Ethical Discourse in Science Textbooks
A Study of Class 12 Biology Textbook

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Abstract

Textbooks play a pivotal role in informing and educating but sometimes the content presented within a textbook is only partially correct or presents the ideology of the dominant few. This could lead to a distortion of some topics given in the textbook. Sciences bear the onus to inform about the creation and application of a particular technology, which help in enhancing the self-sufficiency of a nation whereas ethics decide the course a particular research takes by analysing its impact on society. Hence, technology sans ethics can lead toward unbridled technological growth which has been disastrous. In order to bolster the relevance and place for ethics in science and technology, the beginning has to be at the level of education. The research questions that guided the present study were, how is this technology component represented in the present science education both in its curriculum and practice, also, whether ethics or ethical principles find a place in the present science curriculum or not. In the light of the above questions, the present paper attempts to analyse the class 12 Biology textbook with respect to the inclusion of ethical issues with respect to some recent biotechnology within it along with teachers' perceptions about the current textbook of Biology. The study analyses three science and technology issues viz., amniocentesis, in-vitro fertilisation and genetic modification of organisms. A content analysis approach has been adopted for analysing the selected text sample. The paper then elaborates upon the ethical stance taken by the author within the textbook and corroborating it with the relevant ethical theories and modes of inquiry. The findings reveal that the positive impact of the

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technology component of class 12 Biology textbook is what is being highlighted while neglecting the major debates associated with gender equality, human rights, food safety and other ethical concerns. The in-depth interviews with the teachers unveiled their apprehensiveness in dealing with the ethical issues. Implications are broadly drawn for textbook writers, curriculum developers, policy makers, teachers and teacher educators.

Introduction

Science textbooks are one of the chief translators and a tool for transacting the course content used in the majority of science classrooms in the Indian subcontinent. They are being treated as sacrosanct both by the teachers and students alike without any inkling of a doubt or misrepresentation that prevails many a time in the textbooks. The objectives for teaching any topic in the classroom are being decided by keeping the textual content in mind without even bothering about extending student understanding towards certain broader humanistic aims. These include the aim of a scientifically literate citizenry which is not just aware about the scientific terms and terminologies but also able to reach an understanding up to the application level in solving real-life problems (problem-solving approach). One of the broader aims of science and technology education is also about having the ability to discern and take wise decisions vis-à-vis a particular technology such that it is used for the welfare of human society and not for its detriment (NCF-2005). This is possible only when the students are able to differentiate between what is right and what is wrong and how do we reach that conclusion (process of ethical inquiry). However, there are no set guidelines provided in the document for achieving this goal but have to be communicated via the curriculum, syllabus, textbooks, teachers and their pedagogy. The present paper focusses upon the role of textbook in addressing such issues of ethical concern that impact our society. For this purpose, some selected texts from the class 12 NCERT textbook of Biology have been taken and analysed.

The aims of the present study are: (i) Developing a theoretical framework for the analysis of textbook content with respect to inclusion of ethical issues in class 12 Biology; (ii) Content-analysis of class 12 Biology textbook with respect to the inclusion and representation of ethical issues within it; (iii) Deriving implications for textbook writers, curriculum developers, science teachers and teacher educators.

Background of the study

The present study derives its significance from the recent spurt in researches that have tried to establish strong interlinkages between sciences and ethics by way of socio-scientific issues (Reiss, 1999; Goldfarb and Pritchard, 2000; Zeidler and Sadler, 2008). It has now been well-established that ethics form an indispensable component of sciences and science education. Therefore, the curriculum has to provide adequate space to this component of sciences so as to inform and emancipate science education from a mere materialistic bent towards a humanistic aim. The textbooks are the chief translators of the curriculum and are a direct reflection of the state's educational policy. Hence, the content given in the text is determined and decided keeping in view the greater picture of the state and its citizens. India being a developing nation has to have a major share in the industrial and technology sector so as to expedite its process of development. This is reflected in the science curriculum that has a renewed focus on the technology component so as to initiate and inspire the young minds in this field. But, giving them a content that is unidimenional and written with some prior assumptions will be akin to misguiding our young learners. They need to be informed about the complexity of a particular issue and not just one popular notion. However, the present textbooks digress from taking such an approach, which is as difficult to present as to understand.

A review of the recent trend of studies in the area of textbook analysis has revealed that not much work has been done with respect to analysis of this ethical component within science textbooks. (See Table 1)

Table 1

Review of Studies Related to Science Textbook Analysis

S. No.	*Researchers (Year)*	*Area of Research*
1.	Koulaidis and Tsatsaroni (1996)	A study of relationship between scientific knowledge and school knowledge
2.	Morimoto & Maeda (2002)	Inclusion of appropriate experiments for students within the textbooks and illustration of students' activities in higher secondary Biology textbooks
3.	Chiappetta and Fillman, (2007); Brooks (2008)	Inclusion of nature of science component in school science textbooks

4.	Delgato (2009); Morning (2008)	A study of Textbook adaptation while addressing multiculturalism in science education and construction of race
5.	King (2010)	Prevalent misconceptions and oversimplifications in high school science textbooks
6.	Kahveci (2010)	Studied gender equity, questioning level, science vocabulary load, and readability load in science textbooks by using certain standardised procedures
7.	Teixeira et al (2011)	Did a content analysis of the high school Biology textbook with respect to the addressal of nutritional issues contained in it
8.	Nonaka et al (2012)	Analysed the content of secondary school Biology textbooks regarding the treatment given to the topic Malaria and its control
9.	Udeani (2013)	Adopted a quantitative approach to analyse the content given in a particular text, such as with respect to scientific literacy themes

This all the more increases the need for such a kind of study as ethical issues have recently acquired a predominant role in the area of science education. Therefore, we in our present study decided to take this notion further by analysing the high school textbook of Biology with respect to the inclusion of ethical issues and the treatment given to them therein.

Theoretical Framework

The present study derives its theoretical basis from the three main ethical theories, viz., Virtue theory, Consequentialist (Utilitarian) theory, and Deontological theory. A brief description of each of the afore mentioned theories along with their application forms the major portion of the theoretical framework so as to build an orientation towards these theories.

Firstly, the ***virtue theory*** based on Aristotelian ideas focusses upon the predicative nature of what is good rather than its attributive character (Graham, 2011). As is argued by philosophers working in this area that a predicative nature is more descriptive about the character rather than the attributive nature.

The ***Kantian ethics*** or what we call more appropriately 'Ethics of Good Will' or deontological ethics transcends the virtue ethics and rather than an innate quality of any subject or object gives more importance to the action and the

intention behind it. Thus, even good qualities such as intelligence, wit, judgement etc., can result in an unfavourable, rather harmful, action if misused (Kant, 1959). Thus, in Kant's viewpoint actions hold a supreme value and have the capacity to determine whether a particular act is moral or immoral. Developing and nurturing a 'goodwill' in Kantian terms means holding and abiding by certain duties that Kant defines as 'Categorical Imperatives' and that are beyond our wants and desires. The major critique of this theory is the sole reliance on duty as well as a complete disconnect with the consequence or result. For any act to be moral at least some positive outcome is to be required.

This gave rise to another philosophical doctrine called ***Utilitarianism*** (founded as a moral theory by Jeremy Bentham), meaning the social utility of a particular action resulting in happiness (Bentham, 1960: page no. 126). The major focus of utilitarianism lies with the amount of happiness that a particular action brings about. Utilitarianism is often confused with ***Consequentialism***, but both are actually very different and have distinct approaches. Utilitarianism is more of a hedonist approach whereas Consequentialism concerns itself with some higher aims and aesthetic rewards as compared to a shallow happiness.

Thus, the above-mentioned ethical theories provide us with a brief idea about the basics of ethical mode of inquiry into any issue and also at the same time leaves us with a dilemma as to which theory is completely foolproof. However, such a decision is highly subjective and depends upon individual values and assertions. Such an understanding can only be gained via ethical discourse wherein different viewpoints and theoretical justifications are argued and put together to arrive at a consensus. 'Ethical decision-making' is another area that is being researched upon in recent years, especially in issues from day-to-day life and those in the arena of technology and applied Biotechnology. In order to arrive at an informed understanding with respect to these issues, a person should have a sound knowledge base in the area of STS (Science, Technology and Society) as well as a brief idea about ethical theories for resolving such issues and taking the appropriate decisions. How is the present generation of science students guided in this direction? Was the major research question lurking before us that prompted us to write this paper?

Research Methodology

The content analysis approach has been adopted in order to analyse the content of class 12 NCERT Biology

textbook with respect to the inclusion of ethical issues within it. The research method used will involve critical content analysis of the text with respect to the ethical issues in Biological Sciences. In-depth interviews with ten high school Biology teachers teaching the present Biology NCERT text will also be simultaneously included and analysed so as to get a peep into the prevailing understanding of the ethical issues that the text tries to build up. The following procedure for content analysis has been adopted for the present study.

Sampling of relevant text–The part of the text which is taken for the present study is the selected portions pertaining to some emerging technologies which have both a beneficial as well as a controversial side in terms of certain ethical issues attached to their application and impact on the society at large. For the present paper, only three such technologies will be taken up, viz., Amniocentesis, In-Vitro Fertilisation (IVF) and Genetic Modification of Organisms (GMOs).

Development of Codes and Categories–Based on our prevailing understanding about ethical issues pertaining to some contemporary technologies, such as IVF, Gene Therapy, GM crops and even when it comes to conservation of natural resources some codes and categories were developed by the researcher. Thus, the present study involves a pre-coding scheme of analysis where codes are developed prior to conducting the actual content analysis.

Coding and presentation of textual data–Based on the codes and categories developed the textual data was coded and analysed and the codes were assigned to the selected text. A grid was developed for each topic/issue analysed wherein details about the type of ethical issue, its category number, broad area, length of issue covered in the textbook, reference to any ethical theory, number of arguments raised, and kind of understanding being fostered have been given. This helps in getting a quick view of the kind of treatment given to a particular topic/issue within the textbook.

Analysis and Inference–Based on the coding analysis, a brief idea about the depth to which a particular issue has been dealt within the textbook was generated. Next, the major arguments given in the text were selected as evidences for highlighting the stance taken by the author with respect to a particular issue. These were then analysed in the backdrop of the major ethical theories taken from the theoretical framework of the study developed by the researcher.

Results and Findings

Using the method of content analysis, the selected text-samples from the class 12 textbook of Biology were coded and analysed. The following were some of the findings and interpretations that emerged from the study with respect to each text sample analysed.

1. **Sex-Determination and Amniocentesis–**The issue has been covered in the chapter on 'Reproductive Health' in just about thirty-two words, stating it as,

"Statutory ban on amniocentesis (a foetal sex determination test based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo) for sex determination to check increasing female foeticides, massive child immunisation, etc." (code 2.1.2) (Source: class 12 Biology Textbook, 2006, p.58)

Type of Ethical Issue	*Medical Technology and its Misuse*
Category No./Code	2.1/2.1.2
Broad Area	Reproductive Health
Length of issue covered in textbook	32 words
Reference to any ethical theory	None
Arguments raised	One
Kind of Understanding Fostered	Factual

Figure 1: Presentation of the issue of Amniocentesis in Class 12 Textbook of Biology

Upon carefully scrutinising and deconstructing the above text the point that emerges is that the technique of amniocentesis is being misused for foetal sex-determination and leading to increasing numbers of female foeticides. However, this is also the ethical argument being posed in the text. From the above text it can be inferred that the increasing incidence of female foeticide needs to be checked which is also a reflection on the unequal status of women in Indian society (Code 2.1.1) but the text does not discuss this issue in detail. Such a stark statement is an indication of the patriarchal system (code 2.1.3) and a never-ending craving for a male heir. This also indicates the weaker position that the fairer sex holds which in any way is a big question upon the democracy of a state like India. The woman who gives birth to a child does not have a say when it comes to deciding the fate of her unborn child.

Ethical Basis: The text fails to provide any ethical grounding for such an issue which could be the principle of equality of gender (code 2.1.1) as per which both male and female should receive equal human rights. The right to life is one of those inalienable human rights which is the right of each and every human individual irrespective of gender, class, creed, religion, or region (code

2.1.2). This statement however does not try to undermine the medical diagnostic value of the test, which helps in predicting any kind of foetal disorder, but the ethics lie in using this technique just for diagnosis and not for sex-determination. Banning the technique altogether is not going to improve the skewed sex-ratio, rather an ethical understanding of wisely using the technique can, and it is the responsibility of the medical professionals to follow a code of ethics (Code 2.1.4) in their profession by not divulging the sex of the foetus while carrying out this kind of test.

2. In-Vitro Fertilisation (IVF)

The textbook introduces the issue as a repair mechanism for infertility by offering a medical technology that can overcome this problem. Somewhere the textbook presents the technique as a way out to prevent the female from being stigmatised for her inability to bear a child by saying it clearly that the problem could be with the male partner.

Evidence 2a. *"In India, the female is often blamed for the couple being childless, but more often than not, the problem lies in the male partner." (code 2.4.1) (Source: Class 12 NCERT Textbook of Biology, p.64, 1st para)*

The different kinds of medical interventions in this regard have been taken as embryo transfer technique, zygote intra-fallopian transfer (ZIFT), gamete intra-fallopian transfer (GIFT), artificial insemination (AI), etc. although the technicalities of all these techniques have been discussed (code 2.4.4) but what the present textbook lacks is the whole set of ethical issues associated with these techniques of assisted reproduction. Only towards the end of the topic, the textbook refers to the point of social inequality amongst people in a country like India that prevents them from having access to such a treatment.

Evidence 2b. *"Though options are many, all these techniques require extremely high precision handling by specialised professionals and expensive instrumentation. Therefore, these facilities are currently available only in a few centres in the country. Obviously, their benefits are affordable to only a limited number of people." (code 2.4.5) (ibid., p.64, last para)*

This creates a divide between haves and have-nots. The principle of Equality becomes the issue of concern and demands equal distribution of the fruits of technology to all the people.

Type of Ethical Issue	Medical
Category No./codes	2.4/2.4.1, 2.4.4, 2.4.5
Broad Area	Reproductive Health
Length of issue covered in textbook	1 Page
Reference to any ethical theory	None
Arguments raised	One
Kind of understanding fostered	Conceptual

Figure 2: Presentation of the issue of IVF in class 12 textbook of Biology

Ethical Basis: Although the in-vitro fertilisation (IVF) technology is a medical innovation and an example of cutting edge creativity, every good thing comes with a cost, and so with this technology. The major ethical issue lurking here is the destruction of many fertilised eggs or embryos which are either wasted or frozen for further usage (code 2.4.2). In the United Kingdom under the Human Fertilisation and Embryology Act (1990), human embryos can be kept in frozen condition only up till five years, after which they must be either used up or destroyed. This destruction of human embryos is being regarded as an extremely immoral act, as according to some people human embryo possesses an equal moral status as any foetus, child or adult (Levinson and Reiss, 2003) and therefore should be protected. Another ethical issue in in-vitro fertilisation is its use even by the fertile (code 2.4.3), such as single parent family, delayed motherhood or post-menopausal motherhood, same gender couples, etc. These practises generate many ethical issues, such as what would happen to the children born to such parents, will they have a normal childhood, will their capacities be fully nurtured and developed? Here the principle of Utilitarianism prevails, which favours the act that leads to wellness and happiness to all. And an act such as in-vitro fertilisation and further development of embryo till term is a highly responsible act and hence the consequences should be well thought of. Only after weighing the pros and cons of the technique should it be practised. However, both these ethical issues (codes 2.4.2 & 2.4.3) do not receive even a slightest mention in the textbook and thus portray only the beneficial side of the technology of IVF which fosters only a partially correct understanding in the reader's mind.

3. Genetically Modified Organisms (GMOs) – These include both genetically modified plants as well as animals. These are included in the chapter on Biotechnology and its Applications (Chapter-12, Section-12.1, 12.3 and 12.4). The following grid provides details on some of the aspects of the way the topic has been dealt within the textbook.

Type of Ethical Issue	Socio-economic and Therapeutic
Category No./ codes	3.1& 3.2/ 3.1.1, 3.1.4
Broad Area	Biotechnology
Length of issue covered in textbook	3 Pages
Reference to any ethical theory	Utilitarian
Arguments raised	Utilitarian, socio-economic and therapeutic arguments are being raised in favor of GMOs. Some legal and biosafety arguments are also raised
Kind of Understanding Fostered	Ethical Dilemma

Figure 3: Presentation of the issue of GMOs in class 12 textbook of Biology

The text portrays the technology as useful and beneficial for mankind and provides many arguments for it such as,

Evidence 3(a): *"GM plants have been useful in many ways. Genetic modification has:*

(i) Made crops more tolerant to abiotic stresses (cold, drought, salt, heat).

(ii) Reduced reliance on chemical pesticides (pest-resistant crops).

(iii) Helped to reduce post harvest losses.

(iv) Increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil).

(v) Enhanced nutritional value of food, e.g., Vitamin 'A' enriched rice. (Source: Class 12 Biology Textbook, 2006, p.208)

In addition the use of genetically modified organisms in making genetically engineered insulin and in gene therapy has also been discussed in detail. (ibid. p.210-213)

Within the text there are evidences that point toward the ethical discourse that is inherent within these technologies, such as the following sentences quoted directly from the textbook.

Evidence 3(b): *"Genetic Modification of organisms can have unpredictable results when such organisms are introduced into the eco-system." (code 3.1.1) (Source: Class 12 NCERT Biology Textbook, p.213)*

From the above statement the author is showing his/her concern towards the unknown impact that a genetically modified organism can have on the environment. Here the unprecedented outcome or consequence that such a technology purports to have can have both a positive or a negative dimension. But, the concern is more toward the negative outcome as it hampers the human existence and sustenance. Here, again a utilitarian viewpoint

comes up and the whole of ethical discourse centres upon the application of science and technology for the benefit of mankind.

Evidence 3(c): *"There is growing public anger that certain companies are being granted patents for products and technologies that make use of the genetic materials, plants and other biological resources that have long been identified, developed and used by farmers and indigenous people of a specific region/country." (code 3.1.4) (ibid. p.214)*

The statement discusses the issue of patenting of indigenous crops, methods of crop improvement as well as indigenous resources utilised by foreign multinational companies for their own profit and repute in the global market economy. This is clearly a breach of ethical values and virtues that a person or company should abide by, as well as of honesty and integrity. In terms of the pedagogical discourse (Bernstein, 1990), the text also highlights the unequal power relationships existing between the developed and developing nations and between the affluent and the poor. The ethical discourse here also involves the violation of human rights of farmers as their own ideas and local resources are patented and stolen and not only this but in spite of getting recognition they are being rebuked and even punished for using the patented resources (code 3.1.3).

Evidence 3(d): *"The diversity of rice in India is one of the richest in the world. Basmati rice is distinct for its unique aroma and flavour and 27 documented varieties of Basmati are grown in India. There is reference to Basmati in ancient texts, folklore and poetry, as it has been grown for centuries. In 1997, an American company got patent rights on Basmati rice by US Patent and Trademark office. This allowed the company to sell a 'new' variety of Basmati, in the U.S and abroad. The 'new' variety of Basmati had actually been derived from Indian farmers' varieties and claimed as an invention or a novelty." (code 3.1.4) (ibid. p.214)*

Here the ethical issue which could be raised is the virtue of trust, justice and honesty that has been appropriately addressed by the textbook. The ethical discourse that is evident here is the trade and utilisation of resources by the multinational companies and again a dominance of the influential and powerful groups over under-developed countries.

Ethical Basis: Thus, the present textual content provides food for thought in thinking about this issue of GM crops from an ethical perspective. However, the information given in the textbook is not sufficient as there are many more concerns that are being raised against GM crops which do not receive a mention

in the textbook. This includes the issue of food quality and nutrition, food safety, gene pollution and loss of biodiversity, development of antibiotic resistance and potential for gene transfer which could result in dilution of species diversity and production of super-weeds. The ethical discourse within the class 12 textbook is mainly centred on Bio patents and exploitation of indigenous resources by the foreign multinationals. The positive side of GM crops and GM organisms is being highlighted such as developing disease resistance, drought resistance, insect-resistance and increased yield of the crop. Thus, the stance taken by the author is toward a utilitarian side although the text does mention the role of GEAC (Genetic Engineering Accreditation committee) in determining the impact of the new organism on the environment. Thus, some safety standards are maintained to check the proliferation of such genetically modified organisms in the environment.

Discussion

The current textbook of class 12 Biology only fleetingly discusses the ethical issues attached to some of the contemporary and widely applicable technologies. Their treatment in the

Ethical Issues Reflected in Biology Textbook

Category No.	*Category Name*	*Major Ethical Issues (with Codes)*
1.	Amniocentesis	1.1 Principle of equality 1.2 Sensitivity towards life and care for it (Right to Life) 1.3 Inherent biases in society (Patriarchy) 1.4 Medical profession ethics
2.	In-Vitro Fertilisation	a. Evading stigmatisation b. Wastage of embryos during IVF c. Use of IVF even by the fertile d. Principle of utilitarianism e. Increasing divide between haves and have-nots
3.	GM Crops	a. Unpredictability of the outcomes b. Maintenance of safety standards c. Threat to farmer's autonomy d. Gene patents and biopiracy e. Threat to biodiversity f. Emergence of Superweeds and Superbugs g. GM crops vs. Organic farming

textbook is usually restricted to their beneficial uses rather than discussing about some of the unforeseen and deleterious effects that such technologies can pose to the society. The three science and technology issues taken up in this paper viz., amniocentesis, in-vitro fertilisation and genetically modifying organisms come under controversial issues. As there cannot be any one particular view with respect to these issues so the text portraying just one side of these issues is not justifiable. There are many ethical debates that surround each of these issues, for instance, human rights debate and gender equality associated with amniocentesis, accessibility and resources for IVF and issue of wastage of human embryos that hold a human potential. Similarly, issues such as unpredictability of outcomes, gene pollution, emergence of super weeds, threat to biodiversity, etc are attached with GM organisms. Although one may say that these issues are highly subjective and have not been well-researched the point is not to be judgemental here but to give the real picture to our young readers. If not in the main text, then as vignettes, case studies or simply quoting researches from authentic sources, students should be given some idea about the complexity of these issues.

The teachers also feel that the present textbook only gives a brief mention about the ethical issues as one of them said,

"Ethical validity also needs to be discussed, but they are just touching upon the concepts, a very superficial treatment is being given. If we discuss these, it is fine, but if we leave them, then the child does not know that there could be so many ethical issues attached with this topic."(Interview on Science Curriculum at Class 12, Case A1)

According to her, such issues are important and should be addressed to the students:

"Any technology which we are teaching to the students we should take into account not only its benefits but also its side-effects on nature, on environment, on soil, on humans. So, every time we do this we are sensitising the child toward the effects of advancement on nature. Such that later in life when the child grows up and uses whatever technology, then he knows that this harm could be caused by this technology and hence take responsible decisions in life as well as become a responsible citizen."(Interview on Science Curriculum at Class 12, Case A1)

Therefore, introducing students to these ethical issues in Science will help develop a responsible citizenry which is also one of the major aims of science education (NCF-2005). One of the respondents also highlighted the existence of ethical

issues within the present textbook of Biology by saying,

"Yes, there are many ethical issues, they are talking about GM crops, conservation issues, ARTs, everywhere they have tried to integrate these issues into the curriculum." (Interview on Science Curriculum at Class 12, Case B1)

This can be taken as an overrated statement made by her, as having analysed the textbook from an ethical perspective we know that these issues do not receive their due share in the curriculum. One of the respondents feels the dearth of resource material and training required for dealing with the ethical issues in the classroom and opines,

"Right now the issues are just touched upon and that too in some specific topics like GM crops and Biodiversity and Conservation. There should also be some resource material for the students as well as the teachers for building an understanding on these issues." (Interview on Science Curriculum at Class 12, Case L1)

Almost five out of ten teachers feel that these ethical issues should be discussed in the text alongside the topic and not as a separate section or chapter. This will help learners in connecting well with the issues and also aid comprehension. Putting it in a succinct way, one of the case respondents explained,

"Ethical issues should be placed within the chapter; whenever I am teaching a concept I wish to discuss the issues then and there. I need not tell the students that these are ethical issues, but enable them in reasoning out and helping them reach a conclusion." (Interview on Science Curriculum at Class 12, Case A1)

This makes it evident that the teachers want to discuss these issues in a rather implicit manner by refraining from calling them 'Ethical Issues'. This can be taken as a component of the hidden curriculum which tries to mask the critical importance attached to these issues. This also points toward the apprehension on the part of the teacher in treating these issues as 'Ethical'. The reasons for this could be many, such as lack of proper orientation with respect to tackling these issues in classroom or inadequate knowledge and understanding about the discipline of ethics and mode of ethical enquiry; inability to handle multiple student views and responses on these issues which happen to be controversial and stimulate discussion and debate, etc.

Thus, an effort needs to be made from both sides, i.e., not just the curriculum of higher secondary science but also teachers' involvement and deliberation on such issues of ethical relevance. The textbook should address these issues in greater depth citing relevant

discourses and evidences so as to engage the learners and the teachers both with the ethical issues. The mode of presentation of these issues needs to be made more explicit rather than implicit so as to make them more open and transparent.

Conclusion

The evidences from the text give an indication that ethics and ethical issues are trying to occupy a space in the curriculum via its most useable pedagogic device (Bernstein, 1990) which is the textbook. An analysis of the text reveals that the ethical theories although not explicitly given or stated but remain implicit and need to be drawn out by the reader (in the present case, the teacher and the learner) so as to elaborate upon the inherent meanings of the text. However, at some points the text offers little scope for reflection and deliberation into the sphere of an ethical understanding vis-à-vis the three prominent Science and Technology issues taken up in the present study. Looking at the seriousness of these three issues an effort needs to be made in order to link the text with the major ethical discourses of our society and culture, for instance the issue of amniocentesis and its misuse can be linked to the patriarchal structure of society and the unequal status of women. Then, with IVF is attached the issue of wastage of human embryos and the whole debate of 'Where does life begin?' Similarly, the issue of GM crops can be viewed from the angle of economic benefits of some foreign multinationals versus farmers' distress and vicious cycle of debt. The textbook content needs to move beyond the mere subject matter boundaries so as to include the bigger issues plaguing the whole society. This will build up not only the awareness levels of the learners but also make them able decision-makers and problem-solvers which is also one of the broader aims of science education (NCF-2005). In this regard, the role of teachers cannot be neglected as they are the chief translators of the curriculum, therefore their engagement with these issues cannot be dismissed. The interviews with some high school Biology teachers revealed their inadequacy and unpreparedness to deal with the ethical issues in the classroom. This again suggests that serious gaps in the current NCERT Biology textbook vis-à-vis these issues. Hence a rethinking is required with regard to such issues in the curriculum, so that the vision is more holistic and multi-dimensional.

Educational Implications

1. The textbook should provide some pointers for classroom discussion on ethical issues so

that they can be dealt within more detail.
2. The text should highlight some ethical theories on which a particular argument is based, as ethics has its own mode of enquiry that is different from sciences and thus the students need to be familiarised with it.
3. Certain case studies or vignettes can be included within the text or in the exercise section based on certain ethical dilemmas related to understanding of these ethical issues so as to assess students' understanding and decision-making skills.
4. The teachers should also be oriented towards dealing with such controversial issues in the classroom by way of intervention programmes and in their pre-service pedagogy paper.
5. Bigger discourses related to science and technology and their interface with society need to be mentioned more prominently in the text, as at present it seems to be diffused.

Suggestions for Further Research

1. Such research can be extended to a comparative textbook analysis of different countries wherein textbooks of Biology followed in different countries are analysed and compared. This can bring out some of the cultural components inherent in the text supporting a particular ethical norm/theory and discarding the others.
2. Besides textbooks, classroom discourses can also be analysed for understanding the process of transfer and transformation of knowledge by the teacher. This will help in building bridges between the knowledge 'given' and knowledge 'transmitted/ translated'.

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