TEACHING BIOETHICS IN SCIENCE: DOES IT MAKE A DIFFERENCE?

Vaille Dawson and Peter Taylor

ABSTRACT

This paper describes an evaluation of a Biotechnology course taught at an independent girls school. The course introduced students to ethical theories and the decision-making process. Students also were provided with frequent opportunities to clarify and justify their bioethical values. The extent to which the course enabled students to develop the skills to analyse bioethical issues was evaluated through student interviews and the use of a survey which required students to make and justify a decision about four ethical dilemmas. Their decisions were compared to a similar cohort who had not studied the course, and also to three experts.

It would appear that even though the students who studied the Biotechnology course (and their teacher) believed that they were better able to identify and resolve bioethical issues, their decisions and the reasons given did not differ appreciably from those of students who had not studied the course. The emergent significance of the study lies in the recognition of the value systems that underpin the ethical decision-making processes of teenage girls.
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Introduction

As this century draws to a close, our school students face a rapidly changing and uncertain future. An explosion of advances in biotechnology including such programmes as the Human Genome project have occurred, often with scant regard for the political, moral and social implications. Students need the opportunity to appreciate the social and bioethical implications of biotechnology so that they can become informed decision makers in the future. Some of our students will become research scientists, politicians, lawyers and business leaders, all of whom may need to make direct decisions regarding the use of biotechnology. 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. A lack of understanding by the general community of issues associated with biotechnology may lead to feelings of alienation, fear and anger towards the scientific community and their work.

Science teachers have an obligation, therefore, to help students develop the ability to evaluate bioethical issues arising from the use of biotechnology (Lock & Miles, 1993; Lock, Miles & Hughes, 1995; White, 1991). A number of programmes have been developed to enable students to become aware of and evaluate issues concerned with topics such as genetic engineering, (Lucassen, 1995), reproductive technology (Van Rooy, 1993; 1994), genetic diseases (Hendrix, 1993; Morris, 1994), and human organ and tissue transplantation (Dawson, 1996; Transplantation: The issues, 1992).

Research design

This paper describes a research study focussing on a Year 10 Biotechnology course taught by Carmel (pseudonyms are used throughout) at an independent girls school in Perth, Western Australia. The research study formed part of the first author’s doctoral study which was undertaken to describe and evaluate the types of learning activities
utilised by science teachers who are incorporating bioethics education into their science programmes.

The research methodology employed in the first part of the study is based on an interpretive case study approach (Merriam, 1988). Utilising Guba & Lincoln’s (1989) credibility criterion for judging the quality of this type of qualitative research, the extent to which the teacher’s and students’ experiences were honestly portrayed was enhanced through prolonged observations and frequent feedback to the teacher at all stages of the data collection. Sources of data included multiple classroom observations, multiple semi-structured teacher interviews, multiple semi-structured interviews with a group of five students, students’ work samples (e.g., library portfolios), and reflective journal writing (Holly, 1992) recorded after interviews and observations, and two questionnaires completed by all students at the end of the course. The questionnaires related to students’ perceptions of the learning activities, teaching style, course content and learning outcomes.

In order to clarify the learning outcomes of the course, in the second part of the study, an ex post facto research method was utilised (Crowl, 1996). A survey with four bioethical dilemmas was developed and administered to students who had studied the Biotechnology course. Their results were compared with those of a similar group of students and also with those of three “experts”. In this paper, the results of one dilemma only is reported.

**Purpose of the course**

The purpose of the course was to enable the students to examine, in depth, bioethical issues which arise from the application of transplantation technology and other new technologies (e.g., cloning, genetic engineering and *in vitro* fertilisation) (Dawson, 1996). Thus, in addition to enhancing students’ understanding about the procedure of transplantation, the course was designed to explicitly introduce students to bioethics education. The learning activities that students participated in provided them with opportunities to develop, reflect on, and justify their bioethical values.
The main resource used by Carmel was the Transplantation kit developed jointly by the Australian Kidney Foundation and the Science Teachers Association of Victoria (Transplantation: the issues, 1992). Some of the learning activities that students participated in included whole class and small group discussion of case studies that raise bioethical dilemmas, role plays, design and administration of a questionnaire to determine the views of friends and relatives toward transplantation, and preparation of a library portfolio about a topic that raises bioethical issues.

Teaching students to evaluate bioethical issues

Early in the teaching of the course, Carmel introduced students to a decision making process for resolving bioethical dilemmas. That is, the students were presented with a bioethical dilemma, required to identify a range of options, weigh up the risks and benefits of each, and then select an option. It was not necessary (nor desirable) that all students arrived at the same answer. Carmel also taught students about the bioethical principles of autonomy (the ‘right to choose’ or make decisions that affect oneself), justice (fairness), beneficence (promote good) and non-maleficence (avoid harm) (Beauchamp & Childress, 1994). Carmel used examples such as abortion to demonstrate how these principles can be used to resolve dilemmas.

Almost every lesson, Carmel raised bioethical issues and challenged the students to articulate and reflect on their views in whole-class or group discussions. By the end of the course, she felt that most of the students had made progress in being able to reflect critically on bioethical dilemmas. In an interview toward the end of the course, she commented that:

The kids got a lot out of it. It has opened their eyes to the fact that they do have to think. 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)
During an early interview with five students whom I interviewed regularly, it seemed that they were aware that a consideration of bioethical issues was one of the course objectives. When asked 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”.

At the end of the course, I asked the students how the Biotechnology course had affected the way they thought about bioethical issues. 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”. 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”.

I agree with Carmel’s perception that some of the students were more thoughtful. My impression from observing Carmel’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. As Katie explained, “it didn’t matter what your opinion was. It was the argument that
was important”. Frances agreed that “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”.

At the conclusion of the course, all students completed a questionnaire that required
them to comment on what they had learnt during the course. Most of the class (69%,
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. For example, “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. For
example, “I learnt that I can express my feelings about these things”. Thirty eight
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. For example, “everyone has different opinions and
we should respect their views”.

My overall perception from the interviews, questionnaires and classroom observations
is that the students were provided with numerous opportunities to identify and resolve
bioethical issues. The issue for me was that, despite Carmel’s assertions that the
students were able to reflect critically on bioethical issues and the students’ claims
that they thought more logically and could use the decision making process, I was still
sceptical about whether they could actually apply what they had learnt. That is, were
they better able to resolve bioethical issues after studying the Biotechnology course?

**Can students be taught to evaluate bioethical issues?**

Data collected from Carmel 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. How could I
determine whether the students actually did learn what they claimed to have learnt in
relation to bioethics education? The students claimed that 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 resolve bioethical issues?

One method of evaluating the effectiveness of bioethics courses is through the use of case studies (Hebert, Meslin & Dunn, 1992; Mitchell, Myser & Kerridge, 1993; Self, Wolinsky & Baldwin, 1989; Stevens & McCormick, 1994). That is, students are asked to respond to a series of bioethical dilemmas, determine an outcome, and justify their reasons using bioethical principles. The student’s responses and reasons are compared to a ‘gold standard’ prepared by experts.

In order to determine whether the Biotechnology course had any effect on a student’s ability to resolve and justify bioethical decisions, I developed a survey with four bioethical dilemmas. The content of the dilemmas did not require background knowledge, and did not impinge on content covered in the Biotechnology course. They were clear, concise, realistic and contained an obvious bioethical dilemma. This paper reports on the results of one of the dilemmas, obtained initially from the web page of the San Francisco Exploratorium (Diving into the gene pool, Scenario #3, 1996).

**The cystic fibrosis bioethical dilemma**

The cystic fibrosis dilemma was administered to 23 students who had studied Biotechnology and 38 students (from the same school and year group) who had not. In addition to comparing the responses and types of reasons given by the two groups of students, I also compared the responses of both groups to those of three ‘experts’, Dr Barry Johnson, a retired medical practitioner and past lecturer of medical ethics, Dr Patrick McIntyre, who manages a genetic testing laboratory and Dr Holly Clarke, a philosopher who teaches bioethics at the university level. The names of the experts are pseudonyms.
Students were directed to read the information about 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”.

Bioethical Dilemma 1 - Cystic Fibrosis

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. That is, do both parents have a right to know the paternity of the child?

Results of the cystic fibrosis bioethical dilemma

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 whether 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 difference in the mean
number of responses of each group. The mean number of reasons cited by each group was also compared. Again, there was no statistical difference between the groups.

The frequency of responses of the students in both groups are summarised in Table 1.

Table 1. Student Responses to Cystic Fibrosis Dilemma

<table>
<thead>
<tr>
<th>Response</th>
<th>Studied bioethics (N=23)</th>
<th>No bioethics (N=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>17 (74%)</td>
<td>24 (63%)</td>
</tr>
<tr>
<td>I can’t decide</td>
<td>4 (17%)</td>
<td>9 (24%)</td>
</tr>
<tr>
<td>No</td>
<td>2 (9%)</td>
<td>5 (13%)</td>
</tr>
</tbody>
</table>

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.

Table 2. Types of Reasons Provided to Justify a “yes” Response

<table>
<thead>
<tr>
<th>Reason</th>
<th>Studied bioethics N=17</th>
<th>No bioethics N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both Mr and Mrs C. have a right to the information.</td>
<td>12 (71%)</td>
<td>16 (67%)</td>
</tr>
<tr>
<td>Both Mr and Mrs C. need to know whether the baby has cystic fibrosis.</td>
<td>4 (23%)</td>
<td>6 (25%)</td>
</tr>
<tr>
<td>The father has a right to know he is not the real father.</td>
<td>4 (23%)</td>
<td>11 (46%)</td>
</tr>
</tbody>
</table>
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 as she may be found out. 1 (6%) 4(17%)  
The babies real father has a right to know. 1(4%) 1(6%)  
It is Mrs C’s fault for not telling her husband she slept with someone else. 1(6%) 0  
No reason 1(6%) 0  

The types of reasons given and their frequency do not appear to differ for the two groups. In both groups, most of the reasons stated by students relate to the rights of individuals to information (i.e., both parents, the baby, the biological father).
Four out of the 23 (17%) students who studied the Biotechnology course could not decide whether or not to tell both parents, and two students said that the counsellor should not tell both parents about the test results. 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 also 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.

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), 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.

The students’ views differed from those presented by the experts. In response to this dilemma, Dr Barry Johnson 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.

(B. Johnson, personal communication, December 11, 1996)

Dr Patrick McIntrye 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 has cystic fibrosis, and if paternity was not discussed during counselling, only the mother would be informed about the paternity results.

Dr Holly Clarke 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.”

Discussion

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
would perform better than students who had not. That is, would the students who had studied Biotechnology differ in their responses or the types of reasons given?

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 significantly. 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).

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, moral development, 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. 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 seems to be based largely on the principle of autonomy.

Those students who applied the bioethical principle of autonomy seemed to do so with no apparent consideration of any deleterious consequences. That is, they seemed to be unaware of, or unable to consider, the effect that the paternity information may have on the couple’s relationship. 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. Where future consequences were considered, they related to the baby (finding out later) or the counsellor (who may be sued).

In contrast, the responses and reasons stated by the three experts seem to indicate that, in addition to autonomy, they also considered the bioethical principles of non-maleficence and beneficence. The use of the principles of non-maleficence, justice and beneficence (in addition to autonomy) requires a consideration of the consequences of a decision. I must stress that I am not stating that the students ‘got it wrong’ and the experts ‘got it right’. Rather, the experts are able to draw on their relevant past experiences and deeper understanding of the consequences of these dilemmas in making their decisions.

The data presented here provide an illuminating snap shot of the bioethical values of 15 year old girls at this independent girls’ school. This information may be useful in the design of future bioethics education courses. That is, if teachers are aware that students might over emphasise the principle of autonomy in resolving bioethical dilemmas, then this issue can be addressed.

REFERENCES


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Vaille Dawson teaches secondary science in Perth, Western Australia. Prior to becoming a teacher she worked in medical research in the field of bone marrow transplantation. Her experience in medical research led to her interest in ethics in science. Vaille completed an MSc at Curtin University related to the evaluation of a course that examined bioethical issues in human organ transplantation. She is currently completing her doctoral studies which relate to an evaluation of bioethics education in science. Her research interests include ethics in science, constructivism and gender issues.

Peter Taylor is a science teacher educator at Curtin University’s National Key Centre for School Science and Mathematics. His research focuses on the epistemology of classroom teaching and learning, and includes self-study of his own university
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