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Attitudes and Interests Towards Biotechnology: the Mismatch Between Students and Teachers

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Increasing the scientific literacy of Australians has become an educational priority in recent times. The 'Science State – Smart State' initiative of the Queensland Government involves an action plan for improving science education that includes a Science for Life action. A desired outcome is for an increased understanding of the natural world so that responsible decisions concerning our future wellbeing can be made in an age of science and technology. Biotechnology is a technology that is having profound impact on our lives. This paper describes how 15-16 year old students and biology teachers revealed a mismatch in both attitudes and interests towards biotechnology between the students and teachers. The findings are of interest as the teachers are writing biotechnology into their work programs in response to new syllabus documents. The teacher's areas of interest did not match those of the students, possibly resulting in a curriculum the teachers want to teach, but the students do not want to learn.

Keywords: Biotechnology, Attitude, Interest, Australia

AIMS OF BIOTECHNOLOGY EDUCATION

There is a need for science curriculum's to be relevant, modern and reflective of the needs and values of the community. It is argued that in upholding these pedagogical guidelines, there is an important place in a modern science curriculum for biotechnology education. The inclusion of biotechnology is an important topic in a modern science curriculum in that it increasingly plays a role in the daily lives of citizens. The teaching of biotechnology within a science education presents teachers with many challenges. The vast volume of information rapidly being disseminated in biotechnology leads to a number of practical problems in teaching it to science students. Teachers are faced with questions about what knowledge, and ethical issues related to biotechnology could be taught. Teachers need to address how these topics can be taught effectively. Biotechnology presents broader philosophical questions to the teacher and their students. Some aspects of biotechnology, for example, confront questions concerning the origin of life, and how life itself is defined. Arguably, biotechnology constitutes a very significant and relevant topic for inclusion in a modem science education.

The inclusion of biotechnology in the Australian science curriculum is promoted by a number of educational and scientific authorities. The Commonwealth Government has funded Biotechnology Australia and Curriculum Corporation in the development of *Biotechnology Online* (http://www.biotechnologyonline.gov.au/) which is a collection of teaching resources for biotechnology. Arguably, in respect to biotechnology, of foremost importance is public participation in this new technology. This participation cannot occur without a sound and comprehensive biotechnology education. If people are not educated in issues of science and technology, they cannot have a meaningful participation in the public debates concerning these issues. A biotechnology education requires that students, and thus future citizens, are well informed so they are able to effectively engage in public debate. In a contemporary

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science education, foundation knowledge of biotechnology principals and the related ethical issues are essential for effective engagement in public debate concerning biotechnology. The teaching of biotechnology therefore must provide for a sound understanding of its scientific basis. In addition, there needs to be opportunities for students to develop critical thinking and decision-making skills regarding the ethical use of biotechnology.

Biotechnology is regarded as a very important development for both scientific and economic progress. For this reason, governments and private sector interests strongly support the concept of biotechnology education. The national science framework also recognizes the need for science students to be made aware of biotechnology as an important topic for the Australian Science Curriculum. Curriculum planners and educators are therefore encouraged to incorporate biotechnology into science curriculum. Suggested biotechnology topics that could be taught in a general biology curriculum include: bioethics in biotechnology, biotechnology in agriculture, medicine, environmental science and industry, defining biotechnology, molecular biology of cancer, organismal biochemistry, microbiology, genetic engineering, human genetics and genomic library, molecular biology as a discipline, and DNA fingerprinting.

However, teaching all of these topics is not practical. Planning can assist in deciding which topics could be included in the teaching of biotechnology. A mandate already exists in the Queensland biological science curriculum to allow teachers in Queensland to use their professional judgement in making decisions on what materials are taught in view of their specific student circumstances (Queensland Studies Authority, 2004). To date, no formal planning has occurred in relation to determining the particular attitudes and interests of the key stakeholders – the students and teachers. This study aims to determine the baseline information in relation to biotechnology attitudes and interests of Queensland students and their teachers.

Biotechnology in the Curriculum

Literature that supports the view that biotechnology should be included in a secondary school science education includes Chen and Raffan (1999) who investigated the knowledge and attitudes of Taiwanese and United Kingdom students aged 17-18 regarding biotechnology. The results from the study indicated a limited understanding of biotechnology by these students. However the study noted some differences in student understandings. For example, students in Taiwan did not demonstrate the diversity of definitions and examples that the UK students did. Chen and Raffan (1999) suggest this may be accounted for by the different curriculum approaches both countries have. The UK curriculum allowed for a number of learning opportunities where students had access to biotechnology resources as textbooks, media, contact from scientists and general studies materials; as well as opportunities to discuss the ethical issues associated with biotechnology. This was in contrast to the Taiwanese curriculum, which was more demanding in the sense that students studied more subjects and were more examination orientated in their learning context.

Chen and Raffan (1999) concluded that a good biotechnology education has implications for students and teachers. A biotechnology education is not intended to promote biotechnology or produce students with positive attitudes to it. A good biotechnology educational outcome gives the students current and accurate knowledge, and the opportunities to form their own views, based on their understandings of risks, benefits and disadvantages of modern biotechnology. For teachers, thorough preparation of subject material and opportunities to give students a chance to develop informed views on controversial biotechnological topics are important pedagogical goals. Overall, Chen and Raffan (1999) suggested that the end product of biotechnology education is to assist students to develop independent thinking skills and be better prepared to think about and deal with controversial topics encountered in their future lives.

Dawson and Taylor (2000) support biotechnology education, stating that "If our students are to become well-informed decision makers then they need to be aware of the practical applications of current developments in biotechnology, and appreciate the social and bioethical implications of this relatively new and controversial science (p. 184). With the increase in pace of biotechnology developments since the early 1990's, it is important to educate secondary school students about biotechnology. Schibeci (2000) suggests that as biotechnology is a rapidly developing technology with much health, economic and environmental benefits to Australia, the teaching of biotechnology and its impact on the community is of importance. He advocates that rather than devote a special unit on ethics or the social implications of science and technology, these topics can be taught with the use of a variety of techniques such as laboratory exercises and case studies. Regardless of the methods employed in their teaching, Schibeci further recognizes that the teaching of biotechnology is important both in terms of its science as well as providing a vehicle to examine ethical issues associated with its use.

Crucial to the development of biotechnology education in secondary classrooms are the teachers themselves. Whilst Australia has syllabus mandates and commonwealth funded web sites to develop biotechnology skills in the classroom, there seems to be reluctance from the teachers to present biotechnology lessons. Steele and Aubusson (2004) interview a number of teachers to determine why they were not presenting biotechnology in their biology classrooms. Although the teachers appeared to have a sound understanding of the content, they felt biotechnology was too difficult for the students, and this would disadvantage the students in the university entrance examinations. Another problem according to the teachers is the lack of opportunity for practical work in the classroom.

Biotechnology Attitudes and Interests

The need for attitudinal research in biotechnology is paramount. Researchers have shown that becoming a scientific literate person is not a high priority for many students (Atwater, Wiggins, & Gardner, 1995; Zacharia, 2003). A particular need identified by Zacharia is to investigate the extent the learning experience enhances the students' attitude towards science learning. Zacharia found that a teacher's attitude toward the subject matter and its effective presentation was as significant as the students' perspectives in determining the success of the teaching/learning experience. Fishbein and Ajzen (1975) laid the foundations for the study of attitudes. They argued that 'attitudes' are a function of the individual's beliefs and an evaluative response associated with the belief. Therefore beliefs affect attitudes, and attitudes then affect intentions. This function between attitude and intention is important when considering the impact a teacher has on the curriculum and learning environment.

Student and teacher attitudes have been investigated in various, but separate studies over recent decades. Haladyna and Shaughnessy (1982) posited students' attitudes are determined by the teacher, the student and the learning environment. Simpson and Oliver (1990) later found the preparation of the teacher, the nature of the hands-on activities, and the student involvement in the learning are important variables in student attitude. Hewson, Kerby, and Cook (1995) argued that teachers' conceptions and attitudes have a strong influence on science teaching and learning. Therefore questions about what impact teachers' attitudes have on classroom practice are of great importance. Zacharia (2003) argues the efforts of the science education community should focus on research issues related to the understanding and development of teacher attitudes because of their strong link to classroom action.

Dawson and Schibeci (2003), and Gunter, Kinderlerer and Beyleveld (1998) both conducted surveys of secondary school students attitudes about what are acceptable biotechnology processes. Most support was found for the use of micro-organisms for specific purposes such as beer manufacture. Less support was found for the genetic modification of plants for food, and even less for the genetic modification of animals and humans. In another study Dawson and Schibeci (2003) investigated biotechnology understanding in 15-16 year old students. They found that after 10 years of compulsory schooling in science, the majority of students did not understand the processes of biotechnology. The few studies that have investigated the relationships between biotechnology understandings and attitudes have been inconclusive in their findings (see Olsher & Dreyful, 1999; Dawson, 2003).

There is support for the notion that scientific interest affects science achievement (Benbow and Minor, 1986; Dhindsa and Chung, 2003; Freedman, 1997; Kahle & Meese, 1994; Salta & Tzougraki, 2004; Simpson, Koballa, Oliver, & Crawley, 1994; Weinburgh, 1995). Whilst these studies relate to science education none relate directly to the biotechnology subfield. The emphases of these studies relate to gender and gifted and talented students, but the findings are not consistent. One reason postulated by Chambers and Andre (1997) for inconsistent results in interest research is that the interest instruments used may not be valid instruments. By considering Ajzen and Fishbein (1980) theory of reasoned action, it is possible that inconsistent results may arise from the use of a domain-general instrument rather than a topic-specific instrument. It can be argued that domain-general attitude and interest measures should not be expected to produce quality results in topic-specific studies. Topic- specific attitude and interest instruments are necessary to explore attitude and interest relationships. Consistent with this notion, the present study examines biotechnology attitudes and interests through a purposely constructed topic-specific instrument.

Importance of the study

Research in this domain is needed for a number of reasons. There is a scarcity of research into biotechnology education. A second reason is that teachers' attitudes have an effect on science classroom practice in general, but the extent is not known in relation to biotechnology. A third reason is to investigate the links between biotechnology attitudes and interests of both students and teachers – a yet untapped area. As far as the author is aware, there is no published research which compares the biotechnology knowledge, attitudes and interests of students with those of their teachers. Finally, biotechnology is perceived as being risky for some people (Slovic, (1987), so the question of whether there is a correlation between attitude and knowledge remains unclear and needs exploring. The aim of this study is to provide baseline data on student and teacher knowledge, attitudes and interests to biotechnological topics and processes. Whilst the larger study explores knowledge, attitude and interests across the areas of environmental biotechnology, agricultural biotechnology, genetically modified foods, human uses of biotechnology, and science lesson topics, this present paper focuses particularly on the areas of attitudes 'towards' biotechnology, and interest in science lesson topics.

Questionnaire Methodology

A series of questionnaires (Biotechnology Education Learning/Biotechnology Education Teaching Survey - BELBETS) were used with 508 15-16 year old students of senior biological science and their 35 teachers from eight secondary schools scattered throughout Queensland, Australia. All Year 11 biology students and their teachers present on the days the surveys were administered completed the survey. Eight student surveys were discarded. Of these, six students did not complete the survey in any meaningful fashion (they answered 'Strongly Agree' to all questions or made no attempt to answer any question at all); whilst the remaining two students left major sections of each scale blank.

The administration of the BELBETS is continuing in Queensland schools, however this paper reports the initial findings of the 500 students and their 35 teachers. It is acknowledged that the teacher sample is small, and therefore statistically unstable. The questionnaires use a five point Lickert scale (Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree) with items adapted from Dawson and Schibeci (2003) and Chen and Raffan (1999) and Biotechnology Online (2001). Additional items were created based upon general readings and Internet coverage. A full copy of the BELBETS is available from the author. The student and teacher surveys vary slightly. The statements differ in that a student may read a question written in the following way: *I would be interested in learning about* ….. Whereas, a teacher would read the same question, but in two parts as: *I would be interested in teaching about* ….. and *I think I have the knowledge and skills to teach about* …..

The results of the questionnaires were coded, and analysed using the Statistical Package for the Social Sciences (SPSS). Additional interviews were held with 60 students and three teachers (from three geographically different schools) who had responded to the survey. The interviews were to seek information on the wording and readability of the items, as well as to establish reasons for which the students and teachers gave their particular responses. All students were interviewed by the researcher or a research assistant. Two of the three teachers had to be interviewed via telephone. The full questionnaire revealed five scales: two of the scales relate to biotechnology practices: Towards Biotechnology; and About Biotechnology. Another two scales relate to biotechnology risk: Risk to Humans; and Risk to Environment. The remaining scale relates to the classroom use of biotechnology: Science Lesson Topics. It is the first and last scales that are reported in this paper.

Table 1 report, in accordance to Anastasi (1996), the statistical data relevant to the internal consistency reliability (Cronbach alpha coefficient) and discriminant validity (factor loadings and interscale correlations).

Table 1. Statistical details pertaining to the internal consistency reliability of the 'attitude' items

Scale	Respondent	No of items	Cronbach Alpha	Factor Loadings	Interscale correlations
Towards Biotechnology	Student	7	.73	.65-.88	.22-.35
	Teacher		.84	.71-.91	.33-.41
About Biotechnology	Student	3	.69	.54-.76	.18-.32
	Teacher		.72	.69-.81	.21-.46
Risk to Humans	Student	9	.77	.64-.80	.33-.67
	Teacher		.79	.49-.75	.29-.45
Risk to Environment	Student	5	.81	.74-.91	.38-.59
	Teacher		.91	.81-.95	.31-.51
Science Lesson Topics	Student	4	.88	.61-.79	.21-.51
	Teacher		.90	.71-.82	.26-.57

Table 2. Statistical details pertaining to the Pearson Chi-square for the 'attitude' items

Scale	BELBETS Scale Item Number	Pearson Chi-square
Towards Biotechnology	4, 5, 7, 8, 10, 11, 13	7.432**
About Biotechnology	1, 2, 3	3.448
Risk to Humans	12, 16, 17, 18, 21, 22, 23, 24	6.015*
Risk to Environment	9, 14, 15, 19, 25	4.058
Science lessons	57, 58, 59, 60	111.055***

Note: The asterisks indicate if the Chi-square statistic was statistically significant between the student and teacher (*p < .05; ** p < .025; *** p < .005).

The alpha reliability of the scales ranged from .69 to .91 indicating strong internal consistency within each scale. Omitting items in some scales would have increased scale internal consistency, however these items were preserved to ensure the scale addressed several aspects of the same dimension. As an example, "*About technology"* scale Item 3 (I think that genetic engineering is important because it helps to reduce hereditary disease) could have been omitted to increase the internal consistency of the scale but was retained because of the importance of hereditary concepts in biotechnology. Interscale correlations were generally low, indicating that each scale measured an individual property. Factor loadings for individual items are generally above .5, indicating acceptable association between items scales. In all cases acceptable divergent validity is shown as the Cronbach alpha's are greater than the interscale correlations. Table 2 reports the Pearson Chi-square statistical data. These results indicate that corresponding responses between the students (BEL) and the teachers (BETS) were different enough so that generalisations can be made.

To facilitate comparisons between the student and teacher responses a mean score was calculated for each question using responses of the whole group by scoring 'Strongly Agree' responses as 1.0, 'Agree' as 0.5, 'Neutral' as 0, 'Disagree' as -0.5 and 'Strongly Disagree' as -1.0. As the mean approaches a value of 1 it indicates affirmation of the statement, and as the whole group mean approaches -1 it indicates rejection of the statement. By plotting the 'Whole Group Mean' in a horizontal bar graph, a visual impression of the relationships between student and teacher responses is possible.

RESULTS

The results of the survey are presented in both tabular and graphic form and presented in two sections: (a) Attitudes towards biotechnology; and (b) Science lesson topics of interest.

Attitudes 'towards' biotechnology

Seven items in the BELBETS questionnaire probed the student and teacher attitudes 'towards' biotechnology. Items within this scale relate to the acceptance of gene modification in plants. The responses from the students and teachers, as well as the Whole Group Mean scores are provided in Table 3 (figures in parentheses are teacher responses).

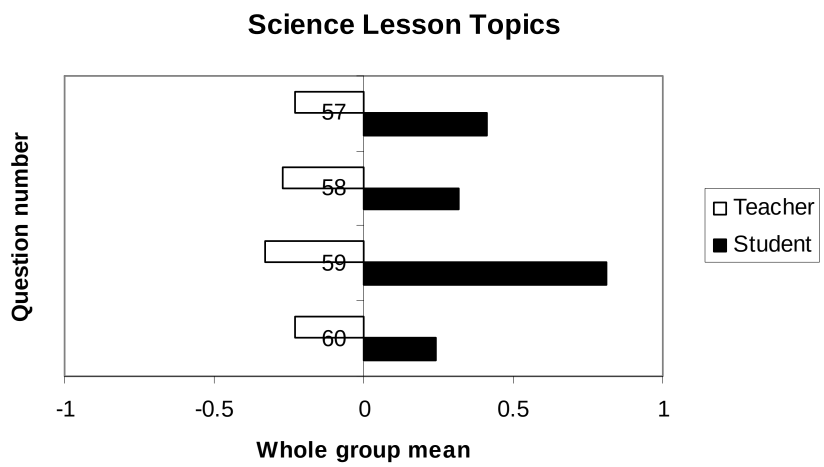
Careful scrutiny of Table 3 will reveal that student and teacher attitudes are similar on a number of items (Items 7, 10 and 13), but vastly different on others (Items 4, 5, 8 and 13). Figure 1 indicates this at a glance.

From Figure 1 it is obvious that there is a student teacher mismatch in relation to attitudes concerning the genetic modification (GM) of food, animals and humans. Students tend to reject the general use of GM, yet teachers tend to accept it (Item 4). When the statements are made more specific to be only the GM of micro-organisms and plants – to the exclusion of animals and humans, the students change their attitudes towards acceptance. Another mismatch occurs in Item 11 in relation to GM micro-organisms for treating human waste. The majority of students (70%) accept this form of biotechnology, whilst 47% of teachers reject it.

When probed in interviews, a number of teachers claimed to look at the bigger picture of biotechnology, as Mr H (School 2) described:

Well, it is general isn't it? Modifying anything is to our benefit I think. It doesn't matter what they [the scientists] modify, people benefit … or they wouldn't be able to do it.

Another teacher, Miss T (School 5), elaborated on a fear commonly held by the teacher's in relation to Item 11:



Note: As the mean approaches a value of 1 it indicates affirmation of the statement, and as the mean approaches -1 it indicates rejection of the statement.

Figure 2. Whole group mean scores for student and teacher interests.

Table 3. Student and teacher: Attitudes 'towards' biotechnology.

Item	Statement					
4	*I accept that the genetic modification of food, animals and human is a good thing.*					
		SA	A	N	D	SD
	n	0 (0)	28 (3)	86 (3)	156 (6)	230 (3)
	%	0 (0)	6 (20)	17 (20)	31 (40)	46 (20)
					Whole group mean adjusted	-0.59 (0.30)
5	*I think it is acceptable to modify the genes of micro-organisms and plants.*					
		SA	A	N	D	SD
	n	198 (2)	256 (7)	30 (1)	16 (3)	0 (2)
	%	40 (13)	51 (47)	6 (7)	3 (20)	0 (13)
					Whole group mean adjusted	0.64 (0.13)
7	*Altering the genes of plants so that they will grow better in salty soils is acceptable.*					
		SA	A	N	D	SD
	n	195 (5)	250 (9)	30 (0)	25 (1)	0 (0)
	%	39 (35)	50 (60)	6 (0)	25 (5)	0 (0)
					Whole group mean adjusted	0.62 (0.60)
8	*I think that adding genes to plants to increase their nutritional value is acceptable.*					
		SA	A	N	D	SD
	n	59 (4)	268 (1)	69 (6)	82 (3)	22 (1)
	%	12 (27)	54 (13)	14 (40)	16 (20)	4 (7)
					Whole group mean adjusted	0.35 (0.13)
10	*Altering genes in tomatoes to make them ripen more slowly and have a longer shelf life is a good use of biotechnology.*					
		SA	A	N	D	SD
	n	98 (1)	168 (7)	95 (3)	70 (1)	69 (3)
	%	20 (7)	34 (47)	19 (20)	14 (7)	14 (20)
					Whole group mean adjusted	0.16 (0.07)
11	*Using genetically engineered micro-organisms to break down human sewerage is a good thing.*					
		SA	A	N	D	SD
	n	100 (0)	250 (2)	50 (6)	70 (4)	30 (3)
	%	20 (0)	50 (13)	1 (40)	14 (27)	6 (20)
					Whole group mean adjusted	0.32 (-0.26)
13	*Altering genes in fruit to improve taste is a good idea.*					
		SA	A	N	D	SD
	n	120 (5)	150 (5)	80(1)	75 (2)	75 (2)
	%	24 (33)	30 (33)	16 (7)	15 (13)	15 (13)
					Whole group mean adjusted	0.17 (0.30)

Note: Figures show the number and percentage of valid student responses for each Likert category. Figures in parentheses are the number and percentage of valid teacher responses for each Likert category.

I don't think it is good to breed super sewage bugs. I think there was a movie a while back where a super bug escaped or something. We already have super streptococcus bugs invading our hospitals. Anyway, imagine if a super bug was to attack sewage, eventually it may mutate or become airborne or something. It would then be present everywhere there is dung .. on our lawns from dogs, on surfaces from poor human hygene .. yuck .. anyway, so this super bug mutates from dung to skin and well …. Yea this is hypothetical but possible.

Students, on the other hand held a different view:

Too right it is a good idea. We could get rid of a whole lot more shit … oh sorry … pooh! Sewage farms could use less water, and like … yea maybe not smell as much. So it would be good (Matt, School 1, Teacher 3).

The existence of these mismatches hold great potential for the biology classroom e.g. explorations of the nature of superbugs, decomposition by miocro-organisms, and the possibility of classroom debate –

student versus teacher. For this to occur, the teacher needs to be familiar with their class' attitudes, but first and foremost, the teacher must be interested in presenting lessons on such topics!

Science lesson topics of interest

Four items in the BELBETS questionnaire investigated the student and teacher interests in four biotechnology topics that could be explored in biology lessons. The responses from the students and teachers, as well as the Whole Group Mean scores are provided in Table 4 (figures in parentheses are teacher responses). Figure 2 provides a simple comparison between student and teacher lesson topic interests.

The majority of Year 11 students (70%) declared an interest in having bioethical topics presented in the classroom:

Bioethics, yea, they are everywhere, like on the news, TV shows and in the papers. I saw a cool episode once on 'House' where the team had to decide to do an emergency op [operation] not in the theatre 'cause another person also needed the operating theatre. Doctors have to make decisions like that all the time so we should be able to do debates and stuff like that too….. Lessons would be more interesting if they were gory and real. (Simon, School 6, Teacher 4)

As one teacher indicated, "I don't want to cover such things. There is a possibility that someone may be offended by another's views, discussions could become a debate, and it is the English teacher's job to do debates, not mine." (Mr H, School 2)

Similar patterns can be found in the responses to Question 58 relating to prenatal testing. The majority of teachers do not want to teach prenatal testing. As Mrs P (School 3) said:

I don't like the idea of a woman knowing her unborn child has a problem, and then her choosing a termination. What if the father didn't want to terminate? We then have a problem. No, ethically I don't like it. I don't think the students should have to explore such things. It isn't really relevant to them at the moment. Besides, it isn't in our text book I don't think.

An examination of the Whole Group Mean data in Figure 1 indicates that the students and teachers surveyed have very different ideas of what topics are of interest for inclusion into biology lessons. This opposition of interests is responsible for at least 1 student reconsidering his enrolment in the subject:

This subject is boring. If I had known we would not be doing cool stuff like CSI, I wouldn't have done biology. I am going to drop it next term and do something else. All the teacher does is text book stuff like study questions and stuff. We do an experiment once in a while if we are good, but sometimes they don't

Table 4. Student and teacher: Science lesson topics of interest.

Item	Statement				
57 (77)	*Bioethics education should be discussed in science lessons.*				
	SA	A	N	D	SD
n	169 (1)	181 (2)	75 (5)	40 (3)	35 (4)
%	34 (7)	36 (13)	15 (33)	8 (20)	7 (27)
				Whole group mean adjusted	0.41 (-0.23)
58 (78)	*Prenatal testing and the issues associated with it should be discussed in science lessons.*				
	SA	A	N	D	SD
n	120 (0)	130 (1)	200 (8)	45 (3)	5 (3)
%	24 (0)	26 (7)	40 (53)	9 (20)	1 (20)
				Whole group mean adjusted	0.32 (-0.27)
59 (79)	*Birth control and the issues associated with it should be discussed in science lessons.*				
	SA	A	N	D	SD
n	308 (0)	192 (0)	0 (7)	0 (6)	0 (2)
%	62 (0)	38 (0)	0 (47)	0 (40)	0 (13)
				Whole group mean adjusted	0.81 (-0.33)
60 (80)	*Human cloning and the issues associated with it should be discussed in science lessons.*				
	SA	A	N	D	SD
n	98 (1)	186 (1)	121 (5)	50 (6)	45 (2)
%	20 (7)	37 (7)	24 (34)	10 (40)	9 (13)
				Whole group mean adjusted	0.24 (-0.23)

Note: Figures show the number and percentage of valid student responses for each Likert category. Numbers in parentheses are the number and percentage of valid teacher responses for each Likert category.

work out like they should. (Paul, School 1, Teacher 3)

It is well known that students are not selecting the sciences in post compulsory schooling, and this has had a flow-on effect into tertiary studies. There have been a number of explanations posited for this demise in science interests; however, very few if any have explored the link between teacher and student interests. It is obvious from these four questionnaire statements, that the students and teachers have opposing interests. The teachers are not interested in providing lessons on the topics students are interested in learning about. In Queensland this is problematic, as the teachers design the curriculum for their particular students. If the small number of teachers surveyed and interviewed is representative of Queensland or Australian biology teachers, it seems teachers do not want to get involved in controversial issues, and they do not want to present topics not found in the text book. Students, on the other hand want to explore ethical concerns. They see shows on the television, consider this material to be 'real' (irrespective of whether it is or not), and desire to do hands-on practical work. One student enrolled in biology in a post compulsory classroom, but found his interests not being met. He planned to withdraw from the study of biology at the first opportunity. The student did not know what subject he would enrol in after biology, except that he knew "it wouldn't be a science subject" (Paul, School 1, Teacher 3). It is unknown how widespread this 'lack of interest' causing departure from a science subject is.

DISCUSSION AND CONCLUSION

In Australia, it is common for educational authorities to impose syllabus documents and standards, for teachers to react and possibly trial the documents, and then for teachers to create work programs and implement them within their schools. It is very rare for any of these documents to be written following consultation with students. Yet the data from the BELBETS questionnaire indicates it may be beneficial to determine the attitudes and interests of the students, as in some cases, there will be disparities with the attitudes and interests of the teacher. The attitudes of the teacher and students may differ, providing a rich discussion or debating base for the classroom. Where attitudes, tend to match, it is highly unlikely the match will be unanimous, so debate and discussion is still possible. The BELBETS has also shown that students have very clear ideas of what they are interested in exploring in biology classes. Where these interests are not being met, it is possible the student will withdraw from the study of biology. This study found that students have very positive attitudes towards studying biotechnology issues, especially where there is personal relevance. Unfortunately, the study also showed that the teachers, who decide upon the curriculum, are not interesting teaching such topics.

It is hoped that the findings from this study will lead to further investigations into biotechnology education. We need more studies that investigate biotechnology education in relation to teacher intention in the classroom. Research into student attrition from the sciences is also needed to determine if the mismatch between student and teacher interests is a contributing factor.

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