# Conceptualizing Critical Science Education using Socioscientific Issues

Synopsis of Ph.D. Thesis

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in Science Education

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August, 2016

# Chapter 1

# Introduction

This thesis seeks to emphasize a vision of science education drawing on critical perspectives that place science within the social, political and ethical context. Broadly, it advances theoretical perspectives that support this position, employing these to critically examine the curriculum documents pertaining to science education, the higher secondary biology textbook (thesis chapters 2 and 3) and reports exploratory empirical work done with higher secondary[1] biology students where they negotiate a controversial socioscientific issue (thesis chapters 4 and 5). I also argue that Critical Science Education (CSE) should persist through higher education and briefly discuss the findings from a study conducted with doctoral students in biology (thesis chapter 6). The empirical work is exploratory and preliminary and intends to illustrate and advance theoretical questions. In this chapter, I will describe the key theoretical ideas that I have drawn from the areas of science education, science-technology-society studies and philosophy of science when conceptualizing and conducting my work.

This thesis can broadly be placed within the area of critical studies in science education (Bazzul, 2016)[2]. These studies critically question the science curriculum, the ideological assumptions that underpin it, and positing alternatives (Bazzul, 2013; Bencze & Carter, 2011; Carter, 2005; Cross & Price, 2002; Hodson, 2003; Raveendran & Chunawala, 2013). However, there are studies which have operationalized these perspectives and conducted empirical investigations involving students and teachers (Bencze, Sperling & Carter, 2012; Levinson, 2007; Roth & Lee, 2004). Many of these studies (both theoretical and empirical) call for inculcating, in students of science and the lay public alike, Critical Scientific Literacy (CSL) and advocate politicization of the science curriculum (Dos Santos, 2009; Hodson, 2003, 2009; Mayberry, 1998; Weinstein, 2009). Hodson (2011) provides a comprehensive definition of CSL in terms of epistemic, sociopolitical and dispositional aspects:

> ... the most important function of scientific literacy is to confer a measure of intellectual independence and personal autonomy: first, an independence from authority; second, a disposition to test the plausibility and applicability of principles and ideas for oneself, whether by experience or by a critical evaluation of the testimony of others; third, an

1 Secondary education in India caters to students between the 12-18 age group, the final two years of which constitute higher secondary education. At the higher secondary level, students choose between the humanities, commerce or sciences, undertaking specialized education in these streams.

2 Bazzul (2016) writes, “The goal of a critical scholar is to render what seems commonsensical, strange”, I interpret this to mean challenge the status quo and mainstream assumptions of science education ought to be.

> inclination to look beyond the superficial and to address the ideological underpinnings of science and technology, the economic and political structures that sustain them, and the norms and practices that accommodate some views and some participants but marginalize or exclude others; fourth, sensitivity to the complex interactions of class, race, gender, language, knowledge and power; fifth, an ability to form intentions and choose a course of action in accordance with a scale of values that is self- formulated; sixth, a commitment to criticism and constant re-evaluation of one's own knowledge, beliefs, attitudes and values. (p.27)

Hodson (2003) further suggests an issue-based curriculum to bring about CSL with potential themes around health, land, water and mineral resources, food and agriculture, industry, energy resources, IT and transportation, and ethics. What I argue in this thesis, however, moves beyond advocating critical scientific literacy at the school level for future citizens. Rather, a *critical science education* which places science within its social, political and ethical context needs to persist through to higher education, even in the science curriculum that caters to specialists.

One way through which the goal of critical science education has been realized is through the Science-Technology-Society-Environment (STSE) initiatives in science education. The area of STSE education is broad and its aims appear to fall in two broad categories:

a) To engage learners who are disinterested in science or excluded by the mainstream science curriculum by presenting it in an appealing context

b) To promote the democratic goal of science education, imparting skills to learners to engage with issues that they would have to face as citizens, and to which they will need to apply considerations other than science.

These two goals are different in the sense that the former does not question the content of science taught in school per se, instead concerning itself with issues of inclusion, while the latter problematizes the science content taught in school and also deals with questions related to ethics, politics and values. The STSE movement in science education arose in response to movements world over in the 1960's and 70's – environmental, pacifist, and the people's health movements which placed academic science under scrutiny, raising critical questions on its impact and accountability towards society at large (Aikenhead, 2003).

In order to understand STSE education in India and how it has evolved, it is important to look at the larger discourses prevalent in the country on the role of science in society. These discourses can be

broadly divided into three kinds – First, the 'science for modernization' discourse or what is referred to as the Nehruvian vision of 'scientific temper' (Rampal, 1992) which views science, technology and development as going hand in hand. Second, the 'science for liberation' discourse exemplified in the People's Science Movement (PSM), where science is seen as an emancipatory tool for social change (Varma, 2001). And finally, there is the 'science as violence' argument, put forth by those referred to by Abrol (2014) as Neo-gandhians - who view the nexus of scientific enterprise and the neoliberal state as against the ideals of justice and equity (Nandy, 1988; Rajan, 2005). The dominant understanding of science and its relationship to society that holds public imagination in India is the one of scientific temper (Chadha, 2005).

In India, the need to bring in STSE education up to class X has been recognized in the national curriculum document, but there is no clear articulation of how and in what manner this should be done (Raveendran & Chunawala, 2013). However, there has been a history of out of school/non-formal educational initiatives that have attempted to bring in these concerns, such as those helmed by the people's science movements (Kannan, 1990). Several initiatives at the higher education level have also aimed at bringing in the social and historical context of science into the science curriculum (Raina, Pattanayak & Valte, 2009).

In the west, the socioscientific issues (SSI) movement in STSE education emerged in response to the perceived limitations of the STSE approaches, which were seen as diffuse and theoretically under-evolved (Zeidler, Sadler, Simmons & Howes, 2005). SSIs are “social dilemmas with conceptual or technological links to science” (Sadler, 2004). These are typically ill-structured, real world issues that are controversial in nature. The nature of SSIs are such that “facts are uncertain, values in dispute, stakes high and decisions urgent” (Funtowicz & Ravetz 1995). These represent cases of science in the public domain that is characterized by uncertainty and require value considerations other than scientific evidence to resolve. The need to introduce SSIs in the school and undergraduate curricula has been recognized by the international science education community as well as by the national curriculum documents in several countries (Hughes, 2000; Zeidler & Keefer, 2003). Research has systematically explored students' negotiation of SSIs examining different factors that affect the reasoning and the argumentation strategies that students adopt (Sadler, 2004).

It is also important to remember that different epistemological frameworks of understanding the science-society interface inform how different researchers understand the issue of negotiation of SSIs. Levinson (2007) discusses these frameworks on the basis of how technocratic they are.

Technocratic frameworks of understanding the science-society interface stress the importance of canonical scientific knowledge in resolving the issue and view scientific experts as solely capable of arbitrating on it. In non-technocratic frameworks of science-society interface, the central role of science in resolving the controversy is not privileged and the science needed to negotiate the issue is seen as tentative and uncertain. Scientific knowledge may also be critiqued and challenged in this model. I adhere to a non-technocratic model of science-society interface and this will be reflected in the theoretical frameworks that I draw upon in the studies reported in the thesis.

Adhering to a non-technocratic framework of understanding the science-society interface does not automatically translate to a rejection of science. To be sure, science has to its credit an impressive array of methods, tested and refined over the past few centuries. However, there is also a certain image of science that exists in the popular imagination and propagated through the textbooks that portrays the nature of knowledge as insular, value free and authoritative (Rudolph, 2005). This image of science has consequences in the way the public receives it - there is an unquestioned reliance and lack of criticality in their evaluation of scientific developments. Lack of understanding of the nature and limits of scientific knowledge also makes experts non-responsive to the needs of the public.

There is a wealth of philosophical literature that looks at the nature and purposes of scientific knowledge from the perspective of its role in society (Allchin, 1999; Kitcher, 2003; Longino, 1983, 1987, 2006; Rudolph, 2005). I employ these to argue that creating a dichotomy between STSE topics and academic science content in terms of viewing the former as value-laden and the latter as value-free reinforces the “myth of purity” of academic science. Engaging with the contentious philosophical aspects of the academic science content along with a discussion of topics that fall within the STSE category is necessary for students who are training to be scientists inorder to be more humble and reflexive with regard to the knowledge that they produce. Likewise, those students who are not training to be scientists also stand to gain from understanding the nature and limits of scientific knowledge.

Next, I review perspectives from philosophy of science and science studies that discuss science's relationship with society (Fig. 1).

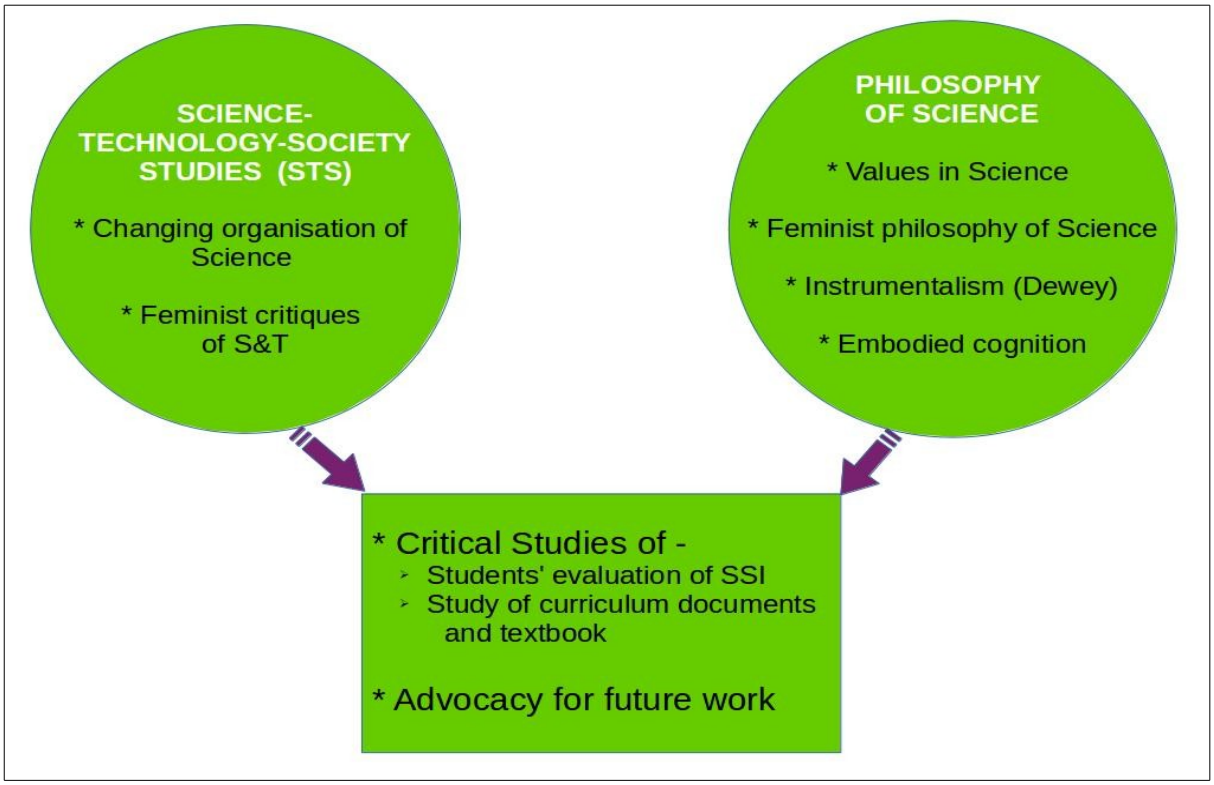


**Fig. 1: Philosophical perspectives informing the work in the thesis**

As Howard (2009) points out, "Science in a social context is science influenced by values, motives, social interests, and political agendas" (p.202). In fact, the fact-value dichotomy[3] maintained "even" in the so-called pure sciences has been questioned (Laudan, 1984; McMullin, 1983; Putnam, 2002). These views have been succinctly summarized by Allchin (1999). Pointing out that the fact-value dichotomy is not as sacrosanct as popular conceptions regard it, he reviews literature in philosophy and sociology of science which discusses the relationship between science and values, identifying three broad ways in which they interact. Firstly, there are values of science which are values internal to science or epistemic values – what scientists regard as necessary values when engaging in scientific inquiry – such as novelty, accuracy, simplicity, precision, repeatability, keeping at bay error, fraud, research ethics and so on. Secondly, values from larger culture could enter science through individual practitioners. For instance, the work of feminist philosophers of science have exposed androcentric values inherent in different areas of scientific research (Longino, 1983, 1987). Finally, values from science – both as a product and process get exported to society. Certain values regarding science are held by society or the public at large – that it is objective and hence, scientific evidence qualifies as the final arbitrator of any socio-scientific controversy. He cautions against this

3 A major proponent of the fact-value dichotomy was David Hume, according to whom statements pertaining to what *is*, or those which are matters of fact need to be seen as different statements that refer to what *ought* to be, or which are statements of value (Reiss, 1999)

conception and discusses how, in risk assessment particularly, where scientific evidence is uncertain, values other than science may play a role in resolving the issue. He also discusses briefly the intersection between new technology and values, pointing out that new technology can either raise new values[4] or radically challenge fundamental values[5].

The post-positivist turn in philosophy of science is also beginning to question notions of whether science faithfully represents reality and more importantly, what are the larger motives guiding theory building in science. Drawing from philosophers of science like Dewey, these perspectives reiterate the need to view the primary function of thought and knowledge as directed towards action/modification of environmental conditions (Colucci-Gray, Perazzone and Dodman, 2013; Levinson, 2010; Rudolph, 2005). According to this instrumental view, knowledge should be viewed primarily as an intellectual tool that addresses human needs, which not only meets practical needs but also serves to understand the world. Kitcher (2003) puts forth a similar perspective elucidating, through different examples, how models of naïve realism – which posit that a unified, true depiction of the world can be arrived at through methods of science – do not hold true anymore and why there is a need to understand that a network of practical and intellectual concerns drive scientific inquiry which are contingent on historical, social and cultural context. Rudolph (2005) points out that these ways of understanding science, counter to the view that is propagated in textbooks that portray it as purely disinterested pursuit of knowledge, opens it up for public scrutiny. Aside from these aspects, tools like language play an immensely important role in how we construct knowledge and the metaphors we use reflect the social and cultural context within which science is done (Colucci-Gray et al., 2013; Martin, 1991).

Recent work in science studies in the last two decades have also pointed out that the organization and institutionalization of science is changing, which is in turn impacting the nature of science. One of the major forces is commercial interest, followed by the rupture of traditional disciplines confined within universities. Science is moving out of the laboratories and we see that it is increasingly being produced within the context of application – as evident in the recent advancements in genomics, robotics, nanotechnologies and so on (Funtowicz & Ravetz, 1995; Nowotny, Scott & Gibbons, 2003). Put differently, the traditional dichotomy between representing and intervening is breaking, and the new knowledge which is *actionable* in nature demands ethical evaluation (Basu, 2015).

4 He discusses the example of organ transplants, pointing out that though they preserve the value of life, they also raise new values, such as issues of equitable access.

5 He discusses the example of new reproductive technologies and how they conflate the concept of parentage.

Bringing it all together, I would like to point out that this thesis is primarily an exposition of an alternative view of what a science education that aims to inculcate critical perspectives on science and social justice concerns *could be*. In accordance with this vision, I report three studies in this thesis. Study 1 (reported in chapters 2 and 3) examined the school science curriculum documents, and one textbook - the higher secondary class XII biology textbook with a focus on how it approaches the fact-value dichotomy. Study 2 (reported in chapters 4 and 5) involved empirical studies with higher secondary students with a focus on the value considerations (epistemic and non-epistemic) that students bring to bear on a socio-scientific issue related to commercial surrogacy. In chapter 6, I argue that critical science education should persist through to the PhD level and report findings of Study 3 involving PhD students, where the epistemic and non-epistemic criteria that students generate while evaluating genetic determinism are explored. The thesis does not compare any of the reported studies, but aims to, a) Point out that the manner in which social, political and ethical concerns are discussed in the existing school science curriculum leaves a lot to be desired, b) Demonstrate ways in which one can design educational experiences that can expose students to the interaction between science and values in context, and c) Advocate a vision for critical science education at all educational levels.

# Chapter 2

## Social, political & ethical concerns in the science curriculum documents and higher secondary biology textbook

There are several initiatives in science education that have tried to engage with the issue of values [6] in science and how to bring an awareness of these concerns into the science curriculum. The STS movement in science education (Aikenhead, 2005), for instance, seeks to teach science and technology by placing them in the larger social, political and ethical context. Unlike many science curricula worldwide that have emphasized STS education, the Indian science curriculum is yet to embrace these concerns in a major way (Raveendran & Chunawala, 2013). This chapter will report an analysis of school science curriculum documents (NCERT, 2006b; 2006c) as well as the class XII biology textbook (NCERT, 2006a) with a focus on how these present social, political and ethical concerns in terms of the ideals of critical science education.

6 The term “value” is used to denote notions pertaining to “what ought to be” and could also include epistemic values. In this chapter, however, I use the term value to denote social, political and ethical concerns.

The higher secondary science curriculum represents a level where disciplinary pressures operate, so it becomes interesting to analyze how STS concerns get treated by the curriculum and textbooks at this level. Can these concerns be omitted from the curriculum? Is a value-free rendering of scientific and technological applications possible? These concerns brought me to analyze the higher secondary biology textbook.

Before I turn to the analysis, I discuss why examining textbooks and the curriculum documents is necessary. Textbooks represent sites where dominant values and ideologies get selectively and authoritatively transmitted, (Apple, 1990) thereby making it necessary to critically analyze them. The discourse in science textbooks become particularly important to examine because they have the quality of speaking “the truth” authoritatively, making it important to question their assumed objectivity (Bazzul, 2013).

The methodology that I employ in my analysis would fall within the tradition of critical discourse analysis (Fairclough, 1989), which predicates itself on the understanding that language is a social activity, where it is viewed not just as a reflection of larger social structure, but as something that actually impacts wider social structures. Fairclough introduces a methodology to examine texts in terms of vocabulary, grammar and textual structures. The analysis will pay attention to these aspects as well, wherever they are apparent, highlighting words and phrases in the text that suggest adherence to certain ideologies. I will then contest these ideological positions from alternative standpoints. The validity of my interpretation is open to the reader to judge based on the force of my counterarguments, and the kind of evidence I bring to bear on my arguments.

The analysis begins with an examination of the National focus group's position paper on the 'Teaching of Science' (NCERT, 2006b) which provided recommendations for textbook writing, both at the national and state level. I find that the position paper gives primacy to facts over values as evident in the positivist understanding of the nature of science, the view that science can alleviate all social problems and the vision for scientific literacy that emphasizes learning of facts, principles and theories:

> Facts, principles, theories and their applications to understand various phenomena are at the core of science and the science curriculum must obviously engage the learner with them appropriately (NCERT, 2006b, p.12 ).

Prescriptions for science education at the higher secondary level in the position paper also marginalize STS concerns, deeming it unworthy of “formal assessment”. On the other hand, the

higher secondary biology syllabus document (NCERT, 2006c) mentions the need to introduce ethical issues in the textbook:

> The syllabus also takes up issues pertaining to environment, health and other ethical issues that arise with any interference of human beings in the natural processes, which have great relevance from the societal point of view (p.1).

In my analysis of the class XII biology textbook, I do two things 1) Examine what the textbook *explicitly* brackets out as values - ethical and political concerns, 2) Examine *implicit* values conveyed when discussing topics that are at the interface of the scientific and social world that relate to human life and its regulation, as well as the relationship of humans with non-human world. These topics include: human health, gender and sexuality, population as well as non-human life forms in relation to human needs (biodiversity and environmental issues). These topics were chosen as they are often discussed in STS literature. As Viswanathan and Parmar (2002) and Basu (2015) point out, any ethical discussion on the new technosciences cannot preclude the discussion of risk. The estimation of risk, by its very nature is a value-laden exercise (Douglas, 2000). Hence I discuss how risk is treated in the textbook as well.

The textbook does make some explicit references to ethical and political issues. For instance, the preface states that, “Patent laws brought biology into political domain and commercial value of biology became obvious” (p.V). The sense that gets conveyed through this statement is that the politics around biological knowledge and applications are confined to issues related to patent laws and intellectual ownership. This is further developed in the section on “ethical issues” in the chapter 'Biotechnology and its applications' where there is a predominant focus on issues of piracy. There is only a cursory mention of the existence of ethical concerns in discussions on medical termination of pregnancy in the chapter and fertility enhancing technologies in the chapter on reproductive health and the human genome project in the chapter on molecular basis of inheritance.

Apart from explicit discussions of ethical and political concerns, dominant, mainstream values are conveyed *implicitly* in the discussion of several topics. For instance, in a discussion related to health, it is stressed that a healthy body is eventually needed for “economic prosperity” while sociopolitical factors of health are sidelined. Similarly, for topics pertaining to gender and sexuality, we find cis-gendered bodies and heterosexual, monogamy being promoted as the norm and those that deviate from this norm being pathologized. Fig. 2, for instance, depicts two individuals who have (a) Klinefelter's syndrome and (b) Turner's syndrome. What is marked out as a “disorder” is

the presence of feminine character in the male and the absence of it in the female.

When discussing the non-human world, the textbook has adopted a largely anthropocentric focus where human life is valued over other forms of life, a recurring theme in the textbook being the need to feed the increasing population of the world and harness the extended non-human world in service of this agenda.

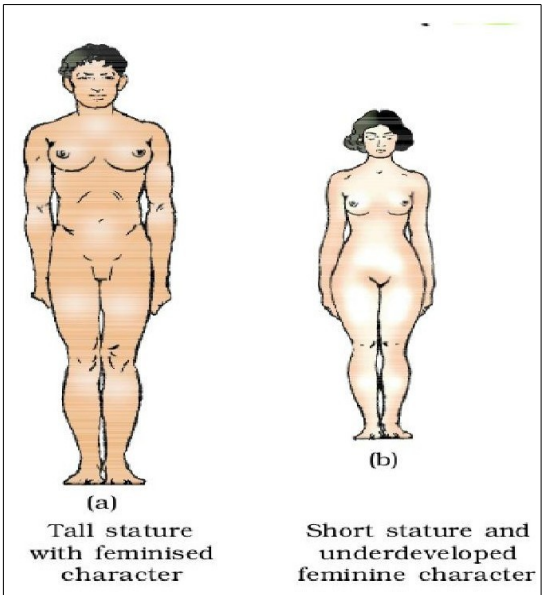


**Figure 2**
**Pathologising infertile bodies**

Thus we find a range of ideological positions held by the textbook on various topics. While, on the surface, the textbook discourse promotes values that support (often regressive) agendas of the state, there are also undercurrents of resistance against these agendas as evident in the discussion on conflicts around topics such as the green revolution technologies and e-wastes and nuclear waste. On the one hand, for certain topics such as nuclear waste, public resistance and issues of risk are acknowledged while on the other hand for topics such as reproductive health, the state's regressive agendas of top down fertility control is promoted (discussed in detail in chapter 3). However, there is no acknowledgement, in any sense, of the epistemological as well as political critiques raised by the womens' health movement. Somewhere in between, we have topics such as biotechnology where public resistance or environmentalists' concerns regarding risks are sidelined, while issues like biopiracy are discussed.

Though, admittedly, there is some acknowledgement of risk around certain technologies, the textbook does not pay any attention to the skills needed to evaluate the nature and extent of risks. I also observe that knowledge in the textbook is treated as a commodity, with focus on questions of patenting and ownership. Indigenous knowledge is viewed as something that can be tapped into by modern science, through patenting regimes. Besides, the nature of indigenous knowledge is not dwelt upon and even in sketchy discussions of topics like *Ayurveda*, indigenous knowledge is portrayed as inferior to modern western science.

In summary, though one can observe that the values and ideologies expressed in the textbook are conflicting and do not reflect any particular monolithic agenda, one also gets the sense that careful attention is not being paid to the kind of values that are getting conveyed by the textbook. This

treatment is consistent with the position paper's advocacy for science education at the higher secondary level, which gives primacy to teaching facts and relegates STS concerns to the periphery. I, therefore, argue that it is important that textbooks begin to reflect the value conflicts around the technosciences as well as topics that fall within the science-society interface. Besides, committees that write textbooks need to acknowledge value conflicts inherent in these topics as well as think through which values, why and how need to be incorporated, with the understanding that values cannot be kept out of discussions related to these topics. Ignoring value conflicts can result in regressive and oppressive agendas of the state and neoliberal global capitalism percolating into the textbook. Hence, science textbook writers need to engage with the wide range of STSE scholarship existing in the country and worldwide.

# Chapter 3

## Reproducing values: A feminist critique of reproductive health in the higher secondary biology textbook

In this chapter, I closely discuss one chapter on reproductive health in the class XII biology textbook (reported in Raveendran & Chunawala, 2015) using a feminist lens. Here too, the focus is on the kind of values that are being conveyed in the discussion on reproductive health, bringing to bear on the analysis, feminist scholarship in India that has critiqued reproductive health policies of the state (Manorama & Shah, 1996; Narayanan, 2011; Qadeer, 2009, 2010), as well as the technologies that have been promoted by these policies. The reason for this in-depth discussion on the chapter on reproductive health is because it affords a context to discuss the next two chapters of the thesis (4 and 5), which present higher secondary biology students' negotiation of a socioscientific issue related to commercial surrogacy. The methodology adopted to analyze the chapter is critical discourse analysis (discussed in chapter 2).

The textbook chapter is critiqued in three ways. The first part discusses how reproductive health is defined with a focus on 'whom' and 'what' this definition includes and excludes. The second and third parts have been devoted to critiquing how population control and infertility are presented drawing on feminist critiques of these technologies.

When discussing the definition of reproductive health, the textbook reiterates the idea of *normalcy* of reproductive organs and behavioral interactions between the sexes:

> The term simply refers to healthy reproductive organs with **normal** functions. However it has a broader perspective and includes the emotional and social aspects of reproduction also... according to the World Health Organization (WHO), reproductive health means a total **well being** in all aspects of reproduction, i.e., physical, emotional, behavioral and social. Therefore, a society with people having physically and functionally **normal** reproductive organs and **normal** emotional and behavioral interactions among them in all sex-related aspects might be called reproductively healthy (p. 57, emphases added).

While the term 'well being' (used by the WHO) acknowledges the individual's subjectivity in her experience of reproductive health; the term 'normal' takes away this individual experience connoting an external, scientific standard of reproductive health, defined by functionality of organs. This definition excludes people of sexes other than the socially accepted male and female sexes. Apart from this, the phrase 'normal behavioral and emotional interactions' also appears to pathologize people with different gender identities or sexual preferences whose experiences of reproductive health may be very different. Such definitions based on the idea of normality make it easier to propose technological fixes to correct abnormalities.

Feminist critiques of reproductive health policies of the state (Narayanan, 2011; Rao, 2000) point out that the population control policy of the state has been top down and coercive. Collaborative approaches to population control, which focus on overall social and economic development (providing access of the population to health, education, food, water etc) have been known to work better (Sen, 1994) in regulating population. Besides, policies on reproductive health needs to be evaluated in the context of the larger changes in the health sector, where we see a withdrawal of the state from investing in public health (Rao, 2000). The textbook, however uncritically promotes the population policy of the state.

The textbook chapter also appears to be devoted to the uncritical marketing of technologies used to facilitate reproductive control and fertility assistance. Dry, technical descriptions of fertility control technologies take up large sections of the chapter. Side effects and users' experiences of these technologies are sidelined, as evident in this sentence:

> No doubt, the widespread use of these methods has a significant role in checking

> uncontrolled growth of population. However, their **possible** ill-effects like nausea, abdominal pain, breakthrough bleeding, irregular menstrual bleeding **or even** breast cancer, **though not significant** should not be totally ignored (p. 62, emphases added).

The women's health movement has raised epistemological as well as political questions on many of these technologies which are harmful. Yet, there is no mention or acknowledgement of the issues raised by the movement. Other important dimensions of reproductive health like maternal and child well being, control of STDs, pregnancy and medical termination of pregnancy are discussed but not given priority. The negligible space devoted to the discussion of these topics is an indication of this.

The textbook's latent function appears to be that of serving the state agenda of reproductive control of its citizens, particularly women, through the use of technology. This is manifested in its celebration of the population control policy as well as the discussion of fertility enhancing technologies, with limited scope to questioning the role of these technologies in reinforcing patriarchal notions of genetic parentage. Importance of the knowledge of the menstrual cycle and the efficacy of natural and less invasive contraceptives are underplayed while chemical and more invasive technologies are celebrated paying only lip service to the serious side effects associated with these technologies. There are no possibilities afforded by the textbook to question the very need of these technologies.

One of the professed aims of the curriculum at this stage is to create future scientists, technologists and medical practitioners (providers of these technologies). In the context of this aim, the absence of any discussion on side effects of the various contraceptive and fertility technologies is worrisome because it implies that the users' perspective or experiential meaning of the technology does not matter in a curriculum catering to the providers of these technologies. The text also promotes technocratic solutions to birth control and fertility assistance, inadvertently suppressing the socio-political dimensions pertaining to these aspects. Thus, values and ideologies motivate decisions on what should qualify as 'content' in the textbook. Interviews with three teachers who teach the topic reveal that they view the topic as value-laden. However, the values that they wished to communicate were largely related to issues surrounding marriage and sexuality.

Recalling the discussion in chapter 2, from the point of view of critical science education, I emphasize that careful attention needs to be paid to what values textbooks convey. Textbook writers and teachers need to understand that discussion of technosciences cannot happen in a sterile manner without bringing in value-positions.

# Chapter 4

## Social and ethical concerns raised by students in the evaluation of a SSI: Case of Commercial Surrogacy

How do students, in the absence of any formal educational exposure, deal with real world socioscientific issues? In this chapter, I report an exploratory study where students encountered and negotiated a socioscientific controversy. The issue presented to the students was commercial surrogacy, which is related to In-Vitro-Fertilization, a technoscience fraught with conflicts which are ethical, political and scientific in nature. A total of 39 students participated in the study, of whom 20 were interviewed and the remaining 19 participated in workshops that involved interactive sessions, group work and debates. Both the interviews and workshops employed questionnaires (Appendix I and II) on the basis of which discussions took place. The interviews were audio-recorded while the group interactions were video and audio recorded.

Students' responses have been illuminated using a theoretical framework proposed by Ralph Levinson (2006). The epistemological framework helps to unpack what is at stake in a controversy in terms of Levels of Disagreement[7] (LoDs) in a systematic and structured manner. The levels of disagreement represent different aspects/layers of the controversy that pertain to evidence, values or worldviews. There are nine LoDs and the direct role of evidence in resolution of the disagreement diminishes as we move from level 1 to level 9. Table 1 discusses commercial surrogacy in terms of the different levels of disagreement.

The **description** of the levels in Table 1 (as discussed in Levinson, 2006, verbatim):

**Level 1**- Disagreement related to evidence which could in principle be forthcoming would be available at some point

**Level 2**- Disagreement related to evidence which is “conflicting, complex and difficult to assess”

**Level 3**- The criteria needed to resolve the controversy may be agreed upon. But disagreement on weightage needed to be given to these criteria.

**Level 4**- Disagreement related to lack of consensus between the parties on ethical premises.

**Level 5**- Disagreement related to difference in interpretation of concepts involved.

**Level 6**- Disagreement related to different perspectives that arise due to difference in interest positions.

7 Levinson (2007) derived this framework on the basis of Mc Laughlin's framework which outlines what is at stake in a controversy in a pluralist, democratic society

**Level 8**[8]- Disagreement due to differing 'total experiences' of people involved.

**Level 9**- Disagreement related to the entire frameworks of understanding/world-view differences.

| LEVEL 1 and 2 | LEVEL 3 | LEVEL 4 | LEVEL 5 | LEVEL 6 | LEVEL 8 | LEVEL 9 |
|---|---|---|---|---|---|---|
| -Health risks to the surrogate mother, biological mother, child<br><br>-Success rate of IVF procedure | Concerns related to affordability and access | Does surrogacy amount to trading the body? And is this acceptable? | -What constitutes 'family'?<br>Does lending genetic material amount to parenthood?Need for genetic family (ensured through ART) versus Need for social family (ensured through adoption)<br><br>-Are the surrogates making a 'choice' to rent their wombs? Is a choice motivated by poverty a free choice?<br><br>-Are the surrogate mothers being exploited? Can someone choose to be exploited? | If participants look at commercial surrogacy from the interest position of commissioning parents, they may see it as justified. But from the perspective of surrogate mother, is it justified? | An adopted person may have strong positions on the issue | Worldview differences stemming from Religious concerns that view IVF/ Surrogacy as unacceptable |

**Table 1: The issue of commercial surrogacy discussed in terms of Levels of Disagreement**

Students raised multiple social and ethical concerns towards the issue (Fig. 3). These can be grouped into bioethical concerns (further classified into concerns related to harm, concerns related to access, concerns related to autonomy and choice), concerns stemming from differences in worldviews (those related to the nature of the family, religion, social acceptability of the surrogate mother), economic concerns (those discussing development of the nation, concerns related to women's economic independence) and epistemic concerns (those invoking scientific knowledge and evidence).

8 Level 7**,** According to Levinson (2007), can be subsumed under other levels. He does not develop level 7 further.

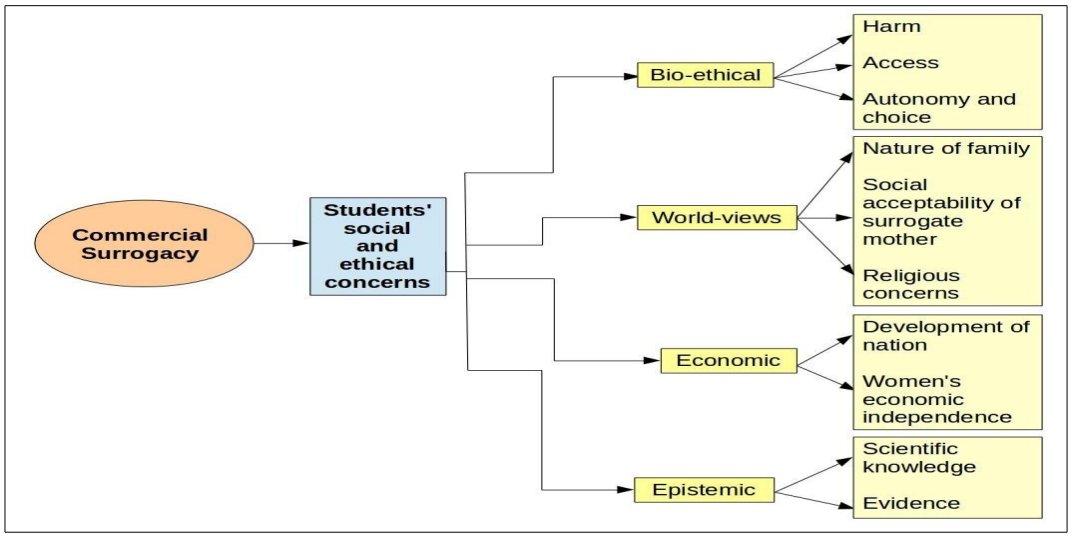


**Fig. 3 : Social and ethical concerns raised by the students**

Except for a few students who questioned the very need for the technology in terms of whether having one's own biological child is necessary or not, most students were accepting of the technology and its potential to offer a solution to infertility. Nevertheless, when probed, many of them raised pertinent questions, which included questions about risks to users.

In terms of Levinson's levels of disagreement, these concerns could be taken up for discussion at multiple levels. At level 1 and 2, several students raised questions as well as concerns related to the extent of health risk posed by the technology to various users. Preliminary explorations in the interview suggested that students needed support to understand the nature and extent of risk. To this end, I (along with another facilitator) conducted a set of structured activities to elicit their understanding of different sources of evidence and their reliability (discussed in the next chapter).

Students also raised considerations that could be pitched at level 3. In some instances, we found them conducting cost-benefit analysis, where they weighed one concern against another. For instance, there were group discussions around whether access for all is a necessity when it comes to IVF. This is an important point to raise for any technology, but some students felt that the technology need not be accessible to the poor because they are unable to take care of their children anyway. This is obviously a prejudiced view and a teacher would need to intervene and raise questions on whether this is a desirable way of framing the question. Questions could be raised such as, is the right to procreate, a universal right? Should the government funds for health care be spent on making services like IVF available through the public health care system?

Another level 3 disagreement that students appeared to grapple with was whether the health risks

posed by the technology could be traded off for the financial gains that the surrogate mother would have by engaging in surrogacy. Students arrived at different decisions on whether the money that she was making was sufficient, taking into consideration the health risks that she is likely to endure. One of the key issues that need to be addressed in order to resolve the disagreement would be to ascertain the levels of risk involved for the surrogate mother, as well as the acceptable levels of risk, which would in turn require a careful evaluation of the evidence available.

At level 4, students indicated disagreements on the basis of differences in ethical or value premises. For instance, we witnessed an exchange between a boy and two girls, where the boy was deeply troubled by the idea of the surrogate mothers' body being treated like a commodity and being “traded”. While one of the other participants in his group appeared to see his point of view after some persuasion, the other student remained indifferent. Handling these disagreements may prove difficult for the teacher, who may have to illuminate different points of view and ensure respect for diverse views. At level 4, we also had students raising concerns and debating on the need for technology in terms of whether a family based on genetic relationships is necessary. Here too, it may be worthwhile to interrogate views that stress the need to maintain sanctity of the bloodline as some of these appeared to come from casteist perspectives. Educators/teachers could also raise questions on the nature of infertility - whether it is a biological problem rooted in notions of genetic relationship or a social problem.

Disagreement at level 5, which involves differences that may arise due to alternative ways of interpreting a concept was also apparent in the interviews as well as group discussions, especially views which questioned the idea of a family. One student, in his interview, raised a fundamental point about the nature of the family when he suggested that one can always treat someone as one's family. He seemed to understand the term “family” differently from most other participants, who did not question the notion of family premised on genetic relationships. Another disagreement at level 5 emerged when students debated on the nature of “experience” a surrogate mother would have, after going through the IVF procedure regarding the side effects and risks posed by it as compared to a doctor, who has a specialized knowledge regarding IVF. Disagreements at both level 4 and level 5 may not be easy to resolve as these differences often stem from considerations that arise from different ethical or value premises. However, these differences ought to be discussed in the classroom, and the teacher could help illuminate differences in premises and consideration of alternative viewpoints.

At level 6, we found students raising concerns based on the interest positions they assumed in terms

of different stakeholders involved in the technology. From the perspective of critical science education where there is an explicit commitment to equity and social justice, it might be important to get students to evaluate the technology from the standpoint of the most marginalized user of the technology, and in this context, the surrogate mother and the risks the technology would pose to her body. Though many students took positions that were concerned about the surrogate mothers health, some found it difficult to evaluate the technology from the surrogate mothers' point of view.

It was difficult to gauge whether any of the student responses could come from deep rooted personal experiences (level 8) as our interactions with the participants were for a limited time. Nevertheless, there is reason to believe that this may have a role in shaping their views at various levels. At level 9, we see participants arguing on the basis of religious beliefs. Arguments at this level would be a challenge for teachers to handle, particularly those views that are regressive and reinforce notions of caste and patriarchy. It is not clear whether all the students subscribed to these notions, because some of them would often *other* these worldviews as something that the extended "society" harbors. This was evident in the debates around the desirability of a biological family vis-a-vis a social family. As Levinson (2007) points out, arriving at a consensus for participants who argue on the basis of differing world views is difficult. So the task for the teacher would be to encourage different worldviews on both the sides and facilitate the development of empathy and mutual tolerance. In this context, it may also be important to keep in mind the point made by Levinson (2007) where he asserts that racist, sexist or other anti-minority views are not to be viewed as controversial since views that oppose equality of human beings are not rationally defensible, and these views cannot be aired in a classroom context, in a climate of mutual respect and tolerance. Therefore, views that are openly prejudicial need to be challenged by the teacher.

To sum up, Levinson's LoDs were helpful as a theoretical framework to parse out the issue of commercial surrogacy in terms of multiple levels. Students' viewpoints were also evaluated from the perspective of critical science education, which premises itself on normative ideals such as social justice and emancipation, which in turn entails a commitment to countering and resisting hegemonic structures such as patriarchy, caste and capitalism. What we witness is that students bring a wide range of social, ethical and political considerations regarding the controversy, indicating a spectrum of worldviews. From the point of view of critical science education, the existence of student discourses that supported inequalities related to class, caste and gender is worrisome. Working with students who harbor reactionary perspectives may prove to be a challenge. There were certain views that could be associated with minority groups as well (those

related to religious beliefs, for instance), which will need to be carefully and sensitively addressed, if brought up in the classroom.

# Chapter 5

## Epistemic concerns raised by students in the evaluation of a SSI: Case of Commercial Surrogacy

There is general consensus that one of the many skills that would help in arriving at informed decisions regarding socioscientific issues is the ability to evaluate evidence, though not the most important one. Nielsen (2013), for instance, points out that socioscientific deliberation is not just about what is true, but what to do and hence requires the integration of values and facts. Students need skills to integrate factual information, if they perceive it as necessary in their deliberations of socioscientific issues. The reported study was conducted to document ways in which students evaluate evidence related to the risk posed by the procedure of surrogacy and its impact on the surrogate mother's health.

This study involved 13 students of class XI who engaged in a series of structured activities (reading and debating around questionnaires) that closely examined their understanding of various aspects of evidence evaluation. The interactions were conducted in a workshop format spanning two days. Students worked on four worksheets individually (Table 2), discussed these worksheets in student-only groups and with facilitators. Their discussions and interactions were video and audio-recorded.

| Worksheet | Purpose |
|---|---|
| ***Worksheet 1 (Q.4)*** *Fictitious scenario involving a potential surrogate mother who wishes to get information on health risks posed by the procedure. She approaches the student to find some information for her. Students are asked to list potential sources of evidence that they would look for.* | *To elicit students' understanding of primary and secondary sources of evidence* |
| ***Worksheet 2*** *Internet research activity where students were asked to locate reliable websites that host information on health risks related to surrogacy* | *To elicit students' understanding of how to evaluate secondary sources of evidence: Do students critically examine the sources from where information is derived? Do they evaluate the websites in terms of who hosts them?* |
| ***Worksheet 3*** *Students were asked to compare between primary sources of evidence: the doctor and surrogate mother.* | *To elicit students' understanding of the distinctiveness and validity of different sources of knowledge.* |

| | |
|---|---|
| *Students were asked to assess 5 sources of secondary evidence and judge their reliability: Newspapers, School and college textbooks, Medical textbooks and Research Journals.* | *To elicit students' understanding of the nature and reliability of sources of information* |
| ***Worksheet 4*** *Students were asked to compare two newspaper articles. While the first article (unfavorable to surrogacy) was written in a more logico-scientific style, the second article (favorable to surrogacy) was written in a more flowery, sensational style, with little evidence, and more rhetoric.* | *To understand how students use evidence in their evaluation of claims.*<br>*Do they evaluate sources of information?Are they sensitive to framing effects? Do they see through rhetoric? Are they ready to confront their biases?* |

**Table 2: Worksheets used for the study and what they probed**

In response to the question (worksheet 1, Q.4) on different ways to find out potential health risks the IVF procedure would cause to the surrogate mothers, all students categorically stated that this is possible by collecting primary (doctor and surrogate mother) and secondary sources of evidence (the Internet). Their views on the reliability and trustworthiness of both sources of evidence were investigated in worksheet 3.

With regard to the primary sources of information, all students recognized that the doctor's knowledge and the surrogate mothers knowledge of the IVF procedure are distinct and valid sources of knowledge. Some students pointed out the limitations and strengths of the two sources of knowledge. There were some who articulated the difference very well as a distinction between declarative, abstract, generalizable knowledge (expert knowledge) and personal, experiential knowledge (lay knowledge).

Results from the Internet research activity indicate that the criteria that students used when establishing the reliability of a website were naive. One criteria was checking if the information in a website is repeated in other websites. This would conversely establish the reliability of the website as well. According to this criteria, which I term *concurrence*, non-conflicting knowledge regarding health risks posed by surrogacy is available, and it is just a matter of cross checking the information with other websites. Another criteria that a student came up with was *corroboration* – evaluation of the information in terms of whether it is corroborated by one's “real life experiences” - knowledge of the issue that one has gathered on the basis of one's own observations. In case this is absent, then one can talk to a knowledgeable elder that one trusts. Other criteria were *speed*, fast websites being more reliable, as well as the *credibility* of who hosts the website (government or private). Students expressed faith in government websites while they seemed unsure about the reliability of commercial websites.

Students, when evaluating various sources of secondary information, again resorted to naive criteria when evaluating these. One criteria was *popularity*; the belief that the popularity of a particular newspaper makes it reliable. Another criteria was *purpose*; as evident in responses which indicated that information in a medical textbook is reliable because it is designed to help people or that school textbooks have true information because their purpose is to educate. The third criteria was *expertise*, which students employed when discussing the reliability of medical textbooks. Finally, when discussing the reliability of research journals some students used the criteria of *generalizability*, pointing out that the presented research may not be reliable because it might be ongoing or localized to a specific sample or location. Only a few students indicated familiarity with what research journals are. Fig. 4 illustrates the criteria students used when evaluating different sources of information.

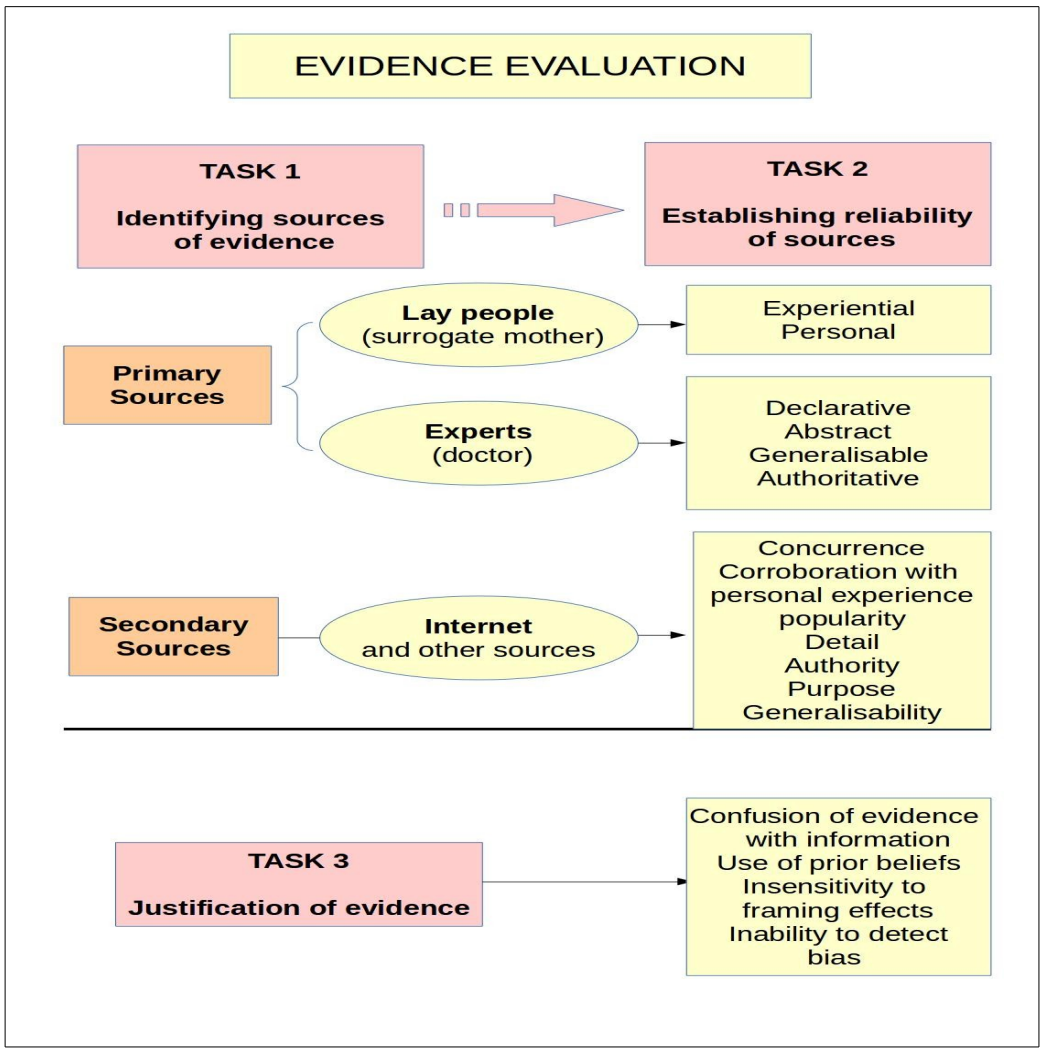


**Fig. 4: Criteria raised by students when evaluating sources of evidence**

In summary, students showed limited and superficial understanding of how to assess the reliability

of different secondary sources of information. While a few students indicated the limited nature of certain sources like newspapers, school textbooks and research journals, as a whole, they did not seem to have a clear idea of how to evaluate different sources of information and what criteria to use when doing so.

The purpose of the final exercise involving the evaluation of two newspaper articles (worksheet 4) was to get students to evaluate the empirical adequacy of the articles, detect bias or vested interests on the part of the authors of the article. While the first article was written more like a research report, the second article was written in an informal manner, using flowery language, with very little evidence. There is also a possibility that the article was written to promote a fertility clinic.

Regarding the students' abilities to use empirical adequacy as a criteria, some of them (5/10) confused the evidence used in the articles with the information presented, reflecting naive strategies of evaluating evidence. Among students who did indicate some understanding of evidence based evaluation of claims, one student exhibited a strong tendency to go by her own prior beliefs regarding the issue. These findings are consistent with what is reported in Driver, Leach and Millar, (1996) and Zeidler (1997). Even when some students used the criteria of empirical adequacy, they did not appear to consider it necessary if the emotional content of the article appealed to them. Gardner, Jones and Ferzli (2009) discuss *framing* as a way of packaging information by the media to capture the attention of the audience by using specific phrases, words or images. When the frame is weighted towards a certain perspective, through the selective use of certain details, then it is called a framing effect. They point out that frames can have a significant effect on how students engage with issues and cite evidence to suggest that negative frames tend to influence students perspectives more than positive frames. Further, they advocate that students need to develop skills to negotiate media frames that they encounter in order to develop scientific literacy. In this study, however, we find students inclined towards both frames. This may have to do with their prior beliefs and commitments interacting with the framing effect of the article, and requires more research to be established. Indian students have been reported to have positive attitudes towards technology (Khunyakari, Mehrotra, Chunawala & Natarajan, 2009; Sjøberg & Schreiner, 2010). This may have had an effect on their resistance to negative frames in the article. Moreover, the students who were veered towards the second article were all female. These students mentioned being moved by the emotional content of the article which discussed tolerance, sacrifice and will power of the surrogate mother. No generalization can be made from a small sample of students, but future studies could look into whether gender of the reader has any role in how they respond to

framing effects.

Literature in personal epistemology postulates that individuals move from views of knowledge as absolute and unchanging, to views that see knowledge as merely personal and subjective, to a more considered and evaluativist position that integrates the objective and subjective dimensions of knowledge. Viewing the results from this framework, one sees some of the participants adopting relativist, subjective positions of evaluating knowledge, considering evidence which conformed to their beliefs regarding the issue, and ignoring contradicting evidence. Only one student applied an evaluative stand vis-a-vis the articles. He tried to rationalize why the articles may have different positions on surrogacy, though he attributed it to the state of mind of the surrogate mother and how she might have felt at the point of time the interview was conducted. I believe that the student was taking a more sophisticated position when evaluating the articles where he resisted framing effects and tried to understand why there was a contradiction in what is reported in the articles. Besides this, the student justified his allegiance to what is said in one article even after noticing that the evidence is insufficient.

In terms of viewing sources of information as corrupted by interests, only one student pointed out the possibility, in the context of discussing primary sources of evidence, that the doctor's knowledge could reflect vested economic interests. Many students exhibited unquestioning reliance on authoritative expert knowledge, as evident in their responses that were uncritical of doctor's knowledge as well as their view of medical textbooks as carrying true, authoritative knowledge.

Overall, the impression one forms, on the basis of the above discussion, is that higher secondary students' knowledge of how evidence gets collected, theorized about and presented is limited. When given specific activities to evaluate information, some of them do engage with it at a preliminary level. But they do not see how information presented in the media need to be evidence based, how to track the evidence presented in these articles to their sources, and also detect bias and vested interest in the information. The study points to a lack of basic media literacy among higher secondary students and the need to impart skills to evaluate conflicting media reports, synthesize one's own perspective on a controversial topic based on a critical reading of information as well as detect bias, vested interest and so on, which would be necessary skills from the point of view of critical science education.

# Chapter 6

## Conceptualizing critical science education beyond the school level

While up till now, the focus of the thesis has been on critical science education at the higher secondary level, which represents the 'entry point' to a specialized education in science, this chapter attempts to conceptualize critical science education for students at the 'endpoint' of a specialized education in science. To this end, I review some work done in India and report findings from a preliminary study with doctoral students (Raveendran & Chunawala, 2015) that explores the value considerations that students employ when evaluating a media article that makes a deterministic claim. Future directions for this kind of work are also discussed.

As mentioned in the introduction, the changing organization of science as well as the concomitant change in the nature of scientific knowledge calls for a different education for those training to be scientists. The new science and technosciences, that have stepped out of the laboratory, and are being produced closer to the context of application[9] (Carter, 2008) are no longer guarded by the Mertonian norms of *communalism*, *universality*, *disinterestedness* and *organized skepticism*. Thus, if we believe in the ideals of socially responsible and environmentally just science, we need reflexive and sensitive scientists who are willing to engage with the public on matters of concern that emerge from developments within science and technology and impact society. Science education will also need to take this challenge head on.

Indian higher education policy and certain initiatives at the higher education level have begun to reflect these concerns. Dhar, Siddiqui and Chandrasekhar (2011), in a discussion of the history of higher education policy in the country point out that the Report of the University Education Commission (1948-49) emphasizes a tripartite division of disciplines on the basis of whether they deal with; facts (Natural Sciences), events (Social Sciences) or values (Humanities) and this compartmentalization continues to rule the understanding of higher education. The report on renovation and rejuvenation of higher education also talks about “cubicalization” of disciplines as being one of the major problems plaguing higher education (Pal, 2009), calling for making disciplinary boundaries porous and for science to concern itself with problems of the real world. Dhar et al., (2011) propose that these priorities need to be operationalized through courses that attempt at “integration” across natural and human science disciplines at the undergraduate level and

9 Market forces have a huge influence on research in science and technology. Rajan (2006) notes that this is true particularly in the biological sciences where contexts of research have become corporatized.

that the natural science student need to move beyond awareness of social and human issues to an understanding of these disciplines. To facilitate integration, they suggest two models of integration at science education institutes: the soft model and the strong model. While the soft model of integration would involve exposing students to courses in humanities and social sciences alongside the courses in natural science in a way that they understand and appreciate the foundations of these disciplines, the strong programme involves getting the disciplines to dialogue in a manner that there is synthesis of new methodologies. To this end, they advocate teaching and research along integrated themes such as cognition, biodiversity and environmental science, biotechnology and bioethics.

Thinking along a more “softer” idea of integration, I believe that instead of introducing students to history, philosophy and sociology of science courses in a decontextualized manner, they should be provided with actual examples within their areas of inquiry which calls into question taken for granted positivist, enlightenment ideals of purity of scientific method and its ability to yield inherent truths about reality. there are plenty of historical as well as contemporary case studies in the sciences that can be used to get students to examine foundational assumptions that go into the construction of scientific claims (Allchin, 2011).

In the area of biological sciences, one such topic is neurogenetic determinism which involve claims that establish links between single gene mutations and complex behaviors which have the possibility of being examined from multiple perspectives: philosophical, ethical and sociopolitical. Genetic determinism refers to the belief system that attributes substantial weight to genes in shaping human traits (Condit, 2007; Lewontin, Rose & Kamin, 1984). This is closely associated with genetic reductionism: the belief that, by understanding human beings at the level of genes or molecules, we can understand what it means to be human. This framework has been criticized for being conceptually flawed. Furthermore, the socio-political ramifications of accepting deterministic claims have been debated widely in philosophical and scientific circles.

In a Nature article titled, “The rise of neurogenetic determinism”, Rose (1995) discussed the epistemic assumptions underlying the faulty sequence of reductive steps employed in constructing deterministic claims in neurogenetics. These include reification, arbitrary agglomeration, improper quantification, belief in statistical normality, spurious localization, misplaced causality, and dichotomous partitioning between genetic and environmental causes (elaborated in the thesis).

Deterministic claims can be criticized not just on the basis of epistemic or foundational (domain

general) assumptions, but also on the basis of more “domain specific” research findings – such as recent research in the fields of neurobiology and developmental biology which has brought forth explanations on the relationship between the genotype and the phenotype which challenge the linear, deterministic model. For every gene, there is a complex and intricate network of regulatory pathways that determine how much protein it produces and at what time. Segments of DNA that are located both near and far away from the gene regulate its activity. These are in turn regulated by proteins produced by other genes, RNA molecules or dietary substances. These findings emphasize that the unit of analysis should not be a single gene but a network of interactions. Therefore, emergent properties in a network, which may not be obvious if we study only a single gene, need to be taken into account in the explanations of genotype-phenotype (G-P) relationship (Berkowitz, 1996). Apart from the conceptual issues delineated above, there is the fact that deterministic claims on behavior are interpreted in a socio-political context and could therefore raise ethical concerns. That is to say “conditions” like homelessness or violence among the poor, which have an obvious social basis and are remediable through social intervention or policy change may get attributed to faulty genes. This may lead to victim blaming or diversion of resources from studies on important environmental and cultural determinants of a trait (Räisänen, Bekkers, Boddington, Sarangi & Clarke, 2006).

Kitcher (2003), in his discussion on political asymmetry, writes, “Standards of evidence must go up when the consequences of being wrong are more serious” (p. 97). In other words, if a certain scientific theory or claim implies support for anti-egalitarian conclusions, the evidence for the former must be strong. Deterministic claims related to behavior, cognitive capabilities and personality could potentially be used to stigmatize already marginalized groups. As per Kitcher’s argument, if scientists engage in such research, they would need to apply rigorous standards of empirical adequacy in their work. Hence, there is reason to believe that ethical sensitivity is a necessary quality in a good scientist and should be a part of science education.

A study involving biology doctoral students (reported in detail in Raveendran & Chunawala, 2015) was undertaken to examine how they approached the problem of genetic determinism and the kinds of criteria that they raised when they examined a media article that reported a correlation between a genetic mutation and creativity. Thirty students (20 females and 10 males), who were involved in conducting research in biological sciences in six premiere research institutes in India participated in the study. The students were contacted by email and asked to respond to a questionnaire which involved a newspaper article. The article reported a study that establishes a link between single gene

mutation and creativity.

The study, originally reported in *New Scientist* claimed that a genetic mutation responsible for causing schizophrenia (neuregulin) has also been found to be responsible for creativity and involved genotyping creative individuals (ascertained through certain criteria like filing a patent or writing a book and creativity tests) for the presence of the mutation. The study concluded that people who had two copies of the mutation were on an average more creative than people who had one copy of the mutation and those with a single copy were more creative than ones with no copy of the mutation. The article reported the lead scientist of the research team (Keri) to have said that it should not be assumed that psychosis and creativity are the same. He speculates that it is IQ that probably determines whether a person develops schizophrenia or creativity as clinical experience has revealed that high IQ people are better able to deal with psychotic delusions.

Students employed a wide range of criteria when evaluating the deterministic research claim (Fig. 5). These criteria generated by students are categorized in terms of two values - epistemic and ultimate. The term epistemic values denotes those values that motivate evaluation of the research study in terms of logical and methodological parameters as well as disciplinary knowledge. Ultimate values, introduced by Allchin (1999), describe values that motivate evaluation of the study in terms of utility and consequences--choice of topics of research as well as decisions regarding their ultimate purposes. For instance, extending knowledge of the natural world or developing weapons technology are value-laden goals.

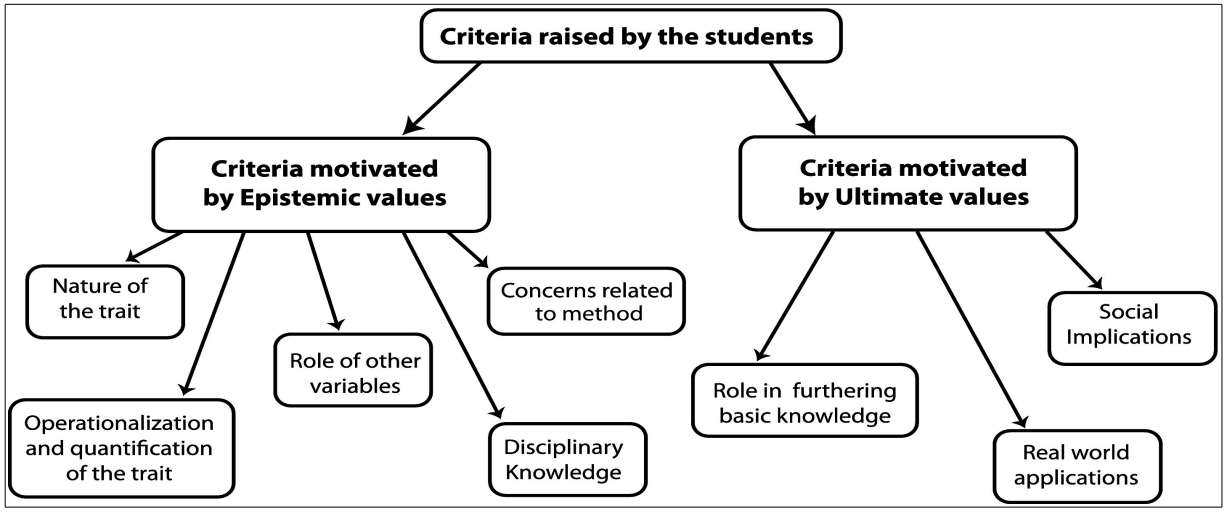


**Fig. 5: Criteria raised by the students**

Deliberating on the foundational assumptions underpinning deterministic research claims is an important philosophical exercise. Rose's (1995) step-by-step dissection of the flawed epistemic

assumptions underlying neurogenetic determinism is a thorough and well-articulated critique of the assumptions underpinning such research claims. Students who raised basic questions on the nature of creativity, whether it can be defined and measured, or role of other variables indicate an orientation that tries to understand foundational assumptions (Table 3). Although a majority of the students did this, their responses indicated varying levels of insights. For instance, students demonstrating a constructivist understanding of the phenomena (understanding creativity as a construct determined by values) understood the problem of reification. This is further demonstrated by their strong skepticism of measuring creativity. Students who did not demonstrate a constructivist understanding of the phenomena pointed out the difficulty in measuring creativity but did not deliberate on its eventual possibility. The difference in the epistemological positions of students who exhibited a constructivist understanding of creativity and others is an important one - the former were highly skeptical of the assumptions of the study, dismissive about its implications and raised questions on whether the study merited funding. One-third of the students adopted a discipline-based approach in their analysis of the claim. They did not critique the foundational assumptions of the study. What motivated this approach needs further investigation.

| | |
|---|---|
| I. Nature of creativity (N=19)<br><br>*Constructivist understanding of creativity (6/19)*<br><br>*Realist understanding of creativity (13/19)* | Pointed out the complexity of the trait, difficulty in measurement. Were skeptical of defining creativity, some pointed out the socially constructed nature of creativity |
| | *"Creativity is a subjective trait and it could lead to inaccurate estimates...there is a bias in how you define and measure creativity...how could you classify a person as 'uncreative'?"* ($P_{12}$) |
| | Did not question the existence of the trait per se, but pointed towards difficulty in defining and measuring<br>*"Creativity is a word that covers a broad range of abilities from writing to dance; from singing to painting. The study should have looked at artistes and writers to see if the mutations were indeed seen in individuals from different streams of art"* ($P_5$). |
| II. Other variables in the environment that could play a role in creativity (N=8) | Role of factors in the environment (age, gender, nutritional status etc)<br>*"The only measured variables were their 'creativity scores' and whether they carried the neuregulin mutation. What about their backgrounds? Did any of these volunteers have parents who were artists?"*($P_{15}$) |
| Students who did not question foundational assumptions of the claim: (N=11) | Did not raise questions on the nature or existence of creativity, but approached it from a purely disciplinary point of view |

**Table 3: Criteria motivated by epistemic values, domain general criteria**

With regard to disciplinary knowledge, we found theoretical knowledge on the Genotype-Phenotype (G-P) relationship wanting in most students. Most references to theory were sketchy and involved elementary knowledge of genetics. Students did not display awareness of the interactionist, developmental coding perspective on genotype to phenotype mapping and of the complex relationship between genes, developmental mechanisms and the environment. There was no mention of the word "development" in any of the student responses. Although some students did talk about the role of the environment in creativity, it was addressed as a variable that needs to be accounted for, by appeal to generic causal logic. Students also used experimental knowledge of their discipline in their critiques. A number of students talked about elucidating signal transduction pathways and carrying out experiments to establish links between the gene and creativity. This is perhaps indicative of the heavily empirical and puzzle-solving nature of biological science research. Working in these paradigms may have influenced students' responses and attitudes towards the study.

Generating ultimate criteria, in terms of implications and funding when evaluating any scientific study is not an easy task. It requires careful consideration of many factors. As illustrated in the results, a considerable number of these students valued the study for its role in furthering basic knowledge of some sort while some evaluated it on the basis of its applicative potential and sociopolitical implications. These different viewpoints among students are interesting and need further examination. Very few raised potential sociobiological implications of the claim despite criticisms of genetic determinism being a part of public discourse and would be accessible to this group as well. Some dismissed the study for lack of applicative potential, while others naively suggested potential applications in drug design or its potential in removing stigmas against the mentally ill (see Table 4). These responses suggest that students show varying levels of competencies in generation of ultimate criteria as well.

| Criteria | Example |
|---|---|
| **Basic knowledge** (N=12)<br>Responses focused on the importance of the study in contributing to the repertoire of basic knowledge in discipline. | *"...Most important implication is increase in the understanding of basic phenomena in the workings of brain and their link to behavioral aspects of humans. (This study) provides a starting point of looking at traits like creativity from a purely molecular and objective way"*<br>( $P_{20}$) |
| **Social implications** (N=10)<br>Responses discussed ethical and socio-biological implications of genetic determinism as a philosophy. | *What motivates scientific studies, is it merely curiosity?….when I raised a debate on 'The search for the gay gene' i.e., a genetic basis to explain homosexuality in humans, I was told 'If you don't possess the curiosity to find biological proof for your sexual orientation, you are* |

| | |
|---|---|
| | *not a scientist' However, I am not sure if scientific studies are always bias free and thus solely curiosity driven*. ($P_7$)<br>*"... On the brighter side, it could alter people's view of mental illness pushing them to appreciate its sophistications rather than look at it with predominantly negative and sympathetic mindset" (*$P_{27}$) |
| **Real world applications** (N=6)<br>Responses raised questions on practical applications of the research study, for example, drug designing. | *"Research should be oriented at more useful endeavors. There is no good application to this kind of research. If one intends to do pure science then it should at least not have harmful implications to society"* ($P_1$)<br>*"...looking at the positive side, a psychotic patient can in fact be treated to become more creative"* ($P_{19}$) |

**Table 4: Criteria motivated by ultimate values**

There are several levels of philosophical questions students can grapple with when they evaluate a deterministic claims on complex behaviors or qualities, like the following which are based on Longino's (2006) discussion of theoretical pluralism:

1. What is the nature of the behavioral trait? Is it a real trait? If we accept that it's definition is contingent on social and cultural context, can it still be measured?

2. If we accept that the trait can indeed be measured, then how do we define our causal space? What factors do we measure and what do we leave out?

3. What is the nature of knowledge that we have produced? (permanent and certain or partial and provisional?)

4. What are the social implications of the knowledge that we produce?

Discussion of these questions can lead to further explorations in philosophy of science, such as how true are scientific descriptions of the world, the social dimensions of scientific knowledge, feminist empiricist research on values in science as well as sociopolitical implications of scientific claims. For teachers to be equipped to discuss such issues, they need to be exposed to philosophical literature that discuss values in science as well as develop an understanding of how genetic determinism opens up questions on values and science. For instance, exposure to Longino's (1983, 1987) classical and accessible work, which illustrates how values mediate scientific inferences could be beneficial. Philip Kitcher's (2003) work that discusses the social responsibility of science also might afford insights into the question of what it means to pursue science with a commitment to democratic ideals.

Trends in our data raise questions regarding the cross-disciplinary knowledge possessed by the

students ─ that goes beyond knowledge of one's own discipline ─ to evaluate deterministic claims. If we take a look at the epistemic criteria that the students generated, we find that only one-fifth of the participants could articulate the problem of reification. Understanding that what is being investigated is an operational definition of creativity determined by value-laden norms requires some exposure to knowledge that is not simply restricted to the discipline of biological sciences. To make sense of this, one needs to ask ontological questions that are philosophical in nature.

From the point of view of critical science education, the fact that only a few students raised concerns regarding the use of the discourse of genetic determinism to support non-egalitarian policies is troubling. Apart from this, straight jacketed disciplinary approaches did not raise questions on the foundational assumptions of the claim, indicating a lack of criticality. The knowledge needed to deliberate on topics like genetic determinism requires the synthesis of scientific as well as non-scientific perspectives that include disciplines like philosophy and sociology. Students with such "cross-disciplinary" (Develaki, 2008) perspectives would not only have knowledge of their own disciplines, but also grounding in other disciplines. Cross-disciplinary perspectives may also contribute to the development of dispositions of criticality towards one's own community. Exposure to the self-reflexive, qualitative paradigms that are gaining ground in the social sciences and humanities, may help develop these dispositions (Dhar et al., 2011).

# Chapter 7

## Summing up: Reflections and future possibilities

What broad insights does this thesis afford? It charts out a vision for a critical science education in India which centers ideals of social justice and equity. It does so by drawing on and emphasizing perspectives on the nature of science and technology that demonstrate its value-laden nature and the need for social responsibility of science, discusses limitations of the existing curriculum and illustrates ways in which this vision can be realized through the introduction of socioscientific issues at the higher secondary level and discussion of value-laden cases of science at the doctoral level. Through this, it attempts to lay down qualities needed by citizens and scientists alike to determine the course of science and technology that are responsive to the needs of all members of society, upholding the ideas of social and environmental justice.

Fig. 6, though a simplification, attempts to capture significant findings from the different empirical

studies reported in the thesis that in turn lays down the basis for critical science education in India. Hodson (2011) characterizes the functions of critical science education in terms of conferring certain epistemic skills, sociopolitical commitments and dispositions (discussed in the Introduction section). The findings from all the studies have been discussed in terms of the characteristics that constitute the epistemic skills and sociopolitical dispositions prescribed by critical science education. The dispositional aspects have not been examined. Study 1, which involved analysis of the class XII biology textbook and curriculum documents demonstrates a lack of careful attention being paid to values, and epistemic skills to critically evaluate information, particularly the risks associated with technosciences. Study 2 shows that when confronting a socioscientific issue, higher secondary biology students espoused value commitments that are inimical to the ideals of social justice. Skills required to critically evaluate information pertaining to the issue were insufficient in many participants. In study 3, which involved work with doctoral students, we find a conspicuous silence among students regarding sociobiological aspects pertaining to genetic determinism, and the adoption of narrow straight jacketed disciplinary approaches to evaluations of the claim.

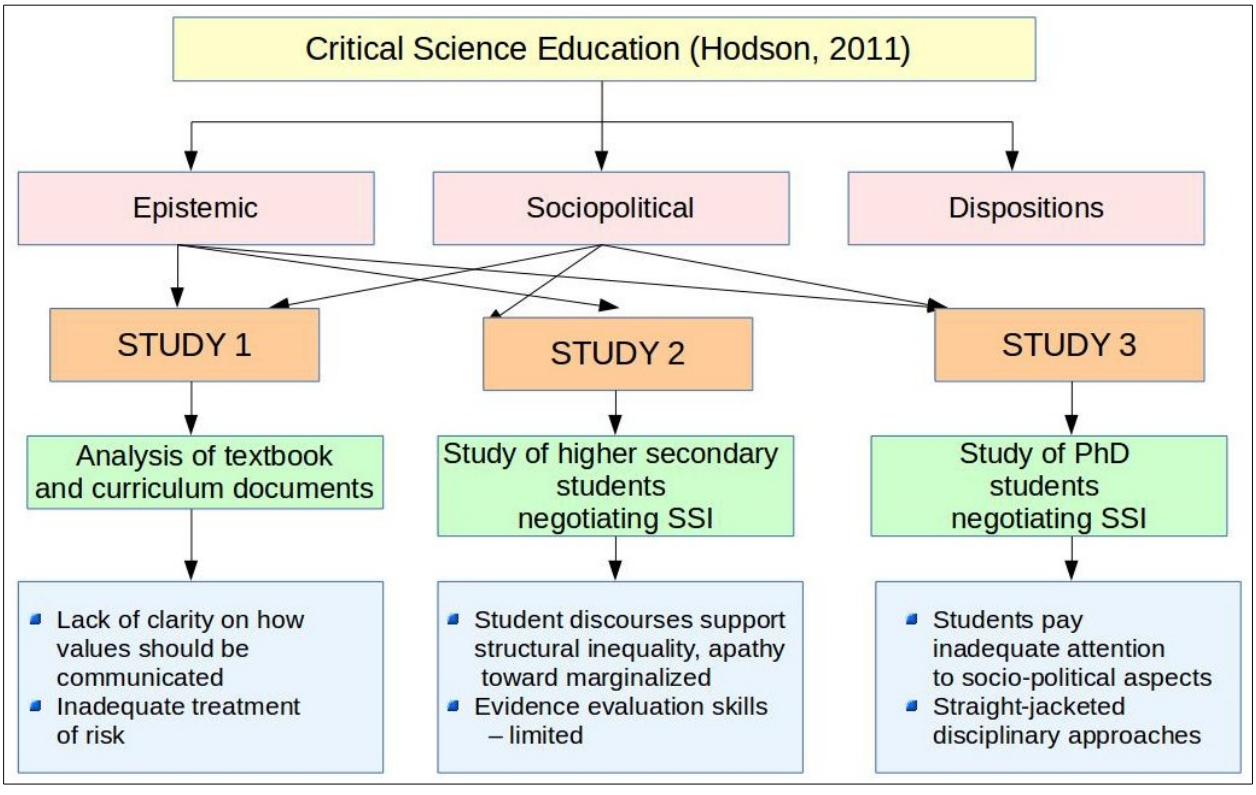


**Fig. 6: Significant findings from the studies reported in the thesis**

There were specific challenges while conceptualizing and executing this work, two of which are summarized below -

*1. Identification of socioscientific issues that were relevant and contemporary:*

Identifying issues that were contextually relevant, contentious socially, politically and scientifically, and that would be of interest to students proved to be an arduous task. It required scouring the Internet, newspapers for relevant issues as well as reading and building perspectives on these topics based on academic literature from various disciplines. Besides commercial surrogacy, five other topical, media reported issues related to medical technologies were identified (reported in Raveendran & Chunawala, 2013). Students' negotiation of these issues were also explored. However, this data has not been reported in this thesis.

*2. Identifying theoretical frameworks which take into account political nature of these socioscientific controversies:*

When one examines socioscientific controversies in the Indian context, the political component inherent in these issues becomes almost impossible to ignore. Developing countries like India are poverty-ridden and pervaded by all forms of social inequalities which are in turn compounded by the power relations that exist between the global north and south. Varughese (2012), points out that although the overt rhetoric that has captured the public imagination in India equates science and technology with development and progress, technoscience, state and industry are complicit in reinforcing the oppressive structural inequalities (e.g. caste, class, patriarchy). Therefore, these aspects become important to discuss when students engage in a socioscientific controversy.

Many of the existing frameworks which theorize about socioscientific controversies restrict the non-epistemic dimension inherent in these controversies to the moral and the ethical dimension alone, often glossing over the political aspects. If one is focused on inculcating critical scientific literacy, then engaging with the political dimensions of socioscientific issues, and subsequently, cultivating political literacy also becomes important. Levinson (2010) unpacks the notion of science education for democratic participation pointing out how we conceptualize what would constitute SSI education is closely tied up to the notions of democratic participation we believe in. A notion of critical science education would presuppose an understanding of democracy as a pluralist system - a political order where there is struggle and dissent between different ideological viewpoints as opposed to an understanding of democracy as consensus building, which would be presupposed in notions of functional scientific literacy (Zeidler et al., 2005). A major challenge, therefore, has been to identify appropriate theoretical frameworks that can accommodate the political dimensions inherent in these socioscientific controversies. Ralph Levinson's (2006) epistemological framework

proved useful as it provides scope to identify the political dimensions as well.

The studies reported are all exploratory and suffer from limitations in terms of the methodologies employed as well as the questions that they seek to answer. Before I conclude, I offer a few directions for future research. My work has only been able to capture, in the form of snapshots, what kind of considerations students bring to bear on socioscientific issues when they first confront them. As Reiss (2010) notes, an "individual's ethical position on a socioscientific issue will be affected by the individuals around them, the particular scientific or technological issue being considered, their motivation and a range of other factors" (p. 14). It would be worthwhile for future studies to carry out longer interactions with students and try and capture these dynamics as well.

Another important area that requires attention is the development of skills required to evaluate evidence, particularly in the media regarding various socioscientific controversies. The existing science curriculum does not pay attention to these skills. From the point of view of critical science education, pedagogical challenges on how to tackle rigid, reactionary worldviews that reflect prejudiced notions of caste, patriarchy and other regressive ideologies are also important to address.

Socioscientific issues are a part of the school curriculum in the United Kingdom, North America, Western Europe and Australia (Levinson, 2007). As argued, though the need to bring in the relevance of science to society has been argued for the Indian curriculum, there is no mention of how to infuse it into the curriculum (particularly at the higher secondary level) leaving us with plenty of questions. First, ought it be a necessary part of the science curriculum? Second, if we decide that this should be so, are science teachers equipped to teach these issues? What skills and knowledge would they require to teach these issues? Third, given the context of disciplinary pressures in the existing higher secondary curriculum, how could one introduce these issues in a way that they are not marginalized and treated as inferior to the academic science content that is taught? These concerns have been taken up for more detailed discussion in the thesis.

Indeed, there have been STS courses offered by various universities and institutes at the undergraduate and post-graduate levels (Raina, 2009), but these have not sustained, perhaps due to a lack of an overarching mandate on how STS education should be instituted at these levels. A way forward would be to draw insights from programs like the integrated science education initiative (reported in chapter 6) that afford interesting models on how to expand student sensibilities to accommodate societal concerns and facilitate the production of new kinds of knowledge(s).

Before I conclude, I recall the argument made by Rudolph (2005) and Varughese (2012), that when

we talk about the science and the “public”, we cannot forget that the public is not a homogeneous category. This thesis only discusses work with relatively privileged students who constitute a certain sphere of the “public” - the scientific citizen public, who would form members of civil society that the scientific community would engage with. Some of them may, in future, become scientists, engineers, doctors themselves. A large population of children and young adults remain unable to access basic education, leave aside an education in science. How should we conceptualize critical scientific literacy for these sections of society? This requires serious and dedicated research.

This thesis reflects a certain vision for science education with an explicit commitment to social and environmental justice. When I embarked on my academic journey in science education, I had not imagined that these commitments can also be enacted through science education. Though the explorations reported in the thesis are preliminary, I think their strengths lie in opening up questions - both theoretical and empirical for future work to explore.

## Acknowledgements

I am deeply indebted to all the participants of this study for their enthusiastic cooperation, my family for their immense patience and moral support, members of HBCSE for their support and the financial assistance received from HBCSE during my tenure as a research scholar and afterwards, from the Hemendra Kothari Foundation.

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# Appendix I

### Probe used for interviews

### Commercial Surrogacy

In-vitro-Fertilization (IVF) is a process that has enabled many couples all over the world, who have otherwise not been able to have children through normal biological process, to do so. The process involves extracting the sperm and the egg from the bodies of the parents, or other people (in case the parents are unable to produce these gametes) fertilizing them in artificial conditions outside the body and implanting the embryo in the body of the surrogate mother The surrogate mother has to undergo some hormonal treatment to be prepared to receive the pregnancy and receives payment for for carrying the pregnancy to term.

Do you think IVF is a good technology for people to use when they want to have children biologically?

Part 2 (PTO and continue reading)

IVF is considered to be a god-sent gift by many childless couples. Also, commercial surrogacy (being a surrogate mother for someone else and receiving payment for it) is serving as a source of employment to many poor women who at least earn about one lakh/pregnancy. Also, since surrogate mothers can be obtained at a cheap rate in India, foreign couples are choosing to avail Indian surrogate mothers' services. A surrogate mother is permitted by law to bear three surrogate pregnancies in her life time. Many people, however, think that surrogacy should not be encouraged because it encourages *only poor women* to come forward and earn money by using their bodies for this purpose.

* What are your opinions on the points raised in the above passage?

## Appendix II

### Probes used for workshops

### Worksheet 1

### In-vitro-Fertilization (IVF) and commercial surrogacy

Many couples all over the world are unable to have children through the natural biological reproductive process. IVF is a process that enables them to have children artificially. The process involves extracting the sperm and the egg from the bodies of the parents, or other people (in case the parents are unable to produce these gametes) fertilizing them in artificial conditions outside the body and implanting the embryo in the body of the surrogate mother. To prepare the surrogate mother's body to receive the embryo she needs to undergo some hormonal treatment. She receives payment for carrying the pregnancy to term. A surrogate mother can earn in the range of Rupees fifty thousand to a few lakhs per pregnancy.

IVF is considered to be a boon by many childless couples. Also, commercial surrogacy, that is being a surrogate mother and receiving payment for it, is serving as a source of employment to many poor women. Since surrogate mothers can be obtained at a lower payment in India than in other countries, foreign couples are choosing to avail Indian women's services. A surrogate mother is permitted by Indian law to bear three surrogate pregnancies in her life time.

1. Do you think IVF is a good solution for people when they CANNOT have children biologically? Why or Why not? Please elaborate.

(If you cannot make a decision, please write what information you may need to make the decision)

2. Do you think IVF is a good means for people to have children even when they CAN have children biologically? Why or Why not? Please elaborate.

(If you cannot make a decision, please write what information you may need to make the decision.)

3.Do you think that being a surrogate mother is a good source of employment for poor women? Why or why not? Please elaborate.

(If you cannot make a decision, please write what information you may need to make the decision.)

4. Fictitious scenario presented to the students:

Jyoti (32 years) is a mother of three children and lives in a slum in Trombay, Mumbai. She works hard as a house-hold help in 5 houses and has difficulty making ends meet. She meets a neighbor who tells her that commercial surrogacy is a convenient way to make a lot of money. Jyoti is interested in the idea but wonders if the procedure can cause some harm to her body. She approaches you to get more information about the health risks involved. Suggest different ways in which you can find this information for her.

**Worksheet 2** (group activity)

Group:_____

Members: _____

Internet search:

Visit websites that may give information on health risks faced by surrogate mothers. Select 4-5 websites that you consider as providing trustworthy information.

i) What Keywords did you use to search for information?

ii) List the websites you selected as trustworthy and why you found them trustworthy

| **Name of the website** | **Whether in favour of surrogacy or not** | **Reason for finding it trustworthy** |
|---|---|---|
| 1) | | |
| 2) | | |
| 3) | | |
| 4) | | |
| 5) | | |

Iii) What health risks were mentioned by these websites ?

iv) Do you think that the information obtained from these websites is enough to advise Jyoti on whether she should go for commercial surrogacy? Why/why not? Please elaborate

**Worksheet 3** Name:

To advice Jyoti on whether there are health risks involved for surrogate mothers you may find information in several ways. One way of gathering information is for *you* to DIRECTLY collect it either by interviewing doctors at fertility clinics or by talking to surrogate mothers.

| Source of information | Why this information may be reliable | Why this information may not be reliable |
|---|---|---|
| 1. Interview a doctor (gynecologist*) who runs a fertility clinic where IVF is done routinely. Ask him/her whether surrogate mothers who visit his/her clinic suffer any health problems after the procedure. | | |
| 2. Interview a woman who has been a surrogate mother. Ask her to relate her health experiences of the preparation phase, the pregnancy phase and after the delivery. | | |

- A gynaecologist is a doctor who has specialized in women's reproductive system

B. Compare the two sources of evidence namely (the Doctor and surrogate mother) in terms of how trustworthy they are (Is one more/equally/less trustworthy than other?). State reasons.

C. Do you think interviewing one doctor and/ or one surrogate mother will be enough for you to decide if there are health risks involved in the procedure for the surrogate mother? What more would you need to do?

INDIRECT methods of collecting information may involve looking up information that has already been collected and written down by *others*. Below are some such sources. Please write down how reliable you consider each of these sources.

| Sources of Information | How reliable do you consider this source (Rate 1-5)<br>1-least reliable 5-most reliable<br>circle one. | Why you consider information from this source reliable |
|---|---|---|
| Newspapers | 1 2 3 4 5 | |
| School/college Textbooks | 1 2 3 4 5 | |
| Medical Textbook | 1 2 3 4 5 | |
| Research Journals (Medical Journals) | 1 2 3 4 5 | |

**Worksheet 4**

**a) Surrogate mothers in India face discrimination, health risks**

(Adapted version) India New England Newsletter, 20/11/2012 By Dipen Hiranwar

According to a recent study by *Sama*, a resource group based in New Delhi that works with women and health issues, surrogate mothers in India are deprived of basic information regarding the various procedures on their body and tests conducted in the course of the treatment.

With the hopes of exposing some of the hidden secrets of the Indian surrogacy industry, *Sama* conducted the study by obtaining crucial and in-depth information by interviewing a wide range of those involved in the Indian surrogacy industry, such as doctors, surrogate mothers, agents.This includes 12 surrogate mothers, 2 agents and 4 doctors from several fertility clinics in Punjab and Chandigarh.

Astonishingly the surrogate mothers are also kept in the dark about many processes and health risks that they have to go though during the treatment. They are also discouraged from asking questions and are not given access to the treatment records, according to the study. As one surrogate mother pointed out,

> "For the first three months, I had a lot of trouble. I was in pain since there was injection after injection for three months. There is the gel one. Only after seven–eight days does the pain subside. I took three and then kept aside the rest. I was in tears and did not want any more injections. Already with all the injections there was no place left and then this injection had a thick needle. Imagine the pain."

Surrogate mothers expressed frustration with the unanticipated heavy doses of medication and injections with certain adverse effects on their health. Surrogate mothers reported continued pain for days following injections, tightening of the skin around the injected area, discoloration of skin and often reducing their mobility for the period. Some reported nausea and lack of appetite, swelling in legs and feet, and weight gain after the pregnancy - unlike any of their previous pregnancies with their own children. In cases of cesarean operations, surrogate mothers stated that the stitches were extremely painful for months.

The report also shows there is no consent from the surrogates regarding decisions such as multiple embryo transfer*, foetal reduction* and cesarean section* delivery. Many cases were found in which the surrogate mothers were told that some of the above procedures were common in the surrogacy process or that the pregnancy would proceed as a normal pregnancy.

*****Embryo transfer refers to a step in the process of assisted reproduction in which embryos are placed into the uterus of a female with the intent to establish a pregnancy. During IVF procedures, more than one embryo is often transferred into the body of the surrogate mother to ensure pregnancy, which is termed Multiple Embryo Transfer. Fetal reduction is done if more than one embryo starts growing in the surrogate mother's body. This involves surgically removing the extra embryo/s. A cesarean section delivery involves delivery through surgical means which involves cutting open the abdomen.

## b) Surrogacy: Realizing poor womens' dreams to a better life

(Adapted version) 6/12/2011, The Guardian Divya Gupta

*At last... a European mother cradles her newborn in a clinic providing surrogacy services in Gujarat, India. Photograph: Suzanne Lee/Panos London*

Dr Nayana Patel says, "Human beings have two main instincts; the instinct of self-protection and the instinct to reproduce." And she should know – she has carved out a career matching infertile couples with women willing to "rent their wombs". Beginning with a couple of surrogacies a year in 2003, Patel's *Akanksha Fertility Clinic* in Gujarat now delivers about 110 surrogate babies a year.

It's business as usual at the Akanksha Clinic. When Patel arrives one Wednesday morning, the lobby is full of women. Some wear brightly coloured saris; others are in western dress. They are either desperately seeking a baby or hoping to lift themselves out of poverty and offer their own children a better life. One of the main attractions of surrogacy in India is the price which is a lot cheaper than it is in western countries. Most of Patel's clients are from the US, Canada and Europe.

What do the surrogate mothers feel about their experiences of surrogacy? *The Guardian* interviews two surrogate mothers and the husbands of one other surrogate mothers from *Akanksha Clinic*. When an accident left 32-year-old Ranju Rajubhai's husband severely burned and unable to work, surrogacy seemed the answer to the couple's problems. "I thought I'll be doing a good deed, my work will also get done and [the couple] will also get a baby," says Rajubhai who is due in a month. Like all the women signed on by Akanksha, Rajubhai will receive $6,225

(about 4 lakh Rupees), the equivalent of seven years wages for her husband. "I will get my husband's surgery done [for his burns]," she says. "I also want to buy a house. It costs $14,500 -$18,500 these days (Between 9 and 13 lakh Rupees). One pregnancy won't be enough, so I am thinking of coming back."

Rajubhai's is a familiar story in the "surrogate house" where she lives with 39 other pregnant women. Owned by Patel, the house is located 10 minutes away from the clinic. With two to three iron-framed beds in each room, the house has the look of a hospital ward. The surrogates, clad in loose, colourful gowns, are sitting, lying, stretching, watching TV or chatting with each other. In one room, hangs a picture of a crawling toddler with the words: "The time to be happy is now."

The majority of the women are second-time surrogates and will have caesarean sections. "We have to cut our stomachs for money," says Anjuman Pathan, a blunt, 30-year-old. "It's not a bad thing, is it?" Life at the surrogate house creates a sense of sisterhood. The women enjoy the rest and care they may not have had during their own pregnancies but are confined to the house for the whole pregnancy. Their families can visit on Sundays but the surrogates only leave the premises for medical check-ups or if there is a family emergency.

"When I used to go, I would just see the surrogates lying around all day," says Kantibhai Motibhai, the husband of two-time surrogate Shardaben. "They count the days to go back home. [But] I guess it works well. Our main interest was in the money. *Their* (the commissioning parents) main interest is in the baby." Sharda's two surrogacies have allowed the couple to lease some land, buy buffaloes and a motorbike, have money for their children's education and start saving. As second-time surrogate from Nepal, Diksha Gurunga, puts it, "You have to lose something to gain something and what we gain is a lot more than what we lose."

Dr. Patel says laws governing surrogacy in the US, for example, are weighted too much in favour of the surrogate mother. "There are so many cases where you are the genetic parent and [the surrogate mother] is blackmailing you. She will not give you the baby... If you don't pay, you're not allowed to see the baby. Couples from abroad write to us saying that the legal liabilities are so much in the US, that after paying so much money also, I don't know if I'm going to hold my baby or not and that is what India has taken care of."

Back at Patel's clinic, three women who come from North America to find a surrogate mother are gushing over a newborn European baby recently born to one of the surrogates at the clinic – proof that their dreams could also come true. "There's no perfect system, but given what we have and under the circumstances, Dr Patel's clinic definitely helps create miracles," says Fatima, a Canadian of Indian and Chinese heritage.

Questions posed (for both the articles):

(a) What position has the author taken in the article? State whether the article is favourable/ unfavourable to surrogacy. Summarize the position in a few sentences.

(b) What information/evidence has the author used to support the position taken in the article?

(c) Do you think this evidence is enough to support the position? Why or why not?

(d) Rate the article in terms of how convincing it is to you on a scale from 1-5. 1- Least convincing 5-Most convincing. State reasons on why you find it convincing.