Continuum of preservice and novice science teachers' beliefs related to teaching ethics in science

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Introduction

Although science can be viewed by some as objective, analytical, rational and unaffected by personal morals and values (Charlesworth, Farrall, Stokes & Turnbull, 1989), I believe that science is a social endeavour, and its application is inevitably influenced by our political, cultural, religious and ethical values (Capra, 1983; Kuhn, 1970). School students need to be equipped with appropriate decision making skills if they are to contribute (as adults) to public debate about the ethics of problematic issues such as population growth, food and health resource allocation, environmental degradation and control of information technology (Frazer & Kornhauser, 1986; Rubba & Harkness, 1993). Thus science teachers whose subject impinges on many areas of ethical debate have an obligation to help students develop the abilities to recognise and evaluate ethical issues (Armstrong & Weber, 1991; Skamp, 1986).

During 1996, I interviewed 20 preservice and novice (less than one year of teaching experience) science teachers. The primary purpose of these semi-structured interviews was to determine teachers' beliefs about the importance of teaching ethics in science. This data was used to guide the development of a short ethics course for preservice science teachers. Teachers were asked about their perceptions of the nature of science, their teaching goals and the types of teaching strategies they had found to be effective in achieving their goals.

The evidence presented in this paper arises from 'grounded theory' (Glaser & Strauss, 1967). That is, as I collected evidence from teacher interviews, I began to categorise the evidence generated and develop hypotheses. I acknowledge that I entered this study with a firm belief that all science teachers should include a consideration of ethics in their science programmes. I was thus taken aback when the first teacher I interviewed, John (see below), disagreed completely. Furthermore, his definition of science as "a set of facts" differed significantly from mine.

Merriam (1988) states that 'Speculation, however, is the key to developing theory in a qualitative study' (p.141). At this point, I speculated that perhaps there was a relationship between a teacher's belief about the nature of science and their views about the importance of teaching ethics in science. For example if a teacher perceives that science is a search for truth and knowledge, does this mean that they would consider the teaching of ethics to be inappropriate?

A preliminary evaluation of the interviews has led to the development of a six-step continuum of beliefs related to the importance of teaching ethics in science. The continuum provides a framework in which to categorise the beliefs of the novice and preservice science teachers who were interviewed. Each of the positions is outlined initially in a brief statement that encompasses a particular view of ethics in science. Each position is illustrated further through an example of a teacher who holds that view. The teacher's views of the nature of science are also described.

Continuum of beliefs

1. Ethics is irrelevant in science. Science is about facts while ethics is about opinion. It is impossible to teach the two topics together. Ethics is an inappropriate subject for schools to teach. If necessary, ethics should only be taught in humanities subjects like religious education, vocational education or social science. It is the parents duty to teach their children ethics.
   (John)
2. Teaching about ethics in science is not something I have considered. If a question related to an ethical issue was asked I would give my opinion but I would not initiate debate on this topic. I would ask students to express their opinion or point of view. All points of view are equally valid. There is already too much material to be covered in science without introducing topics that are best covered in social science or personal and vocational education. (Mandy)

3. Ethics and science are related because the practice of science raises many ethical issues. A discussion of ethical issues can be a great motivator for students who don't like science. It is important that students are able to articulate their views and appreciate that others may have different views. (Joanne)

4. Students need opportunities to develop, articulate and critically evaluate their ethical values. They need to tolerate the values of others. The teacher can assist in this process by providing information and frequent opportunities for discussion. (Matt)

5. The teaching of bioethics is part of a science teacher's duty of care. Schools are an avenue for social change and therefore ethics should be taught as part of every subject. Students need to become aware of ethical theories that can help in deciding what one ought to do (e.g., consequentialism, Kantian ethics). The teacher can facilitate students' ethical development by providing case studies of dilemmas in science. Principles of justice, beneficence and respect for autonomy can be introduced to students to provide a basis for effective decision making. (Cherie)

6. It is not possible to teach science without ethics. We are not fulfilling our obligation as a science teacher unless we equip our students with an understanding of ethics. However, students need to be aware, not only of Western ethics, but of the alternative belief systems that exist in different cultures. Only then can our students be empowered. (Michael)

Position 1 - John

Ethics is irrelevant in science. Science is about facts while ethics is about opinion. It is impossible to teach the two topics together. Ethics is an inappropriate subject for schools to teach. If necessary, ethics should only be taught in humanities subjects like religious education, vocational education or social science. It is the parents duty to teach their children ethics.

John (a pseudonym) completed an undergraduate degree in science, majoring in human physiology and biochemistry. He completed his Diploma in Education in 1995 and is in his second term of teaching. That is, he has been teaching for about 16 weeks. John (29 years old) decided to become a science teacher because he "works well with teenagers" and also because he "is a scientist". I asked John how he would define science. John replied, 'the scientific method, a systematic search for truth, and knowledge, far removed from witch doctoring etc. It is the opposite of artistic thinking.' I question him on what he means. 'I am a scientist with a scientific mind. It is due to my training. I would have been different if I had done an Arts degree. Arts is about emotion. Science is about hard facts.'

John informs me that ethics has no place in science. He doesn't believe that teaching ethics is part of his role. 'They are children and children under 18 don't have formed views on such things. Perhaps, they could present an opinion and not just parrot others views. Parrots are useless!' he states emphatically. 'Some students are taught to be parrots at school instead of getting true understanding.'

I ask if he has ever discussed any ethics in science.

'Indirectly, I suppose, but not explicitly. It is difficult as children have limited experience, limited points of view, understanding. But students can process some issues. They can have extreme views.'
I interrupt, 'So do you see a role in challenging these views?'

'No, when these children come to us at 14 you can't change their mind. Everything has been done.'

Several days later, John comments to me, 'I have no idea how to teach ethics. I would have to look up the word in a dictionary, but I do know right from wrong. I don't feel comfortable talking outside of the field of science. Ethics is wishy-washy, not concrete like science. Ethical behaviour is about right and wrong. It is up to the parent to teach it. I can't be a teacher and a parent.'

Comment

John associates science with "hard facts" and "the search for truth and knowledge", while ethics is seen as soft and "wishy-washy". He believes that ethics can not be taught as children are limited in their capacity to understand. What views they do hold are inflexible. Furthermore, John believes that it is the parent's responsibility (and not the teacher's) to teach children right and wrong.

Position 2 - Mandy

Teaching about ethics in science is not something I have considered. If a question related to an ethical issue was asked I would give my opinion but I would not initiate debate on this topic. I would ask students to express their opinion or point of view. All points of view are equally valid. There is already too much material to be covered in science without introducing topics that are best covered in social science or personal and vocational education.

Mandy (28 years old) is a preservice science teacher doing her final teaching practice. She is majoring in physical science. She completed a degree in science with a major in chemistry. She worked for a few years in a laboratory undertaking research and development, and quality control. She explains that she originally wanted to work in industry because of the money. Despite earning a good salary, she didn't enjoy the work because it was too routine. Even though the work was called research, she received a lot of guidance and it wasn't very stimulating. She had always wanted to be a teacher. Thus, she enrolled in a Diploma of Education.

When asked how would she define science, she pauses. 'I don't know.' she replies. 'I guess it's all the areas of chemistry, biology and physics. Science explains the environment and what's happening in the world. Science is also related to medicine and the development of new technology.'

I ask Mandy if she has ever thought about ethics. She hesitates, so I ask her if she wants me to define ethics. 'No, I think it's just the morals related to science and medical ethics. Sometimes they (the scientists) go too far. I don't think the public should have an input as they don't have the scientific knowledge, but then again scientists shouldn't always decide either. They (the scientists) want to do the research as it's fascinating for them. Some things have gone too far though, like embryo research. Maybe the public should have a say.'

I paraphrase what she has just said. 'Mandy at the start you said that the public shouldn't have a say and now you seem to be implying that they should.'

'I'm not. Oh, no. The scientists have to decide as they have the scientific knowledge. The public could have a bit of an input. The public may have a better view of what is morally acceptable. Scientists get so focused on what they're doing, they look past moral issues.'

I ask Mandy whether she feels that, as a science teacher, she has a role in teaching students about medical and environmental Ethics.

'You mean the environment, like pollution? Yes, I would talk about that and give my own point of view. I don't know about other areas.'

Mandy has not studied ethics in either her undergraduate degree or her Dip. Ed. She says, 'I can't remember any science
teacher, including high school, ever mentioning ethics in relation to any topic, even the environment.' She looks apologetic and laughs.

I assure her that her experience is by no means unique.

'So, with no background, what assistance or resources would help you if you wanted to discuss ethical issues?' I ask.

'None really. I do read environmental books. If it was biotechnology, I know nothing. If I needed information, I would go to the library or talk to other teachers.

I reach to turn the tape off as she asks, 'Do you think it is critical that students know about ethical issues? Because surely they'll come across it in university or later life.'

'Well you didn't in your Chemistry degree and I didn't in mine.'

'No, you don't, but you come across it in the news. Anyway, I think ethics are a personal thing.'

'Yes, that's true. Your values are personal, but you can still be taught to tolerate the views of others. That's what teaching ethics is about. It's not indoctrination. Did you think it was?'

'No, but if you teach your point of view... The students are young and they will be influenced by your view. It's not brainwashing but it will influence them.'

'The fact that you are aware of that possibility is good. If you teach about ethics, it's not about passing your views onto students. Students already have their own values.'

Comment

After interviewing Mandy, my perception was that she is tentative and ambivalent about the issue of teaching about ethics. The interview is interspersed with 'I'm not sure' and 'I don't know'. I don't think Mandy had thought previously about teaching ethics and I believe that she equated the teaching of ethics with 'giving her own point of view'. Mandy's view of the nature of science as chemistry, biology and physics, and its relationship with technology and explaining the world, seems to suggest she believes that science is a set of facts that explain how the world works.

Position 3 - Joanne

Ethics and science are related because the practice of science raises many ethical issues. A discussion of ethical issues can be a great motivator for students who don't like science. It is important that students are able to articulate their views and appreciate that others may have different views.

Joanne (22 years old) is a preservice teacher doing her final teaching practice. She is majoring in biological science. Her family is from Yugoslavia and she is a Muslim.

Joanne decided to become a teacher because she liked science at high school. She had initially wanted to study medicine but didn't get the grades. So she thought that she would do something related to medical science ('not physical science'). However, when studying for a degree in Pharmacology at university, she found the practical work to be boring and monotonous. She felt that she couldn't face the prospect of working by herself in a laboratory all day. She describes herself as a "people person". This led her to enrol in a Diploma of Education after completing her undergraduate degree.

Joanne defines science as applying concepts in everyday life and as a logical way of explaining what happens.

I ask Joanne whether she has considered the role of ethics in science.

She replies, 'Mostly in science you are talking about facts. If you are talking about ethics you have to keep it open. Like with evolution. Some people don't believe in evolution and its dangerous to push it. As a teacher you have to be
objective about it. You don't just say, this is what happened. You say, it's logical that this could have happened or this evidence shows that it is a possibility. With evolution, they need to accept it as a scientific idea, for the examinations. I don't even know if I believe it. And like with animal testing. I don't like the idea of a rat dissection. I don't think I could do it."

'So do you see teaching about ethics as part of your role?'

'I think I have to help students have an open mind.'

'Do you think you have the skills?'

'Yes. I think so.'

'How would you teach about ethics?'

'I would give them different scenarios and ask them to make up their minds based on information. I mean, I don't know all the answers myself.'

Comment

As Joanne spoke about her own ethical dilemmas with evolution and the use of animals in science, I could see how she grappled with and attempted to see all sides of the issues. She believes that students need information to help them make up their minds (and have an open mind). She defines science, not as a set of facts, but as a process, "applying concepts in everyday life" and "a way of explaining what happens".

Position 4 - Matt

Students need opportunities to develop and articulate their ethical values. They need to tolerate the values of others. The teacher can assist in this process by providing information and frequent opportunities for discussion.

Matt is a 27 year old chemistry and biology teacher at a large metropolitan state high school in Perth. I interviewed Matt after meeting him at a science seminar and finding out that he was teaching a biotechnology option unit to year 10 students.

Matt completed a degree in geography with a double major in environmental science and political science. Despite assurances to the contrary, he found himself unemployed after completing his degree. He then completed an honours degree on the history of the Green Party (a political party with a strong environmental platform). This didn't further his job prospects, so he went to Europe for a year and on his return enrolled in a Diploma of Education.

He defines science as 'a logical, inquiry process into how things work. Science also involves looking at things sensibly and logically, and developing theories and explanations. In teaching science his main goal is that 'at the end of a course, students take away not only knowledge, but a good feeling about science'. He recognises that he is responsible for making science stimulating, especially when some of the topics are 'bland, abstract or both'.

Matt currently teaches a year 10 Biotechnology course. The purpose of the course is to raise students' awareness of issues in biotechnology and to increase their understanding of new technology. Most importantly, he wanted to meet the needs of his students by studying areas of interest to them.

I asked Matt what topics he had taught to his students. He had begun the year with genetic engineering (e.g., isolating DNA), then beverage production (beer brewing), waste management (sewerage) and, finally, organ transplantation. Matt informs me that one of the major aspects of this last section was 'having discussions on the ethical issues, the rights and wrongs'. Students had also been introduced to in vitro fertilisation (IVF). Matt organised a guest speaker from an IVF clinic. The speaker raised issues associated with IVF such as ownership of gametes and frozen embryos, and the rights of biological parents.
I asked Matt whether he believes that teaching about ethics is part of his role as a teacher. He replies, 'Yes, definitely. Not to persuade, but just to make students aware of ethical issues. For example, we watched a video in biology about conception and pregnancy. I pointed out after how many weeks you could still have an abortion. We looked at the foetus fully formed, and I said this foetus could still be aborted. I asked them what they thought of it. They were surprised. I don't think they had ever linked the appearance with the vacuum and cutting.'

Comment

Matt believes that teaching students about ethics is an integral part of his teaching role. This doesn't mean persuading students to adopt a particular point of view but rather to raise their awareness of areas that raise ethical issues. He provides information and through frequent informal discussions provides opportunities for students to ask questions and discuss their views. Matt views science as a process - a logical inquiry process into how things work.

Position 5 - Cherie

The teaching of bioethics is part of a science teacher's duty of care. Schools are an avenue for social change and, therefore, ethics should be taught as part of every subject.

Students need to become aware of ethical theories that can help in deciding what one ought to do (e.g., consequentialism, Kantian ethics). The teacher can facilitate students' ethical development by providing case studies of dilemmas in science. Bioethical principles of justice, beneficence and respect for autonomy can be introduced to students to provide a basis for effective decision making.

Cherie completed her initial degree in Microbiology and then worked in Virology. She spent ten years at home with a young family. She chose teaching as a career as it allowed her to care for her children. So how would she define science? 'Science for me is a way of explaining phenomena of the world in a physical and biological sense, and how things work.'

Cherie believes that it is important that students can take a moral stand on issues and that they know how to make decisions about ethical issues. She believes that there are many resources available to help her and students to understand ethical issues. These include the scientific literature, television programmes such as Four Corners, and talking to people. She believes it is difficult to learn about ethics from a book.

Cherie has recently taught a Year 10 Biotechnology course based on human organ and tissue transplantation. The course focuses on bioethics. In this interview extract, Cherie describes how she taught the class.

Cherie: We discussed the issues as a class. To me the big issue was interfering with nature. In Junior (an Arnold Swarznegger movie), the man is having a baby. "Is this right?" I said to them, "do you want to give up your unique role?" They didn't think anything of it. They hadn't thought about it. In fact, after seeing their lack of reaction, one of my objectives in this unit is to make them aware of the implications of what they read or see, instead of just accepting everything at face value. We also discussed briefly rights based and consequentialist theories, and those in between.

Me: And rights can be relative when there is conflict. Its not easy, like between the foetus and the mother.

Cherie: Yes, we talked about the case in the USA where two right to lifers shot and killed an obstetrician who did abortions.

Me: It's great to get kids thinking about rights.

Cherie: Yes, we discussed the right to autonomy, in terms of abortion. I told them there are two sides, those who won't and that's fine and those who will. The guiding principle is we allow every one to have a choice. I said, "There is a belief about doing no harm but then there is autonomy." So although there are principles and you try to do the right thing, it's very hard, there is conflict. We also talked about decision making, weighing up the pros and cons.
Comment

Cherie believes that students need a set of rules to guide their views on ethical issues. Thus, in the Biotechnology course, Cherie introduces students to ethical theory, bioethical principles and the decision making process. Throughout the course, students are provided with frequent opportunities, through case studies, to clarify and reflect on their own ethical values, as well as learn to respect the values of their peers.

Position 6 - Michael

It is not possible to teach science without ethics. We are not fulfilling our obligation as a science teachers unless we equip our students with an understanding of ethics. However, students need to be aware, not only of Western ethics, but of the alternative belief systems that exist in different cultures. Only then can our students be empowered.

Michael is completing a Bachelor of Education. Michael did his initial degree in Geology. For a number of years, he worked alone in the bush, in mineral exploration. He returned to Perth when he married and, subsequently, decided to enrol in a teaching degree. In addition to his studies, he teaches science to Aboriginal students.

Michael finds it difficult to define science. He used to believe that science was a way of understanding the world, but his experience with indigenous people has caused him to reassess his view. He views science as a Western cultural construct that is not always applicable to his students.

'For example', he explains, 'my students will tell me stories about their uncle going behind a rock and coming out as an eagle. Now, for that student, that is very real, and that is his reality, and that doesn't fit within a Western science framework. So, there is another paradigm operating here. Indigenous and Western people operate under a different knowledge systems. Each of them are valid.'

I ask Michael whether he believes that ethics should be taught in science.

'You can't teach science without ethics. I also model ethical behaviour in the way I teach. I listen to and respect the students' views. One of my goals is to empower indigenous people. Teaching our students about Western ethics helps them to understand our beliefs and ideologies, the corporate culture and capitalism. This is especially important when dealing with the mining industry. It stops them being exploited.'

He is, however, aware that his values are influenced by his Western culture. He hopes that, in the future, his students will write curriculum materials that would allow the teaching of ethics that are more appropriate for their own culture.

Comment

Thus, Michael views science as one of a number of knowledge systems that can be used to view and understand the world. He believes that other knowledge systems such as indigenous knowledge systems are equally valid. In relation to ethics, Michael believes that it is impossible to teach science without ethics.

Conclusion

It is apparent that preservice and novice teachers hold a broad range of views regarding the nature of science. Their definitions of science vary from a 'set of facts' to a 'Western social construct'. In addition, the teachers views' about the importance of teaching ethics in science vary concomitantly from 'irrelevant' to 'essential'.

The views of these teachers suggest that teachers with a factual definition of science (John and, to a lesser extent Mandy) believe that ethics and science are unrelated. Thus, they do not perceive that they have a role in teaching their students about ethical issues in science. In contrast, teachers with a more process orientated view of science (Matt, Cherie and Joanne) were more likely to consider the teaching of ethics as part of their role. Finally, Michael, who defined science as one of a number of knowledge systems for making sense of the world considered that it was
impossible to teach science without ethics.

If tertiary science educators are to encourage preservice teachers to consider the role of ethics in science, then it may be necessary for them to probe their students' understandings of the nature of science. Indeed, if tertiary educators are to prepare their students to teach school science, then they need to be aware that their students may hold widely differing views about the nature of science, which may affect how and what they teach when they graduate. Students need to be aware that, from a historical perspective, the nature of science has evolved. There is a strong case for the teaching of history and philosophy of science to all preservice science teachers.

References


