anyone know of a different type of microscope?”

“An electron microscope.”

“What is it?”

“A big microscope that has electricity passing through it”, the same student answers.

Mark says, “Yes. Instead of light there is a beam of electrons. They cost more than \$100,000. You can only look at dead material though, not living cells. This is because the cells have to be thinly sliced. You end up with a photograph of the cell.”

Mark informs the students that “with an electron microscope it is possible to see lots of small structures inside the cell; for example the mitochondria, which is like the power house of the cell. They make energy.”

I note that the boys appear to be attentive. Mark has a comfortable, conversational and controlled tone with the 20 boys in this class.

Mark hands out the new student booklet on DNA technology. He refers the students to the heading ‘cell theory’ on page 2. Cell theory, he explains, allows us to decide whether a substance is living or not. There are four components of the theory. They are 1) all living things are composed of cells, 2) all cells come from other cells, 3) the chemical reactions of a living organism takes place within its cells and 4) cells contain hereditary information which is passed from parent cells to daughter cells.

“So, if this theory is true”, he queries, “where did the first cell come from? It is like the chicken and egg problem. There are different theories. It may be that God created life or that life was formed from components of the atmosphere or the primordial soup and subsequently evolved.”

Mark refers the students to the bottom half of the page which introduces prokaryotic and eukaryotic cells. He tells the students that “prokaryotic cells are very simple in

structure and probably evolved first. They have no nucleus and few organelles, but they contain DNA and/or RNA. Living examples of prokaryotes are the bacteria. Eukaryotic cells are more complex in structure and probably evolved more recently.”

While Mark is setting up the video cassette recorder, one of the boys asks him if he saw the ‘cave man’ article in yesterdays newspaper. The article, which originated in England, told of how DNA testing of a ‘cave man’ (some of whose body parts were preserved) was carried out, along with that of teachers and students at a local high school. According to the article, one of the teachers was a direct descendent of the cave man. Mark explains to the students how mitochondrial DNA can be used to trace ancestry through the female line.

Only female mitochondrial DNA is passed from one generation to the next. At fertilisation, the head of the sperm (containing nucleic DNA only) enters the egg cell. Thus, the only mitochondria in the fertilised ova is from the mother. The mitochondrial DNA is thus passed from generation to generation.

Unlike most cellular material, the DNA molecule is very resistant to degradation and thus is stable over a long period of time. The cave man was dated to 9000 years. It is thought that mitochondria (the site of cellular respiration and thus energy production) were originally an intracellular parasite within unicellular organisms. Mitochondria contain their own DNA, RNA and ribosomes (sites for making proteins) and are able to reproduce independently of the cell.

I would, however, argue against the finding of the school teacher being a direct descendent of the cave man. DNA randomly mutates or changes its structure. What is most probable is that of all the samples taken, statistically, his DNA was most similar to the cave man’s DNA. It makes a good news story though.

Mark reminds students that they need to take notes about the microstructures inside the cell. He refers them to an electron micrograph, in the booklet, showing cell structure. The video called ‘The Cell’ is more up to date than the one I show my students. The video covers the history of the discovery of cells and the development of cell theory. The limitations of light microscopes are discussed which leads into the electron microscope and cell microstructure.

Even though the presenter is animated I can see that the boys are not overly attentive. There are several reasons for this. The end of the period and recess is approaching. Also, like some of my students, a video can be perceived as a time to 'switch off', although in biology, high quality video material can be a valuable teaching resource. Finally, compared to the previous discussion about the cave man, the video seems a bit theoretical. Mark senses their unrest and quietly reminds them to take notes about the content of the video. As boys start to move around outside the classroom, Mark stops the video and tells the students that tomorrow they will have a closer look at the nucleus and chromosomes.

(Adapted from classroom observation, 10/3/97)

## **Vignette Two**

The second vignette is a compilation of three consecutive one hour lessons. Mark had told me prior to these lessons that he intended to introduce students to genetic engineering and ethics. He wanted students to begin to think about their ethical values. Mark also informed me that he had spent a considerable amount of time preparing this lesson, partly because I was there to observe him.

### ***Questions About Ethics***

Mark begins the lesson by explaining to students the concept of genetic engineering. He reminds the students that the previous lesson they had used restriction enzymes to cut their DNA into fragments which they then electrophoresed and stained. He explains to students that the cutting up of DNA is part of the process of making transgenic organisms, (i.e. organisms with foreign DNA in their genome). Mark demonstrates on an overhead the technique of splitting the DNA at known sites and then splicing the pieces of DNA together.

Mark asks the class what is the purpose of the restriction enzymes. A number of students reply, "to cut the DNA", "break it into different lengths", "cut it where certain bits of the code are". Mark explains that "each restriction enzyme cuts the DNA at a different place. In a small length of DNA, there may be a useful gene, e.g., insulin that can be spliced or recombined in to another piece of DNA, e.g. a fast growing bacteria. This is, in fact how recombinant insulin is produced." Mark continues, "Recombinant DNA is where we take a copy of a gene from one organism and splice it in to the DNA of another organism. For example, a gene from Arctic fish has been spliced in to the DNA of tomato plants. The tomato can then be chilled without bruising and thus the shelf life is increased. This is called a transgenic tomato."

Mark tells the students that today they are going to look at genetic engineering. They will watch a video. "If you have any questions during the video you should write them down and I will answer them at the end. Then I want you to think about your opinion. That is, is genetic engineering right or wrong?"

The video, produced by the CSIRO, is called *Exploring the issues* (1992). It demonstrates some of the current and potential uses of genetic engineering, including recombinant DNA vaccines (current), blue roses (potential), plant resistance to pests (current), and the production by fermentation of large amounts of growth hormone (current). All of these examples have huge economic potential.

Mark stops the video. He addresses a series of questions to the students. "All of this technology has ethical implications", Mark states. "What do I mean by ethics? We have a Christian ethics centre at the school. As a Christian, you need to think about what you believe in and what is considered morally right. What do you associate with ethics or being ethical?"

Andrew replies, "Religion."

Sam replies, "Values, the Constitution."

"Any other terms?" asks Mark. No answer. "So if we say someone is a moral person, what does that mean?"

"That you are fair." "That you base your decisions on more than opinion."

Mark asks the boys, "if someone was ethical what would they be like?"

The boys are catching on and there are a range of responses.

"A good person who does what is right." "Truthful." "Humane." "Has a clear conscience." "Has feelings." "Cultured." Mark asks what he means. The student replies, "Worldly, knowledgeable."

Mark asks another question. "if you wanted to be ethical what would you stand for?"

"The rights of individuals or organisms not to be tampered with after they have been made by God."

“Would you be able to think of a sentence that summarises what ethics is?” Mark queries.

“Doing what you believe is right.” “Expressing views on a controversial topic.”

Mark writes the students’ responses on the white board as they speak. He repeats what they say and provides positive comments.

“Ethics isn’t just about what you think. It is about what society thinks,” says Mark. Cary comments that “it can include your personal views though.”

Mark writes his own definition of ethics on the board. “Standards or guidelines regarding the moral conduct of individuals with respect to life and living.” Mark explains this statement while the students write it down. He then asks them to think about their definition of ethics and compare it to his.

“Sir,” asks Sam, “if genes code for how we look, then are there genes for our ethics?” (This is a well thought out question and I wait for Mark to answer it.)

Mark adopts the standard biology line. “Our characteristics, including our ethics are partly genetic and partly environmental.” (I would agree with this, although place more emphasis on environmental effects.)

Sam then asks “if our genes change during life, then do our ethics change?” Mark answers. “No, as the DNA won’t change, but other factors such as hormones and our brain change during life and this may affect our personality and how we respond to ethical problems.”

“Can the environment affect our genes?” “Yes”, replies Mark. “For example, with alcohol dependency and homosexuality. There seems to be a genetic link and an environmental link, but it is hard to measure the effect of each.”

Mark moves on. “If we are to examine some of the issues associated with genetic engineering to see if they are right or wrong, we need to ask questions to get information. What kinds of questions can we ask to decide whether we are behaving ethically?”

The students provide answers which Mark records on an overhead.

“Why do you think what you are doing is right?”

“Why are you doing it?”

“What advantages or disadvantages are there to society?”

“Is the practice offensive or outrageous to our community or religion?”

“What is the cost to the community?”

“What is the long term effect?”

“Is the benefit personal or for mankind?”

“Do you believe in playing God?”

At the end of the lesson, Mark tells the students that they will continue with the ethics next lesson.

The following lesson, Mark reviews the previous lesson. Since that lesson, he has prepared a handout that includes the students' questions from the previous lesson (see Appendix B). Mark refers the students to the article on the cloning of Dolly on the fourth page of the handout. Mark informs the students that it is important to be able to examine the issue carefully and to think logically. Mark tells the students that they should refer to the questions they raised last lesson to help them answer some questions related to the cloning of Dolly. He asks them to discuss the article and then select six questions from the previous lesson or construct new questions and to discuss them (in groups of three or four) in relation to the article to try and arrive at an ethical position.

He reminds the students to remember that when working in a group they need to listen to each other, don't prejudge and to keep an open mind, as all perspectives are valid.

The students are discussing and writing their answers to the questions. Some of the groups finish early and are chatting. I think that Mark overestimated the amount of time the students would need. Mark moves from group to group keeping them on track. After 20 minutes he brings the class together.

He praises them by saying that “it is good to see most of you debating the issues with passion. I am aware that different groups have different perspectives. I want you to be attentive and think. I want each group to tell me one question that they wrote.”

The questions which the students state as most relevant in deciding whether cloning is ethical are:

1. If you have the right to clone animals then why not humans? (It should be okay to clone animals for food but not humans)

2. What is the reason for cloning sheep? (e.g., disease resistance)
3. Will it ruin or alter the products from sheep?
4. Could the technology of cloning provide medical benefits for humans?
5. What is the risk to other sheep or organisms?
6. Is it right to interfere with nature?

The students record the questions on their handout. The lesson ends with Mark telling the students that they will continue tomorrow.

The next day, Mark asks the students to take out the list of questions from the previous lesson on ethics. As they do so, Mark asks them, “did anyone see the paper yesterday?” “Yes”, says one of the boys. “There were two articles about genes.” Mark explains that one of the articles was called ‘Genes - key to cancer’. In this article, the gene for breast cancer was described and its effect on oestrogen. The gene is related to one of the rare forms of breast cancer where if the gene is present, it is frequently inherited and the affected women get breast cancer. The second entitled ‘Genes - key to heart bypass’ is about heart disease. Researchers have found a gene which produces a protein that can cause new blood vessels to grow around a blocked blood vessel.

He continues. “Now let’s return to the last lesson. You came up with questions to consider but we didn’t discuss the answers in relation to the cloning of Dolly.”

Mark begins with Question one from the list of questions constructed during the previous lesson. That is, if you have the right to clone animals, then why not humans? “Why would you want to clone a human?” Mark asks. A student replies that “if a person is a good basketball player then you might want a copy.” Mark says that this is possibly exploitation but would have economic benefits. Cary says that “if a person had incurable cancer then they may want to clone themselves.” Marks asks if the cloned person would be the same. “No”, says Cary. “Because of the environment.” Another student says, “you could clone for bone marrow transplants.” Mark says, “yes that’s different. That would mean making spare parts and is analogous to a car repair.” Another student says, “if a person has cancer then we could develop clones and practice the drug on the clones before the person.” (This is a good suggestion and already cloned cancer cells are used to test the effectiveness of drugs.) Sam suggests that cloning should be allowed to satisfy our natural curiosity to see if it can be done. Another student says it may be good to clone horses to win races and make money. Mark reminds the students again that although the clone would be the same genetically, the environment would have an impact.



Mark moves on to Question two. What is the reason for cloning sheep?

“To prove they can do it.” “It may be to obtain a better species of sheep.” “To get better wool.”

As the students respond, Mark continues to restate and add to their answers.

Question three. Will it ruin or alter the products from sheep?

Eugene says that because the clone is female then her wool, meat and milk may be affected.

Question five. What is the risk to other sheep or organisms?

A student states that the sheep may have a dormant genetic disease that kills it. Mark agrees that this is a possibility. “Also”, he adds, “the disease may transfer to other sheep or other species, like the viral disease from horses in Queensland that affected humans.”

Time is running out so Mark closes the lesson by stating that “these are questions to which there is no clear answer. Maybe we need more information. Where would we go? The newspaper?”

“No”, says Cary “because they present an opinion.”

Mark agrees and suggests that they should read about the original research in scientific journals which contain more detailed scientific information than television and newspapers.

(Adapted from classroom observations, 21/3/97, 26/3/97, 27/3/97)

### **Students’ Perceptions**

As stated earlier in this chapter, I interviewed four students about their impression of the learning activities in the final part of the DNA technology section. The questions I asked during these interviews are in Appendix A. The four students interviewed were Sam, Cary, Josh and Ken. Mark had selected the students for me. He considered that they represented students with a range of learning experiences. He felt that Sam and Cary had engaged with the learning activities to a greater extent than Ken and Josh. Mark’s perceptions are supported by the boys’ interview comments below.

*Sam and Cary*

According to Mark, Sam is an exceptional student, and the top academic student in his year group. I had already surmised that he was very insightful and intelligent from the comments and questions he had raised during class. He told me that the DNA technology section had:

really changed my mind about whether to do chemistry and physics or chem. and biol. and I'm doing biol. It was so interesting. It is almost too amazing how complicated we are. It is beyond our comprehension.

I asked him whether the lessons related to ethics had any effect. He replied:

I am thinking about ethics, whether it's moral for us to mess around with how we were created or how we evolved. If this is a path that nature has led us then maybe we should continue instead of heading down another path. By changing our structures we will be creating new organisms. Like changing genetic structures. It is amazing that people are doing research for diseases that can't be cured.

(Interview, 27/3/97)

When I asked Sam if the ethics lessons at the end of the course had helped him to make a decision about the cloning of Dolly, for example, he said:

Yes, because you get a lot more insight into technology. Like I understand the cloning of Dolly. It is complex. I have worked with DNA, so I understand better. It changes your perception just by having contact with the technology.

I think if someone's gonna do an experiment like cloning humans, I think that scientists need to answer questions about what's right. There should be a tribunal with people who know, geneticists, scientist human rights organisations, people who are religious. All domains to give a balanced view.

(Interview, 27/3/97)

Cary, like Sam was enthusiastic about the lessons on ethics. From my classroom observations, I had noted that Cary responded often during classroom discussions. He told me:

I learnt that they can do some pretty amazing stuff. But the question is, will it harm us or benefit us in some way? I found it interesting that we're stuck in a hole trying to decide whether to progress or not. Everyone has different opinions about whether it's good or bad.

I don't think I could make a decision though. I guess I kind of feel, who has the right to say yes and who has the right to say no? I can't decide who should have a say. There's not a dominant force to make a decision. You have kind of got two different parties, the ones who want to conserve what we've got now and the ones that want to pursue things.

It [DNA technology] made me more aware, learning about new processes. But when the ethical part came, I kind of thought about the other side of it. When learning the facts, it was all good, good and when the ethics part came in I actually stopped and thought about what could happen. They have introduced species before like rabbits and it's been a disaster. It makes you think about everything. At the beginning we were all pretty naive about what it was about, what was happening. Now, I'm much better informed. If you put the two together, the theory about how it works and then thinking about whether to use it or not.

(Interview, 27/3/97)

Sam and Cary both emphasised that an understanding of the scientific processes related to DNA technology was important. Both of them seemed to believe that an understanding of the technology helped them to appreciate the complexity of issues. When interviewed, Sam stated that because he was now familiar with the technology, he was much better able to state his opinion. He believed that because he had actually isolated and electrophoresed the DNA, he had more insight than if he just read about the cloning of Dolly, for example, in the newspaper. Although, this information helped Sam to make a decision in favour of the use of DNA technology, Cary did not feel that the lessons about ethical issues helped him to make a decision. Prior to the ethics lessons he had been in favour of the use of DNA technology. Subsequently he felt that it was not straightforward and that there were many questions that needed to be considered. Cary reiterated this stance when he was interviewed six months later. During this interview, I asked Cary questions about what he had learnt in the course. He told me:

We learnt about ethics. We learnt that we have the power to clone things but the ethics hasn't been sorted out. It is like the technology is developing

quickly, but socially people are not fast enough to keep up with it. In fact, in some cases, people are heading in the other direction. They are becoming more conservative like the Pope.

I have learnt there is often no right or wrong. Morally we often can't arrive at a correct answer because many of the processes will help some people and harm others. For example, maybe a farmer starts to use a new pesticide that protects his crops. It may be that the run off from the pesticide hurts another farmer. I have learnt there are always two sides to an argument.

Until the end of the course when we looked at ethics, I was really enthusiastic about the use of biotechnology. Then I started to think about some of the issues. It was better studying it at the end of the course rather than the beginning because I know about the technology. I think that if it was at the start without understanding the technology, I wouldn't have thought it was relevant or important.

(Interview, 9/97)

### ***Ken and Josh***

The interviews of Ken and Josh indicated to me that within Mark's class there were a range of learning experiences. When I asked Ken about the ethics lessons, he told me:

I didn't pay a great amount of attention. It was a lot of people going on about nothing just because a sheep was cloned. It's not all that worrying. I didn't see anything wrong with technology.

(Interview, 27/3/97)

I asked whether there were any good reasons to study ethics in science. He replied:

Yes, as there is a chance things may be hazardous. You need to just decide where to stop. There's nothing wrong with cloning sheep. You might get to the stage that people use it to live forever. Until that point, you shouldn't worry.

In relation to whether Ken had learnt how to make decisions about ethical issues he stated:

Yes I can, but it comes down to common sense. Like, if you were going to make a killing machine, then it's wrong. But if it's a blue rose, then what's

wrong with that? It hasn't affected my views because it comes down to common sense.

Josh's response was brief and similar to Ken's. He told me that:

The cloning of Dolly is of no interest to me. I didn't find the course interesting. I liked some parts, but I found the DNA part boring because it was mainly theory. Ethics is of no interest to me. Also we're taught about ethics in other classes like English.

(Interview, 27/3/97)

Josh was rather reticent and I had difficulty drawing any more information out of him. I also perceived from his lack of eye contact that he was not comfortable talking to me.

### ***Other Students***

In addition to the interviews, I also obtained information about the students' perceptions of the learning activities through a written questionnaire completed by students (16) at the end of the DNA technology section. Most of the students (12/16) indicated that an understanding of aspects of DNA technology was one of the most important parts of the course. Comments included "now I know what all the fuss is about DNA" and "it has opened my eyes to an area of biology that I had little or no contact with". A smaller proportion (5/16) mentioned that learning about ethics was important. Most of the students commented that the classroom discussion helped them to understand ethical issues. For example one student wrote that "I found the class discussions most helpful. It gave each member a chance to express what their concerns might be and why or why not they think about things on a subject".

### **Mark's Perceptions**

Mark's intention with the first vignette was:

to create interest in the students by showing them a couple of articles that were extracted from the newspaper. One about Dolly and the other about the Rhesus monkey and the cloning of organisms and to link that back to what technologists were doing with DNA. What I was trying to do was link a relevant topical example with a piece of corner stone biological content, that being DNA and its role in development of organisms and protein synthesis.

The whole reason I included ethics in this first lesson was to try and make the links between technology or activities that are carried out by scientists, biologists in this case. There are ethical implications for most things when you are dealing with living organisms whether it's a plant through to a human.

(Interview, 14/10/98)

Mark felt that most of the students learnt that "DNA does control physical characteristics and that man is now able to manipulate that, also about where it occurred in the cell and its presence in the nucleus". He believed this because "they were be able to respond about the basic tenets of cell structure and where the DNA was found by questioning in the immediate lesson and follow up lesson".

Mark explains that the second vignette:

is a series of three lessons looking at DNA technology that tries to get students to understand that the technology that has been developed where DNA can be cut with genetic scissors and combined to produce transgenic organisms. So by reinforcing and explaining how the DNA is cut and by showing a video about how it occurs the idea is to give them enough content knowledge, which I think is an important aspect of understanding, so they can take an ethical position.

Mark goes on to explain why an understanding of content was one of his pedagogical goals.

I think if you don't have some understanding of the content it is hard to have an informed ethical position. You can have an ethical position but it may be misplaced because you don't fully understand the implications of a technique. So that is certainly my intention, to expose them to content so that they can have a more informed ethical position rather than have an ignorant ethical position.

In addition, in this vignette:

I think they realise that there are a lot of questions that need to be asked to come up with an ethical position. You can't immediately arrive at an ethical position. You might make an off the cuff comment, but quite often it is an emotive comment. I think they do learn it is more than getting information.

It is asking questions and seeking more information, to ultimately develop an ethical position. I hope they realise we haven't answered all the questions. In fact, that is how I finish the lesson. By suggesting they need to seek more information.

When I asked Mark if he felt that all students learnt the same thing he said no. He went on to explain that "this is due, in part, to their intellectual ability and their intrinsic interest". For example, he recalled that one of the boys I interviewed was at the stage of "well, who gives a stuff?". He believes that because of "variation in individual student's cognitive development some are less able to deal with discussion about these issues". Nevertheless, Mark still feels that it is worthwhile exposing all of the students to ethical issues. He explains:

It is good to expose them to it so they can see how their peers react to it. But sometimes they have a blase attitude or look for a simplistic answer to it. Like you shouldn't do it because you are playing God. They don't really seek a real answer or a depth of understanding because it involves effort. Some stay with a superficial viewpoint but it varies from student to student. I felt that sometimes they couldn't deal with the discussion aspect because of their developmental stage. I don't think that's a reason for not trying it though. Some students will benefit. Some won't.

At the end of the day for me if you don't expose them to ethical issues then you breed a degree of ignorance in the greater society. I want to provide them with the opportunity to link knowledge and affective outcomes.

## **Discussion**

The two vignettes in this chapter represent the learning activities that Mark used to introduce his students to bioethics (i.e., initial research question one). As I wrote these vignettes, I was struck by the necessity of providing students with information. I believe that individuals would find it difficult to consider in a meaningful way, the issues associated with DNA technology, without an understanding of the processes.

One of the strengths of Mark's approach in these vignettes is, I believe, that he ensured that students were exposed to the theory and practical aspects of DNA technology before they considered ethical issues. Mark believed that it was essential that students understood the technology if they were to make informed decisions about associated ethical issues. I agree with Mark. I believe that to attempt to consider

ethical issues without an understanding of the context is deceptive and leaves the student in comparative ignorance.

An understanding of the content was one of Mark's teaching goals. Thus, before introducing any discussion of ethical issues, students had been exposed to cell structure and function, especially the role of DNA, protein synthesis, and also the use of restriction enzymes in the production of transgenic organisms. Rather than merely present written information, Mark used a whole class question and answer approach to elicit information from students and also to gauge their level of understanding. He incorporated topical issues like the cloning of Dolly to increase student interest in the content.

In the second vignette, students discussed the meaning of the word 'ethics'. Mark used their responses and his own beliefs to construct a working definition. He asked the students "what kinds of questions can we ask to decide whether we are acting ethically?" I was very impressed by the profound questions asked by some of the students. The quality of the questions appeared to demonstrate that some of the students were thinking carefully about the ethical issues associated with the use of cloning. Also, by requiring students to pose the questions, they needed to think about how they would decide whether an action was ethical or not. Thus, Mark seems to have achieved his teaching goal of increasing his students' awareness of ethical issues. However, the interviews with Sam, Cary, Josh and Ken imply that not all students found the topic of DNA technology interesting. Nor did all of the students find the discussion about ethical issues useful or relevant. I agree with Mark that student factors related to academic ability, maturity and interest were significant factors.

In conclusion, it would appear that when dealing with complex DNA technology topics such as cloning and genetic engineering, it is difficult to discuss or resolve ethical issues in a meaningful way without an in depth understanding of the processes involved. It is likely that, within the next decade, our society will need to consider the ethics of cloning humans. Unless all students are taught about these techniques and the associated ethical issues, they will be unable to contribute in a meaningful way to decision making.



## CHAPTER NINE

### HELEN AND THE REPRODUCTIVE TECHNOLOGY COURSE

#### INTRODUCTION

In this Chapter, I introduce Helen, a biology teacher in a Catholic girls' school. Helen taught the topic of Reproductive Technology in Year 11 Senior Science. In this topic, students were introduced to some of the procedures associated with reproductive technology. Students also had the opportunity to identify and discuss bioethical issues that arise from the use of this technology.

In this Chapter, I address initial research question one, that is, *what learning activities are utilised by secondary science teachers who are incorporating bioethics education into their teaching programmes?* The first part of this chapter describes the context and structure of the reproductive technology topic. Two vignettes that illustrate the type of learning activities in which students engaged are presented. I also address initial research question three, that is, *to what extent did I establish a caring and communicative relationship with the research participants?* I outline how I developed a trusting and caring relationship with Helen and also with her students.

Finally, I also address the following two emergent research questions. *To what extent did Helen achieve her teaching goals related to bioethics education? From the multiple perspectives of the students, the teacher and myself, what impact did the learning activities have on student learning?* In addressing these questions, I describe Helen's teaching goals. After presenting the two vignettes, Helen and I reflect on the extent to which the learning activities enabled Helen to achieve her teaching goals. Finally, the students' perceptions about what they learnt are presented.

#### BACKGROUND TO REPRODUCTIVE TECHNOLOGY TOPIC

I first met Helen in October, 1996, when I ran a professional development session (on bioethics in science) for the Science Teachers' Association of Western Australia. Helen attended the session. She shared with the group her recent experience teaching her Year 11 Senior Science students about bioethics associated with reproductive technology. She felt she had not been overly successful, partly because of the lack of suitable resources and also because of the limited academic ability of her students.

At the end of the session, I asked Helen if she would be willing to participate in my research study. She agreed and the following year (July, 1997) I organised to visit her. I was pleased that Helen had agreed to participate. I believed that her involvement would add a rich dimension to my study. Catherine and Mark had taught different content areas from Helen (i.e., transplantation technology and DNA technology) in different school systems (independent girls' school, independent boys' school). The opportunity to conduct research in a Catholic girls' school would, I felt, provide me with a different perspective. The topic taught by Helen, reproductive technology, would provide an increased opportunity to compare and contrast the findings from each of the case studies.

Helen was the final teacher I worked with. At this time, I had written up Catherine's and Mark's case records. I had begun to identify issues that might contribute positively to the quality of bioethics education. These issues included the importance of content material, a student centred approach and a positive effect of bioethics on students' attitudes to science. Thus, I decided to be sensitive to these factors in the data generation phase of Helen's case study. I wanted to observe more carefully the types of learning activities and classroom interaction that occurred in Helen's classroom. I also decided to maintain a comprehensive record of my perception of classroom observations and interviews in my journal, and also to regularly share my interpretations with Helen.

### **Data Sources**

I visited Helen's classroom once or twice a week for a period of four months during Term 3 and Term 4 in 1997. I obtained permission from the school principal (see Appendix C) to visit Helen's class. Although Helen has agreed to her name being used, the school and the students are anonymous. During the four months, I interviewed Helen at the end of each lesson. The length of interviews ranged from 20 minutes to one and a half hours. We discussed our respective perceptions of the lesson. I did not tape these interviews. Often, our interviews took place in an open plan staff room where the background noise was not conducive to audiotaping. Thus, I took brief notes which I wrote up and added to the reflections recorded in my journal.

While observing Helen's class, I spoke informally with her students. I formally interviewed students on two separate occasions. On the first occasion, I interviewed all 15 students in the class. At the time, they were carrying out individual

investigations related to reproductive technology in preparation for an oral presentation. The purpose of the interview was to determine the students' perceptions of the importance of the topic and also to ascertain what they expected to learn. At the end of the course, all of the students completed two questionnaires (see Appendix A) to determine their perceptions of what they had learnt. A second interview of four students was conducted at this time where I asked them to elaborate and explain their questionnaire responses. Other data sources included copies of all assessment items and the students' final examination. The examination contained questions intended to assess the bioethics component of the course (see Appendix D for a copy of all assessment items). Helen's students also completed the bioethical dilemma survey. The students' responses to the dilemmas were similar to those of Catherine's and Mark's students. A summary of their responses is in Table 14 (Appendix E).

Although the bioethics component was taught in the final weeks of the course, I felt I would be more insightful and gain a deeper understanding of the learning environment if I observed Helen's class throughout the entire course. This would enable me to develop a caring and trustful relationship with Helen and her students. It would also enable me to share with Helen my ongoing perceptions and interpretations of the classroom environment. Helen could also share her perceptions with me.

Recently, I reinterviewed Helen after she had read the sections of this chapter relating to her teaching goals and the vignettes. During this interview, Helen outlined her perception of the extent to which the learning activities in the vignette allowed her to achieve her teaching goals. Helen also spoke about the purpose of the activities and what she felt that students learnt. The interview questions are in Appendix A.

### **Context of Course**

In relation to assisted fertility treatment, the only procedures approved by the Catholic Church are artificial insemination by husband (AIH) and gamete intra fallopian transfer (GIFT). In AIH, the husband's sperm is deposited in one of the fallopian tubes when the woman is ovulating. With GIFT, the husband's sperm and women's ova are inserted in one of her fallopian tubes (Fisher, 1989). In both cases, fertilisation occurs inside the body (i.e., *in vivo*). Catholic couples using these procedures are required to adhere to strict procedures. Couples must be husband and wife. No surplus gametes (sperm or ova) or embryos are to be used for research or donation. These procedures are intended to complement rather than replace sexual intercourse. Sperm is collected during normal intercourse using a 'seminal collection device', so as not to prevent the opportunity for fertilisation to occur naturally (Protocols for couples

adhering to Catholic principles and practices). The Catholic Church is opposed to other forms of fertility treatment including in vitro fertilisation (IVF), a process in which fertilisation occurs outside the body.

Because Helen taught in an all-girls Catholic school, I wanted to determine whether the teaching of bioethics associated with reproductive technology would conflict with, or complement the religious teachings of the school. I asked Helen how she approached issues that were not permitted by the Catholic Church. For example, I asked her what stance she took on informing students about genetic screening and counselling. Typically, one of the options discussed by genetic counsellors would be the possibility of an abortion. She told me that, even though she is not a Catholic, she is a teacher in a Catholic school. Thus, she has a duty to ensure that the students are aware of the Catholic Church's views on these issues. The purpose of genetic screening enables the parents to prepare for the birth of their child and abortion is not an option. In relation to methods of contraception, even though their use is not permitted by the Church, she believes that her students still need to understand the procedures.

The reproductive technology topic is taught by Helen as part of Year 11 Senior Science, a subject designed for students who are not seeking entry to university when they complete their secondary schooling. Senior Science is a Curriculum Council approved upper secondary science course. The content of Senior Science varies throughout Western Australia and is flexible in order to meet the variable needs of students. However, teachers of Senior Science are required to address specific learning outcomes. Senior Science is based on student outcomes assessment and a variety of assessment tools are recommended (e.g., practical work, oral presentations library research and written tests). (See Appendix D for a copy of the learning outcomes and the assessment items used in this course.) The emphasis is on continual assessment rather than written content based tests.

Typically, the student cohort is less academically able than other Year 11 science students. I feel uncomfortable about drawing attention to this point but it would be foolish to ignore the fact that these students have their own unique needs and that the subject matter and teaching style needs to be adapted to their ability. In the section below (Reciprocal Assistance) are extracts which illustrate the limited academic ability of the students.

## Structure of Course

The reproduction course was taught over two school terms (approx. 18 weeks) with 5x45 minute periods a week. The topics studied include plant, animal and human reproduction, contraception, genetics, genetic diseases and reproductive technology (see Appendix B for a copy of the teaching programme).

During the course, students studied asexual and sexual reproduction in plants. Helen had found, in the past, that some students do not know that plants come from seeds or that plants produce seeds. The students also studied mitosis by observing the cells in the root tips of onions. In this way, the students could actually see the chromosomes in the cell nuclei rather than merely looking at a diagram in a book.

Helen used frogs to demonstrate metamorphosis. Students observed the eggs hatch and develop into tadpoles and then metamorphose into frogs. The students also engaged in a long-term project on reproduction in mice. At the start of Term 3, a pure bred black female mouse was mated with a pure bred white male mouse. Two mice were born. As part of a major assessment, the students made detailed observations and measurements of the pregnant female and observed morphological changes in the newborn mice. Through this activity, students experienced pregnancy, and then growth and development of the newborn in a practical hands-on way. Students also studied the structure and function of the male and female human reproductive systems.

Helen taught students about basic genetics including dominant and recessive genes and the use of Punnet squares for predicting the proportions of genotypes. Students were introduced to the inheritance and characteristics of human genetic diseases including Klinefelter's Syndrome, Turner's syndrome, cystic fibrosis and haemophilia.

The final part of the course addressed bioethical issues associated with reproductive technology. Helen began the section by showing the students a video called *Hand me down genes* (1997). The video showed families that were affected by genetic disorders. In some instances, the parents were aware prior to the birth of an affected child and the video emphasised that it is the parents' choice to decide. The importance of genetic counselling was discussed. The video made the point that a genetic disease was not always a catastrophe. At the end of the video, Helen asked the students how they might cope if they were the parents of such a child.

Students also watched and discussed a video called *Exploring the Issues*(1992). The video explained how embryos (14 days post fertilisation) are harvested and frozen for future fertility treatment and research purposes. The scientists believed it was ethical to experiment with embryos of one to four cells. The video raised a number of ethical questions which students debated. For example, if a embryo has a genetic disease and is subsequently not implanted, is this abortion? If the parents die, who owns the embryos? What should happen to frozen embryos that are not used by parents? It is possible to harvest and freeze ova taken from the ovaries of a 16 week old foetus. Is this ethical?

Students also completed a library research project. Students constructed a glossary of terms including IVF, amniocentesis, genetic engineering, bioethics, muscular dystrophy, and eugenics. Students were required to research the definitions of the terms. The students then selected a reproductive technology topic to examine in depth. They prepared a talk which they presented to the rest of the class. These two activities, preparing a glossary of terms and the oral presentation, are described in the two vignettes later this chapter.

As the only teacher of Senior Science at her school, Helen had relative freedom to adapt the programme to suit her students' progress. I asked Helen how she had decided on the scope and sequence of the course. She explained that she had endeavoured to teach a logical sequence. Rather than a linear sequence, she used a "spiral approach, gradually introducing more information" on the same topic. For example, to help students understand the structure and function of the reproductive systems, when the mice arrived early in the course, the students observed and drew the external genitals. Sexual reproduction was re-introduced during the dissections of male and female rats. More information on sexual reproduction was supplied later, regarding the human reproductive organs. An understanding of reproduction led into inheritance and genetics, genetic and reproductive technology and, finally, bioethics.

Like Mark, Helen deliberately introduced the concept of bioethics at the conclusion of the course. Helen believed that students needed a thorough understanding of the basis of reproduction before they could examine the bioethical issues. When I asked Helen whether she felt there were any advantages in leaving bioethics until the end, she told me that the bioethics was the "culmination of the course" (Interview, 11/9/97). The students would not understand if they were taught from a "position of ignorance". Helen stated that "otherwise their views will be naive and simplistic". She considered that she could use her "position of authority" to enable students to "see the light". She believed that every student should have the opportunity to examine bioethical issues. I

support Helen's decision to place the bioethics at the end. I agree with her argument that the students need to understand reproduction and genetics before they can appreciate aspects of reproductive technology and subsequently the bioethical issues.

### **Helen's Teaching Goals**

Helen realised that this course may be the last (and only opportunity) for her students to become aware of issues associated with reproductive technology. She believed that some of her students may need to deal with fertility problems or genetic diseases either directly or indirectly. Thus, Helen wanted to equip her students with the knowledge and skills to understand how these issues impact on themselves and society. She explained that

my students will be voting in a year or two and it is important that they understand issues. They will not be continuing with science at University, so they need to be exposed to issues in science now. Explicitly teaching bioethics is important in the area of reproduction because the students ask ethical and moral questions. You can't avoid the issues.

(Interview, 24/7/97)

Helen hoped that by introducing students to bioethical issues, students could understand, for example, how it would feel to be pregnant with a child with a genetic disease. She explains:

I want students to understand that the genetic diseases are more than a word on a piece of paper. I want them to appreciate the anguish faced by a parent with a child who has a severe genetic disease. They can only address the ethical issues if they have some appreciation of the trauma involved.

(Interview, 24/7/97)

Otherwise, she asserted, they would be unable to appreciate the seriousness of the situation. In her experience, students with little understanding tended to be naive or to adopt an inflexible stance.

When Helen read this section in August, 1998, in conjunction with the vignettes, she asked me to add another teaching goal to this section. She told me that she also wanted her students to appreciate the complexity of issues. She explained:

I wanted them to see there is no such thing as black and white. These issues, even though there might be morally right and morally wrong viewpoints, real life comes in shades of grey. If we are to live in a compassionate society, even though maybe this is not a morally right thing in some ethics book, it's happened and what are we going to do? Are we going to forgive them? Help them? What sort of choices do we have? They have to learn to cope with the grey. I want them to see that moral issues are a complex set of relationships and you can't just say this is right and this is wrong. They have to learn to cope with that to see their way through it and not be simplistic.

(Interview, 8/98)

Overall, Helen wants to equip her students with the skills to cope with reproductive technology issues when they are adults.

## **ESTABLISHING A CARING TRUSTING RELATIONSHIP**

In this section, I reflect on the extent to which I established a research relationship with Helen that was based on care and respect (i.e., third initial research question). In addition to a moral obligation, I believed that it was essential to establish a trusting relationship so that Helen would be able to raise problematic issues with me as I visited her classroom and also as I shared my interpretations with her (i.e., member checks). This process helped to enhance the credibility of the data generated. I have used excerpts from classroom observations and my personal journal to illustrate how our relationship developed and evolved.

### **The First Interview**

Because I spent an extended period of time (four months) with Helen and her students, I had the opportunity to establish and maintain a trusting and caring relationship. I found it easy to establish a rapport with Helen, partly because we shared common interests and backgrounds. She is a similar age to me with similar aged children. During our first interview (24/7/97) we found that we shared much in common.

We both taught biological science in girls' schools. Like Helen, I had taught students with limited academic ability and was thus aware of the difficulties faced by those students when they are required to read and comprehend scientific information. Helen and I also discovered that our employment history overlapped in that we had both tutored in the same subject (Cell Biology) in adjacent departments (Biology and Biomedical Science) at the same university. We had also both worked in the



Immunology department at the same hospital, although at different times. The fact that we shared these common experiences meant that it was easier to begin to establish a trusting, communicative relationship.

At the time I wrote in my journal:

I feel that Helen and I have communicated well. We helped each other in our respective teaching by swapping resources and ideas. For example, Helen has given me the drawings of the male and female reproductive systems and a copy of an assignment on sexual reproduction while I gave her an Internet assignment, the cloning of Dolly activity (from Mark's case) and some reproductive technology resources. This mutual exchange of resources and sharing of ideas helps me, I believe, to demonstrate to Helen that I value her. I wasn't there just to 'get data'. I am willing to learn from Helen. Given that I hope to visit Helen at least once a week for two terms (18 weeks) it is essential that we cooperate with and respect each other.

(Personal Journal, 24/7/97)

I found Helen to be a warm and easy going person. This was reflected in her dealings with me and also in her classroom teaching. During our interviews she spoke easily and confidently about her teaching history and her current teaching. Originally, she completed an Honours degree in Botany studying genetics and tissue culture. On graduating, she taught biology at the local technical (TAFE) college. She enjoyed teaching and while overseas with her husband completed a teaching qualification at the University of London. On her return to Australia, she again taught biology at a TAFE college. For three years, she taught biology at Curtin University before obtaining employment at this school. She has taught Biology, Senior Science and lower school science for the past four years.

### **Enhancing Credibility**

In order to enhance credibility, I endeavoured to stay behind after each lesson to discuss with Helen her perception of the lesson, partly as a debrief, but also to clarify my perceptions. At regular intervals, I gave Helen my case record which contained interview details, journal extracts and classroom observations. When I gave Helen the notes that I had written about my first visit, I explained to her that there were two reasons for giving her what I had written. Firstly, it was important that she knew what I had written as I may have misinterpreted or not explained fully the issues we had spoken about. Secondly, from an ethical perspective, it was important that Helen

had an opportunity to express her view point. Although Helen didn't *have* to give me feedback, it was essential that I gave her the opportunity to do so.

By seeking feedback, I was also able to reassure Helen about her teaching. After two weeks I gave Helen a copy of the case record to read and comment on. The following week, I asked Helen what she thought of the case record. She replied, "Yes, it was good, but strange to read. A mixture of verbatim conversation between us and also what the students had said." I said that I was trying to record as complete an account as possible of what was happening and that later I would select segments for my thesis. "I hope it's not a waste of time," Helen says. "It must seem quite chaotic." "No, not at all." I said. "Everyone is working well. Everyone seems to know what they're doing." (Interview, 19/8/97)

### **Raising Problematic Issues**

I felt that by establishing a trusting and caring relationship, Helen would be able to raise problematic issues with me. This did seem to be the case. The following extract from my journal relates to an incident where Helen perceived that I wanted her to change the structure of the course.

Today, Helen asked me what sort of time line I was envisaging in the study. "How flexible is your research?" she inquired. She explained that normally she would have taught the bioethics component at the end of the course when the students understand reproduction, principles of genetics and genetic diseases. She said that she was a little concerned as to how she was going to structure the course with so much happening.

I realised immediately what she meant. She thought I was only interested in the bioethics component of the course and that I wanted her to teach it at the start of the course. I reassured her it wasn't so. I said that I was interested in the context of the bioethics section and that she should teach the course as she had planned. "Please," I said. "Don't adjust the course to suit me! Teach it the way you normally would. I am flexible. I would, however, like to visit your class regularly so that I can understand what the students have learnt during the whole course."

"Oh, good." she said. "I was worried that you wanted me to teach about bioethics now."

“No, no.” I replied. “Don’t change the course just to suit me.”

(Personal Journal, 30/7/97)

I think Helen was reassured by our conversation. I was relieved that she had felt able to raise her concern with me because I certainly did not intend for her to feel pressured to change the course to suit me.

### **Re-seeking Permission**

I visited Helen’s class over a period of four months. About half way through the study, even though there was no indication I began to wonder how Helen felt about my continuing presence in her classroom. Did she find it onerous, stressful? I decided it was time to re-seek permission and thus give Helen the opportunity to discontinue if she wished. I asked Helen if it was still okay to keep visiting. I also asked her whether she had any concerns or problems about the study. Helen said that she had no problems. She told me she is definitely aware of my presence. It had made her think more about the sequence of her teaching. I asked Helen how she felt about me observing her and her students. Even though it seemed to me that she was relaxed, I felt it was important to ask. She said that she didn’t get nervous, although my presence did cause her to think more about what she was going to say (Interview, 11/8/97).

### **Reciprocal Assistance**

After several weeks of sitting in Helen’s class writing notes, I asked her if she would mind me helping the students. This was partly to offer something in return for her extended invitation and also to engage the students in dialogue about their understanding of the topics covered. She replied that it would be “great to have an extra pair of hands” (Interview, 7/8/97). I was glad that Helen did not feel threatened about me assisting in her classroom. I felt that this was one way of reciprocating her kindness in allowing me to visit her classroom. Even though the class is small (15 students) the students seemed to benefit from the extra one-to-one assistance.

Thus, when students were engaged in practical work, I frequently helped in class as the following extract demonstrates.

Students are staining and observing root tips where some of the cells are undergoing mitosis.

Helen holds up the microscope and shows the students the position of the coarse and fine focussing knobs and the objective lens. She asks the students to prepare a slide with the acid softened root tips, add the dye, and look for chromosomes ("like worms") in the centre of the cell. The students, working in groups of two, quickly and efficiently prepare a slide.

I approach a pair of students and ask if they can see anything. "I don't know," one replies. I ask if I can look. Under the microscope, I see many unstained rectangular shaped cells. I change the objective lens to high power and move the slide so that the edge of the root tips can be seen. I know from experience that this is where a single layer is most likely to be found and also that the stain will penetrate these outer cells first. I can see square cells with an orange nucleus and I suggest to the girls that they look around this area.

Helen is occupied with students on the other side of the room. I move to an adjacent group. "Is it focused?" I ask. "Yes, I can see cells." "May I look?" The student moves aside and through the lens I see five small air bubbles. I explain what they are and focus under high power. I find a group of four cells. I can see the chromosomes in one of them. I ask them both to look at the four square cells. I ask them both if they can see the round structure in the middle. "What is it?" I ask. "A nucleus." "Are all four cells the same?" "No," replies the student. "One of them has little lines in it." "They are the chromosomes," I explain. "They separate to each end of the nucleus." I demonstrate it with my fingers. One of the student's information sheets depicts the stages of mitosis. I show the students what stage the cell is at. Over the next ten minutes, I help several more groups to focus on cells where chromosomes are visible.

(Classroom Observation, 7/8/97)

I benefited from working with Helen's students in an unanticipated way. Helen's teaching of these students and my interaction with them made me reflect on my own classroom teaching. Helen had already told me and I agreed with her that the students in her class are academically weak. The misconceptions articulated to me by Helen's students made me consider that some of my students may have similar misconceptions. Thus, when teaching microscopy and mitosis this year, I have endeavoured to be more aware of my students' prior knowledge.

In Helen's class, I found that some of the students seemed to adopt a form of acquired helplessness and my immediate reaction was to help them (e.g., focus the microscope,

search for cells undergoing mitosis). My perception of the academic weakness of these students (rightly or wrongly) had a significant effect on the way that I responded to them.

When I mentioned this to Helen, she agreed that the students would often sit back passively. They would attempt what was asked of them and then if unsuccessful would wait for her to assist. We realised that we both fell into well established roles. We seemed to be almost programmed to respond to offer help and occasionally just to do it for them. The students seemed to need constant reassurance and were not confident in their ability to solve problems as the following extract demonstrates.

As the students fill their pots with potting mix, Tania asks how deep the mint should be. Helen responds by asking her how deep she thinks it should be. "Just above the root," she says. "Yes." "Do I water it?" Tania then queries. "That's a good idea." replies Helen.

I move over to where Helen is speaking with a group of six students. They have measured the tadpole length and head width. "How will you know which tadpole is which next time they're measured?" "Maybe label them," guesses one. "How?" asks Helen. "No, that's not possible," says another. "So, how will you know if they've grown or not?" Helen asks. Several students laugh. "We don't know, Mrs D. You tell us." "No, I want you to work it out," says Helen. "I know," says one. "Why don't we do an average?" "That's a good idea," affirms Helen. "With the mice we could identify them as individuals and make individual measurements. With the tadpoles though, we'll treat them as a group and record the average length."

(Classroom Observation, 14/8/97)

I observed that Helen adapted to the needs of the students by providing simple, clear explanations to their queries. At other times (e.g., planting the mint above) she reflected the question back to them. She was still responding to their need for reassurance, but was encouraging them to make a decision and take some responsibility for their learning.

I believe that over a period of four months, Helen and I established a caring and communicative relationship where we helped and supported each other. In many ways, the relationship was similar to that which developed between Catherine and me. I believe that the factors that contributed to the establishment and maintenance of a

caring relationship included an extended period of interaction, similar background, similar teaching goals and a shared belief that bioethics education is valuable.

## LEARNING ACTIVITIES

As described earlier in this chapter, the final part of the Senior Science course was concerned with bioethical issues associated with reproductive technology. This section presents two vignettes compiled from classroom observations during the final part of the course. The purpose of the two vignettes, *Defining the Terms* and *Oral Presentation*, is to illustrate the types of learning activities that students engaged in (i.e., initial research question one). The vignettes indicate the type of interaction that occurred between Helen and her students. At the end of the vignettes, I use the two emergent research questions as a focus for discussion about the learning activities. I reflect on the quality of the learning activities in achieving Helen's teaching goals, that is, to increase students' awareness of ethical issues associated with reproductive technology, and to appreciate the complexity of these issues in our society. The perceptions of Helen and the students are also presented.

### Defining the Terms

For the previous four lessons, the students have been working in the library searching for information to define and describe a range of terms associated with reproductive technology and genetic diseases (see Appendix D). Some of the terms provide background information (e.g., genome, foetus) while others raise ethical issues (e.g., eugenics, Human Genome Project).

During this activity, Helen uses a question and answer whole-class discussion to go through the definitions. As each term is defined by a student, Helen, if necessary, expands on the definition. She also asks questions to draw her students' attention to bioethical issues associated with each procedure.

For example, in an early part of the lesson, a student defines eugenics as "using genetics to improve the human race". Helen informs the students that eugenics was used in Europe during the first part of this century in an attempt to rid Europe of Jews, gypsies and mentally incapacitated individuals. Helen asks the students, "what are the disadvantages of eugenics?" Students reply. "Variation is needed for the survival of our species." "Unethical." "Goes against human rights." "It's not natural."

Helen continues with the list of terms asking individual students to read their definitions and asking questions related to the term. For much of this activity, the students were very quiet with only four students responding with brief answers to Helen's questions about issues.

However, towards the end of the second lesson, the term surrogacy is defined as "where another bears and then gives up the child who may or may not be genetically related". Helen tells the students that the Australian Capital Territory allows non profit surrogacy. She shows the students a newspaper article where a woman had a child for her sister. The woman had tried using her sister's ova and the husband's sperm, but it was not successful so they used her own ova and the husband's sperm. Thus, the child is genetically related to the surrogate mother. Helen asks if there are any problems with this.

A number of students answer.

"The mother may not want to give up the child."

"The baby might find out."

"You must tell the baby when it's young."

"They should involve the genetic mother in its upbringing."

"It might be okay for related people, but may not be realistic."

"There was a case in America where the woman was paid"

"The child needs to know in case they fall in love with a relative. They need to know or incest may occur and the chance of recessive diseases may increase."

At the end of this brief interchange, Helen tells them that they have been talking about issues, about the ethics. They have been having an ethical discussion.

(Classroom observations, 20/10/97, 27/10/97)

### **Oral Presentations**

After the students had defined the terms (in the vignette above), they were assigned a topic related to an aspect of reproductive technology or to genetic diseases. They were required to prepare an oral presentation which they presented to their peers. (See Appendix D for a copy of this assignment.) In this vignette, the oral presentations of Jacquie (sex linked diseases), Rachel (surrogacy), Maria (amniocentesis and chorionic villus sampling) and Tanya (abortion) are illustrated. The presentations are in the same order as they occurred during the course.

*Jacquie (sex linked diseases)*

Jacquie is the first student to give her presentation. She appears to be nervous and reads her talk from written notes. She places an overhead transparency on the overhead projector. She states that muscular dystrophy is a sex linked disease. She explains what this means and why males inherit the disease while females are carriers. On the overhead transparency, she has a diagram of XX and XY chromosomes, and a pedigree to show how the defective gene is inherited. She is talking rapidly. The students are trying to copy the notes on the overhead transparency as she speaks. Jacquie realises this and pauses to let them write.

While they write, Helen asks Jacquie, "are there any ethical issues?"

Jacquie replies, "one issue is that scientists are spending time and money trying to understand the abnormal gene and finding a cure."

Helen asks, "if you knew you had a history of muscular dystrophy, what issues would that raise?"

Jacquie says, "whether to get married or abort the baby."

"What would you do?" Helen asks.

'Not have children,' replies Jacquie.

'What about the rest of the class?' asks Helen. A number of students respond to the question.

"Get counselling."

"Get information so you know what you're getting into."

"What would a counsellor do?" asks Helen.

"Look at the family history and give advice."

"What if the mother was already pregnant and had an antenatal test. How do you make up your mind about whether to have a baby?" asks Helen. There is no answer.

A student asks. "How can you test for the disease?"

Jacquie answers. "If you have a family history, then you can have a test to find out."

A student asks. "Are carriers affected?"

"No." says Helen. "Because they have one normal gene, but they can pass it on. What would it be like to be a carrier?"

Jacquie says, "I would find out as much information as possible. Some mothers may be desperate for a baby. Some may believe it is morally wrong to bring a child into the world who will die."

Helen asks Jacquie what she learnt from her talk.

She replies, "I learnt to gather information and to listen to others."



***Rachel (surrogacy)***

On an overhead is the question “what is surrogacy? - an arrangement under which a woman agrees to bear a child for another person who cannot have a child of their own”. Rachel explains the difference between altruistic surrogacy between sisters or close friends and commercial surrogacy where the surrogate mother is paid. She explains that usually the ova belongs to the surrogate mother and sperm is from the adoptive father. Thus, she is the genetic mother. Rachel gives an example where surrogacy was successful and another where it wasn't.

Rachel points out that IVF, where a fertilised egg is implanted in a surrogate mother, is not as problematic because the child is not genetically related to her. Again, Rachel supplies a specific example.

Rachel concludes her presentation by outlining the arguments in favour of surrogacy (i.e., the only method if other reproductive technology methods fail, child is really wanted, and women should be free to use bodies how they wish) and against (i.e., deliberate creation of life, not natural, planned separation of child and birth mother at early stage of life is unnatural, and not all participants (e.g. relatives) of surrogate may agree).

When Rachel is asked what she believes, she says that it is a personal decision and must be based on a person's moral beliefs. However, she recognises that it offends some groups, as it puts women in the role of being reproductive incubators. A student asks, “what's your personal opinion?” Rachel replies, “It's fine.” Helen asks Rachel whether she would be a surrogate for a sister. Rachel responds that it would depend if she had her own children and on how old she was. Helen asks her if she is aware of the Catholic Church's view. Rachel says, “This is like playing God so they probably don't agree.” (She is correct.)

***Maria (amniocentesis and chorion villus sampling (CVS))***

Maria begins her presentation by outlining some of the problems associated with chromosome abnormalities. She draws students' attention to the overhead indicating the increasing risk of Down's syndrome with age. The risk increases from 1 in 525 at 20 years of age to 1 in 20 at 45 years.

She explains that amniocentesis is where amniotic fluid is removed from the amniotic sac and tested at 16 weeks gestation. This may occur if there is a family history of

genetic diseases or if the mother has been exposed to harmful substances. With CVS, cells can be extracted and tested earlier (12 weeks). However, CVS has a higher risk of miscarriage. Genetic counselling is provided if the foetus is abnormal. Options include abortion or further counselling to understand the disease.

Maria states that many couples choose to abort. For example, in New South Wales, in 1993, 70% of foetuses with spina bifida, 75% of foetuses with Down's syndrome and 50 % of foetuses with a limb deficiency were aborted.

"If children have a disability," Maria asks, "is it right to terminate? It reduces our tolerance to disabilities. Are these tests of benefit or do they assist 'perfect baby syndrome'. What do you think?"

The ensuing discussion focuses on abortion rather than the genetic screening tests.

"I don't know if I want to say in public." begins one student. "Go on." "I think everyone over 43 should have an amnio., not for abortion but to prepare them."

Helen asks, "If you find out it's a girl and you have five girls, is it okay?"

A student adds, "in India, girls are aborted as they want boys."

Helen asks, "should doctors tell their patients the sex of the foetus?"

"Only if they want to know."

"The doctor has a responsibility to tell."

"I reckon it's the parent's choice."

Helen asks, "should the father have a say?"

"The husband has as much right as the wife."

"The mother should have the final say."

"No, both."

"I don't think anyone should be born with abnormalities."

"No, no."

"Like what's the point?"

Helen asks, "how do you decide if it is major problem?"

"As long as the parents can care for the child, it's okay."

"It's a big responsibility. What if the baby were dumped in a home?"

"The doctor should advise."

Helen asks, "what if it was a Catholic hospital?"

"Nothing would happen."

The students are all talking over each other. They are very animated, asking and answering each others' questions.

***Tanya (abortion)***

Tanya begins by defining abortion as “the ending of the foetus or embryo”. It may be “natural or induced”. She describes how abortion laws vary throughout the world. For example, abortions are permitted in Russia and Japan up to the fourth month of pregnancy. In Britain and Australia, if the mother’s mental/physical health is at risk then an abortion can be performed up to seven months. India and China include abortion as part of their population control programme. In Ireland, an abortion may be performed only if the mother’s or baby’s life is in grave danger.

She outlines the different methods of abortion; curettage/vacuum aspiration in the first trimester; injection of a salt solution to kill the foetus followed by prostaglandins to induce premature labour in the second trimester; and RU-486 which may be used up to five days after unprotected sex.

“In Australia, the average abortion is performed at 10 weeks,” explains Tanya. “One day,” she says, “you may have to go against everything you believe, all that your family and friends believe, and make a decision that could be murder.”

Helen asks the class “what would a victim of rape in Ireland do?” No answer. “Go to the United Kingdom,” she says. “Who should decide the law?”

“Government people.”

“Why is it legal?”

Helen replies, “because women were dying of ‘backyard’ abortions. Thus, it was legalised so it can be controlled and also to provide counselling.”

“It should be allowed because the mother might not care for it. I am personally against it, but it should be up to the person.”

“It is not the same as killing a child.”

Helen asks “what is the difference?” No reply. “If it is done at seven months, the baby will feel pain.”

A student relates a story about a baby who was born with a blocked oesophagus and could not be fed, so gradually died of starvation.

Helen asks, “which is kinder?”

“Abortion. Not letting the baby suffer.”

“If a baby has a major defect, it can be put up for adoption.”

Helen says, “it might be difficult if it has a major defect. “

“It should still be offered.”

“I agree if the mother is under 16 or the baby is deformed.”

“People who protest against abortion are really selfish, like that one where the 13 year old girl was raped in Ireland.”

“The baby could have been put up for adoption.”

“Why carry it for nine months?”

Helen moves the students on. Despite the Catholic Church’s unequivocal opposition to abortion, within this class, the students seem to be in two groups, those who are in favour of abortion and those who are against.

(Classroom observation, 6/11/97, 10/11/97, 11/11/97, 12/11/97)

## **PERCEPTIONS OF THE LEARNING ACTIVITIES**

The discussion in this section relates to the learning activities illustrated in the two vignettes. In writing this section, I was mindful of the two emergent research questions. To what extent did Helen achieve her teaching goals of increasing her students’ awareness of the complex ethical issues associated with reproductive technology and encouraging them to appreciate the impact of the technology on themselves and society? From the multiple perspectives of the students, the teacher and myself, what impact did the learning activities have on student learning?

### **Helen’s Perceptions**

After Helen had read the vignettes, I interviewed her about the learning activities described. I asked her why she selected the activities, and also the extent to which each activity contributed to her achieving her teaching goals. Helen told me:

The first activity, [defining the terms], was an introductory activity, leading down the path to the issues. I wanted them to have an idea of what the words meant so that when we got into it they would realise what it was about. My goals for the whole section weren’t realised by that activity. It was leading them up to it.

(Interview, 8/98)

By requiring the students to research the terms, she hoped that they would read beyond the definition. Even though Helen could easily have told students the definitions, she believed that they would learn more if they found the meanings through their own reading. Thus, this activity did not address her articulated goals. As Helen explained:

I wanted them to have the background knowledge of what those terms meant so they could make a more informed choice about what areas to do research on. Otherwise they would tend to choose the words they knew already and avoid the words that looked harder because they didn't know what they were.

(Interview, 8/98)

Helen believed that all of the students did learn what the terms meant. She based her belief on their ability to define and use the terms appropriately in their final written test and also during discussions. Although there was some variation amongst students, Helen felt that this was due to their academic ability and the amount of work they had done.

Helen told me that the second activity, the oral presentation was "the culmination, when they actually showed their understanding and what they got out of it". She felt that by investigating one topic in depth and giving an oral presentation on the issues that they needed to think about their own values. Helen believed that her questions also encouraged the students to think about their values (Interview, 11/11/97). She maintained that, "although it might have seemed like those giving the talk were doing the learning, it was the other students in the room" (Interview 8/98).

Helen felt she had begun to achieve her teaching goals during the second activity when "they all started talking over each other". She continued. "That's what I wanted to happen. I wanted them to get interested and start bubbling over. Wanting to say, 'I've got an opinion. I've got to tell you about it.' Rather than sitting and thinking, I don't have an opinion. I don't care. I don't want to know." (Interview, 8/98)

Helen used the discussion after each oral presentation to increase the students awareness of the complexity of issues. She explained:

In the questions after the talks, I tried to give them vignettes to try and make them see that maybe this is not the best way to look at this case. Sometimes I played devil's advocate and said the opposite of what I believed to challenge their point of view. They need to realise there are others out there with different points of views and they have a right to them.

(Interview, 8/98)

Overall, Helen felt she had achieved her teaching goals because of the way the students answered her questions. Also in the final test, Helen deliberately included some of the same questions as those raised and discussed. Helen felt that when she marked the

tests, most of the students “showed that they had listened and learnt. Not this is right or wrong, but that there are several answers.” (Interview, 8/98)

### **Students’ Perceptions**

In this section, I describe, firstly, the students’ expectations prior to engaging in the learning activities. Secondly, I present the students’ views of the oral presentation they engaged in. Finally, I summarise the students’ perceptions of what they learnt.

#### ***Students’ Expectations***

I interviewed the 15 students in Helen’s class while they were researching the topic of their oral presentation (prior to the second vignette). I asked the students why their topic was important and what they hoped to learn. I was interested in whether their learning goals were similar to Helen’s teaching goals.

The three interview extracts from Amelia, Maria and Jacque were representative of the range of students’ responses.

Amelia was investigating the topic of bioethics. She told me:

It is about moral decisions and finding out about religious and other people’s views. I want to expand on what I know so that when it comes to making a decision I know what options I have. As a Catholic, I need to know what can and can’t be done. Reproduction has helped a bit because I can understand about some of the issues. Like abortion is killing. I know what abortion is, but I can think more about my attitude rather than just what it is.

(Interview, 30/10/97)

Amelia seemed to want to know more about ethical issues so that if she needed to make a decision she would be aware of her choices. She also wanted to be aware of the views of others, including the Catholic Church.

Maria (whose talk was in the second vignette) investigated the screening tests of chorionic villus sampling and amniocentesis. She told me that it was important to learn about her topic because:

It is about what’s happening right now. It is used by a lot of people. It is an issue today and I need to work out whether it is right or wrong. Abortion

might be involved if the baby is abnormal. Other issues are producing the perfect child to produce a perfect race. And also fertile people may be picky or selfish. People have to think about whether to test or not. I want to see different points of view, get stories from people who have had it. We need to learn about these issues because they come up in the news and we need to understand them. A lot of adults don't know about these things.

(Interview, 30/10/97)

Maria seemed to believe that her topic was important because it was an issue that is relevant in our society. She felt, therefore, that she needed to be able to express her view point. She also wanted to be aware of the views of others.

Jacquie had been assigned the topic of sex linked diseases. She explained that her topic was important because:

One day, I'll be a mother. I need to know what's happening and to be more aware. These topics are issues in today's society. It is important to understand. We'll be the future generation, politicians etc. So, we'll be making the decisions.

(Interview, 30/10/97)

Jacquie felt that the topic was personally relevant because she may be affected herself. She also seemed to realise that reproductive technology issues are important in our society now and in the future.

Overall, the students' reasons for studying these topics seemed to relate either to being able to cope better if they experienced problems associated with reproduction (e.g., Amelia) or to a need to be aware of current advances in those areas so they can make decisions in the future (e.g., Maria and Jacquie). The students' interview responses suggested that most of the students felt that they needed to know more about the procedures while a smaller proportion were concerned with the issues. The Catholic Church and religious beliefs were mentioned by several students. With these students, the emphasis seemed to be on doing what is 'natural'. Some of the students expressed their own ethical values in those terms.

### ***Perceptions of the Oral Presentation***

At the end of the course, students were asked (in a written questionnaire) to comment on the type of assessment. Almost all of the 15 students chose to mention the oral presentations. (This may have been because the questionnaires were completed at the conclusion of the oral presentations.) Their responses were mixed. Some of the students did not like speaking to their peers. Their comments included:

I don't like speaking in public.

I dislike talking in front of people, especially on a not so good topic.

I didn't like talking in front of people. I get nervous.

Well the talk was easy to find information and I had a topic I had an interest in, but I don't like doing talks.

(Questionnaire, 12/11/97)

The students' comments seem to suggest that it was not the actual topics that were disliked. Rather, it was the oral presentation. Several students indicated that they benefited from the activity, as the two responses below demonstrate.

We were able to research topics important in today's society and then listen to other people talk about them.

The oral, I think we learn more discovering for ourselves than learning and being tested on it.

### ***What Did The Students Learn?***

At the end of the course, students completed two questionnaires where they were asked to comment on what they had learnt in relation to science and society, ethics and the topic of reproductive technology. In addition, four students were interviewed and asked to elaborate on their questionnaire responses.

Rather than search for, and select only those comments that were congruent with Helen's teaching goals or my pedagogical framework, I took a different approach. Using a grounded theory approach, I grouped the students' written responses into four emergent categories. For each of the four categories, I have included several written comments that are representative of the range of students' views. The four categories were:



*An understanding of the topic of reproductive technology*

Student comments included:

I learnt what happens if you want a baby and you can't have one the normal way.

We have learnt about a lot of issues to do with human reproduction such as diseases and sex linked disorders. Also methods of helping pregnancies and saving or ending lives.

The issues that affect everyone such as genetic diseases, types of diseases that may affect people. I have also learnt what genetic engineering is.

I know a lot more about sex linked diseases and different forms of creating pregnancies. I also know that genetic counselling is available that will go into detail about these issues and help people make up their mind.

I learnt all about surrogacy and data about abortion and other topics. All about genetic engineering and bioethics.

All of the students mentioned at least one of the topics presented in the vignettes. The topic most frequently mentioned was abortion. Many students also outlined their views about a topic and supplied reasons. Although an understanding of the topic of reproductive technology was not mentioned explicitly by Helen as a teaching goal (as Mark did), in order to understand the associated bioethical issues, students need to be familiar with the procedures used in reproductive technology. Both of the learning activities provided students with the opportunity to increase their knowledge about reproductive technology.

*Impact of science on society*

Like Catherine's topic of transplantation technology, the topic taught by Helen seemed to challenge the students' beliefs and attitudes about science. Unlike Catherine's students who seemed to have an overall positive attitude there were a wide range of views expressed by students about the impact of science on society. The number of positive comments expressed by students (about one third) was similar to the number of negative comments.

Positive comments included:

I now realise that science covers many different avenues and that science is a major factor in our world.

Science is a major part of today's society. Through science, our world is developing hugely. Science is bringing us forward in the world.

People trust science to make major decisions e.g. abortion

It is very helpful because you can work out cures for diseases and prevent them from showing up in the first place.

I know that science is a major part of life that the society relies on everyday to bring new theories.

I know that science can be used to help people suffering from genetic diseases.

Although similar in frequency, negative comments (from my perspective) seemed rather more vehement. Student comments included:

Messing with nature can be disastrous.

What the scientists are doing is wrong.

I realise that scientists really can get carried away with things. What happens when things get out of hand?

I have learnt that science in our society is moving very fast, but I think that before they start to make changes to the world they should consider every factor and I don't think they are.

I believe we are playing God when it comes to genetic engineering and similar because we are altering humans.

I believe that they are destroying nature and that they should maybe stop and think about what they are doing before they go and stuff things up (e.g. genetic engineering)

I believe that most of the issues shouldn't be done on humans. e.g. genetic engineering is wrong to do on humans. It is not natural and we can't all be perfect.

About one third of the students wrote comments that I perceived to be neutral, indicating that this group of students were aware of the benefits of science while also cautioning against the potential harm of scientific advances. The comments of these students included:

There's a right and wrong side in science and it's so much more complicated that I thought.

Science is developing ways to help infertile couples, but it may also be wrong in ways such as eugenics.

We can use it to better the state of things, but we can unfortunately abuse it as well.

That it can have advantages and disadvantages depending on one's personal and moral thoughts of the topic.

I do not recall Helen saying explicitly that science was good or bad, although during discussions, Helen did inform students about some of the problems associated with the use of reproductive technology. This may have had an effect. I am unable to comment on whether the students' religious beliefs might have contributed to a their attitude. As mentioned previously, during interviews, several of the students stated that some of the procedures were not "natural". Regardless of the students' attitude to science (positive, negative or neutral) they were able to state a position, indicating that Helen did achieve her goal of helping students to appreciate the impact of science on society.

#### *Personal relevance of issues to themselves*

The students' responses included:

I have learnt about how all of the topics discussed could be appropriate to me or the people around me, the options available and what I think about the issues so it can help me make up my mind. e.g. abortion.

I have learnt about how to cope if we happen to have a Down's syndrome baby and what the symptoms of other diseases are.

It was more personal and relates more to personal experiences we might have in later life.

By finding my own ethical and moral decisions to certain topics. Like with abortion. I don't think I would personally be able to have one, but I know people who have and I don't feel any different towards them.

Helen had stated that one of her teaching goals was to help students reflect on how they would respond if faced with an ethical decision. The students' written responses indicate that a few of them seemed to be aware that they may be personally affected.

## *Ethics*

Students' comments related to aspects of ethics were numerous. Thus, I regrouped the comments from this category into four sub-categories. The sub-categories and examples of comments were

1. An awareness that ethical issues exist.

I have become aware of all the issues that society is faced with today and what peoples beliefs and moral points of view are.

There are many issues on one simple topic.

I didn't know about any ethical issue before.

I think all students should be taught about this topic so they can come to a decision if they are faced with an issue.

I researched bioethics and discovered the issues are so controversial.

2. The importance of information in decision making.

Using the knowledge I now have, I think it will be easier to make a decision.

I can decide better in what I believe since discussing these issues because I now know the facts behind each issue and exactly what the issue is.

I can say or back up what I believe now concerning issues better with all the facts influencing my beliefs.

I know a lot more about the issues that relate to genetics. Because I know more information I find it easier to come to a decision on what I believe.

Now I know most of the information about a topic, I would be able to put forward my opinion easier and more persuasively.

With these facts, it has helped me to change some viewpoints I once had and to express what they are and how they differ.

I can express my view point because I know all the facts and situations about these issues.

3. To be tolerant to views of others.

I believe everyone has a right to their opinion and other people should be open minded to these opinions and not turn against that person because of their view point.

Some people are narrow minded - they should allow people to speak even if it is not what they believe.

I think some class mates should learn to keep an open mind and not force their beliefs on others. We listen to them. They should listen to us. By this I learnt other people's point of view and this made me think that in a situation I will consider other's beliefs.

4. How to resolve ethical issues.

Before, I wouldn't have thought much, just said no. Now, I still would not have an abortion, but I would think about it more. I would talk to my family. If I was raped, I would talk to as many people as possible to get information. I would think about the long term effects. It's hard to make a decision.

I would deal with these issues by getting all the information possible and doing some research. If necessary I would get genetic counselling and have peoples' opinions open to me, but overall it would be my decision.

Listen to people's views. Think what my view is about the issues. Then I'll make a true decision about the issues.

It has taught me to look at the advantages and disadvantages.

I'd find out all the facts about the issues, then find out if the Catholic Church is against it or for it and then I'd find out people who have dealt with this issue and from them their opinion.

Well if it was abortion, I would first look at the situation and weigh up other issues involved.

There was a wide range of student comments related to ethics. The types of comments suggested that most students were aware that ethical issues exist and that their views may differ from their peers. They also seemed to be aware that to resolve ethical issues, they needed to collect and weigh up information and listen to the views of others.

## Discussion

In the first vignette, the students participated in an activity where they defined and discussed terms associated with reproductive technology. Thus, the students were introduced to the language of reproductive technology. Through questioning, Helen introduced her students to some of the bioethical issues associated with reproductive technology. Early in this activity, the students seemed reluctant to participate. Only when asked directly would a student offer a definition. They answered Helen's questions about issues with brief responses. At this stage, the students did not

augment their classmates' definitions. Also, they did not engage in debate about the issues.

My perception from observing the students' behaviour during these lessons was that they seemed to perceive that the purpose of the learning activity was to check that their definitions (completed previously) were correct, whereas Helen's aim was to use the definitions as a spring board to introduce issues. It was only towards the end of this activity that students started to become more actively involved through discussion. The discussion following the defining of surrogacy was the first occasion where several students spoke without prompting from Helen. The students started to ask (and answer) their own questions.

In the second vignette, the students presented a talk on a topic that they had investigated. They had been informed that they would need to present and defend their views and also contribute to discussion following other students' presentations. In relation to my presence in the classroom, when students were discussing their beliefs about emotive issues (e.g., abortion) they seemed very open and uninhibited. Perhaps, this was one of the advantages of visiting the class over an extended period of time and being (I hope) a non threatening female.

The small class size was a positive factor in enabling all of the students to participate. Although there were 15 students enrolled, there were usually only about 12 students present. Helen encouraged all of the students to articulate their views by asking the quieter students direct questions (e.g., What are your views? what do you believe?). Nevertheless, I observed that the extent to which students participated in debate seemed to vary. This may have been due to student factors such as academic ability and personal interest.

When students expressed extreme views, Helen did not refute their comments. Rather, she asked questions to encourage them to consider alternative viewpoints. Helen also challenged students who offered simplistic answers by providing information to help them become more aware of the complexity of the situation. Through careful questioning, Helen also encouraged students to reflect on how they would respond if they were in a problematic situation (e.g., abortion, surrogacy).

During the discussions that followed the student presentations, I noted that Helen did not directly express her ethical values. On occasion, she would appear to be supporting a particular ethical stance, but when a student supported her comment, she would adopt an alternative viewpoint and challenge that student's views (e.g., the

discussion about abortion following Tanya's presentation). Although Helen did not adopt the Catholic Church's stance as the final arbiter in the complex issues raised, she did ensure that students were aware of the Catholic Church's viewpoint.

Based on Helen's and the students' perceptions and my own observations, I would conclude that Helen did address her teaching goals. She did provide students with many examples of bioethical issues. Through her questions and comments, she challenged students to appreciate the complexity of these issues in our society and also increased their awareness of the impact of science on society.

## **CHAPTER TEN**

### **RESEARCH FINDINGS**

#### **INTRODUCTION**

The purpose of this chapter is to address a final overarching question, that is, what have I learnt about bioethics education? Initially, I present a summary of each of the three case studies. The purpose of the summaries is to highlight factors which are relevant to the overall findings of the study. The research findings are presented as inferences. The inferences are grouped in to five themes and are based on my research experience with Catherine, Mark and Helen. In the third section, I reflect on the implications of the findings for my own teaching practice. I consider how this doctoral study has modified my initial pedagogical framework.

#### **SUMMARY OF CASE STUDIES**

In this section, I provide a brief overview of the three case studies. Because the cases were presented separately in previous chapters, it may be difficult for the reader to distinguish the similarities and differences between cases and their possible significance. The issues that I have summarised for each of the case studies include the context of bioethics education, student and teacher characteristics, teacher's goals and the research findings.

##### **Catherine**

Catherine taught (for the first time) the topic of transplantation technology in an independent girls' school. The Biotechnology course which comprised 24 lessons over six weeks, was originally developed by myself. Students chose the course when they selected five out of seven science courses in Year 10. The bioethics education component was integrated throughout the course with students taught explicitly about bioethical principles and a decision making process to resolve bioethical dilemmas. The learning activities were student centred and provided numerous opportunities for students to discuss their developing bioethical values about issues associated with human organ and tissue transplantation. Students also had the opportunity to evaluate one issue in depth by completing a portfolio. Small group and whole class discussion formed the basis of most learning activities.



There was a range of academic ability within the class of 30 students. However, there was a predominance of academically weak students, partly because many of the students chose the course as an alternative to physics and chemistry courses. Catherine was a relatively inexperienced teacher in her second year of teaching. She was very organised and her lessons were highly structured. Catherine was firm and controlled, but also kind and considerate toward her students. She always listened to and respected their views. Her main teaching goals were to encourage students to think critically and question information, and also to enjoy science.

Because I taught at the same school as Catherine, I had the opportunity to visit Catherine's class and to interview her and a group of students regularly for the duration of the course. Afterwards, I was able to readily re-interview Catherine and her students. Thus, when I realised that one of my initial research questions (on 'effectiveness') was problematic, I was able to pursue a range of emergent research questions. In doing so, I became aware that Catherine's students had a positive attitude to science, a factor that they attributed to the course.

I wrote narrative tales which I used to clarify my perceptions of the learning environment. This led me to realise that bioethics education seemed to have a variable effect. Amongst the students, there were a range of learning experiences. I found that student attributes such as maturity, motivation, interest, attitude to school and science seemed to be important. It appeared that all students did become aware that bioethical issues exist and are associated with transplantation technology. Some students also became aware that others have different bioethical values and that their values should be respected. Later, few students were able to recall that bioethical principles and a decision making process existed.

I pursued the question of whether Catherine's students could resolve bioethical dilemmas better than students who hadn't studied the course. This led to the development of the bioethical dilemma survey. When asked to resolve four bioethical dilemmas, the responses of Catherine's students were no different from those students who did not study the course. Despite the lack of difference between students, the results provided an illuminating snap shot of the bioethical values of 15 year old girls at this school. The results also indicated that, compared to experts, the girls tended to adopt a rights based approach to decision making and that their reasoning was naive and romantic. The students did not seem able to consider the long term consequences of their decisions.

## **Mark**

Mark had taught a DNA Technology course in an independent boys' school for the past eight years. He was involved with developing the course which comprised 14 lessons over four weeks. The course formed part of a larger compulsory biotechnology course that replaced a traditional year 10 Biology course. The bioethics component was explicitly introduced in the final five lessons of the course. However, bioethical issues were raised and discussed, where relevant, in prior lessons. The main bioethics education activity, which Mark taught for the first time this year, involved the students constructing a definition of ethics, developing questions to decide if an action was ethical, and an examination of a case study, 'the cloning of Dolly the sheep'. Thus, students examined one issue in depth. In the classroom, Mark had a formal, controlled approach, similar to a chairperson leading a committee. All questions and comments were directed through him and he made a choice about whether to answer or reflect the question back to students.

My perception (and Mark agreed) was that the students in his class exhibited a range of academic ability, although most were academically able. Mark was an experienced teacher (11 years) with clearly articulated goals of increasing his students' knowledge about DNA technology and increasing their awareness of ethical issues so that they can make informed decisions in the future. He also had a clear understanding of how to achieve his goals, that is, teach the content, present the students with bioethical dilemmas, and conduct open ended group and whole-class discussions.

The findings of this case suggests that an understanding of the procedures associated with DNA technology was crucial in enabling students to consider ethical issues. Many of the students felt that an understanding of DNA technology was important if they were to make decisions about the issues. The student data suggested that the learning outcomes were variable. While some students found the topic relevant to them and thought carefully about their ethical values, others were less interested. Mark suggested that this difference was due to their academic ability and also their interest in science.

## **Helen**

Helen taught a reproductive technology course in a Catholic girls' school. The topic formed the final part of a Year 11 Senior Science course. Helen is an experienced teacher (eight years), although this was only the second time that she had taught the reproductive technology component. The course comprised 48 lessons over 18 weeks

with the bioethics component covered in the final ten lessons. The bioethics learning activities were student centred, requiring students to choose and investigate one topic in depth to present to their peers. Whole-class discussion formed a major part of all learning activities.

I observed Helen's class over an extended period (18 weeks) which enabled me to develop a caring relationship with Helen and her students. The 15 students studying Senior Science were academically weak with variable motivation. Helen's teaching goals were to prepare her students for the future when they may be faced with ethical issues associated with reproductive technology. She wanted them to comprehend the complexity of issues and also to appreciate the impact of science on society. When interacting with her students, Helen was caring, generous and tolerant.

The research findings suggested that through participation in the learning activities, Helen's students developed an increased understanding of reproductive technology procedures and associated ethical issues. Most of the students seemed to be aware that in order to make a decision they needed to obtain information and then weigh up the advantages and disadvantages. The students also realised that others may have different views and that they need to consider them. Finally, the students seemed to be aware that science has an impact on our society that may be beneficial and/or harmful.

### **WHAT HAVE I LEARNT ABOUT BIOETHICS EDUCATION?**

With the exception of the third initial research question (i.e., *to what extent did I establish a caring and communicative relationship with the research participants?*), all of the research questions related to aspects of bioethics education. The third initial research question was concerned with the nature of the research relationships that I established with Catherine, Mark and Helen, and their respective students. As described in Chapters Four, Eight and Nine, it is my perception that, notwithstanding constraints such as time, in all three cases I was able to establish a caring and communicative relationship based on trust and respect.

I feel privileged to have had the opportunity to observe the classroom teaching of Catherine, Mark and Helen. Although I teach in a classroom every day, I am not always aware of how my students are responding. Observing these teachers helped to enrich my understanding of my own teaching. As an observer, I had a different view of classroom events. I could observe the students' actions without being concerned with time, classroom management, use of equipment, deciding what to do next and the

other variables that usually occupy my mind when teaching. For example, having the opportunity in my non-teaching role to observe Helen's academically weak students alerted me to misconceptions that may be held by my own students. I was also given resources by Mark and Helen that I have incorporated in to my own teaching programme.

During this research study, I had the opportunity to investigate the teaching practices of Catherine, Mark and Helen, as they incorporated bioethics education into their science curricula. In addition, I read literature about philosophy, ethical theories and the teaching of ethics and bioethics. My understanding of bioethics education was modified further by people I met who had an interest or expertise in the field of bioethics (e.g., at conferences).

As a result of this multitude of experiences, I have identified a number of findings or inferences related to bioethics education. By presenting my findings as inferences, I acknowledge the tentative and contextual nature of the research. Thus, it is not my intention that the inferences be viewed as a definitive set of outcomes that are applicable to all situations. In the next section, I reflect on the implications of the research findings and the extent to which these findings have modified my initial pedagogical framework.

### **Research Findings**

It is important to note that the type of research study that I conducted (i.e., interpretive case study) has not been duplicated in the bioethics literature. I used ethnographic research methods and investigated the views of both students and teachers. Most of the literature about bioethics education in science does not present individual student data. Thus, some of the research findings are not confirmed in the literature.

In presenting the research findings, I have reflected on my experiences with each of the case study teachers and their students. I have considered whether I have sufficient evidence to warrant my claims. I have tended to be cautious and not extend the inferences beyond this research study. Prior to writing this section, I reviewed the data and constructed a list of statements that, I felt, represented the key findings from the study. I grouped the statements into themes. I found that five themes emerged, each of which is outlined below.

### ***Teacher Attributes***

Despite the differences in school type, teaching experience, prior work experience, gender (of the teacher) and student attributes, (e.g., gender and academic ability) there were some similarities amongst the three teachers that, I believe, contributed significantly to the quality of bioethics education. Firstly, Catherine, Mark and Helen were committed to the teaching of bioethics education. They were emphatic about how important it was for their students to develop the skills to cope with bioethical issues. These teachers seemed to consider that the teaching of bioethics was a central part of their science teaching role. Mark and Helen had deliberately chosen to modify their existing teaching programmes to include aspects of bioethics education. In addition, they were still required to teach the same content material as were their peers. Thus, both teachers persevered with an increased work load as they sought out or designed suitable learning materials for their students.

Secondly, all three teachers clearly articulated their pedagogical goals related to bioethics education. Before teaching their respective courses, each of the teachers was aware of what they wanted to achieve in their classrooms. The teachers planned and implemented a series of learning activities that they felt would best address their goals and lead to their intended student learning outcomes. The learning activities that teachers implemented were student-centred and based largely on discussion. However, despite a student-centred approach, the three teachers maintained control of the discussion; that is, they initiated and guided classroom discussion. The teachers assessed ongoing student learning primarily through questioning during whole-class discussion.

Thirdly, all of the teachers endeavoured to create a safe learning environment where students were able to freely express their views. All three teachers modelled ethical behaviour by listening to and acknowledging the views of their students. Where extreme views were expressed, the teachers, through questioning, challenged the students to consider alternative viewpoints without rejecting the student.

### ***Design of Bioethics Courses***

There was a range of content areas that acted as a platform for bioethics education, including transplantation technology, reproductive technology and DNA technology. Regardless of the content area, it may be important for students to have the opportunity to examine one topic in depth. Comments from Mark's students indicated that they

needed time to understand the process of DNA technology before they could grapple with the associated ethical issues.

Each of the teachers utilised learning activities that provided their students with the opportunity to examine at least one issue in-depth. For example, Catherine's students completed a portfolio on a science topic of their choice. Helen's students prepared an oral presentation on one issue associated with reproductive technology and Mark's students participated in an extended activity about the cloning of Dolly.

When Catherine taught the Biotechnology course, she integrated bioethics education throughout the whole course. At the start of the course, Catherine taught her students about a decision making process and bioethical principles. For the duration of the course, she continually reinforced the use of the principles and the steps involved in decision making. In contrast, Mark and Helen opted to introduce bioethical issues at the end of the course. Mark and Helen considered that it was important for their students to have an understanding of the theory associated with their topic (i.e., DNA technology and reproductive technology, respectively) before they could fully appreciate the related ethical issues. The topics of DNA technology and reproductive technology have specific, complex, technical aspects that students may not have been exposed to previously. I am unable to state which option is preferable. However, it is a decision which the teacher must make based on their teaching goals, student attributes and other factors (e.g., time constraints).

All three teachers selected learning activities that provided students with the opportunity to be active and interact collaboratively with their peers and the teacher. Most of the learning activities incorporated small group and whole-class discussion. The teachers used resources, such as video material, topical case studies, and activities such as the 'Liver Transplant Activity' to stimulate and inform group and whole class discussion. Discussion about bioethical issues with their peers and their teacher had the potential to enable students to begin to develop and modify their values. In addition to articulating their own values, these types of learning activities provided students with the opportunity to listen to the views of others so that they could become aware of alternative solutions.

### ***Student Attributes***

Evidence from the three cases (especially Catherine's) suggested that the impact of bioethics education on students was variable. The students' responses in the bioethical dilemma survey suggested that there was a range of decision making abilities amongst

students. Teachers' and students' commentaries about the narrative tales of Holly and Leanne alerted me to the possibility that student related factors may inhibit or enhance a student's receptivity to bioethics education.

There appeared to be a range of intrinsic factors that affected student learning. Factors raised in the case studies included maturity, academic ability, preferred learning style, attitude to science and attitude to school. The literature (e.g., Soloman, 1990) suggests that a student's ethical maturity, personal values, family and religious values and verbal skills may also influence their learning about bioethics.

Although there was variation amongst students, the results of the bioethical dilemma survey suggested that the majority of students across all three cases tended to resolve and justify their bioethical decisions in a way that was naive, idealistic and rights based. Compared to experts, the students seemed to give undue emphasis to the bioethical principle of autonomy in their decision making. Also, the reasons supplied by many of the students to support their decisions suggested that they did not consider the long term consequences.

### *Attitude to Science*

Evidence from the case studies suggests that a consideration of bioethical issues in science may influence students' attitudes to the subject of science. One of Catherine's pedagogical goals was to enhance her students' attitude to science. At the conclusion of the Biotechnology course, all of her students seemed to have a positive attitude to science. This may have been due, in part, to the students achieving academic success when previously they had not done well in science. Also, in her teaching, Catherine continually stressed the importance of understanding science. Many of the students indicated that the course had modified their view of science and influenced positively their choice to continue studying science beyond Year 10.

In contrast, Helen's students were ambivalent. Their written comments suggested that science could be both harmful and beneficial. They seemed to recognise that the use of science has an impact on their lives and society. However, many of the students expressed their concerns about science "going too far". In her teaching, Helen adopted the role of devil's advocate, alerting her students to the risks as well as the benefits of reproductive technology.

### ***Constraints***

The literature (e.g., Cross & Price, 1996; Macer, 1996) suggests that, in addition to the intrinsic student factors mentioned previously, there are other issues that may have a negative impact on the quality of bioethics education. These constraints include: a lack of expertise by teachers in the content areas that raise bioethical issues; a lack of experience in the types of learning activities appropriate for bioethics education; a scarcity of resources; and insufficient teaching time.

Some teachers may not be familiar with recent advances in the fields of transplantation technology, DNA technology and reproductive technology. They may also be unaware of the associated ethical issues. Most science text books contain factual information. They do not consider the ethical implications of science in our society. For example, Helen had found that there were few resources available related to reproductive technology.

Some teachers may not be willing to discuss bioethical issues with their students. For example, at Catherine's school, in 1997, another science teacher taught the Biotechnology course. The teacher did not feel comfortable about teaching the bioethics component of the course. Thus, when she taught the course, she focussed primarily on the procedures associated with transplantation technology and avoided the ethical issues. At Mark's school, even though there were two other teachers of DNA technology, he was the only one who was willing to include a consideration of bioethical issues.

### **MY CURRENT PEDAGOGICAL FRAMEWORK**

The purpose of this section is to reflect on the significance of the research findings for my teaching practice and also to consider how the findings have modified my pedagogical framework. The changes in my pedagogical framework will influence the focus of bioethics professional development sessions that I conduct for preservice and practising science teachers. In addition, when I teach bioethics in the future, I need to consider the implications of this study.

I began this study with an initial pedagogical framework that was informed by my previous experience of teaching bioethics in my own classroom and also by my reading of the bioethics literature. As described in Chapter One, I believed that science teachers have a responsibility to introduce their students to ethical issues associated with science. Because of my interest in bioethics education, I had developed, taught



and evaluated a bioethics course as part of a Master's degree. The course was based on transplantation technology and was taught from a constructivist perspective. Briefly, the findings of that study suggested that the use of collaborative student-centred teaching strategies by the teacher could enable students to reflect critically on, articulate and justify their developing ethical values. In addition, the teacher needed to adopt a multiplicity of roles ranging from a facilitator of discussion to a provider of information.

### **Teacher Attributes**

From the research findings, it appears that the values and actions of the teacher are crucial elements in the quality of bioethics education. Science teachers need to be aware that bioethics education is an important and worthwhile topic to teach. I need to remind myself that not all science teachers share my enthusiasm about bioethics. I realise that when addressing preservice or practising science teachers, I need to be explicit about the reasons for teaching bioethics.

A teacher's pedagogical goals and/or intended learning outcomes of a bioethics course will influence the selection and implementation of learning activities. Thus, it is important for the teacher to have clear pedagogical goals and intended student learning outcomes prior to designing a course.

The teacher should also endeavour to establish and maintain a safe and caring learning environment. Students need to be aware that they will not be ridiculed about their ethical values although they may be called upon to justify them. The articulation of values which are strongly held or different from those of their peers and society can be a threatening experience for students. The teacher, in adopting a caring approach, can minimise their students' fears.

From speaking to teachers, there seems to be a perception that bioethics cannot be assessed. Teachers seem to be reluctant to assign a number or grade based on a student's decision making ability. However, with the impending introduction of outcomes based assessment in Western Australia (Curriculum Council, 1997) it may be possible for students to demonstrate the acquisition of decision making skills. For example, through questioning, it may be possible for a teacher to determine whether a student can identify an ethical issue, propose a range of options, weigh up the options and make a decision.

## **Design of Bioethics Courses**

When I began the study, I believed that the criteria for the selection of learning activities in bioethics education should be based on the extent to which they provided students with opportunities to reflect critically on, articulate and justify their bioethical values. As a result of this study, I realise that there are other areas that may need to be addressed. I now believe that the learning activities should provide students with opportunities to increase their awareness that:

- a) bioethical principles and a decision making process exists;
- b) bioethical issues in science do exist;
- c) a group of individuals will hold a wide range of bioethical values;
- d) they need to listen to and respect the bioethical values of others;
- e) to resolve bioethical issues, they need to seek information;
- f) they need to provide sound reasons to justify their bioethical values.

There are a range of suitable content areas that can act as a platform for bioethics education. Regardless of the content area, it seems that students need the time and resources to investigate ethical issues associated with one topic. An in-depth examination of one topic over an extended period of time may enable students to think about and understand more fully the scientific content as well as the ethical issues surrounding a topic. This may be particularly pertinent when dealing with complex fields of biotechnology such as cloning. An understanding of the content would not be possible if the teachers adopted 'a topic a lesson' approach.

A decision about whether to integrate bioethics education throughout an entire course or to leave it until the end should be considered by the teacher and will depend on their goals and other factors that they consider relevant. Regardless of the approach taken, the teacher needs to be clear about the rationale of their choice. Although I support the decision of Mark and Helen to introduce bioethics education in the final part of the course, I am concerned that students may view bioethics component as an optional 'add on' that is of minimal importance.

When designing a bioethics course, teachers need to explicitly teach their students about bioethical principles and a decision making process. The bioethics literature (e.g., Beauchamp, 1994) suggests that students need a basis other than their personal opinion, intuition or the teacher's beliefs to think about and resolve bioethical issues. The four bioethical principles of autonomy, beneficence, non-maleficence and justice can enable students to resolve the types of issues that arise in the field of bioethics.

Historically, ethics education is based on an understanding and application of rules to make an ethical decision. From my experience in this study, I would argue that students need frequent opportunities to engage in learning activities where solutions to complex ethical problems are produced collaboratively with their peers. This model approximates how decisions are made in our democratic society. One rarely makes an important ethical decision in isolation, relying solely on rules, without first seeking information and the views of those whom we respect and trust, be it family, friends, experts or church leaders.

### **Student Attributes**

When selecting learning activities, teachers need to be aware and tolerant of the variable ethical maturity of their students. For example, if teachers are aware that students may place undue emphasis on the principle of autonomy in resolving bioethical issues, then the teacher may need to select learning activities designed specifically to address this issue. Teachers also need to understand that some students may not consider the long term consequences of their decisions. Teachers can assist their students by explicitly drawing their attention to the long term consequences of their ethical decisions.

Because of variation amongst students, teachers need to be aware that the responsiveness of a group of students may vary. It may be preferable for bioethics education to be incorporated throughout the five years of secondary school science. Repeated exposure to bioethics education (e.g., in a spiral curriculum) may increase the likelihood that all students, regardless of their ethical maturity, will have enhanced opportunities to learn about bioethics.

### **Constraints**

The constraints identified in the research findings are easy to state, but difficult to address. Some of them require significant changes in the way that science is currently taught. For example, schools may need to modify their science curriculum to allow time for the inclusion of bioethics education. This may necessitate the removal of some material or the provision of additional teaching time in science.

Teachers may need the opportunity to update their understanding of recent scientific advances and associated bioethical issues. In addition, science teachers need to be equipped with the skills and resources to teach bioethics education. The development and provision of appropriate professional development and resources need to be

readily available. Professional development could be incorporated into preservice teacher training and post graduate study in science education.

## **CODA**

I began this doctoral study with the mind set of a scientist, hoping to find and prove that particular learning activities would be 'effective' in achieving my a priori goals of bioethics education. As a result of this study, I realise that there is not a single method or formula for the successful teaching of bioethics education. Instead, I leave this study with renewed enthusiasm about bioethics education, an informed and robust pedagogical framework and an enhanced awareness of the constraints and possible solutions.

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**APPENDIX A**  
**STUDENT QUESTIONNAIRES, TEACHER AND STUDENT**  
**INTERVIEW QUESTIONS**

## **BIOETHICAL DILEMMA SURVEY**

**Please read the following and complete the section below.**

### **GENETICS TESTING #1**

Mr. F, a 42-year-old man and his 21-year-old son George come to a genetic testing center for advice. George wants to be tested for Huntington's disease, a progressive, fatal inherited brain disorder that usually strikes its victims in their 30s, 40s and 50s.

There is a 50% chance that Mr. F has inherited the gene for Huntington's disease and, if so, a 50% chance he has passed it along to his son George. Mr. F doesn't yet show symptoms of the disease and he doesn't want to be tested. He prefers to live his life and make decisions without knowing whether or not he has the gene. George, on the other hand, wants to know if he has inherited the gene so he can plan his life accordingly.

If George gets tested and is found to carry the gene for Huntington's disease, his father, Mr. F, must also carry the gene. The two men agree that, given their close relationship, it would be impossible for George to keep his test result a secret from his father.

**Does George have a right to know whether or not he carries a disease gene even if it interferes with his father's wish not to know his genetic status?**

Yes \_\_\_\_\_

No \_\_\_\_\_

I can't decide \_\_\_\_\_

**Please write the five most important reasons that explain your answer. Write on the back of this sheet if necessary.**

### **Case Study: "What Good Is It?"**

Ms. Franklin is a member of the town council in a small community. She is also co-owner with her brother of a sporting goods store. The community in which Ms. Franklin and her brother live has endured a depressed economy recently. Ms. Franklin and her brother are uncertain if they will be able to keep the business going much more than another year. Thus one of Ms. Franklin's most important personal goals as Councilperson is to enhance the economy of her community.

At tonight's council meeting a developer is proposing to construct a hydroelectric dam in the canyon of a nearby river. Although the electrical energy generated by the dam is not needed in the community, it can be sold to a regional power grid and during times of need it can be sent hundreds, even thousands, of kilometre away where it can be used. Although the developer and his associates will receive all profits from sale of the power, the dam will mean construction jobs and the huge reservoir created by damming the river can be used by the community for its own recreational (swimming, fishing, boating, camping) and economic interests (a hunting and fishing lodge, marina). The developer asks that the council pass a motion in favour of the hydroelectric project.

Following the developer's proposal a scientist from the State University several hundred miles away asks to be heard. She informs the council that an endangered fish species lives in the canyon just downstream of the proposed dam site. The fish, called the "drimp", grows to about a foot in length and is a dull greenish-brown in colour. Because of its secretive nature and muddy water habitat, few people have or will ever see one in their lifetimes. It is an Endangered Species. The scientist informs the council that the water used to turn the energy generating turbines and then released from the base of the dam will cause the drimp's downriver habitat to be icy cold and, consequently destroy its ability to reproduce. Without young, adult drimps will grow old and die and the canyon's population will become extinct. There is in the world only one other population of these fish known - it is several hundred miles to the south downstream of a rapidly growing city. The scientist asks that the council reject the water developer's resolution and vote instead for the continued existence of the endangered drimp.

**Should Ms. Franklin vote in favour of the hydroelectric project?**

Yes \_\_\_\_\_

No \_\_\_\_\_

I can't decide \_\_\_\_\_

**Please write the five most important reasons that explain your answer.  
Write on the back of this sheet if necessary.**

#### **Case Study 4 - Whose body?**

A husband wishes to remove eggs from his wife's dying body to be fertilised by his sperm in vitro and then implanted in to a surrogate mother.

**Would you allow this request?**

Yes \_\_\_\_\_

No \_\_\_\_\_

I can't decide \_\_\_\_\_

**Please write the five most important reasons that explain your answer.  
Write on the back of this sheet if necessary.**

### Genetics Testing #3

Mr. and Mrs. C come to a genetics clinic for prenatal diagnosis.

They have each been tested to determine whether they carry the gene for cystic fibrosis, a hereditary lung disease that causes severe breathing problems.

The cystic fibrosis gene is recessive, so a child must inherit a copy from each parent to get the disease. In this case, both Mr. and Mrs. C are carriers for the cystic fibrosis gene. The specific mutations for each parent were identified in earlier tests.

Mrs. C, who is pregnant, undergoes prenatal diagnosis to determine if the foetus is affected. DNA analysis indicates that the foetus does have two copies of the cystic fibrosis gene, but one of the mutations it carries is different from that of either Mr. or Mrs. C. That makes it virtually certain that Mr. C is not the baby's father.

**Should the genetics counsellor tell both Mr. and Mrs. C about the test results?**

Yes \_\_\_\_\_

No \_\_\_\_\_

I can't decide \_\_\_\_\_

**Please write the five most important reasons that explain your answer. Write on the back of this sheet if necessary.**

### References

URL- [http://www.exploratorium.edu/genepool/scenario\\_1.html](http://www.exploratorium.edu/genepool/scenario_1.html) Diving into the gene pool  
Scenario #1 - Genetic testing, 9/10/96

URL- [http://www.exploratorium.edu/genepool/scenario\\_1.html](http://www.exploratorium.edu/genepool/scenario_1.html) Diving into the gene pool  
Scenario #3 - Genetic testing, 9/10/96

URL- <http://www.gene.com/ae/AE/AERC/WWC/1992/> 1992 Woodrow Wilson  
Activities Collection - Bioethics, 9/10/96

## **CATHERINE'S CASE STUDY - STUDENT QUESTIONNAIRE**

### **BIOTECHNOLOGY - YEAR 10**

Please give as much information as possible so changes may be made to the unit if necessary. Your opinion is valued. You don't have to sign your name.

1.     What part/s of the unit did you like most?
  
  
  
  
  
  
  
  
  
  
2.     What part/s of the unit did you like least?
  
  
  
  
  
  
  
  
  
  
3.     Can you suggest ways in which the unit can be improved?
  
  
  
  
  
  
  
  
  
  
4.     Has this unit changed your opinion of science? Please comment.
  
  
  
  
  
  
  
  
  
  
5.     If you had the choice now, would you choose this unit?
  
6.     How was this unit different from other science units?
  
  
  
  
  
  
  
  
  
  
7.     Were you happy with the type of assessment? Please comment.
  
  
  
  
  
  
  
  
  
  
8.     Were you happy with the style of teaching? Please comment.
  
  
  
  
  
  
  
  
  
  
9.     What other subjects are taught like this unit?

10. What were the three most important things that you learnt in this unit? (They don't have to be facts.)

11. Do you think this unit has taught you how to deal with other ethical issues? e.g. availability of abortion, euthanasia (mercy killing), withdrawal of food and treatment from severely disabled infants, use of animals in medical research. Explain how you might deal with these issues.

12. Any other comments?????

Thank you for completing this evaluation.



# **CATHERINE'S CASE STUDY - STUDENT QUESTIONNAIRE ON TEACHING STRATEGIES**

## **Year 10 Biotechnology Unit**

### **Questionnaire on Teaching Strategies**

This questionnaire lists some of the teaching strategies that have been used in the Biotechnology unit.

How useful were these teaching strategies in helping you to understand some of the ethical issues associated with biotechnology?

Circle a number from 1 to 3 to record your response.

|                                   | No<br>Use | Moderately<br>Useful | Very<br>Useful |
|-----------------------------------|-----------|----------------------|----------------|
| Portfolio                         | 1         | 2                    | 3              |
| Video material                    | 1         | 2                    | 3              |
| Oral Case studies                 | 1         | 2                    | 3              |
| Transplant Questionnaire          | 1         | 2                    | 3              |
| Liver Transplant Activity         | 1         | 2                    | 3              |
| Group work                        | 1         | 2                    | 3              |
| Classroom discussion with teacher | 1         | 2                    | 3              |

**Thank you**

### **Questionnaire on Teaching Strategies**

Usefulness of teaching strategies. Number = 29

|                                   | No<br>use | Moderately<br>useful | Very<br>useful |
|-----------------------------------|-----------|----------------------|----------------|
| Portfolio                         | 2         | 20                   | 7              |
| Video material                    | 0         | 2                    | 27             |
| Oral Case studies                 | 2         | 10                   | 17             |
| Transplant Questionnaire          | 0         | 12                   | 17             |
| Liver Transplant Activity         | 5         | 13                   | 11             |
| Group work                        | 1         | 13                   | 15             |
| Classroom discussion with teacher | 0         | 1                    | 28             |

## **STUDENT AND TEACHER INTERVIEW QUESTIONS - MARK'S AND HELEN'S CASE STUDY**

### **Teacher Questions**

1. What do you believe are the three most important things that the students have learnt in this course?
2. What have you learnt?
3. How has teaching this class differed from your other science classes?
4. Do you think that students are better informed about
  - a) what biotechnology is
  - b) the impact of biotechnology on their lives
  - c) ethical issues associated with biotechnology
  - d) how to make decisions about the use of biotechnologythan before they studied the course? Please explain.
5. Do you think that *any* science teacher could teach this course?
6. What skills are needed?
7. What teaching strategies seem to be most effective in teaching this unit?

### **Student Questionnaire**

1. What are the three most important things you have learnt in this unit?
2. Is this course different from your other science classes? Please explain.
3. Having studied this course are you
  - a) aware of what biotechnology is
  - b) aware of the impact of biotechnology on society
  - c) aware of ethical issues associated with biotechnology
  - d) better able to make decisions about the use of biotechnology that before?
4. What classroom strategies or activities has your teacher used that have seemed effective in helping you to understand biotechnology?

## STUDENT QUESTIONNAIRE - MARK'S CASE STUDY

## YEAR 10 BIOTECHNOLOGY - EVALUATION

Please give as much information as possible. Your individual comments are confidential and your opinion is valued.

1. What part/s of the Biotechnology course did you like the most?
2. What part/s of the Biotechnology course did you like least?
3. Can you suggest ways in which the course could be improved?
4. Has this course changed your opinion of science? Please explain.
5. How was this course different from other science courses?
6. Please comment on the type of assessment in this course.

9. What classroom activities have been particularly effective in helping you to understand some of the ethical issues associated with DNA technology?

## **STUDENT QUESTIONNAIRE - HELEN'S CASE STUDY**

### **YEAR 11 SENIOR SCIENCE- EVALUATION**

These questions refer to the work you covered in Term 3 and 4. That is reproduction, genetics and issues associated with reproduction. Your opinion is valued. You don't have to sign your name.

1.      What part/s of the Biotechnology course did you like the most?
  
  
  
  
  
  
  
  
  
  
2.      What part/s of the Biotechnology course did you like least?
  
  
  
  
  
  
  
  
  
  
3.      Can you suggest ways in which the course could be improved?
  
  
  
  
  
  
  
  
  
  
4.      Has this course changed your opinion of science? Please explain.
  
  
  
  
  
  
  
  
  
  
5.      If you had the choice now, would you choose this course?
  
  
  
  
  
  
  
  
  
  
6.      How was this course different from other science courses?
  
  
  
  
  
  
  
  
  
  
7.      Please comment on the type of assessment in this course.

8. Please comment on the style of teaching.
9. What are the three most important things that you have learnt in this course.  
(They don't have to be facts.)
10. Do you think that this course has taught you how to deal with other ethical issues? (e.g., availability of abortion, euthanasia (mercy killing), withdrawal of food and treatment of severely disabled infants, use of animals in medical research.
11. Explain how you might deal with these issues?
12. Any other comments???
13. What have you learnt during the last section on genetics and bioethics?

14. What have you learnt about the use of science in our society?
15. What do you know now that you did not know before?
16. In relation to issues, can you decide better what you believe? Please explain.
17. In relation to issues, can you express your viewpoint better? Please explain.
18. In relation to issues, can you explain/justify your viewpoint better? Please explain.

## **FOLLOW UP INTERVIEW QUESTIONS WITH CATHERINE, MARK AND HELEN**

Could you read the attached vignettes and your teaching goals (taken from interviews) and consider the following questions *for each vignette*.. I realise they are tough questions and you may not be able to answer them but I want to give you the opportunity to think about them before I ask you in person. Okay?

1. What did you expect students to learn from this activity?
2. What do you think they did learn from this activity?
3. How do you know or how did you determine what they learnt?
4. Can you comment on the quality of this activity in achieving your goal related to teaching students about bioethics.
5. Do you think that all of the students learnt the same thing from this activity?
6. What factors may have influenced how much students learnt?

Good luck



**APPENDIX B**

**COURSE OUTLINES**

## **BIOTECHNOLOGY**

- Lesson 1
- Introduction to Biotechnology.
  - What is Biotechnology? (Definitions)
  - Aim of the unit
  - Assessment
  - Definitions of : Issue, Social, Ethical
  - Students to give examples of social and ethical issues.
  - It is important at this stage to stress there is **no right or wrong** answers but it is important to defend your decision or choices eloquently and clearly.
  - Go through some examples of issues. (open for discussion)
- Lesson 2 & 3
- Bioethics: Rights-based consequences, Consequences-based positions
  - Guiding principles: Beneficence, Respect for each person's autonomy and Justice.
  - Decision making
  - Looking at Bioethical decisions by looking at the issue of Transplantation
  - Organ donation - Which organs and tissues are currently being transplanted.
- Lesson 4
- **Activity 5.1 The guts of the matter**
  - Students in groups construct a human body on butcher paper and draw in where they think the internal organs are.
  - Use torso to show students the correct position of the internal organs.
  - Review again which organs and tissues can be transplanted.
- Lesson 5
- **Activity 1.1 Transplantation spectrum.**
  - What organs and tissues are currently transplanted? Is it expensive? Is it successful?
  - Briefly do **Activity 1.3 The history of transplantation**
- Lesson 6
- **Activity 1.2 What do you know ? What do you think?**
  - What are the issues?
  - Show the video "Share yourself around" - 30mins with Roy Knudson discussing the issues with a group of students. Excellent
  - Use the video to generate discussion of the issues.
  - Use a concept map to relate issues?
- Lesson 7
- **Activity 1.5 The questions to be asked**
  - Design a questionnaire
  - Students to show the teacher their draft before the end of the lesson.
  - Homework: Assessment (worth 20%) is to interview 10 people using the questionnaire they have designed and to hand in these questionnaires.
  - Remind students that people may be very sensitive about transplantation
- Lessons 8 & 9
- Read the Article "From donor to Recipient" (p19)
  - Watch the video "Transplant Equations"
  - **Activity 2.1 The people involved in the transplant equation**
  - Students identify the needs, rights and duties of the people involved. i.e. The donor, recipient/s, their families and the medical staff.

- Lesson 10
- The liver transplant committee activity
  - Students to work in groups of 4 to role play a hospital ethics committee who need to select 4 liver transplant recipients from a list of 12.
  - Important to debrief the students the students after - How did they feel about having to decide etc.
  - **Homework:** Give out articles and students to prepare:
    - (i) Summary of one article (what is it about)
    - (ii) Their opinion of the issue/s in the article
 Then they will present this to the class for peer assessment (worth 20%)
- Lesson 11 & 12.
- **Activity 4.1 & 4.2 Defining and determining death.**
  - Students to write their own definition of death.
  - Go through the differences between brain death and cardiac death.
  - Read the article on brain death (Act. 4.2 Reading about brain death)
  - Prepare a flow chart which demonstrates the procedure for the diagnosis of brain death.
  - Structure and function of the brain, especially the brain stem.
  - Watch video segment on brain death.
- Lesson 13, 14, 15, 16 & 17
- **Portfolio** (worth 30% )
  - 5 lessons in the library - 10 Articles - different issue
  - For each of the 10 articles the students need to prepare
    - (i) Summary of the article
    - (ii) Their personal opinion of each article
- Lesson 18 & 19
- **Activity 3.7 A day in the life of a Kidney donar**
  - Watch video segment on Haemodialysis and children
  - Read and discuss extracts written by kidney donors.
  - How would you feel if you were the donor or the recipient of a kidney?
  - What are the advantages and disadvantages of living related organ donations.
  - Define the following: Dialysis, tissue typing, tissue rejection, Immunosuppressive drugs.
  - Look at immunosuppressive drugs. (if time there is a story on immunosuppressive drugs.
- Lesson 20 & 21
- Presentations of Articles (peer assessment)
- Lesson 22
- Test

### **Spare lessons**

- Lesson 1
- Guest speaker from the Australian Kidney Foundation, preferably an organ recipient.
- Lesson 2
- Cloning
  - Articles
- Lesson 3
- Genetic Engineering
- Lesson 4
- What does the future hold

## **LESSON 28. ETHICS, DEFINING THE ISSUES**

**ETHICS** is a term that we often associated with scientific investigations that are using animals of all types. Probably the debate about ethics becomes more intense when examining issues related to experiments on the human form or on animals that have a special association to people. Ethics is the basis for discussions that seek to determine whether the actions of scientists, in this context, are valid in terms of the effect/s they will have on people and living things

Examples of groups in the community that are seen to be involved in ethical discussions might include; animal liberation groups, environmental groups (Greenpeace), right to life groups, religious groups, hospitals and government bodies.

What do you consider to be **ETHICS** ? What are the characteristics of an ethical person?.....

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**Ethics could be defined as the standards or guidelines regarding the moral conduct of individuals with respect to life and living.**  
Where moral means.....

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Examine the first two sections of the CSIRO Genetic engineering video to refresh your understanding of techniques use in the area of Recombinant DNA Technology.

What are some questions that you believe we should be asking to formulate our opinions on whether Recombinant DNA technology should continue. In asking these questions try not to become fixed on a particular issue, but think broadly so that your questions might explore the issues in a far and open way.

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## LESSON 29 ETHICS; DO YOU HAVE A POSITION?

In the previous lesson you were asked to come up with questions that you felt needed to be asked in determining whether you considered the biotechnological activity ethical.

Examples of the questions proposed were:

1. Why do you think the activity you are undertaking in the area of DNA technology is right?
2. Why are you involved with DNA technology?
3. What advantages will come from your activities?
4. Are you aware if your area of research is offensive to any community groups?
5. Is there going to be any long term benefits or costs, economic/social, to the community?
6. What will be the long term effects of your techniques on the organism?
7. Is the techniques being developed for personal gain or the greater human population?
8. Is it right to interfere with nature?
9. Do you believe that you are playing God?
10. Do you believe in God?
11. Is there a risk to the environment from your technique?
12. Should companies be allowed to own the technology?
13. Should companies be allowed to exploit nature?
14. Can the technique provide medical benefits?
15. Who should control the rights to the technique?
- 16 How is it different from selective breeding of domestic animal.

### **Developing an ethical position on issues**

You have built up a body of knowledge about cell structure, DNA and Recombinant DNA technology (genetic engineering). This knowledge allows you to have some insight into the techniques that are being used to manipulate the molecules that code for life.

Review the questions stated in the section above, select the ones you think are appropriate in helping you decide what your ethical position is on the techniques and issues discussed in the article, that is presented at the end of this lesson. The questions above can be added to and are not meant to be the only ones that you may consider need to be asked in assessing the article.

[illegible]

4

What is your overall opinion on whether the techniques in DNA Technology in this article that you have been examining are ethical?

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Is there any other information that you feel would confirm your position on the issues you have been examining in this article or alternately change your position?

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**Note: For copyright reasons, the following newspaper extracts on pp259-60 of this thesis, have not been reproduced.**

**Designing the future, *The West Australian*, Tuesday, 25 Feb., 1997 p.6**

**Amalfi, Carmelo High-tech solution to faulty genes. (newspaper title not stated)  
18.3.97**

**(Co-ordinator, ADT Project (Retrospective), Curtin University of Technology,  
20.11.02)**

## SEMESTER 2 MODULE 2. REPRODUCTION

| WEEK          | CONTENT   | TEXTS                           | ACTIVITIES  | ASSESSMENTS  |
|---------------|---|---------------------------------|---|--|
| TERM 3<br>1-2 | SEXUAL AND ASEXUAL REPRODUCTION<br>- Mitosis<br>- Meiosis   | D. p20-21<br>B. p263<br>D. p134 | Video<br>Growing and preparing onion root tips.<br>Lilium anther slides   | Prac book<br>T1  |
| 3             | PLANT VEGETATIVE PROPAGATION techniques (cuttings, runners, bulbs, grafting)  | D. p108-111                     | A number of pracs using different plants and techniques   | Prac book<br>Poster and Plant Presentation<br>T5   |
| 4             | [Tissue culture techniques and the horticulture industry]<br>PLANT SEXUAL REPRODUCTION<br>Flower structure and function<br>Monocotyledon and dicotyledon seed structure and germination | D. p120-126                     | [Growing Carrots or African Violets on agar]<br>Dissection of different flowers<br>Pollen tube growth in sugar solns<br>Video [1] & [2]<br>Seed dissection and germination<br>Video [3] | Prac book<br>Prac book<br>Prac book<br>T1  |
| 5<br>1-10     | REPRODUCTION OF BOTH VERTEBRATES AND INVERTEBRATES<br>Reproductive anatomy and life cycles<br>SIMPLE GENETICS   |                                 | - Video [4]<br>- Mice dissections<br>- Raising tadpoles<br>- Morphological measurements of mice<br>Breeding mice [begin term 2]   | Prac Book<br>Frog Assignment<br>T2<br>Project on growth/development<br>T6<br>Project on practical genetics<br>T6 |
| 10            | TOPIC TEST REPRODUCTION   |                                 | Performing F1, F2 and back crosses<br>Double lesson test  | T6<br>T7   |
| TERM 4<br>1-4 | HUMAN REPRODUCTION<br>- anatomy/physiology<br>- contraception<br>- STDs<br>- genetic diseases   | D. p112-119                     | Video [5]<br>Worksheets<br>Video [6] & [7]  |  |
| 5-8           | BIOETHICS<br>- Embryo testing<br>- IVF<br>- Genetic Engineering   | B. p267-272                     | Article from "the West Magazine"<br>Video [8]<br>Research choice of ethical topics on human reproduction  | Summary<br>Assignment<br>T3<br>T2  |
| 5-6           |   |                                 | Oral presentation of research on Bioethics<br>Video [9]   | Oral report of Bioethics assignment<br>T2  |
| 6             | TOPIC TEST  |                                 |   | T2<br>T7   |

## **APPENDIX C**

### **PERMISSION LETTERS**

Dear Parent

I am studying for a post - graduate degree in science education at Curtin University. As part of my thesis, I am evaluating the Year 10 Biotechnology unit that your daughter is currently studying.

Your daughter has agreed to be interviewed as part of a small group, as she studies this unit. All information obtained will be treated confidentially.

If you like any further information regarding this study, please contact me at

Thank you

Mrs V. Dawson

Friday 25th October 1996

Dear Mr

I have recently been in contact with one of your science teachers, Mr Mark M. Mark has agreed to allow me to visit and observe his Year 10 biotechnology class to collect data as part of my doctoral research program. The research involves observing teachers who are teaching innovative biotechnology programs. I envisage visiting Mark's classes on two or three occasions during the next few weeks while he is teaching biotechnology.

Any data collected from the classroom observations will be anonymous when reported in my thesis.

The purpose of this letter is to request your permission to enter your school for this research. I trust that this request will be satisfactory to you. If you would like any further information concerning this research please contact me at.

Yours sincerely

Vaile Dawson

Monday 28th July 1997

Principal

Dear

I have recently been in contact with one of your science teachers, Mrs Helen D. Helen has agreed to allow me to visit and observe her Year 11 Senior Science class to collect data as part of my doctoral research program. The research involves observing teachers who are teaching innovative biotechnology programs. I envisage visiting Helen's classes on several occasions during the next few weeks while she is teaching reproductive technology.

Any data collected from the classroom observations will be anonymous when reported in my thesis.

The purpose of this letter is to request your permission to enter your school for this research. I trust that this request will be satisfactory to you. If you would like any further information concerning this research please contact me at.

Yours sincerely

Mrs Vaille Dawson

## **APPENDIX D**

### **LEARNING OUTCOMES AND ASSESSMENT ITEMS FROM HELEN'S CASE STUDY**

# YEAR 11 SENIOR SCIENCE

## TASK 5: ORAL PRESENTATION

This task is designed to assess your ability in the following outcomes.

Outcome 1: *Demonstrate a working understanding of relevant concepts in an issue in human reproduction.*

This will be assessed by the content of your talk, your ability to answer questions after your talk and also on the notes you make for the talk which you will hand up.

Outcome 6: *Communicate effectively using appropriate scientific terminology.*

This will be assessed on the clarity of your talk and how effectively you communicate information. Also on the quality of your notes; their organisation and written expression(including spelling).

Outcome 9: *Discuss how science has an impact on the environment and our society.*

This will be assessed on how well you have researched and presented the way your issue affects individuals and society.

### ISSUES TO CHOOSE FROM:

- Sex-linked genetic diseases such as Muscular Dystrophy and Haemophilia
- Non-sex-linked genetic diseases such as Huntington's Chorea and Cystic Fibrosis
- Chromosome abnormalities such as Down's Syndrome, Klinefelter's Syndrome, Turner's Syndrome
- IVF versus GIFT programs [including Catholic church perspective]
- Embryo Testing Techniques [amniocentesis and chorionic villi sampling]
- The Human Genome Project [description, benefits and dangers for society]
- Eugenics [Examples, historical examples, dangers and how it could occur now]
- Genetic Engineering [technique, examples and uses]
- Transgenic Organisms [technique, examples and uses]
- Surrogacy
- Artificial insemination and ova donation
- Frozen Embryos
- Human embryo experimentation
- Foetal embryo harvesting
- Abortion
- Bioethics



# LIBRARY INVESTIGATION

Use library sources such as ENCARTA, encyclopaedia and Human Biology textbooks to find out about the following issues in Human Reproduction

## IVF

Definition \_\_\_\_\_

Description of procedure \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## GIFT

Definition \_\_\_\_\_

Description of procedure \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## EUGENICS

Definition \_\_\_\_\_

Historical example \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## AMNIOCENTESIS

Definition \_\_\_\_\_

Description of procedure \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## CHORIONIC VILLUS SAMPLING

Definition \_\_\_\_\_

Description of procedure \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## ABORTION

Definition \_\_\_\_\_

### **SURROGACY**

Definition \_\_\_\_\_

Description of events \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **GENOME**

Definition \_\_\_\_\_

### **DNA FINGER PRINTING**

Definition \_\_\_\_\_

Description of procedure \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **GENETIC ENGINEERING**

Definition \_\_\_\_\_

Uses \_\_\_\_\_

\_\_\_\_\_

### **TRANSGENIC ORGANISMS**

Definition \_\_\_\_\_

Examples made so far \_\_\_\_\_

\_\_\_\_\_

### **FOETUS**

Definition \_\_\_\_\_

### **ARTIFICIAL INSEMINATION**

Definition \_\_\_\_\_

Description of procedure \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **BIOETHICS**

Definition \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **MUSCULAR DYSTROPHY**

Description of symptoms \_\_\_\_\_

Description of causes \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **HAEMOPHILIA**

Description of symptoms \_\_\_\_\_

Description of causes \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **HUNTINGTON'S CHOREA**

Description of symptoms \_\_\_\_\_

Description of causes \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **CYSTIC FIBROSIS**

Description of symptoms \_\_\_\_\_

Description of causes \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **DOWN'S SYNDROME**

Description of symptoms \_\_\_\_\_

\_\_\_\_\_

Description of causes \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### **KLINEFELTER'S SYNDROME**

Description of symptoms \_\_\_\_\_

\_\_\_\_\_

Description of causes \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# TASK 3 : SUMMARISING A PIECE OF POPULAR SCIENTIFIC WRITING

Read the article on "sex choice" in the West Australian June 22 1996.  
Answer the following questions.

1. What are the sex chromosomes of the human male? \_\_\_\_\_ [1]
2. What are the sex chromosomes of the human female? \_\_\_\_\_ [1]
3. Show how a man and a woman would be expected to produce equal numbers of boy and girl babies. Do this by showing the sex chromosomes of their gametes and then join the gametes in a punnet square. [3]

♀ gametes \_\_\_\_\_ ♂ gametes \_\_\_\_\_

4. Sex-linked genes are carried on the X-chromosome. Many genetic diseases are sex-linked and recessive. For instance colour blindness is found on the X-chromosome: it is shown like this  $X^bY$  for a colour-blind boy and  $X^bX^b$  for a colour blind girl. If the girl has only one recessive colour-blind gene, she is called a "carrier" and does not have the condition herself but can hand on the gene to her children.

If a woman carried the sex-linked recessive gene for Muscular Dystrophy (d) and her husband had a normal X-chromosome (D), show the symbols for both of their sex-chromosomes.

Now list the gametes that each could produce. ♀ \_\_\_\_\_ ♂ \_\_\_\_\_ [3]  
Now join the gametes up in a punnet square.

5. What fraction of their children would be expected to suffer from Muscular Dystrophy? \_\_\_\_\_ [4]
6. What fraction of their girls would have the disease? \_\_\_\_\_ [4]
7. What fraction of their boys would have the disease? \_\_\_\_\_ [4]
8. What fraction of their girls would be 'carriers'? \_\_\_\_\_ [4]

9. Can you now explain why parents such as those above would choose to have only girl babies if they could? [4]
10. What do the initials IVF stand for? [1]
11. Explain the what is done in an IVF treatment. [1]
12. What disease did the mother in the article carry? [1]
13. How did the scientists know which embryos were female and which were male? [4]
14. Is the law regarding pre-implantation tests the same all over Australia? Explain. [1]
15. What was the next step in this scientific procedure that worried the Victorian ethicist? [1]
16. How might embryo testing affect human society in the future if it is allowed to proceed with no checks or balances? [9]

17. Who do you believe should be on the ethics committees that oversee the development of future IVF selection procedures? Explain your answer. [9]
18. What sort of safeguards do you think an ethics committee should put in place? [9]
19. Embryo selection is one kind of genetic engineering. Other techniques involve combining the DNA of different organisms to produce better crop plants, food animals or medicines; such as frost resistant tomatoes and pigs with human genes. Imagine what the world might be like in 100 years time when these kinds of plants and animals could be commonplace. What dangers for the environment could you predict? [9]

**Note: For copyright reasons, the following newspaper extracts on pp274-5 of this thesis, have not been reproduced.**

**Salom, Tom Sex-choice twin birth sparks row of ethics. (no further details given)**

**Choosing baby girls. *Herald Sun*, 20/6/96**

**article beginning “ Mr Tonti-Filippini said....” (no further details given)**

**(Co-ordinator, ADT Project (Retrospective), Curtin University of Technology, 20.11.02)**

**YEAR 11 SENIOR SCIENCE  
GENETICS AND BIOETHICS TOPIC TEST**

1. What do the letters GIFT stand for?
  - (A) Gametes In the Fallopian Tubes.
  - (B) Gamete Intra Fallopian Transfer.
  - (C) Gametes In Free Transfer.
  - (D) Gametes Into Female Tubes.
  
2. What do the letters IVF stand for?
  - (A) In Vitro Fertilisation.
  - (B) Into Vivo Fertilisation.
  - (C) Intense Vitro Fertility.
  - (D) Improved Virtual Fertility.
  
3. What is the Human Genome Project?
  - (A) An assignment topic in Human Biology.
  - (B) A project to count the number of chromosomes humans have.
  - (C) A project to map all the genes on human chromosomes.
  - (D) A technique used in genetic engineering that could lead to transgenic animals being created.
  
4. Which of the following is the correct, complete sequence of human development?
  - (A) Gametes---->embryo---->foetus---->baby
  - (B) Gametes---->zygote---->embryo---->foetus
  - (C) Gametes---->zygote---->foetus---->embryo---->baby
  - (d) zygote---->embryo---->foetus---->baby
  
5. One couple already have three sons. What is the chance that their next child will be a girl?
  - (A) 1 in 2 (50%)
  - (B) double the chance (2:1)
  - (C) 1 in 4 (25%)
  - (D) three times as likely (3:1)
  
6. In most families, blue eyes are recessive to brown eyes. If a blue eyed man married a brown eyed woman from a totally brown-eyed family, what percentage of their children would be expected to have blue eyes?
  - (A) 50%
  - (B) 25%
  - (C) Zero %
  - (D) 75%
  
7. Two parents with dark brown hair have 3 girls also with dark brown hair and then they have a boy with bright red hair. Which of the following is the BEST explanation for this.
  - (A) Red hair is only found in boys and is a sex-linked gene.
  - (B) Red hair is dominant to brown and the parents were heterozygous for the red gene.
  - (C) Red hair is recessive to brown and the parents were heterozygous for the red gene.
  - (D) The child was adopted since these parents could not possibly produce a redhead.



8. In mice, black fur is dominant to white fur. If a pure black female mouse was mated to a pure white male mouse, what coat colour would you expect in their first litter?
- (A) White, because males are dominant.  
 (B) Black, because the black gene masks the white gene.  
 (C) White for the boy mice and black for the girl mice.  
 (D) Grey, because both coat colours are expressed.
9. Which of the following symbols would you choose to write for the coat colours of the two parent mice above?
- (A) Male, ww and female, BB  
 (B) Male, bb and female, BB  
 (C) Male, WW and female, BB  
 (D) Male, WW and female, ww
10. What genetic term would BEST describe the offspring of the black and white parent mice?
- (A) Pure-bred (B) Heterozygote  
 (C) Homozygote (D) Cross-bred
11. What symbols would you choose to describe their offspring genetically?
- (A) BW (B) BB  
 (C) Bb (D) Ww
12. When a gene is said to be sex-linked, which of the following is true?
- (A) The gene is found on the x-chromosome.  
 (B) The gene only occurs in boys.  
 (C) The gene affects the sex of the baby.  
 (D) The gene causes the x-chromosome to be small and mutated.
13. What is the sex chromosome content of the human EGG cell?
- (A) XY (B) XX  
 (C) Y (D) X
14. What is the sex chromosome content of a male ZYGOTE?
- (A) XY (B) XX  
 (C) Y (D) X
15. Boys with Klinefelter's Syndrome have an extra x-chromosome. Which of the following is true.
- (A) They have 46 chromosomes in every body cell but they have 47 chromosomes in sex cells.  
 (B) They are very small, feminine and can't have babies.  
 (C) They 22 pairs of ordinary chromosomes and 3 sex-chromosomes X, X and Y.  
 (D) They are not really boys at all, but are tall girls.

# YEAR 11 SENIOR SCIENCE GENETICS AND BIOETHICS TOPIC TEST

- |          |           |           |
|----------|-----------|-----------|
| 1. _____ | 6. _____  | 11. _____ |
| 2. _____ | 7. _____  | 12. _____ |
| 3. _____ | 8. _____  | 13. _____ |
| 4. _____ | 9. _____  | 14. _____ |
| 5. _____ | 10. _____ | 15. _____ |

## QUESTION 16

In rats, yellow fur colour is **DOMINANT** to grey.

- a) Write appropriate letters to represent a homozygous (pure) yellow rat \_\_\_\_\_  
 Write appropriate letters for a homozygous grey rat. \_\_\_\_\_  
 Write appropriate letters for a heterozygous (hybrid) mouse \_\_\_\_\_ [3-3]
- b) A girl bred a pure breeding (homozygous) **YELLOW FEMALE** rat with a pure breeding **GREY MALE** rat.  
 Draw a Punnett square in the space below to show the gametes produced and the offspring expected.



x



3-3]

|  |  |
|--|--|
|  |  |
|  |  |

- c) What colour would you expect the offspring to be? \_\_\_\_\_ [4-1]
- d) If she then crossed two heterozygote (hybrid) rats, show below in a Punnett square the colours she could expect. [3-3]

|  |  |
|--|--|
|  |  |
|  |  |

- e) After a number of hybrid crosses, 160 mice had been born. Of these, 130 were yellow and 30 were grey. Show the working to calculate the percentage that were:?

(i) black? \_\_\_\_\_

(ii) yellow? \_\_\_\_\_ [7-2]

- f) She expected to get yellows to greys in the ratio of 3:1.

What FRACTION should have been GREY? \_\_\_\_\_ [7-1]

What PERCENTAGE should have been YELLOW? \_\_\_\_\_ [7-1]

HOW MANY (i) grey and how many (ii) yellow rats should have been born out of the 160? (show working)

(i) grey \_\_\_\_\_

\_\_\_\_\_

(ii) yellow \_\_\_\_\_

\_\_\_\_\_ [7-2]

#### QUESTION 17.

- a) Why do some women choose Chorionic Villus Sampling instead of Amniocentesis?

\_\_\_\_\_

\_\_\_\_\_ [4-2]

- d) List 2 reasons why couples would want to undergo either amniocentesis or CVS?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [9-2]

- e) Do you think all pregnant woman over 43 years of age should undergo embryo testing? Give an explanation for your answer.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [9-2]

- f) Imagine you are a doctor and your pregnant patient has had amniocentesis. The foetus is found to have a disease such as Cystic Fibrosis. You have to decide what to tell the woman. Would the decision about what to tell the woman be a simple one? Explain the issues you would have to consider before talking to her.

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[9-3]

- g) Your nurse suggests you tell the husband first. How would you respond to this idea? Explain.

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[9-2]

- h) What would you decide to tell the woman? Explain your decision.

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[9-3]

#### QUESTION 18

Already we can genetically test embryos and when the Human Genome Project is complete we will be able to identify the genes for all human differences. Some ethicists believe this will lead to *designer babies*?

- (i) What do you think they mean by the term *designer babies*? \_\_\_\_\_

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[9-1]

- (ii) Why would they use a word like '*designer*', which usually describes clothes? \_\_\_\_\_

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[9-1]

(iii) Describe two ways such babies could be produced. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [9-2]

- f) Many Bioethicists are concerned with such technological advances in human reproduction. Suggest three ethical issues that may arise (or have already arisen) from such reproductive technology.
- (i) \_\_\_\_\_  
\_\_\_\_\_
- (ii) \_\_\_\_\_  
\_\_\_\_\_
- (iii) \_\_\_\_\_  
\_\_\_\_\_ [9-3]

#### QUESTION 19

Imagine a new discovery in genetic engineering that could cure Muscular Dystrophy. The woman carrying the faulty gene would need to agree to an IVF conception but her eggs would first be treated to insert a piece of pig DNA which would cure the muscular Dystrophy in any baby resulting from a successful pregnancy. The addition of the pig DNA would make no other changes to the baby - it would appear perfectly normal.

Without the new DNA, the baby would have a 50% chance of either having the disease or of carrying the disease into the next generation. Children with Muscular Dystrophy become progressively weaker as they get older and rarely live past 18 years of age.

You are a member of the bioethics committee at the hospital that has proposed to try this new technique. What concerns would you raise? Would you agree to proceed and why or why not?

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**APPENDIX E**

**SUMMARY OF BIOETHICAL DILEMMA SURVEY  
RESULTS**

## CATHERINE'S CASE STUDY

Table 9

t-test Results for the Bioethical Dilemma Survey; Mean Responses of Students (yes=3, I can't decide=2, no=1, Catherine).

| Dilemma                 | Bioethics<br>n=23 |       | No Bioethics<br>n=38 |      | t-value | P<br>(sig<0.05) |
|-------------------------|-------------------|-------|----------------------|------|---------|-----------------|
|                         | mean              | SD    | mean                 | SD   |         |                 |
| Cystic Fibrosis         | 1.43              | 0.811 | 1.60                 | 0.86 | -0.79   | ns              |
| Huntington's Disease    | 1.14              | 0.48  | 1.15                 | 0.37 | -0.12   | ns              |
| Environment             | 1.81              | 0.60  | 2.02                 | 0.79 | -1.18   | ns              |
| Reproductive Technology | 1.62              | 0.74  | 1.55                 | 0.72 | 0.33    | ns              |

Note: ns = not significant at the 5% level (two tailed test)

Table 10

t-test Results for the Bioethical Dilemma Survey; Mean Responses of Catherine's Students Before and After Studying the Biotechnology Course in 1997 (yes=3, I can't decide=2, no=1).

| Dilemma                 | Pre-course<br>n=30 |      | Post-course<br>n=30 |      | t-value | P<br>(sig<0.05) |
|-------------------------|--------------------|------|---------------------|------|---------|-----------------|
|                         | mean               | SD   | mean                | SD   |         |                 |
| Cystic Fibrosis         | 1.5                | 0.68 | 1.5                 | 0.73 | 0       | ns              |
| Huntington's Disease    | 1.12               | 0.34 | 1.03                | 0.18 | 1.36    | ns              |
| Environment             | 2.16               | 0.78 | 2.26                | 0.81 | -0.62   | ns              |
| Reproductive Technology | 1.71               | 0.82 | 1.74                | 0.77 | -0.23   | ns              |

Note: ns = not significant at the 5% level (two tailed test)

## MARK'S CASE STUDY

Table 11

t-test Results for Mark's Case Study; Mean Responses of Students (yes=3, I can't decide=2, no=1).

| Dilemma                 | Bioethics<br>n=20 |      | No Bioethics<br>n=22 |      | t-value | P<br>(sig<0.05) |
|-------------------------|-------------------|------|----------------------|------|---------|-----------------|
|                         | mean              | SD   | mean                 | SD   |         |                 |
| Cystic Fibrosis         | 1.40              | 0.68 | 1.59                 | 0.80 | -0.84   | ns              |
| Huntington's Disease    | 1.50              | 0.37 | 1.82                 | 0.59 | -0.21   | ns              |
| Environment             | 2.0               | 0.92 | 2.50                 | 0.80 | 0.07    | ns              |
| Reproductive Technology | 1.85              | 0.81 | 1.68                 | 0.72 | 0.71    | ns              |

Note: ns = not significant at the 5% level (two tailed test)

Table 12

Student Responses for the Bioethical Dilemma Survey (Mark).

| Bioethical Dilemma      | Response       | Bioethics n=20 | No Bioethics n=22 |
|-------------------------|----------------|----------------|-------------------|
| Cystic Fibrosis         | Yes            | 13 (65%)       | 13 (59%)          |
|                         | I can't decide | 4 (20%)        | 5 (23%)           |
|                         | No             | 3 (15%)        | 4 (18%)           |
| Huntington's Disease    | Yes            | 17 (85%)       | 20 (91%)          |
|                         | I can't decide | 3 (15%)        | 2 (9%)            |
|                         | No             | 0              | 0                 |
| Environment             | Yes            | 8 (40%)        | 4 (18%)           |
|                         | I can't decide | 4 (20%)        | 3 (14%)           |
|                         | No             | 8 (40%)        | 15 (68%)          |
| Reproductive Technology | Yes            | 8 (40%)        | 10 (45%)          |
|                         | I can't decide | 7 (35%)        | 9 (41%)           |
|                         | No             | 5 (25%)        | 3 (14%)           |



Table 13

Types of Reasons Provided to Justify a 'yes' Response for the Cystic Fibrosis Dilemma (Mark).

| Reason   | Studied Bioethics n=17 | No Bioethics n=24 |
|--|------------------------|-------------------|
| Both Mr and Mrs C have a right to the information.                             | 12 (71%)               | 16 (67%)          |
| Both Mr and Mrs C need to know whether the baby has cystic fibrosis.           | 4 (23%)                | 6 (25%)           |
| The father has a right to know he is not the real father.                      | 4 (23%)                | 11 (46%)          |
| The baby has a right to know who his/her real father is.                       | 2 (12%)                | 2 (8%)            |
| Tell Mrs C, but not Mr C.  | 2 (12%)                | 0                 |
| The mother needs to know as she may decide to abort the baby.                  | 1 (6%)                 | 3 (13%)           |
| The baby may be affected at a later time if he/she finds out about the father. | 1 (6%)                 | 4 (17%)           |
| The genetics counsellor should not withhold information.                       | 1 (6%)                 | 4 (17%)           |
| The baby's real father has a right to know.                                    | 1 (6%)                 | 1 (4%)            |
| It is Mrs C's fault for not telling her husband she slept with someone else.   | 1 (6%)                 | 0                 |
| No reason  | 1 (6%)                 | 0                 |

## HELEN'S CASE STUDY

Table 14

Student Responses for the Bioethical Dilemma Survey (Helen).

| Bioethical Dilemma      | Response       | Bioethics n=14 |
|-------------------------|----------------|----------------|
| Cystic Fibrosis         | Yes            | 9 (64%)        |
|                         | I can't decide | 2 (14%)        |
|                         | No             | 3 (22%)        |
| Huntington's Disease    | Yes            | 12 (86%)       |
|                         | I can't decide | 2 (14%)        |
|                         | No             | 0              |
| Environment             | Yes            | 1 (7%)         |
|                         | I can't decide | 5 (36%)        |
|                         | No             | 8 (57%)        |
| Reproductive Technology | Yes            | 5 (36%)        |
|                         | I can't decide | 5 (36%)        |
|                         | No             | 4 (28%)        |