What Discourse of Science Dominates Lower Post-Primary Education in Ireland?

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Abstract

This study examines the discourse of science presented at lower Post-Primary level in Ireland. In the investigation the text materials for the course were qualitatively examined. The data analysis revealed five key themes in the presentation of the course. First, it was found that the course advocates and glorifies the use and manufacture of all kinds of consumable products and industrial technology such as deodorants, perfumes, cars and so on. Enlightenment Rationale is clearly evident in this portrayal as these productions are deemed to be the means through which society has developed and the current model of society is deemed to be an advanced and improved civilisation. In this relationship society is almost dependant on science and its ‘progression’ is fuelled by scientific technology. Society thus is seen to be constantly improving and its potential is deemed to be limitless. This view of development centres on convenience, easy access, industrialisation, creature comforts and consumable products and does not draw attention to the social or moral dimensions, and only isolated attention to the environmental aspects. Secondly, science is shown to have provided resources for technology, industry and agriculture and as all of these areas shape national and international economy, science can be seen at the root of this ‘growth’. This depiction offers a modernist ideology of progress and the question of whether or not science is beneficial to society, or alternate models of development, never arises in the course, and Western desirability and superiority are underlying premises in the course as a whole. The third prominent theme is the reoccurrence of the Modernisation Theory of development in these texts, suggesting that the best way for Third World Countries to develop is through industrialisation, or, becoming like Western countries. While these values and attitudes are quite prevalent in the course, the fourth theme highlights how science is generally represented as value-free or value-neutral and links are not drawn between science and influential factors from society. Instead, scientists are depicted as honest, noble and respectable men who, often seemingly spontaneously, have produced laws, theories and equations. The course is also steeped in recent history, with scientists, their theories and contributions awarded prestigious and prominent positions. The discourse of science presented here has many connections to society and it offers a contemporary account of science, focusing on developments rather than scientific processes. The texts explicitly advocate approaching science education from technological and societal perspectives through the use of ‘Science Technology and Society’ (STS) and wish to draw the links between them. Finally, the fifth theme shows that rather than presenting a nuanced account of science and development, the majority of the texts glorify and promote Western society and the way of life it has given rise to, which is often at the expense of other forms of knowledge and values.
Declaration

The work presented in this thesis is entirely my own work. It has not been submitted previously to this or any other institute for this or any other academic award. Where use has been made of the work of other people, it has been acknowledged and referenced.

Signed: ___________________________    Date: ______________________
“The belief that one’s own view of reality is the only reality is the most dangerous of all delusions”

(Paul Watzlawick 1921-2007)
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Chapter 1: Introduction

1.1 Orientation of the Research
Since the introduction of the Junior Certificate in Irish Post-Primary schools in 1989 there have been significant changes in Irish society. The *Celtic Tiger* era saw a period of unprecedented economic growth in Ireland and the current economic downturn has resulted in more changes to Irish lifestyles. Since the early 1990s, diversity in the Irish population also increased dramatically (Bryan 2010, p293). This increase in ethnicity has brought multicultural issues to the fore and has raised much interest in issues such as representation, identity, integration and race amongst others. All of these issues are very important at school level where adolescents encounter these issues and come to establish their understanding of them. The dominant cultural group in Ireland is traditionally defined as white, heterosexual, Irish-born, settled, Catholic (Bryan 2010, p255). Along with this majority there is now an increased ethnic minority, increased in both number and diversity. This minority can be understood as an *other* (Said 1991) and conceptualised as distinct from cultural majority due to their ethnic differences. This division can create a cultural divide and can affect many issues such as justice, equality, civic rights and access to resources and can also lead to more internalised problems such as identity crisis and issues relating to esteem and belonging (Ó Conaill 2003; Tormey and Haran 2003).

This increase in diversity has many implications for curriculum. Some, such as Michael Apple (1996), see education as deeply implicated in the politics of culture. He sees curriculum as part of a *selective tradition* which means it is always somebody’s selection and represents some group’s version of legitimate knowledge, it is never simply a ‘natural assemblage of knowledge’ (Apple 2006, p22). He sees the national curriculum as a mechanism for the political control of knowledge (Apple 1996, p35). Tormey (2006) examines the Irish Primary Curricula statements, from 1971 and 1999 and the role they play in constructing and reinforcing a particular version of national identity. Bryan (2010) also examined educational policy documents and examined the construction of national identity in the face of increased multiculturalism. She found that the materials produced a dynamic of the Irish as the ‘embracer’ or ‘tolerator’ of difference and that the produced
‘Other’ are only welcomed as long as they contribute positively to the existing Irish culture (Bryan 2010, p265).

This study will look to examine the composition of Irish Post-Primary science education. This examination will focus on the construction and definition of science given and especially the multicultural dimensions of this course. Science is a popular topic for research, as evidenced by the fact that a search for “science” on Google Scholar returns 6.45 million results compared with 2.35 million for “language”, 4.26 million for “culture”, 4.27 million for “education”, 2.16 million for “computers” and 2.34 million for “economics” (accessed 29/04/2011: 15:40). Therefore it is important to look at what is deemed to be ‘scientific’ and what attitudes and values the study of science promotes. Science is also given a prestigious place in society and plays a major factor in political issues such as policy making, economic developments and local and international directives. Science as a subject is commonly depicted as an objective, value-neutral or value-free discipline and is held in higher regard than other forms of inquiry or knowledge generation such as natural enquiry, traditional knowledge or social research findings. Knain (2001) in his study of the ideology in Norwegian science textbooks found that science is presented as knowledge that should be trusted because it is true, indisputable knowledge (Knain 2001, p323). Features of the scientific method are thought to be reliability, repeatability, transparency and the production of numerical data. Science is also often viewed as singular, comprising of a singular method, type of result and system of enquiry and knowledge production. This leads to the question of how the ‘Other’ is depicted in science, whether there is parity and inclusion of if there is a lack of representation of multicultural science (Harding 1998).

Others, such as Kuhn, Feyerband and Polanyi have argued that science does not constitute a singular body and is not practiced according to a well-defined and stable scientific method (Shiva 2002, p29). Historically, for example, there have also been many changes in how science was conducted in the Western world itself, for example the move from the alchemist to the scientist (a term which was first used in 1840 [Harding 1998, p10]). This change in practice was signalled by the introduction of the scientific experiment and established empirical evidence as the basis of knowledge and gave primacy to logic and reason (Nanda 2005, p175). Science, as it is currently constituted, can be traced back to Francis Bacon and the scientific revolution of the sixteenth Century. It was in this period that the highly experimental, “objective” model of science gained
prominence and shaped the future of the subject. Later scientists such as Robert Boyle, Gregor Mendel, Georg Ohm, Robert Hooke and Michael Faraday all employed Bacon’s scientific method. This version is associated with high predictive and explanatory powers and through this method there has been a proliferation of technological products. Bacon’s science held the promise of uncovering the ‘laws of nature’ through logic and reason and the experimental method. This system of scientific inquiry comprised of a worldview privileging reason and observation and a methodology designed to acquire accurate knowledge of the natural and social world. Essential to this methodology is a critical spirit and a commitment to the incessant testing of hypothesis through observations and/or experiments, and revising, adjusting, altering or dismissing this hypothesis as a result (Sokal cited in Nanda 2005, p173). This philosophy became the standard operating procedure for investigation in the Western world and with the aid of this technique many discoveries have been made and new areas of expertise have been created such as quantum mechanics, quantum physics and microbiology. As this version of science has its roots in a particular timeframe and was developed in Western culture I will refer to it in this thesis as Modern Western Science, emphasising it as a version of knowledge rather than a singular category.

Some see this version of science as a universal, suitable for people of all ages, genders and backgrounds (Needham 1976, Nanda 2001). Meera Nanda, for example, sees the ‘track record’ of science as support for its universalism as she believes a natural human interest in reliable knowledge drives the suitability of this approach (Nanda 2005, p169). Nanda argues that ‘ordinary’ people tend to find scientific theories “as rationally persuasive and empirically warranted” when introduced to them (Nanda 2005, p160). However, there are scholars who would not accept this view of science which claims that science is universal and as a functional discourse for people of all cultures (Shiva 2002, Harding 1993, Longino 1997, Nandy 1988). Such scholars typically are known as postmodernists and argue that as this discourse of science was originated in the West it contains the values and the ideals of these countries. They propose that this discourse of science is indigenous to Western societies and is just one system of inquiry in the world. According to Aikenhead (1996) science is widely recognised as a subculture of Western culture. In this thesis the term Third World will be used to refer to economically undeveloped regions. I am however cognizant to other terms for this region, such as Global South, developing world, Less developed countries, emerging economies, as well
as the postcolonial and Foucauldian argument against this term. Many Third World countries, as well as many countries worldwide, have their own systems for coming to understand the world around them. They also see violences associated with Modern Western Science, especially against women, the marginalised and nature (Shiva 2002; Harding 1998; Esteva and Prakash 1998). Lloyd (1996) for example, describes what is seen as the mechanist nature of Modern Western Science in that its methods are seen as analogous to the workings of a machine. This understanding attempts to understand nature by analysing its individual parts in an attempt to understand the whole. One alternative viewpoint is the organic model, which views nature as an interconnected whole (Lloyd 1996, p47). The mechanistic, modern, western approach to scientific investigation is also said to be associated with a patriarchal rather than matriarchal character (Shiva 1993, p303). Harding (1998) challenges the universal applicability of Modern Western Science and promotes *Standpoint epistemologies*, which are alternative views and forms of knowledge, often suggested by groups outside of dominant culture. She sees the perspectives of those at the margins of society as especially valuable as they can articulate alternative aspects of science and technology that otherwise could be hard to detect (Harding 1998, p189). She further enforces the conflict between West and non-West as she identifies that Modern Western Science creates the following conceptual dichotomies: “reason vs. emotion and social value, mind vs. body, culture vs. nature, self vs. other, objectivity vs. subjectivity, knowing vs. being” (Harding 1993, p165). In each case, the first is seen to be the desirable and is associated with science and masculinity, while the latter is presented as the weaker, undesirable which is systematically associated with feminine. These dichotomies serve to give primacy to Western forms of knowing and legitimise Modern Western Science and its methods, and consequently to legitimise or marginalise other ways of knowing. As Modern Western Science derives all its knowledge from one (masculine) way of knowing it neglects what feminist writers see as the typically feminine considerations of balance and harmony and thus feminist scholars refer to Modern Western Science as reductionist, as it is reducing human’s capacity to know nature by excluding other ways of knowing and other knowers (Shiva 2002, p22). Reductionism can be seen as a process of “reducing the complex and varied to the simple and standard” and is associated with focusing on the parts rather than wholes (Chambers 2003, p42).
The Amazon region and Africa are places where the needs of Western development and the needs of local populations are in opposition to one another. Deforestation and pollution cause environmental damage which directly impacts upon the ability of the local populations to survive in these regions. Shiva argues that local people here have survived and conserved their environment through their ecologically evolved and indigenous systems of knowledge. In addition to the damage caused by Western interests and practices, the introduction of Western models of development have also had serious consequences for indigenous people (Esteva and Prakash 1998). Economics and Western knowledge along with a model of development centred on industrialisation and globalisation leads to environmental damage and imbalances in nature, and has highlighted the need for discussion about the possible limits to growth (Tormey 2006, p66-67). When areas such as the Amazon region are exposed to Western models the results are often devastating; “What local people had conserved through history, Western experts and knowledge destroyed in a few decades, a few years even” (Shiva 2002, p26). Western models are said to deny holistic ways of knowing and do not incorporate views that rely on a respect for nature’s processes and its interconnectedness into its version of science. This leads to a view of Western development as Maldevelopment as it favours certain practices which are perceived as having a negative effect on the planet. Shiva sees maldevelopment as a threat to nature itself, especially diversity of life, unity and harmony and despite the growth of commodities with managed farms with commercial interests; she sees nature as shrinking (Shiva 2002, p5).

Others refer to Modern Western Science as a subculture of Western culture (Aikenhead 1996; Cobern and Loving 2001). In social studies this version of science is often characterised as; mechanistic, materialistic, reductionist, empirical, rational, decontextualized, mathematically idealized, ideological, masculine, elitist, competitive, exploitive, impersonal, and violent (Aikenhead 1996, p220). The difficulties experienced by cultural groups (minority and Western) in learning science and the cultural oppositions to the acquisition of scientific concepts have been argued to show the inadequacies of “Science for All” (Mutegi 2011; Sutherland and Dennick 2002; Knain 2001; Aikenhead and Jegede 1999; Aikenhead 1997; Aikenhead 1996). These studies found that the existing worldview of students can lead to internal conflict and potentially can lead to rejection of scientific theories or lead to a loss of their natural cultural identity (Assimilation). These issues are most pronounced for those with a sharply contrasting
culture, such as First Nation peoples in the US and Canada (Aikenhead 1996). The question of the suitability of Modern Western Science as a legitimate lingua franca for the world (Nanda 2005, p173) versus alternate versions of science and problem solving raises many issues. These problems arise around cultural implications, particularly the transmission of Western values and a type of acculturation and cultural imperialism (Aikenhead 1996, p220). This further shows the importance of the construction of curriculum in dealing with multicultural education as the way in which the subject discipline is framed and presented will have paramount influence on students’ perceptions of science, and also their ability to perform in the subject discipline.

Within calls for multicultural science there are two main schools of thought. The first looks for concessions for multicultural concerns, allowing for multicultural dimensions to be added to the existing model (Cobern and Loving 2001), while others call for multicultural concerns in the very foundations of science itself (Nandy 1988; Shiva 2002; Harding 1993). The first would generally accept many of the virtues of science, but see the need for added units and strands to address some of the needs of multicultural education. In such accounts although science is being critiqued, and often found lacking in certain dimensions, the underlying tone addresses science favourably. On the other hand, the latter take issues with the guiding philosophy of science and would advocate the Modern Western scientific discourse. They call for radical change and their views would not allow for multicultural/ethnic science to exist within the dominant structure. Their view does not see science as lacking in certain areas, or being misapplied in different contexts but see the underlying thoughts and assumptions as being violent against women and nature;

This violence does not arise from the misapplication of an otherwise benign and gender-neutral model, but is rooted in the patriarchal assumption of homogeneity, domination and centralisation that underlie dominant models of thought and development strategies

(Shiva 2005, p65-66)

Within the makeup of the science curriculum the representation of the other is an interesting issue for examination. This idea of the 'Other' draws on the work of Edward Said (1991) and shows how the image of people outside of the dominant culture can be created and perpetuated. This characterisation is generally in juxtaposition to the perceived image of the dominant culture and plays a role in reinforcing this perception.
Within the course, the extent to which science is presented as an exclusively Western phenomenon, or how possible contributions or contributors from other cultures are excluded or omitted is worthy of examination. This examination would include the depiction of the origins of science in historical accounts, and also look at the contemporary picture of science and the interactions between cultures. A discussion of the issues around the representation of the ‘Other’ and identity would also provide for interesting findings. The portrayal of both Eastern and Western contributions to science in the course, and the resultant implications of this experience on students’ perceptions of science would give insight into the type of multicultural education in this area.

During the colonial period science and scientific theories played a part in defining the relationship between the indigenous peoples and invading powers (Gould 1993; Andreasson 2005). The influence of Western culture on the theory produced by Western science is also evident in these theories. Prime examples can be seen in how the history of racial differences were explained and justified through science. The ‘scientific’ theories of craniometry and polygeny of the eighteenth and nineteenth centuries were used to explain racial differences (Gould 1993). These theories did not create racism, but rather were used to reinforce and offer ‘evidence’ for existing deep-rooted racism which existed in society. Gould (1993) stresses that in order to understand the impact of science upon society’s views of race during this period we must recognise that racial conceptions were widespread during this time, and even the leaders and intellectuals did not doubt the appropriateness of racial ranking, this ranking placed Indians below whites, and black people below everyone else (Gould 1993, p85). As knowledge is seen to be influenced by the culture that conceived it, these attitudes may exist in the assumptions and underlying premises of the subject. The perpetuation of these thoughts would have very serious consequences and will thus be a concern of this thesis.

In terms of education in the Irish system many important educational and curricular issues are not being addressed. Gleeson (2009) has shown that in Ireland the debate on education centres on technical rather than critical issues (p138). The current mindset in the Irish system is within the context of the technical paradigm, and education and curriculum are viewed as neutral, apolitical and immune from ideological and political influences (Gleeson 2009, p141). This lack of curriculum contestation is worrying for the welfare of the education system in general, and it also highlights the absence of analysis examining education from standpoint epistemologies, and examining
education from outside the dominant discourse. In the Irish system, the questions; What knowledge? Whose knowledge? To what ends? In whose interests? How is it taught? How is ‘achievement’ measured? (Gleeson 2009, p133) have not been posed or probed. The value of examining these issues is paramount to understanding the education system in its entirety;

Foucault reminded us that if you want to understand how power works, look at the margins, look at the knowledge, self-understandings, and struggles of those whom powerful groups in this society have cast off as “the other”. The New Right and its allies have created entire groups as these “others” – people of color, women who refuse to accept external control of their lives and bodies, gays and lesbians, the poor, and… the vibrant culture of working class life

(Gleeson 2009, p33)

1.2 Thesis Structure
The focus of this study has been explained in this chapter. This study will examine the construction of ‘Science’ in lower Post-Primary education in Ireland. It is concerned with the ‘discourse’ of the subject discipline that is produced and the attitudes and beliefs that are promoted. The second chapter is the Literature Review and is divided into three sections. The first will explore the creation and production of knowledge and will employ the work of Michel Foucault as a framework. It will also discuss the relationship between knowledge and society and the interplay between them. The concept of ‘discourse’ is the main concern of this chapter and the issues regarding its formation and operation will be dealt with. The second part will focus on science itself and the features of Modern Western Science and the criticisms of it. Feminist accounts and ecological concerns are discussed here. The violences of Modern Western Science are dealt with here and offer a strong critique of Western development and practices (Shiva 2002). Following this discussion some of the underlying issues in Western writings will be explored, such as Orientalism (Said 1991), racism, oppression and domination (Gould 1993; Galeano 1973; Fanon 2008). The third part of this chapter details the Irish education system and discusses curriculum issues.

The third chapter is the Research Methodology chapter and this outlines how the research will be conducted. The Silverman Analytical Induction method and Foucault’s Archaeology method are the main methodologies followed. This study will conduct a text
analysis and explore a range of curriculum materials including the *Junior Certificate Science Syllabus, Textbooks* and *Exam Papers*. This section will also include an examination of the different philosophical considerations dealing with research as well as a description of how the text materials were coded and analysed.

The fourth chapter discusses the findings of the study in line with the existing literature and addresses issues such as the Western influence in the course, Westernisation, the type and extent of the inclusion of multi-cultural material and also discusses the depiction of the relationship between science, development and the environment. This section discusses the issues raised in the *Literature Review* as it relates to the material found in the analysis. The final chapter is the *Conclusions* which gives a summary of the findings, recommendations for curriculum as well as areas for future study.

### 1.3 Conclusion

This chapter introduces some important issues dealing with multicultural science and multicultural science education. It shows the different vie of science, some seeing it as a discourse with universal implications (Nanda 2005) while others see it as a violent, paternal subject that is causing physical and cultural damage to some of the World’s most vulnerable populations (Shiva 2002). This argument leads to questions dealing with the suitability of teaching Modern Western Science, especially to students whose backgrounds are outside of Western culture. Others discuss the obstacles faced by ‘Others’ in learning Modern Western Science and the cultural conflicts that can result (Mutegi 2011; Sutherland and Dennick 2002; Knain 2001; Aikenhead and Jegede 1999; Aikenhead 1997; Aikenhead 1996).

This study will examine the composition of the Irish Junior Certificate Science Programme and look at the dominant ideologies of this course, as well as the extent and type of dealing with multicultural science. This research will show how science education is defined in the Irish context and the discourse that is promoted. It will also show, in historical and contemporary accounts, how Modern Western Science is influenced by and compares to other ways of knowing and problem solving, as well as the limitations of science. The historical dealing with science and society, especially regarding race will
also be a focus of this study. By conducting this examination it will show how some of the issues found in other contexts and countries compare to the Irish case.
Chapter 2: Literature Review

2.1 Introduction
In this chapter I will examine literature relating to research, discourse, science, identity, racism, multiculturalism, development, education, sustainability and curriculum. As outlined in the Introduction, science is not a single category but rather there are multiple different versions of the subject and approaches to doing science. In this study I will refer to the dominant model in the World as Modern Western Science as it is a version of the subject which is heavily, and perhaps fundamentally, shaped by Western attitudes, policies and interests. In turn, this dominant version has had wide influence on political policies, protocol and directives. This study will examine the possibility for science to become an emancipatory and intercultural subject and will also seek to examine how the course represents minorities at present. The racial dimensions within science and identity, focusing on the creation the ‘Other’ (Said 1991) as well as feminist viewpoints are central to this research.

The key issue for examination in this study is the representation of science within the Irish Post-Primary science curriculum and the effects of this portrayal. Education plays a pivotal role in the collective development of society. Through education people not only become informed about issues, but what they learn also has a role in shaping how they view topics. The material included in scholastic science will contribute to how people view science and their understanding of it. The selection in science curriculum may also influence wider opinions and attitudes, especially in the case of science, towards technology, development and nature.

The Literature Review is split into three parts. The first will deal with the nature of knowledge, and specifically how knowledge is produced, shaped, bound to power and cultural interests and how certain types of knowledge are given prominence over others (Rist 1997; Ish-Shalom 2006). The second part will examine the cultural dimensions of science and will challenge the assumption that Modern Western Science is a functional discourse for all people. The Enlightenment and ‘The Age of Reason’ will be analysed in this section as key eras in the development of the West and Modern Western Science. It
will detail feminist accounts of science such as those offered by Sandra Harding, Donna Haraway and Vandana Shiva and will contrast these with the dominant paradigm. The third and final part will locate this discussion in the broader context of the Irish education system and analyse the make-up of curriculum in Ireland, with a special focus on science curriculum. This section will discuss the work of Michael Apple on curriculum and Jim Gleeson’s research into the Irish system. This section will detail the education system in Ireland and the history of curriculum making in Ireland.

2.2 The Nature of Knowledge

2.2.1 Discourse
There are many factors that influence when, how and what type of knowledge is created. This study is concerned with what is taken to be ‘science’ and what students learn about in science schools. For many, there is only one type of science and it is concerned with clinical testing, numerical accuracy, white coats, experiments and theories. This section will challenge this idea and show that there are many different forces at play in producing an understanding of something such as science. It will show the complexity and diversity in establishing and perpetuating certain knowledge systems and deal with how there can be different understandings of the same area. This study will analyse the construction of science curricula in Ireland, its make-up and the implications of this composition. In exploring the way subjects come into being and the rules which govern their operation the philosophy and methodology of Michel Foucault are useful tools.

Foucault’s work is characterised as having an anti-realist orientation, which means that he is opposed to the idea that there is a permanent and unchanging real world. Foucault is opposed to the idea of a natural order and universals. In conducting his work Foucault came to describe ‘discourse’ as the way in which subjects are created. The word 'subject' in this context means the area, topic, phenomenon or object that is formed in discourse, rather than a subject discipline such as English, Geography or Mathematics. One understanding of discourse sees it as comprised of statements which make up relationships with other statements. These statements share space and establish contexts, however they are not permanent and can be replaced by other statements (Danaher 2010, p35). Discourse was seen as constructive in that it was seen to provide the framework and
guidelines by which a subject or phenomenon could operate and come into existence. 
Foucault would not recognise an area or field, such as medicine, to be a coherent field, 
with a definite and ‘right’ way of conducting itself. Instead he suggested that different 
understandings come to define what medicine is, and thereby govern what can be 
contained within the field. In this way discourse is seen to be able to produce certain 
‘subjects’ such as, “the madman, the hysterical woman, the homosexual, the 
individualized criminal, and so on” (Hall 2001, p80), and in his understanding, these 
figures would not exist in the same way and have the same meaning throughout history, 
but would be “specific to specific discursive regimes and historical periods” (Hall 2001, 
p80). In a similar fashion discourse is also seen to produce knowledge and is particularly 
influential in producing certain types, which will be discussed later.

For Foucault discourse is not permanent, coherent or unchanging but rather it is *a 
priori* of methods, understandings, phrases and language. Foucault introduced the concept 
of *episteme* to describe the way thoughts about a subject were gathered together to 
produce a functioning discourse for a subject in a particular time period, and each 
episteme was characterised by a particular world-view (Danaher 2010, p15). Episteme are 
the grounds upon which we base everything, so they are often taken for granted, 
unconscious principles for understanding. Discursive formations then are the *organising 
principles* of an episteme. Discursive formations regulate knowledge around particular 
subjects and it is through them that ‘objects of knowledge are produced’ by making 
certain speech possible and organising certain ideas or concepts in a certain way (Danaher 
2010, p21-22). In this way, a discourse is similar to the idea of an 'ideology', with the 
difference being that an ideology is seen as a false belief system, whereas discourse or 
episteme make no claims about truth or falsity. The statements that are produced come to 
characterise and define the episteme and establish discourse. In this analysis;

What one must characterize and individualize is the coexistence of these dispersed and heterogeneous statements; the system that governs their division, the degree to which they depend upon one another, the way in which they interlock or exclude one another, the transformation that they undergo, and the play of their location, arrangement, and replacement

(Foucault 1972, p34)

However, Gomm (2004) indicates that not all of discourse is concerned with knowledge 
formation and production. Discourse can also be viewed as a phenomenon which exists 
independently of individuals and their speech and writing, and a piece of writing itself
can be seen as a manifestation of a particular world-view and particular type of understanding or ways of doing, and thus can be viewed as an aspect of culture (Gomm 2004, p246). In addition, discourses can also serve as evidence of the ways individuals, groups or social bodies interpret the world. This representation can be seen to emerge, to a certain degree, in writings and speech (Gomm 2004, p246). This links to the earlier assertion that it is discourse itself, and not the subjects who speak it (or write it) that produce knowledge. Instead, individuals are simply seen to produce certain statements or texts, and as they are working within, and subject to, the limits and constraints imposed by episteme, along with the discursive formation, and also a specific regime of truth, of a certain location and historic period. In this way the subject or phenomenon is always, by definition, subjected to discourse and so cannot operate outside of discourse, and the subject can only be produced in the discourse. The subject will be shaped by the dominant rules, conventions and power/knowledge relations in existence (Hall 2001, p79).

Foucault employed an archaeological method in order to analyse discourse through analysing texts. As Foucault tracked the history of the subjects (such as medicine and madness) he found that the meanings and understandings which informed the subject changed, often drastically at certain points. Foucault was not interested in explaining why or charting how these shifts came to pass, but instead to show the differences they embodied (Rouse 1994, p94). These shifts, or breaks, changed what could be thought of and produced, making different understandings possible while denying others. These shifts also change the will to truth of that society – which McNay (1994) describes as the way knowledge is put into practice, given validity and distributed by providing a distinction between truth and falsehood (McNay 1994, p86). By this understanding knowledge is temporal and each episteme will produce its own knowledge. This realisation led Foucault to introduce the concept of games of truth, which emphasise that while meanings may appear to be natural, universal and ‘true’, they are in fact simply the product of institutional and discursive practices (Danaher 2010, p40). Although this understanding attacks the permanence of subjects, it is not always possible to analyse what influences society is under that leads to the production of certain types of knowledge, instead of others. Foucault offers the principal of rarefaction to explain why society cannot recognise all of the influential factors that are in operation at a given time and why society is always limited and constrained by that which it cannot recognise;
The principal of rarefaction is offered as an explanation of why it is that, in any era, everything that can be said is never said; that in relation to the wealth of possible statements that can be formulated in natural language, only relatively few things are actually said. (McNay 1994, p74)

Rarefaction thus would suggest that certain ideas and observations cannot be made during certain periods, and so the knowledge and perspectives available to society at any given time will always be relatively limited. In terms of discourse, Sheridan (1980) sees discourse and the will to truth as self-perpetuating, suggesting that true discourse is unable to identify the will to truth that drives it, as the pervading domination is so encompassing that the ‘truth’ it seeks to unmask can only be hidden by it (Sheridan 1980, p124).

The work of Foucault has influenced Sandra Harding in her development of the concept of *Standpoint Epistemologies*. This concept is centred on the belief that there are multiple perspectives on society and each society produces its own forms of knowledge. Harding does not view any one perspective inherently as more valuable than another, but hold that other viewpoints – especially of those located on the margins of society – can have valuable insights due to their position (Harding 1987, p159). Standpoint epistemologies can be understood as *situated knowledges* (Haraway 2004). The account offered by a particular standpoint may be invisible to the dominant perspective and so these perspectives can allow for different analysis and critiques. Rarefaction suggests that there are many oppressing factors in operation at any given time and they can only be perceived by future generations (Wicks 1998, p94). Standpoint epistemologies would suggest that by looking towards the margins of society, considerations which cannot be seen by dominant groups could be brought to light, as while rarefaction places limits on knowledge due to period constraints, standpoint epistemologies discusses the cultural constraints on knowledge formation and understanding.

A Foucauldian approach to research necessitates an examination into how knowledge is produced and comes to function as “truth”. For many subjects there could be competing versions and alternate viewpoints but often a certain stance is taken to be the legitimate one, and while standpoint epistemology highlights the existence of these different views, it freely admits that in society certain forms of knowledge are more powerful than others (Harding 1998, p74). Discourse analysis seeks to investigate the mechanisms through which a subject becomes recognised in a particular and coherent way and the conditions that enable people to recognise the subject in this way. Discourse analysis also examines the rules and interplay of statements accepted as true and those
believed to be false and the conditions they produce that enable people to view and categorise a phenomenon in a certain way and come to classify it as “madness” or “scientific” or “medical” as opposed to any other classification (Faubion 1998, p462). In this analysis;

the problem does not consist in drawing the line between that in a discourse which falls under the category of scientificity or truth, and that which comes under some other category, but in seeing historically how effects of truth are produced within discourses which in themselves are neither true nor false.

(McNay 1994, p107)

The discursive formation which is established around a subject and comes to define it can come to form a rigid understanding, which Foucault in the case of madness dubbed the so-called truth of madness, and this can serve to edit out and dismiss anything which does not fit with the current prevailing understanding at either a local (discipline-based) or general (cultural-based) level” (Danaher 2010, p23). Faubion (2002) describes five traits which characterise the “political economy” of truth. Firstly, he sees “truth” as a product of both scientific and institutional discourses but also subject to economic and political incitement and thus “truth” can have economic and political dimensions. Secondly, he says truth circulates through educational and other institutions “it is the object, under diverse forms, of immense diffusion and consumption” (Faubion 2002, p131). Thirdly, he refers to the power/knowledge dimension of “truth” as he mentions the ability of dominant political and economic institutions (such as military, media, universities) to produce and transmit it. However, his fourth trait says that although such institutions can dominate claims of truth, they are not exclusive in its production. Finally Faubion points to the “ideological struggles” of truth within political debates and social confrontation (Faubion 2002, p131). In disallowing the sacredness and uncontested nature of truth many new areas become open for contestation. Different societies throughout history have held different moral and ethical values as ideals, including harmony, religion, nature and reason. Following the Foucauldian argument no discourse is superior to another and societies do not naturally ‘progress’ from one age to another. Instead Foucault sees each society as investing a certain discourse and its practitioners with effects of power. This process does not come about due to the intrinsic qualities of a certain discourse, such as Marxism, but more due to the issues of truth as discussed previously. Foucault queries;

Which theoretical avant garde do you want to enthrone in order to isolate it from all the discontinuous forms of knowledge that circulate about it? When I see you straining to establish the scientificity of Marxism I do not really think that you are demonstrating once
and for all that Marxism has a rational structure and that therefore its propositions are the outcome of verifiable procedures (Foucault cited Rouse 1994, p103)

This idea of equality across societies is taken up by Danaher (2010) who argues that in our society the past is viewed as a rough copy of modern times, rather than being seen as a ‘foreign country’. This world-view, he says, is perpetuated at all levels in our culture (Danaher 2010, p14). This model promotes the idea of linear progression and development. This depiction also adds a certain justification to modern ideals and morals which can be shown to have existed in some form since antiquity, and it is as though these ideals have been strived for over centuries. The narratives which are a key feature in history education at all levels are shown to begin with a specific epiphany or event (such as the Magna Carta in Britain or the 1916 Rising in Ireland) and then is unfolded until it reaches its modern eventuality (Danaher 2010, p14-15). The presumed superiority of mankind and modern man can be seen in the theory of evolution and natural selection and the traditional explanation as to why man outlasted the dinosaurs “mammals, the story went, were more intelligent, better equipped to handle changing conditions, and generally more advanced” (Danaher 2010, p16). This is but one example which shows how political and social factors affect the production of knowledge and make it function as truth. Even pursuits such as science, which are often deemed to be value-free and objective, are subject to external influences, and especially so from economic incentives which often provide motivation for the development of arms (such as weapons of mass destruction) while limit the work on environmentally friendly fuel sources, which large oil companies militate against (Danaher 2010, p38). Foucault proposed that scientific discoveries and advancements were the fruits of chance, politics and policies, patronage and favouritism rather than as ‘a disinterested quest for the absolute truth about the world’ (Danaher 2010, p38). Foucault also showed how ‘truth’ can change from one era to another and how over time the same category, such as medicine, madness and crime and punishment, can be incommensurable paradigms and not superior formations (Norris 1994, p160). These ideas dispel the notion of universal truth and a natural progression toward righteousness and instead show the environmental elements which sometimes shape and mould society.
2.2.2 Power/Knowledge

One theme that is present throughout Foucault’s work is the relationship between power and knowledge. For him, power and knowledge are inseparable and there is no knowledge without the exercise of power, and likewise, there is no power without knowledge (Hindess 1998, p63). The idea that knowledge can exist independently of power, in Foucault’s opinion, is a false abstraction and so, for Foucault, one cannot be studied without also examining the other (Wicks 1998, p87). Therefore, it is not possible to examine power constructs in effect without looking at the influences people are under and to examine what they value, respect, consider important and believe and how knowledge is constructed in their society. Foucault’s worldview rejects ‘natural’ beliefs and instead suggests that these are in fact social constructs. For him, nothing is inherent, everything has an origin, a source and is subject to power relations. Foucault’s philosophy requires what is referred to as a systematic scepticism, especially as regards what are often considered anthropological universals. Foucault’s work does not require a rejection of these notions but instead it promotes a sceptical approach to them (Wicks 1998, p87). In examining a subject, one cannot assume something to be ‘right’, ‘necessary’ or ‘natural’, every aspect of the field must be broken down and problematised as only by this method can a Foucauldian analysis of the discourse be conducted. This approach and scepticism is often referred to as a ‘hyper-and pessimistic activism’ (Dreyfus and Rabinow 1996, p232).

We must question those ready-made syntheses, those groupings that we normally accept before any examination, those links whose validity is recognised from the outset; we must oust those forms and obscure forces by which we usually link the discourse of one man with that of another; they must be driven out from the darkness in which they reign (Foucault 1972, p22)

This is evident in Foucault’s approach to genealogy, which much like Nietzsche, centred on investigating the origins of discourses and powerful institutions which claimed to be either universal, unchanging or permanent (Danaher 2010, p24). Foucault's later work is characterised by this move towards genealogy and archaeology assumed a minor role (Burrell 1988, p224). As in archaeology, genealogy is interested in discontinuities, but it avoids the depth associated with archaeology and is interested in the unexpected and the superficial, and in genealogy practice becomes much more important than theory (Burrell, 1988, p224). In this genealogical period, the issues of power, knowledge and the body, and how they relate to one another were the focus of Foucault's work. Foucault wished to examine the type of knowledge produced by different societies and the origins of this way
of thinking. In this way, he wished to chart the changes in knowledge and meaning that would happen over time, or from era to era. When discussing how different types of knowledge can produce different systems of power, and vice versa, Foucault postulates;

power and knowledge directly imply one another…there is no power relation without the correlative constitution of a field of knowledge that does not presuppose and constitute at the same time power relations

(Foucault, cited in McNay 1994, p63)

These points lead to questions about the nature of knowledge and power. In Foucauldian philosophy power is not seen to be a concrete entity, or have a physical form, instead it is manifested through social practices and knowledge. Power exists only when it is put into action, especially where certain actions modify others. Power can have many effects and consequences, but power is not necessarily a function of consent (Margolis 1998, p47). Power can influence people strongly, whether or not they consent to this influence, or even if they are aware of it. Foucault proposed that one of the main functions of government was la conduite de la conduite (the conduct of conduct). However, rather than overtly imposing certain models of behaviour, governments try to manipulate the behaviour of the governed by indirectly influencing the manner in which they regulate their own behaviour (Hindess 1998, p66). This manipulation of behaviour can take the form of laws, restrictions, rules and regulations enforced by the government, the ideals of the constitution, and also by policies and strategies supported by the government. These can all have effects and impacts upon the societies’ attitudes and actions, in dictating social norms and on the la vie quotidienne (the everyday life) of that society. The establishment of social practices and norms is a complex dynamic, and is not solely influenced by the will of the government, or “a monotonous logic of domination”, but is influenced by numerous bodies, actors, current social practices and the societies’ version of its history (McNay 1994, p119).

O’Farrell interprets that power, for Foucault, is not seen as the sole property of governments, monarchs or dictators. Instead power is seen as a relation between individuals and different groups. In this sense power is not a concrete entity (Rouse 1994, p109) or ‘capacity’ which can be held, but only manifests when it is put into practice (O’Farrell 2005, p99). As well as in the extremes of producing constitutions, laws and regulations, power can also be seen in the everyday, seemingly mundane and normal social practices and interactions, “its insidiousness lies in its very ordinariness” (Young 2009, p201). Foucault thought of power as an all-encompassing entity, one that is ever
present in society and wrote; “Power is everywhere; not because it embraces everything, but because it comes from everywhere” (Foucault 1978, p93). It is also important to remember that power cannot exist independently, and is only present when it is being exercised, as O’Farrell reminds us; “a King is only a King if he has subjects” (O’Farrell 2005, p99).

Arising from this view of power (as an outcome of social processes and appearing as an abstract effect, having no place or body) there are many interesting applications. In everyday life these relations of power may not even be seen to exist or be recognised, which is perhaps when they are at their most powerful. When people are under influences that they do not know are present and when the power in action is so widespread, so encompassing that it is seen as the natural and proper order of things, people do not consent to be under the power influence. They are unknowingly subject to them and passively accept them. Foucault refers to this as the microphysics of power and capillary power where power produces certain activities and behaviours which serve to regulate people. Examples of this could be how students act in a classroom or why people are driven to earn a wage and purchase objects. In this way, power reaches “into the very grain of individuals” and has a profound impact on all aspects of their lives (O’Farrell 2005, p101).

The Foucauldian worldview also has links to the education system. Michael Apple has illustrated that education is deeply embedded in the politics of culture, and the selection and system of what constitutes education is a political and cultural activity. However, unlike Foucault, Apple focuses on ‘ideology’ and in this sense differs from Foucault. Apple discusses the selective tradition whereby a consistent assemblage of knowledge is produced and legitimised and taught as legitimate knowledge. This production and proliferation is tied to the cultural, political and economic milieu as they relate to the powerful groups of society, and likewise serve to marginalise and discount the knowledge of other groups (Apple 1996, p22). This stance has obvious implications to education where choices are made on a daily basis regarding what to teach, how to teach it and the intended outcomes of the learning. Curriculum is seen to comprise of three main elements namely; the written curriculum, what Eisner calls the null curriculum - which entails what is excluded (1985), and finally the hidden curriculum (Lynch 1989) which is comprised of all the materials that students learn as by-products of what is explicitly intended. The hidden curriculum includes, amongst others, social, behavioural, self-worth, moral and ethical dimensions (Apple and Beane 2007, p14). The hidden
curriculum accounts for many of the lessons and experiences that students will have during their academic careers and these lessons are not guided by curricula or lesson plans or means tested, yet all play a significant role in people’s development and their experience of education. This study will analyse all three of these aspects and will be especially concerned with the selection of what is seen to constitute science, the null curriculum, and the possible associated attitudes and images that the course promotes. This discussion on curriculum will be continued later in the chapter.

The issue of normalizing society, either through or along with la conduite de la conduite is one of the reoccurring themes in Foucault’s work on society. The perpetuation of ideas and truths through history and society is practiced through the knowledge that is given to the society. Therefore the knowledge that is available to a society will be an important issue in the society’s development. Foucault suggests,

The production of knowledge is ineluctably bound up with historically specific regimes of power; every society produces its own truths which have a normalizing and regulatory function

(McNay 1994, p107)

The production and decimation of knowledge, therefore, is specific to each society, as each society has taken its own path, featuring differing dominations, oppressions, power regimes, changes in understandings and meanings, and so forth. Each society will also have its own history, traditions and myths. According to this view all people in all societies, regardless of their position, social class, background, occupation, social status and even regardless of how many people they themselves influence, are subject to and influenced by power relations. These influences will of course not be the same in different societies, the only thing which will be the same is the presence of these manifold relations of power. In this way Foucault sees power as productive, meaning it generates and gives authority to specific types of knowledge and cultural order (O’Farrell 2005, p100).

Some authors (Such as Meera Nanda 2005, Sokal and Bricmont 1998) hold that modern science is a universal and value free system of knowledge formation and generation, and due to its neutrality, the strength of its knowledge, and its logic it has displaced other systems of knowledge and ways of knowing. Some also claim that its methodology allows it to make objective claims about nature (Shiva 2005, p15). Scholars influenced by a Foucauldian tradition do not accept this view of science, or claims that science is universal and functional discourse for people of all cultures. Along with Harding, standpoint epistemologies are favoured by other feminist and anti-colonial writers such as Vandana Shiva (2002, 2005), Ashis Nandy (1995), Sonia E. Alvarez
(2000), Arturo Escobar and Madhu Suri Prakash (1998). All of these authors try to show the shortcomings of Modern Western Science as a value laden ethno-science which has emerged due to distinctive morals, methods and cultural interests. Their argument points to the individuality of each culture and the similar processes through which knowledge is established and discovered. They see knowledge as inextricably bound to culture and reject the notions of value-neutrality, objectivity and cultural-neutrality. They propose that this discourse of science is indigenous to Western societies and is just one system of inquiry in the world. They argue that Western science could not have arisen in any other location, as the features and climate (political and cultural) in Europe could not be duplicated anywhere else. They argue that science and society co-construct each other, shaping the progression, possibilities and interests of each other (Harding 1998, p2).

Events in European history, such as the Cold War, the Space Race, the Industrial Revolution, all create conditions which affect politicians, sociologists, economists, historians and scientists alike and also have profound influence on education systems, legal systems, economic relations, religious beliefs and practices and state projects (such as war) and gender relations (Harding 1998, p4). Serena Nanda (1980), as distinct from Meera Nanda cited above, says Einstein could never have “invented” the theory of relativity if he was working within a different cultural framework as his work was predicated on the work of others and his efforts simply expanded the Western tradition (Nanda 1980, p49). Zilsel refers to the existing class structure which existed in Europe which made experimental work possible, while in another culture, the class distinction between manual and mental work would have prevented this type of enquiry (Zilsel 2000, p946). In this view science and society, do not exist independently, nor is it a one-way system where one is dependent on the other; it is a mutual relationship as each body co-evolves the other. It is claimed that as sciences and technologies are bound to people’s historical experiences they must also carry the values and cultures of its place of origin, therefore science cannot be neutral as it carries the values of Western society where it evolved (Byanyima 1994, p59). This argument further highlights the need to look at the cultural elements of Irish Science curriculum and to examine which of these contrasting views is promoted in the course – the value-neutral objective model of science or the culturally-dependent model as a particular strand of knowledge formation.

As discussed, in the Foucauldian understanding of power and ‘truth’, relations will differ across societies and cultures due to the changing interplay of oppressions,
dominations and meanings and so forth. However another insight offered by Foucault is how understandings, meaning and actions differ across time periods and from one era to the next. This understanding is markedly different from the ideology of Marx, who thought that as time passed, society advanced towards ‘truth’. In the Marxist understanding, political disputes and contestations as well as struggles for domination and power fade away as subjects discover their ‘truth’ and true nature as this continual progression continues (O’Farrell 2005, p98). In this ideology, the features of modern society could all be traced back and identified as coming into being at a discrete moment in history, and the only difference between modern and past societies is that our ancestors had not figured ‘it’ out and did not know as much as we do (Danaher 2010, p14). Foucault rejects this notion of advancement and instead favours equality across the ages, each operating under their own philosophies, and having different meanings and understandings. Marx affords superiority to modernity as it is further along on the march to truth, while Foucault sees modernity as simply the latest incarnation of society. In Foucault’s understanding modernity does not signify a ‘breakthrough’ nor is it marked by an epiphany where the limits of the past are realised and overcome; instead it is seen as the latest shift in understanding, similar to those which have come before it;

Modernity is not a specific historical event, but a historical conjuncture which has happened several times in our history, albeit with different form and content: for example, the breakdown of the traditional virtues in Athens at the same time of Socrates and Aristophanes, the decline of the Hellenistic world, the end of metaphysics at the time of Kant

(Dreyfus and Rabinow 1996, p117) In this sense ‘truth’ is not uncovered but instead may be altered or substituted for another form of ‘truth’. In this way what may count as ‘truth’, or as an important aspect or consideration in one period may not even be entertained as a candidate at another (Rouse 1994, p93). Discourse creates the conditions that allows for the creation of the subject and the meanings it can have, and likewise what cannot count. In this sense any particular understanding of ‘truth’ is very much a thing of this world and this time.

Power, as an entity, creates what people view to be the truth and what is right. Not only does power lead to what knowledge people learn and what they see as important, but it also accompanies knowledge, as it is inherent in it. Power influences how people accept knowledge, how they interpret it, what they choose to assimilate and adopt into their current views on the subject and also what they dismiss. This power/knowledge relation also has important applications to the history of a society. History plays a role in how people construct their identity and can play a role in determining the values of certain
societies, their actions, their professions, the rules and regulations that they formed, their customs, festivals and traditions and other aspects of their lives. However, the version of history that is in popular usage in societies is perhaps more important than whether or not that version is particularly accurate. Romanticised stories, selective events, errors and omissions all can combine to give a biased view of past events and present this version history to the people. Due to the far reaching effects and the influence that history has, the presentation of history, or of a history, as well as the control of history is a very powerful and important tool in shaping societies, and in line with Foucault’s view of power, will shape people’s knowledge and values. This issue is central to the work of Eric Hobsbawm in his text *The Invention of Tradition*, which will be discussed in the next section.

In his work Foucault also addresses the issue of ‘truth’ and relates it to the power/knowledge relation. For Foucault, ‘truth’ is not outside of power or lacking in power, but rather ‘truth’ is a thing of this world produced only by multiple forms of constraint, and ‘truth’ itself produces regular effects of power (Foucault 1980, p131). Foucault was interested in the types of discourse that were accepted and how it makes certain knowledge to be taken as ‘true’. In this way, ‘truth’ is linked in a circular relation with systems of power, which allow it to exist, function and extend (Faubion 2002, p132). Foucault views ‘truth’ as “a system of ordered procedures for the production, regulation, distribution and operation of statements” (Hacking 1996, p35). Every society has its own “general politics” of truth and “regime of truth”. What this means is every society has its own particular discourses which it selects and makes function as true. This allows for certain statements to be allowed and others to be excluded or disregarded. It also influences who is authorised to make these statements (Faubion 2002, p131). In this way, certain forms of knowledge and understanding assume positions of power and authority and come to function as true, but also, in a self-fulfilling manner come to have the power to make itself true (Hall 2001, p76). The effect of this is that certain forms of knowledge operate as ‘true’ and thus become a factor in the regulation of the conduct of others, constraint and the disciplining of practices (Hall 2001, p76). ‘Truth’ then is not a self-contained, pure, value-free entity or the rewarded of liberated society, but rather can be constructed and perpetuated through discourse (Faubion 2002, p131). The issue of ‘truth’ was not the primary concern of Foucault’s study, and he was more concerned with the application and effectiveness of power/knowledge, and their relation. Foucault held that knowledge is always a form of power, and furthermore, power is always associated with
whether or not knowledge will be applied, and also the contexts, circumstances and occasions this application will, or will not, be made (Hall 2001, p76). The Greek philosopher Plato also offers insight into why power and knowledge can take precedence over the issue of truth, and may offer a different variety of insight into the structure of society;

true belief can be just as efficacious as knowledge; so the same powers can arise from true belief as from knowledge. Lastly, false belief might not always leave us powerless.

(Plato cited in Nola 1998, p111)

2.2.3 Science as a Discourse

Having discussed two of the central issues in Foucault’s work I will now apply these ideas to the discourse of science which will be examined in this study. To aid this discussion I will draw parallels between Foucault’s own work on the medical discourse. The similarities between these discourses will aid the analysis as more direct comparisons can be drawn.

An important distinction to draw when analysing a discourse is the difference between the object itself and the discourse which is formed and created around the object. Discourse discounts the possibilities of objective knowledge, a concrete or simple group of facts.

The unity of a discourse on madness would not be based upon the existence of the object ‘madness’, or the constitution of a single horizon of objectivity; it would be the interplay of the rules that make possible the appearance of objects during a given period of time: objects that are differentiated in daily practice, in law, in religious casuistry, in medical diagnosis, objects that are manifested in pathological descriptions, objects that are circumscribed by medical codes, practices, treatment, and care.

(Foucault 1972, p32-33)

Within discourse, rather than to try to assess or seek unities within that discourse, the work focuses on the interplay of rules which define the discourse and allow for transformations and the breaks produced over time. The non-identity is more pertinent than the apparent identity and the internal discontinuity that suspends its permanence is more significant than any claims promoting natural origins (Foucault 1972, p33).

As previously dealt with, the formation of a discourse is seen to be dependent on the power relations in effect in the locale where the discourse is established. Foucault challenges the popular notion of the ‘inevitable progression’ of civilisation and the idea that society is moving towards a better incarnation. Foucault instead suggests is that our current knowledge and understanding is not inevitable, but is dependent on the way in which our episteme is ordered. Due to this, our understanding of things is limited as we
cannot understand how things could be different, or of speaking in a different way about them (Danaher 2010, p21). Although a discourse may be produced in a particular environment and be successfully functioning here, Foucault has shown that discourses are not permanent, and shifts in understanding and breaks in the discourse occur. Sometimes these changes are sudden, as was the case in the medical discourse in the early part of the nineteenth century, much as Kuhn describes sudden paradigm shifts in Sciences. Here a sudden, rapid change was seen in the discourse where the understanding of illness, the role of the doctor and the patient’s position in the discourse all underwent significant change.

Foucault’s analysis examined the change in the medical discourse which led to a profound discursive shift;

in less than half a century, the medical understanding of disease was transformed from a classical notion that disease existed as separate from the body, to the modern idea that disease arose within and could be mapped directly by its course through the human body (McNay, 1994)

Before the nineteenth century the endeavour of medicine was to monitor and analyse the diseases, as opposed to trying to treat the patient. Medicine in the nineteenth century focused on the creation of a corpus of knowledge (Foucault 1972, p33) which dealt with diseases and their treatments and so the doctor became the expert, while the diagnostic abilities of the patient lost credibility. This central body of knowledge in medicine became its most important aspect. It provided a unity to medicine, giving a definition of what medicine is. This body of knowledge became necessary to ‘know’ and to practice medicine. It also provided the guidelines of correct and ‘best’ practice. Having a common body of knowledge also provided medicine with its own language, its own system of communication. This language was common to those who practice medicine but alien to others. This led to a change in the fundamental approach of treating the sick, where the doctor’s central question changed from the eighteenth century question of ‘What is the matter with you?’ to the nineteenth century question of ‘Where does it hurt?’ (Windschuttle 1998, p13). The doctor, as the expert in this dynamic assumes all the diagnostic power while the patient is constituted as a passive body, who after stating where the problem lies then relies on the doctor to assess their condition and to decide upon the most suitable treatment for them. This redefined doctor/patient relationship and attributed more importance to the doctor’s ‘gaze’, and placed them in a position that could now ‘read’ the illness and diagnose it through the established corpus of knowledge, in a similar way an astronomer could identify a star system (Hall 2001, p74-75). This
example shows how shifts in focus and understanding can change, the effect this has on the discourse, and the potential this has to influence power relations and society.

This example shows how, in a short period of time, the structures and functioning of discourse can undergo drastic and dramatic changes. The change in the medical discourse led to a reorganisation of the hospital and medical knowledge as well as a new understanding of the patient in society. It also altered the social relationship between the public and the medical profession (Dreyfus and Rabinow 1983, p14-15). The explanation within the medical discourse was that, with Bichat (regarded as the father of modern histology and pathology), medicine was finally able to break free from fantasy and superstition and come to objective truth about the body and diseases (Dreyfus and Rabinow 1983, p12). Foucault accepts the explanation of the timing and significance of this break, but gives it a total interpretation seeing it as a change in the syntactic form rather than the semantic content of the modern structure of clinical perception that underwent change (Dreyfus and Rabinow 1983, p15).

As stated, the medical discourse and the scientific discourse share many similarities, and in many ways are analogous. Science and medicine in their current constitution share many tenants, such as objectivity, a unique language, a central corpus of knowledge, a prestigious place for the expert, high levels of specification and so on. Another similarity between the discourses is that the nineteenth century was also a time of great change in the scientific community as new ‘breakthroughs’ challenged and changed their view of the world as new and more fitting ideas were brought forward. This new material again led the scientific world in a different direction and led to a different style of problem solving and manner of statement.

Certain features of science also tend to exclude, or marginalise, those which are deemed ‘unscientific’ by the current incarnation of the discourse. The specialised nature of science, the language and especially the demands and criteria of the scientific method serve to limit the contribution other science can have as a discourse that does not follow these guidelines will have no credibility in the world of this discourse and so their knowledge’s will be quickly dismissed. Danaher (2010) argues that the widespread acceptance that medicine is useful, valuable and good for you is due to the propaganda of hospitals, medical colleges, government bureaucracies, schools and the media all tell us that this is so. He goes on to say that as well as defining what ‘real’ medicine is, such as antibiotics, we are also told what it isn’t, namely anti-oxidant vitamins, the blood of a chicken prepared by a witch, or holy water from Lourdes as examples (Danaher 2010,
There is a similar correlation with science which outlines things such as spiritual theories and other phenomena, such as acupuncture and Chinese medicine for example, that are currently unexplainable under this discourse of science, as unscientific as they cannot be ‘proved’ under the rules established by this discourse. The power/knowledge relation can be clearly seen here. The scientific discourse values objectivity, reproducibility, reliability, empirical methods, pure reason and so forth and this works to the exclusion of less systematic and more experiential types of knowledge, which are deemed to be unreliable or irrelevant to developments in formal knowledge by modern Western society (McNay 1994, p53). However, despite the empirical and ‘objective’ nature of modern scientific methods they are far from flawless, as evidenced by the prescription of Thalidomide in the 1950s to cure morning sickness which led to malformed babies (Danaher 2010, p38).

The following section will examine how these Foucauldian ideas apply to science education and will highlight the effect of discourse and the power/knowledge relation on educational structures. This section will show the cultural fingerprints on the discourse of science and the Western bias in the subject discipline.

2.2.4 Cultural Background and Science Education

This section will discuss how the Foucauldian concept of discourse applies to Modern Western Science and it will offer an example as to why it is not a universal, unbiased discourse. While “Science for all” curricula are being promoted at present, studies have shown that students from different cultural backgrounds experience science in very different ways. Aikenhead (1996) explains how students from non-Western backgrounds experience cultural conflict when dealing with Modern Western Science (Aikenhead 1996). He identifies science as a sub-culture of Euro-American culture and the cultural differences faced by first nation students in North America are seen as obstacles to learning science (Aikenhead 1996, p218). In this view, the cultures of school, school science and science itself all must be acquired in order for students to succeed in these settings. These cultures are sources of conflict for first nation students as they enter these settings from their own cultures of peers, family and tribe (Aikenhead 1996, p218). As students move from one culture to another they must navigate border crossings (Aikenhead 1996, p224) and their ability to transition between native and foreign culture
greatly impacts on their ability engage with these cultures. Therefore, success for non-Western people when dealing with science education will depend on the following factors;

(a) the degree of cultural difference that students perceive between their life-world and their science classroom, (b) how effectively students move between their life-world culture and the culture of science or school science, and (c) the assistance students receive in making those transitions easier

(Aikenhead and Jegede 1999, p270)

Aikenhead (1996) identified some of the commonly identified features of Modern Western Science as “mechanistic, materialistic, reductionist, empirical, rational, decontextualized, mathematically idealized, communal, ideological, masculine, elitist, competitive, exploitive, impersonal, and violent” (Aikenhead 1996, p220). This version of knowledge is very different from the beliefs of places such as the Solomon Islands and certain African countries where the indigenous knowledge systems are based on magic and anthropomorphism respectively (Aikenhead and Jegede 1999, p273). In such cases, the contrasting worldview offered in science education can force students to abandon or marginalise their own, traditional concepts and replace them with Modern Western Scientific ways of conceptualizing. Aikenhead and Jegede (1999) refer to this process as assimilation and state that it “can alienate students from their indigenous life-world culture, thereby causing various social disruptions” (Aikenhead and Jegede 1999, p274). Where students hold on to their cultural beliefs they can become alienated from science and not engage in learning science content in a meaningful way (Aikenhead and Jegede 1999, p274).

2.2.4 Applications for Research

Is any knowledge objective? Can any knowledge be taken as valid? As truth? How has our understanding of knowledge been shaped? What has influenced and changed it? What ‘games’ and ‘regimes’ are currently dominating? Following a Foucauldian approach forces us to examine these issues and abandon our prior conceptions and beliefs in attempting to offer answers to these questions. However, it is not Foucault’s wish to uncover these truths, or the origin and source of absolute knowledge,

With regard to the problem of truth, discursive analysis does not seek to pierce a mystificatory realm of ideas in order to uncover an objective truth; rather it examines the particular way power – knowledge complexes operate at a microsocial level in order to produce regimes of truth.
While some areas may appear to be natural assemblages of knowledge that have existed since antiquity Foucault’s extensive work has shown the transient nature of discourse, and the relatively recent origins and understandings of areas such as Western medicine, punishment and madness and even that modern man himself is a recent incarnation and no more permanent than “a figure traced in the sand at the edge of the sea” (Luxon 2004, p479). This recognition leads to the development of a *problematique* in order to break down and examine the inner workings of a discourse and the key components therein. This philosophy rejects the notion of a singular version of a subject which could have developed insulated from cultural and social concerns.

This study will utilise this philosophy in order to break down and examine science education in Ireland. This research will portray the discourse of science that dominates the Irish education system and whether or not it is depicted as a universal. In Foucauldian terms discourse is seen as a particular selection of lenses and filters and one version of an area. This view is especially relevant in an educational context where curriculum can require the selection of a particular approach to education and favours the development of a particular type of knowledge and skills. Therefore, this study will also deal with the implications of this selection and the broader, social consequences. This study will examine the possibility for science to become an emancipatory and intercultural subject and will also seek to examine how the course represents minorities.

Following on from this discussion the next section will focus on the cultural and racial aspects of discourse and Westernisation. It will analyse the violences, both physical and psychological, associated with oppression, colonisation, the loss of traditional culture and values. It will also introduce the feminine perspective of science and contrast this with the established discourse of Modern Western Science and the perception of this discourse as a suitable discourse for all peoples. This analysis should further develop the idea that knowledge, and particularly science, are particular discourses of knowledge.
2.3 Cultural Concerns relating to the dominant Modern Western model of science

2.3.1 Inheritors of the Foucauldian tradition
The dominant model of science, dubbed Modern Western Science, receives little contestation in the public sphere and has widespread support. There are however elements of this discourse that are seen as strongly negative by some parties, as opposed to the commonly held perception of science as inherently good. Much of the criticism of Modern Western Science comes from feminist and anti-colonial writers and they point to the Eurocentric nature of the subject and masculine understandings of the World as embedded in this discourse. Rather than a value- and culturally-neutral enterprise this section will highlight the limitations and potential hazards of Modern Western Science and introduce the feminist and anti-colonial viewpoints and the specific criticisms of the dominant discourse.

The cultural bias within Modern Western Science will also be dealt with by examining its influence on identify formation, representation, race relations, development policies and aspects of oppression and violence associated with Modern Western Science. In this discussion colonial relations and the effect of subjugation will help to show how non-Western people are marginalised by the dominant discourse and how Modern Western Science is tailored to Western needs. Edward Said’s concept of Orientalism is also useful in this context as it helps show the history of relations between the Orient and the Occident and how the identity of the West was produced in opposition to and in the process of, perceiving an identity of the East (Said 1991). The history of racism within Western culture and the history of this racism within Modern Western Science will also show the bias within the subject and the possible remnants of this racism in contemporary accounts and practices. This discussion will explore the view that Modern Western Science is very much a particular discourse of science that was produced though a complex interplay of power/knowledge relations and that the area is a socially constructed ethno-science filtered through Western norms, morals, beliefs, values and practices.
2.3.2 Characteristics of Modern Western Science
This study deals with Modern Western Science and its depiction in the Irish education system. This section will clarify what is meant by the term ‘Modern Western Science’ and identify the key traits of this discourse. Modern Western Science, as it is currently constituted, can be traced back to Francis Bacon, Auguste Comte and the Scientific Revolution. It was in this period that the highly experimental, ‘objective’ model of science gained prominence and shaped the future of science. Scientists such as Robert Boyle, Gregor Mendel, Georg Ohm, Robert Hooke and Michael Faraday were all advocates of this method. Some of the traits associated with Western science are; a distinctive method of research, high standards of objectivity and a particular model of what is counted as good reasoning, a critical attitude towards traditional belief and the use of mathematics to express nature’s order (Harding 1998, p147). Western science is associated with high predictive and explanatory powers and through this method there has been a proliferation of technological products. Western science held the promise of uncovering the ‘laws of nature’ through logic and reason and the experimental method. This system of scientific inquiry comprised of a worldview privileging reason and observation and a methodology designed to acquire accurate knowledge of the natural and social world. Essential to this methodology is a critical spirit and a commitment to the incessant testing of hypothesis through observations and/or experiments, and revising, adjusting, altering or dismissing this hypothesis as a result (Sokal cited in Nanda 2005, p173). This is seen to enable science to produce universally valid, bias-free facts (Nanda 2005, p148). This philosophy became the standard operating procedure for investigation in the Western world and with the aid of this technique many discoveries have been made and even new sciences have been created, such as quantum mechanics, quantum physics, microbiology and many others. The argument in this section will highlight the criticisms of Modern Western Science and show the cultural and epistemological biases within the subject.

2.3.3 The Birth of Modern Western Science
When analysing Modern Western Science the period known as the Enlightenment, circa the seventeenth century, is a key period as it was this era that provided the inspiration for Modern Western Science in its current form. The Enlightenment marked a shift in the thinking of Europeans and had profound influence on culture, art, lifestyle and
philosophy. One of the most significant effects of the Enlightenment was the changing of the Aristotelian-Augustinian notion that the glory days of mankind lay in the past. This belief can be stated as follows “the irreversible decline of the world made it necessary to refer back to the model of the Ancients, who had lived in happier times” (Rist 1997, p35). With this fundamental change in beliefs, the barriers of possibility were completely redrawn and the potential for change grew exponentially. According to Rist:

from the end of the seventeenth century, what had previously been unthinkable became quite reasonable: the intellectual landscape suddenly shifted, and the ideology of progress acquired a dominant position (Rist 1997, p35).

This change in beliefs allowed the generation and widespread acceptance of models which proposed a utopian future, which up to that point had been unfathomable. In this period Modern Western Science emerged as the primary method of problem solving and the best way to uncover the secrets of nature and gain an understanding of the world. Enlightenment rationality allowed for the possibility of a prosperous future, and this discourse, in its most recent incarnation, became the vehicle which was seen to be able to bring about this progress. Scientific rationality and the scientific method thus came to occupy a prestigious place in society, as did its practitioners.

The Enlightenment established a new social order and had profound influence on the development of Western Civilisations. Therefore, the Enlightenment had a role in shaping future society and an influence on future social practices and norms. In Foucauldian terms, the Enlightenment is an extremely important and powerful period in European development. In Foucault’s Power/Knowledge relation the regulation of individual lives, and societies is an extremely important aspect. The Enlightenment did not represent a violent or overt power struggle, though it played a role in the possibility of imagining better futures that inspired revolutions in France, America and in the growth of revolutionary Socialism and Communism and thus radically altered la vie quotidienne (the ordinary life) for Western societies (McNay 1994, p148). For Foucault the lasting effect of that “delusory Enlightenment project” constituted an ethos or a philosophical life which analyses our being and the historical limits that were placed on us and challenges these limits in the hope of breaking through them (Norris 1994, p169-170). The Enlightenment was an ideological revolution that captured the hearts and minds of Europeans and resulted in a new set of goals, principles, beliefs and ideals, in short, the Enlightenment served to delimit the realm of possibility for Europeans;
The permanent achievement of the Enlightenment was to bring about a change in the cultural habitus by setting new standards for evidence, truth and authority that were inspired by advances in science

(Nanda 2005, p162)

However, some critics argue that due to the dominance of Enlightenment thought and rationality it no longer delimits the field of possibility and instead almost enjoys a monopoly of thought to the extent that “Enlightenment now shows up as a symptom of the condition for which it once professed to be the cure” (Norris 1994, p170).

Another lasting legacy of the Enlightenment was to restructure the source of knowledge. Before the Enlightenment either Nature or God were viewed as the source of knowledge and responsible for the order of the world. In the Modern age, ‘man’ has become the basis of knowledge and knowledge generation;

So the ‘measure of all things’ from the end of the eighteenth century, according to Foucault, was not God or Nature, but ‘man’

(Danaher 2010, p20).

This understanding shows ‘man’ (not man as a species, but ‘mankind’ as it current understands itself as a rational and self-governing being) to be an invention of recent date, and would suggest that his placement at the pinnacle of society and knowledge is a temporal one and if the circumstances were to change, much like with the cultural revolution which saw it rise to ascendancy then the time “then one can certainly wager that man would be erased, like a face drawn in sand at the edge of the sea” (Foucault, cited in McNay 1994, p56).

In terms of Modern Western Science the Enlightenment also had profound effects. The restructuring of knowledge led to a change in the operation of science as both empiricism and inductive logic came to prominence. Nanda claims an understanding of the Enlightenment as essentially “a revolt against supernaturalism in all its guises” (Nanda 2005, p162). This rejection of inherited knowledge from tradition, religion or metaphysics and of anything which has not been seen, observed and tested by the self is what separates the moderns from the ancients (Nanda 1995, WS3). She also suggests that modified or alternative models of science are unnecessary as Modern Western Science can be applied and, especially due to its reliability, is a suitable knowledge system for all peoples;

Cultures with different ontological categories can still agree on methodological rules of science, because all cultures have an interest in reliable knowledge, and science has a proven track record of picking out reliable knowledge more often than other ways of setting up inquiry

(Nanda 2005, p169)
This ‘track record’ of modern science is seen to justify its proliferation and its adoption throughout the world. As she sees science as based upon reason and grounded in facts and empiricism she sees it as a legitimate “lingua franca of the modern world” (Nanda 2005, p173). Sokal and Bricmont (1998) see this model of science as made up of four main themes which are; an academic pursuit aimed at achieving a rational understanding of the world, a corpus of theories and experiments, a social community comprised of particular customs, traditions and practices and links to society, and also as applied science – science and technology (Sokal and Bricmont 1998, p202). The ‘critical spirit’ of science and its methodology is seen to overcome cultural constraints and thus presents it as a knowledge system of equal value to all people;

I am referring to the nearly universal acceptance of the universalism of modern science. It is simply an empirical fact of the modern world that regardless of the culture they were born into, ordinary people when introduced to scientific theories and reasoning behind them, tend to find them as rationally persuasive and empirically warranted (Nanda 2005, p160)

The advocacy and support of science of goes so far in fact that Nanda and Gellner are seen to have a quasi-religious stance on science (Kumar 1997, p109) and in many regards hold it beyond reproach (Nanda 2005, p173). For many, science is the most important category in the world and according to Harding “Neither God nor tradition is privileged with the same credibility as scientific rationality in modern cultures” (Harding, cited in Shiva 2002, p36).

Joseph Needham, who worked extensively to show the large number of scientific development in China and the influence these had on Modern Western Science, also sees science as a universal. This universality was achieved through the merger of natural science and mathematics and this allowed it to become “the common property of all mankind” (Needham 1993, p31). For Nanda the acceptance of science comes from the natural inquisitiveness of all human beings and stems from their desire for ‘true’ knowledge, which she sees as independent of culture, race or background. She states that people have an innate desire in acquiring reliable knowledge which can allow them to predict and control the forces of nature (Nanda 2005, p169). Needham has shown that ‘Science’ is not, and was never, unique to Western science, but rather that modern science simply came into being in the West. This science, he claims, should not be the sole intellectual property of the West but should be shared and used by peoples of all race and creed;
For what was born in the time of Galileo was a universal palladium, the salutary enlightenment of all men without distinction of race, colour, faith or homeland, wherein all can qualify and all participate. Modern universal science, yes: Western science, no!

(Needham 1993, p45)

2.3.4 Postmodernism and the production of knowledge

Despite Nanda and Sokal’s advocacy for this version of knowledge formation their enthusiasm is not shared by all. They celebrate the Enlightenment as the period in which science broke free of superstition and tradition and gave birth to ‘reliable and empirical’ practices. The significance of the Enlightenment is shared by postmodernists, but they view its impact in a much different way. Postmodernists offer radically different interpretations of the nature of Modern Western Science and especially on the suitability of this discourse for all cultures. Postmodernism is a school of thought that rejects many of the tenets of universality. One understanding of postmodernism, as detailed by Watson (1998) focuses on the commonly held view that our understanding and knowledge of the world has been dominated by masculine and Eurocentric perceptions and influenced by the justification of colonialism and imperialism (Watson 1998, p14). Postcolonial accounts usually focus on promoting the interests of minority groups such as women, the poor and indigenous people (Ish-Shalom 2006, p289). Watson identifies a common underlying premise in postmodernist philosophy which suggests that the rights of minority groups have been denied and that education has been used to try to mould them into the European image (Watson 1998, p14). Essentially, postmodernists see Modern Western Science as a social and political activity rather than simply a methodology for gaining information about the World. They not only reject that science is neutral, objective and free from cultural constraints, but also reject these as possibilities;

Science, so the postmodernist argument goes, is a social and political activity, and as such is contaminated by power-seeking and spurious ideologizing... what positivists consider essential, that is, an objective, universal and ideology-free foundation, postmodernists consider a sham, an ideological myth obscuring the true nature of science, as a servant of the current exclusionist status quo. Science is an ideologically based - and biased – political activity.

(Ish-Shalom 2006, p289)

Postmodernists examine science and its structures and are particularly interested in how it relates to society. They suggested that sciences and the cultures that conceived them co-evolve one another and effect how each is created, maintained and progress (Harding 1998, p3). This is known as constructionist and is concerned with the distinctiveness of how each culture gains and manages knowledge. This understanding would serve to show
that biases and prejudices are always present in any system of knowledge and denies the possibility that any knowledge could be trans-cultural or a-cultural (Harding 1998, p14). Some of the perceived intrinsic qualities of Modern Western Science are that it is to be paternalistic, Eurocentric, patriarchal, mechanistic and reductionist amongst others. Haraway (2004) discusses how science and technology are not gender neutral and that certain consequences of industrialisation (such as ecological disasters and deterioration) more harshly affected women than men (Haraway 2004, p334). These types of observations are seen to enforce constructionist views and that the knowledge produced by European societies contained the views, ideals and assumptions of that culture. Harding (1998) maintains that science still occupies a prestigious position and receives widespread support, even with inadequacies in explaining, predicting and controlling environmental destruction and practices that cause carcinogens or contagious diseases (Harding 1998, p166). Part of this can be contributed to the fact that science constructs itself as singular, and this construction does not allow for alternate versions to compete with science, or even to exist alongside it (Hackling 1996). Haraway (2004) also claims science has abetted the exclusion of women from affirmative participation in science by reinforcing and rationalising male dominance (Haraway 2004, p355).

Fundamentally the worldview advocated by Modern Western Science and that held by postmodernists are at odds with one another. While the former see science as culturally liberating and see any other form of knowledge as lacking and inferior, the latter see Modern Western Science as culturally limiting and voice the need for alternatives. Advocates of Modern Western Science favour the replacement of native theories as due to the reliability and rigour of its knowledge it offers a more accurate description of the world and so places it at a higher level than less conclusive theories. Postmodernists argue that as all systems of science have grown in the same way and the methods have undergone similar processes to create the dominant discourse and so all sciences have equal standing as they are all in fact ethno-sciences (Marriott, cited in Barber 2002, p. 749). This conflict will be analysed in this study and the way science is presented in science education will be a telling factor in the construction of the discourse.

Throughout European accounts there is an underlying premise which maintains that other cultures were incapable of developing as efficiently as European nations, for example Said (1991). These views would view these underlying beliefs as part of science and influential in its practice. Postcolonial authors typically attribute this belief to the
larger dominant conceptual frameworks in Europe, namely its conceptual Eurocentrism, androcentrism, service to class interests and a faith in Enlightenment rationality. However, certain accounts have shown that Europe actually lagged behind other cultural centres in some economic, political, technological and scientific respects during the ‘Dark Ages’ and was no more than on par with conditions in China and India in other respects (Harding 1998, p26). Many of these European frameworks imply the superiority of Western people, practices and society. According to Harding;

Central among the presuppositions of eurocentric discourses are that peoples of European descent, their institutions, practices, and favored conceptual schemes, express the unique heights of human development

(Harding 1998, p14)

One such belief that is prevalent in European thought is the idea of the ‘European Miracle’. Blaut (1992) describes the ‘European Miracle’ as a belief that at some stage in the past (in prehistoric or medieval times) Europe forged ahead of other civilisations and that this “internally generated historical superiority” provides explanation for world history and geography after 1492, including the modernisation of Europe, the rise of capitalism and the conquest of the world (Blaut cited in Harding 1998, p27). This thinking places European nations “ahead” of and more progressive than others prior to colonialism. Europe’s economic and social modernisation was also credited to its internal character and not due to its contact with other nations, this is what Blaut calls the “autonomous rise of Europe” (Blaut 1992, p2).

This study will address the concerns of constructionists and postmodernists and will investigate the existences of these cultural biases and issues of domination and oppression. The political and social dimensions of science would have particularly interesting consequences in education as they could play a role in establishing norms as well as values and ethics for students. In order to conduct this analysis the biases and values potentially associated with Modern Western Science will need to be examined. This section will explore the current conflict regarding the nature of science as well as some of the dominant ideologies in Western society that would be seen to be important in the construction of science according to the postmodern argument. This investigation will examine the relationship between science and nature as well as between science and the marginalised. Past interactions between East and West and Europe and the Third World, will also be dealt with and this examination will especially focus on colonisation.
2.3.5 Violence associated with Modern Western Science

One alternative framework to Modern Western Science is feminist science. Feminist science is characterised by a close relationship with nature and is predicated on mutual respect, conservation and sustainability (Shiva 2002). Modern science has a much different understanding of nature and under Bacon’s construction seeks to control and manipulate nature rather than revere it (Lloyd 1993, p46). Also, while feminist science treats nature as an organism, modern science views it as a machine, and seeks to understand the mechanisms of nature by examining the individual parts (Lloyd 1993, p47). Instead of attempting to work with nature, science seeks to separate from nature and become its master. Shiva gives the following description of how Western science acts on nature;

We make by act trees and flowers to come earlier or later than their season, and to come up and bear more speedily than by their natural course they do. We make them by act greater and sweeter and of differing taste, smell, colour and figure from their nature (Shiva 2005, p17)

Feminists detail how the gender relations present in the discourse, and in society at large, affect the emergence and maintenance of how knowledge is valued and given validity in Modern Western Science. They are also concerned with the significance gender relations have had on the patterns of knowledge and ignorance in science (Harding 1998, p121). Feminists do not claim to be able to produce superior knowledge than what Modern Western Science has produced, (which would of course necessitate the definition of ‘superiority’, which would no doubt be a contested debate) instead they focus on the ways in which Modern Western Science has limited knowledge production, and the harmful effects this mode of knowledge has had on societies. The limitations of science of which Harding speaks refer to the standards set by Modern Western Science defining what counts as knowledge and what can be understood as a scientific account. Within science, she claims, the dependence on physics as a knowledge system has produced a disproportionate focus on discrete, isolated, short term and “purely physical” aspects of our world (Harding 1998, p186).

Other criticisms of Modern Western Science focus on the bias within the subject towards masculine and Eurocentric interests. Theorists such as Sandra Harding (1993, 1998), Gustavo Esteva and Madhu Suri Prakash (1998), Chandra Talpande Mohanty (2003) and Vandana Shiva (2002, 2005) refer to the Western model of development as
maldevelopment and Modern Western Science as reductionist due to these biases. In their work they highlight the destruction associated with the Western model, not only of the environment and natural resources, but also of knowledge through the violence they perceive against marginalised groups such as women and the poor. Shiva (2002) uses the term *reductionist* to describe Modern Western Science as it has reduced our ability to know nature as it serves to exclude other knowers and ways of knowing (Shiva 2002, p22). Like Lloyd (1993), she also criticises the ontological assumptions of modern scientific research which views nature as if it were a machine and distorts the interconnectedness of nature by examining systems by breaking them up into their parts (Shiva 2002, p29). Shiva identifies four main violences of reductionary science as:

i. Violence against women

ii. Violence against nature

iii. Violence against the beneficiaries of knowledge

iv. Violence against knowledge

### 2.3.5.1 Violence against women

The perceived source of the violence against women in feminist studies is seen to come from the masculine nature of Modern Western Science and the consequent knowledge it can produce. Since the time of Francis Bacon and the Royal Society, science has been dominated by males and male interests (Shiva 2002, p16). Bacon saw the previous incarnation of science as passive and weak and in *The Masculine Birth of Time* claimed that he sought to create ‘a blessed race of heroes and supermen’ who would rule over society and nature (cited in Shiva 2002, p16). In this new system of enquiry, nature was no longer ‘Mother Nature’ but became a feminine subject of study, one which could be conquered and controlled by an aggressive masculine mind (Shiva 2002, p17). This understanding of nature is in direct opposition to that of certain groups of indigenous people who live in harmony with their surrounding and their ways are characterised as having inter-connectedness with nature (Esteva and Prakash 1998). Such a stance is not understood by modern science which instead views nature as a resource. This view is reflected in the following quote from 1987 Nobel Prize winner Robert Solow; “The world can, in effect, get along without natural resources, so exhaustion is just an event, not a catastrophe” (Shiva 2002, p218).
In decision making in developing countries, it is often the modern scientific experts who are given the authority to make key decisions regarding development, and not the locals who through daily participation and interaction with the environment are the real experts on issues such as forestry, food and water (Shiva 2002, p26). Many case studies and social anthropological accounts have shown the ingenuity and opportunism of poor people and their ability to adapt and survive (Chambers 2003, p164). In certain subsistence economies the knowledge of the local population far outweighs the knowledge of Westerners; for example Serena Nanda (1980) refers to the work of Harold Conklin and his study of the Hanunoo of the Philippines. He found that the knowledge of the Hanunoo exceeded that of Western botany and that they had a much more refined understanding of soil, with over forty linguistic categories to describe soil quality and mineral content (Nanda 1980, p125). The silencing of the voices of those with this local knowledge, who are often women, is a direct form of violence of modern science against such groups and serves to marginalise and discount their input.

2.3.5.2 Violence against nature
Due to the economic and consumer interests of the West nature is being forced to change in many ways. Scientific interventions and the associated impact on the environment often have negative consequences such as the degradation of soil, contamination and air pollution (UNEP, 2007b). Shiva sees this damage as arising, not out of the misapplication of an otherwise objective and value-neutral discipline, but rather as a direct consequence of the underlying epistemology and philosophy of the dominant models of thought and development (Shiva 2002, p46). Economic considerations, which are often the key driving force behind Western models, are frequently in direct opposition to diversity and subsistence as these offer models of sustainability rather than profit. Western models view natural, unmanaged systems as underdeveloped and underutilised and thus set about ‘developing’ them. As modern science analyses the environment in its separate parts, the river, the forests, the crops and the grasslands are all developed independently and thus the delicate balance of nature can be disturbed (Shiva 2002, p45) as well as changing the very cycles of nature. The Western influence on Third World regions has served to radically alter the understandings in these areas. The categories and definitions introduced by the West redraw the philosophical and political landscapes and alter the ways these regions move forward. Traditional and manual labour in these regions and the growth of
natural and organic crops can be seen as signs of poverty, backwardness and as unproductive and in need of replacement with regulated and technological (modern) methods. The clean, stable, harmonious, unspoilt and natural landscapes are seen by the West as untapped resources, undeveloped and underutilised (Shiva 2002, p4). Diversity in such areas is also seen as undesirable and in need of replacement it does not serve to promote a maximum yield and so needs to be replaced with managed, mono-species commercial crops.

Shiva cites the Amazon region and certain African regions as examples where local populations had survived and conserved their environment through their ecologically evolved and indigenous systems of knowledge. However, when these areas were exposed to Western models the results were often devastating; “What local people had conserved through history, Western experts and knowledge destroyed in a few decades, a few years even” (Shiva 2002, p26). One such example of Western methods causing environmental damage is the case of the Aral Sea (Tormey 2006, p75). In this case water from the rivers leading to the Aral Sea was used for irrigation to grow rice and cotton. The reduction in the volume of water reaching the sea has cause health and economic problems for the people living here and has led to a major drop in animal life and diversity in the region. While production and agricultural outputs increased here from 1940 to 1980 they have since retreated to 1960s levels and the effects of this short lived boom may be irreversible (Tormey 2006, p75). Shiva sees maldevelopment as a threat to nature itself, especially diversity of life, unity and harmony and despite the growth of commodities with managed farms with commercial interests; she sees nature as shrinking (Shiva 2002, p5). In response to the dominant modern model, Shiva talks of the need to adopt the Feminine principle (Shiva 2002, p14) in order to restore the balance of nature. The Feminine Principle marks a radically different way of thinking and has a much different value system than the modern market driven model. When discussing the Feminine Principle Shiva say that

It allows an ecological transition from violence to non-violence, from destruction to creativity, from anti-life to life-giving processes, from uniformity to diversity and from fragmentation and reductionism to holism and complexity

(Shiva 2002, p14)

This style of thinking would move away from a form of science that dominates over nature and tries to control and manipulate it, to a holistic form that centres on a respect for
the inter-connectedness of nature and its processes as well as the balance of nature. However, Shiva notes that at present the consideration of such values and ethics are excluded from the dominant psyche as “the maintenance of ecological cycles has no place in a political economy of commodity and cash flow” (Shiva 2002, p45).

2.3.5.3 Violence against the beneficiaries of knowledge
Modern forms of science and development aim to alleviate poverty and improve the standard of living for the people of the World. However, contact for local populations with Westerners has often proved to be disastrous for certain groups, especially certain tribal and indigenous peoples. Serena Nanda tells of the cultural damage and the erosion of the social structure of the Yir Yoront tribe due to their contact with Western missionaries. The missionary settlers replaced the stone axes used by the tribe with metal ones and thus the hierarchical structures of society were undermined as the use, manufacture and possession of the stone axes had great social significance (Nanda 1980, p50).

Feminists see Modern Western Science as the cause for the deterioration of not only the environment, but also of the social status for many of the World’s people, especially the most vulnerable. They see the problems caused not simply as misapplication of science, or unfortunate consequences, but rather due to the intrinsic nature of modern science and the type of knowledge it creates. In a world where antibiotics have created super-infections, where floods have been abetted by flood control measures, where the fertility of soil has been reduced by fertilisers and where the scientifically ‘advanced’ nations are advancing the destruction of the planet the cause of these problems must be examined, they argue. Gustavo Esteva claims that ‘sacred’ development policies of the West are actually threatening survival itself (Esteva, cited in Shiva 2002, p14). Shiva states that due to development processes there are in fact less fertile soils, less water and less generic wealth (Shiva 2002, p13). Marshall Sahlins (1972) assesses that this, over any period in history, is the time of unprecedented hunger (Sahlins 1972, p36). Shiva also talks of modernity as a time of unprecedented poverty, where the labels of poor, underprivileged and underdeveloped were assigned to groups, especially in the Third World. While the idea of under-development proposed the idea that the Third World had ‘not-yet’ reached its destination, it served to reduce the possibilities for these
nations and limit them to a future based in economic interests (Esteva and Prakash 1998, p282). Underdevelopment was defined through Western understandings and from a Western perspective and so with the introduction of global development two billion people became underdeveloped overnight (Esteva and Prakash 1998, p282). The power to assign these definitions and consequently shape development policies led to perceived poverty becoming real poverty (Shiva 2002, p41). Shiva points to the case of the Ethiopian famine as an example, in part, or “the creation of real poverty by development aimed at removing culturally perceived poverty (Shiva 2002, p11). Feminists see the reductionist, patriarchal and masculine categories of Modern Western Science as restrictive and an oppressive force which is producing violence against vulnerable groups;

‘Development’ could not but entail destruction for women, nature and subjugated cultures, which is why throughout the Third World, women, peasants and tribals are struggling for liberation from ‘development’ just as they earlier struggled for liberation from colonialism

(Shiva 2002, p2)

2.3.5.4 Violence against knowledge
The rejection of universal, value-free knowledge systems and the view of all knowledge as bound to the location that it was produced in arises from the idea that the understandings, methods and variations allowed by cultures in different situations are unique to that culture and when people share culture they share these understandings (Nanda 1980, p43). In this line of thought, Western models of science and development are seen as simply one way of understanding and as one type of knowledge. While Western knowledge has its advantages, it is limited in certain ways. Chambers (2003) points out that scientists' reliance on averages slows learning and the implementation of change. In contrast, the knowledge of local people can be more dynamic and up-to-date due to continual revisions as conditions change (Chambers 2003, p173). Shiva traces the birth of modern scientific knowledge and economic development to the Age of Enlightenment and states that they are viewed as sacred categories (Shiva 2002, pxis). Shiva (2005) says that modern science protects itself from analysis and critiquing through this assigned sacredness that forbids and prevents any questioning of the claims or nature of science (Shiva 2005, p26). Harding also sees this assigned sacredness as preventing examination of these discourses and thus holding them above reproach. This position of science, she claims, masks the gendered social structures and masculine identities of
science as well as the cultural fingerprints left on scientific knowledge by the individual scientists responsible for the “problematics, concepts, theories, methods, interpretation, ethics, meanings and goals of science” (Harding op. cit., p30). The primacy of these modern models silences alternate versions and formations of knowledge and the sanctity of their structures prevents any critique – as the methods are seen as sacred commandments rather than cultural artefacts. As Foucault reminds us; “the gaze that sees is the gaze that dominates” (McNay 1994, p51).

Certain authors see the need for a place for a multicultural dimension within the existing discourse of science and promote a shared ownership. Others see the need to scale down modern development in order to help sustain the planet and call for more responsible application of science. However, these feminist authors do not seek a shared-ownership or an introduction of other aspects into the discourse but rather a need for the abandonment of the pursuit of the goals of modern science, and they place an emphasis on ‘feminine’ concerns including diversity, unity, harmony and balance.

2.3.6 Power/Knowledge in Science and the ability to define the subject
While some writers see all forms of science as having equal credibility and equality in their formation, there is little contestation that some discourses are more powerful than others (Harding 1998, p74). Modern Western Science is the most dominant discourse and as the most powerful it has been able to define what constitutes science, and consequently, what is not science. Having the ability to legitimise a certain method of science, at the expense of others, affords a great deal of power to those who can do so. Much like with history, the ability to turn a version into the version can have great effects in controlling how a society functions and the behaviour and image and identity within that society;

Those who own the past own the present, George Orwell said. Perhaps those who own the rights to shape the pasts of our selves also can claim part-ownership of our present selves

(Nandy 1995, p54)

The discourse of Modern Western Science denies the parity of other methods of knowledge formation, especially the subjective and the social sciences. Harding claims that relativism and subjectivism can never reach the same level of acceptance and value as they carry ancient associations and connotations with “not masculine” or “not European” and thus “not ideally human” (Harding 1998, p140). The undermining of this
type of knowledge prevents it from receiving widespread support. Even though alternative types of research, approaches and knowledge have been shown to offer valuable input and insight, as they fail to meet the criteria offered by modern science, they are dismissed none the less. Examples of this phenomenon are especially visible in development studies where the views, insights and values of the people whom development policies are allegedly designed to help are largely ignored. Harding criticises development policies as gendered, masculine and Eurocentric to the extent that they ignore, or at least marginalise the concerns of all institutions other than the economically and politically most advantaged, a group from which women, the poor and the vast majority of southerners are excluded (Harding 1998, p122). Vandana Shiva attacks the actions and activities which intertwine development and destruction as she says;

Somewhere along the way, the unbridled pursuit of progress, guided by science and development, began to destroy life without any assessment of how fast and how much of the diversity of life on this planet is disappearing. The act of living and celebrating and conserving life in all its diversity – in people and in nature – seems to have been sacrificed to progress, and the sanctity of life been substituted by the sanctity of science and development

(Shiva 1993, p303)

Western problem solving not only approaches issues in a certain way but can only conceptualise a certain type of problem, and the goals it strives to achieve are also typically Eurocentric and focus on issues such as economy, wealth, industrialisation, politics and GNP (Gross National Product) (Frank 1996, p21) as opposed to issues such as sustainability, harmony, diversity or ideals such as the Bhutanese marker of Gross National Happiness (GNH, [Andreasson 2005, p978]). As society moves forward its goals become extremely important as these will determine the type of change that will occur and this change will have profound effects on society, nature and potentially future generations. In Third World countries this question becomes even more complex as a history of colonisation and issues of representation and race become important factors.

2.3.7 Race, Identity and Oppression
Thus far the discussion has focused on the competing understandings of science and nature, with the positivistic argument claiming that modern science is a universal value free system of knowledge and due to these traits is justified in displacing all other belief and knowledge systems (Nanda 2005, p160). Others call for successor sciences that allow
for more fitting, diverse and better accounts of the world that enable harmony and reduce oppression (Haraway 2004, p84-85). Other opponents of Modern Western Science challenge its neutrality and objectivity further by detailing the close association of science and society and suggest that they co-construct each other (Harding 1998, p3-4). Concepts and ideas such as Modernisation Theory, The European Miracle, racial difference, Enlightenment Rational and justification for colonisation all support the ideas of the superiority of white males, the supremacy of Western civilisation and faith in scientific reasoning as well as the unquestioned benefit of the Enlightenment and the Industrial and Scientific Revolutions. As scientific theories are seen to carry the values and ethics of their place of formation then they could in part contain aspects that could be related to racism, oppression and Westernisation. The work of the theorists Frantz Fanon, Edward Said and Eric Hobsbawm will be employed to help address these issues.

As ‘development’ is brought to the Third World social relations, infrastructure, economic concerns and technology are all transformed. Central to these issues is Modern Western Science. As Modern Western Science is introduced other ways of knowing and traditional knowledge and values are replaced, and as in the Chinese case, since the late 1800s Modern Western Science has been “systematically replacing traditional Chinese knowledge in school curricula at all levels” (Ma 2011, p155). The effect of replacing the knowledge and customs of traditional societies with Western ideals and knowledge has many psychological effects on the local people. One influential study which deals with this psychological impact is that of Frantz Fanon who studied this effect in his homeland of the Antilles. Fanon's work was first published in the 1950s and 1960s and is a series of classic studies rather than a recent one. Fanon examined the internalisation and the manifestation of an inferiority complex which occurs as a direct result of contact with white Europeans and the resultant domination, subjugation and oppression (Fanon 1990, 2008). Racism and racist attitudes were prevalent in colonial periods and Europeans saw colonialism, slavery and supremacy as their natural right. ‘Logic’ such as “his body is black, his language is black, his soul must be black too” (Fanon 2008, p139) became the norm in these places. The black man therefore came to represent Evil and Ugliness and was seen as inferior to whites.

Western settlers in colonies constructed racial difference and the inferiority of people with black skin, who it was proposed, were closer to apes than white men were (Gould 1993, p86). As the white invaders took their positions of power and rule it is
argued that they instilled these values in their subject peoples, who began to see themselves as inferior. White people proceeded to depict black people as less intelligent, less developed and ultimately less human than white humans, to the point that “It is in fact customary in Martinique to dream of a form of salvation that consists of magically turning white” (Fanon 2008, p30). This oppression led to a crisis of identity in the colony and the desire to show white men that they were in fact equal became a driving force for the indigenous people. According to Fanon;

There is a fact: White men consider themselves superior to black men. There is another fact: Black men want to prove to white men, at all costs, the richness of their thought, the equal value of their intellect

(Fanon 2008, p3)

To overcome the perceived limitations of their blackness, the Antilleans began to try to assimilate into white culture. They adopted English as their language and rejected Creole, they adopted European styles and customs and other European ways. All of these practices were deemed to bring black people closer to the white world, beginning with acceptance and ultimately humanity. This longing for recognition led to many people in Martinique, around the ages of twenty and thirty studying the works of the writers Montesquieu or Claudel for the sole purpose of being able to quote them (Fanon 2008, p149-150). The assumption in this was that knowledge of such respected writers would overshadow their colour and they could thus gain parity (Fanon 2008, p149). Language has deep symbolic and socialising dimensions and is closely associated with national identity worldwide. To speak a language is to adopt a culture, therefore “The Antilles Negro who wants to be white will be all the whiter as he gains greater mastery of the cultural tool that language is” (Fanon 2008, p25).

In the colony, and former colonies, the ideas of race and colour were permanent and paramount. Fanon speaks of the overriding use of zoological terms by the settlers when describing the local populations. Such usage serves to dehumanise the indigenous people, or quite simply turn him to an animal (Fanon 1990, p32). Issues with colour also continually appear in everyday social interactions and exchanges. Fanon when speaking of his own experiences in the twentieth century says;

When people like me, they tell me it is in spite of my color. When they dislike me, they point out it is not because of my color. Either way, I am locked into the infernal cycle

(Fanon 2008, p88)
These are just some of the psychological implications that racism, colonialism and oppression have had on the local populations in colonies. The effects are so instilled and embedded in the psyche that they cause black people themselves to accept notions of inferiority. Fanon compares this damage done by the internalisation of these ideas to physical disability using the following example; “The crippled veteran of the Pacific war says to my brother, ‘Resign yourself to your color the way I got used to my stump; we’re both victims’” (Fanon 2008, p107). Such constructs and issues of equality, freedom and identity serve to show some of the affects that arise due to the implementation of alien systems, social orders and values. While this argument focuses on the experience in the Antilles, the correlations to the psychological damage of the introduction of Western structures into other locations can be made.

Fanon's ideas, while old, are hugely influential and theorist such as Edward Said and Chandra Talpande Mohanty follow in these footsteps. His ideas are also very important in this study and the applications of these ideas will be discussed in the next section. Issues discussed by Fanon, such as alienation, feelings of inferiority, loss of culture and Westernisation all relate to Modern Western Science and also to education, especially in former colonies and where Western and non-Western cultures interact.

2.3.8 The Westernisation of the Education System in Colonial Africa

One example of where Westernisation has occurred in the Third World is in the education system. In parts of Africa, organised education has been introduced and is often in the form of boarding schools. These schools act as centres of education and attract students from a wide catchment area. This model of schooling is in stark contrast to traditional education which was based in the child’s own community, where everyone was a teacher (Nyerere, cited in Rahnema and Bawtree 1997, p152). In this environment it was difficult to differentiate between everyday life and education (Wamahiu 1996, p47). In modern Africa, these boarding schools can produce divides in two ways; first they physically separate the child from their community, and they also produce a cultural divide between the child and their family. The aim of this type of education is also very different from education in traditional life and this shift in education establishes a new social order and culture;
Indigenous education was for the maintenance of the status quo, not for change. It was for the perpetuation of ethnic identities, and preservation of ethnic boundaries, and not for pan-ethnic unity

(Wamahiu 1996, p48)

Authors such as Willis (2005) discuss the issues of cultural globalisation and cultural homogenization and the results of globalisation, and more specifically, Westernisation (Willis 2005, p193). In her discussion she says that rather than cultural displacement and the eradication of cultural values and practices a process of 'hybridization' may take place, where non-traditional values are integrated into the existing society (Willis 20005, p193).

Other authors, such as Fanon (2008) have detailed how Western institutions, much like Modern Western Science, carry Western values which serve to indoctrinate people into Western ways. The Antilleans Fanon spoke of, who return home after spending time in France and now speak, walk and act like the Frenchmen they encountered (Fanon 2008, p14), could be compared to students in Western-based education system in non-Western countries as their exposure to these structures introduces discontinuities in society.

Rahnema and Bawtree (1997) claims that separation from their community has severe effects on students. The discontinuity which arises through education provides students with a sense of superiority and separates them from their parents, community and cultural milieu. Furthermore, it alienates them from manual labour and from all unschooled people, “whom they tend to perceive as ignorant and under-developed” (Rahnema and Bawtree 1997, p 152). Formal schooling also establishes a ‘new’ African and thus establishes a new way of life, new values and ethics. By this idea, future generations of Africans will bare less and less resemblance to their ancestors. The Western educational system has created a hierarchical structure within society and has further established classes. Even where the Western model has led to greater opportunity for classically educated Africans, this opportunity also comes with a cost in the form of leeching. African students with primary school certificates move to small towns, while those who earn high-school diplomas relocate to the capital and the graduate and postgraduate migrate to rich countries (Rahnema and Bawtree 1997, p153). Through this dynamic Africa tends to lose its best and brightest scholars and so the people who perhaps are best able to fight for African rights are Westernised and/or lost to Western countries. This structure is further leeching African resources and not only prevents African countries developing to their potential but it also limits the ways in which they can conceptualise development.
Education however, is seen favourably where it is introduced. Adults in these countries are anxious for their children to attend schools to try to afford them a chance at ‘a better life’, or more precisely a Western life, and education is seen as the key to this goal;

The school system, introduced by colonialism in countries under their rule, was soon co-opted by the emerging nation-states. It became one of the most important vehicles of development strategy, being presented to the excluded as the answer to all the problems of their ‘underdevelopment’, the redeeming genie which could henceforth save their children from misery and shame

(Rahnema and Bawtree 1997, p152)

As the colonised people did not have the same formal education levels as their colonisers they were made to feel inferior, as second rate citizens. They perceived that for their children to overcome these constraints they must then become as educated as their white oppressors.

2.3.9 Racial difference and Inferiority in Western Thought
 Writers such as Edward Said have shown that the idea of European and Western superiority is a common characteristic of Western texts. His work particularly dealt with the way Western texts depict the East and how the character of the East (Orient) is set out in opposition to the West (Occident). Said called this invented distinction between Orient and Occident imaginative geography, whereby certain traits were assigned to the peoples each side of this man-made division (Said 1991, p36). This distinction introduces the concept of ‘The Other’ which Said used to refer to all non-Western peoples. ‘The Other’ and ‘Otherness’ were created as non-Western, and were created in opposition to the Western identity. In Western accounts Said found that the constructed character of the Orient was typically depicted in opposition to the West and was thus seen as immature, illogical, irrational, unchristian, childish, unscientific, mysterious, backward and feminine as Europe was seen as logical, rational, Christian, sensible, scientific, advanced and masculine. This construction established inequality between the people of each region, and made Western society superior to the ‘Other’, placing the West in a more powerful position. Said’s concept is known as Orientalism, and as well as discussing the formation of identity, it also deals with how the Occident establish power over the Orient and offered a persuasive argument to justify the rule of the West over the ‘Other’;
Orientalism can be discussed and analysed as the corporate institution for dealing with the Orient – dealing with it by making statements about it, authorising views of it, describing it, by teaching it, settling it, ruling over it: in short, Orientalism as a Western style for dominating, restructuring, and having authority over the Orient (Said 1991, p3)

As the European Empire grew, creating colonies in the Americas, India, Africa and throughout the World, social orders and social dynamics were restructured or completely redefined. The inequality that was created in the Occident, depicting it as superior to the ‘Other’, was a key feature in justifying Western rule. Westerners viewed some colonised nations as unfit to rule themselves, while others were seen to have shown natural weakness and had thereby forfeited the right to self-rule. The fact that Europeans saw themselves as logical, rational and mature entitled them to make these decisions as opposed to the immature, illogical, irrational and childish ‘Other’. According to Eric Hobsbawm, it was widely accepted in Britain that the Indian people had lost the right to self-government as they had allowed, through their own weakness, a series of invasion and conquests, dating back to the Aryan invasion and as recent as the imperial rule of the Mughals, from whom Great Britain seized control (Hobsbawm 1991, p166). At this time, the only real point of contention about British rule in India centred not on the inability of the Indian people to rule themselves (which was taken for granted) but rather about whether the Indian people could ever develop the competence for self-rule. The argument went that the Indian ineptitude was not necessarily permanent and under the proper tutelage they could develop the necessary skills and abilities for self-rule. As Britain itself had lived through a feudal period, the evolution of competence was a possibility, as under analytical terms, the Indian present could be compared to the British past. The feudal system in India thus received support as India was seen to have the potential to develop into a modern, political, economic society (Hobsbawm 1991, p167).

Although the majority of African colonies had been relinquished by 1960, Western countries have still had major influence on these countries and the ideas of Western superiority and African inferiority persist in many ways. In political circles Western society and civilisation became viewed as the pinnacle of human achievement, and other nations were seen to occupy an earlier stage on the same developmental path. Western development theorists of the 1960s, such as Learner and Rostow, viewed traditional society as a stagnant stage in development and thought that the best way to advance their development would be to mimic the institutions and structures of the West (Di Bona 1981, p203). Walt Whitman Rostow produced a hypothesis, which became known as
Modernisation Theory, which was said to explain how ‘Underdeveloped’ societies become ‘Developed’, and specifically how nations move from a primitive to a modern society. According to this theory, as all nations were on the same path towards the same end, namely modernity, the best way to aid developing countries was to help speed them along this path. The presumption that modernity was the ultimate goal was unquestioned. When dealing with development Rostow used terms such as “achieved”, “reached”, “take-off”, “mature” and “victory” (Rostow 1959) to describe the journey to modernity. The greater size of production in Western countries, along with the dominant role that reason plays within it and the scale of its scientific and technological discoveries were given as evidence supporting the indisputable ‘lead’ of Western society (Rist 1997, p40). The subtext of his paper was that the United States of America was at the top of the development process and the selection of the terminology dealing with development glorifies the USA and presents it as a high, almost utopian level that all should strive to achieve. Consequently, it places other nations in need of development and portrays their civilisations as deficit and backward. Therefore, the inferiority of the ‘Other’ is still a common feature in these writings.

Rostow claimed that accepting the transmission to modernisation would hold countless benefits to the people of the Third World and offered them a greater range of possibilities and choices including; a longer lifespan for them and their children, a new range of consumption, new devices of productivity and higher levels of welfare (Rostow 1959, p5). This policy established a ‘Western’ future for the Third World and brought them into economic development as those ‘who-are-not-yet-there-but-will-become’ (Esteva and Prakash 1998, p282). Modernisation received widespread approval and it seemed to meet ‘common-sense’ assumptions that in order to make the Third World developed then it must function like the West – The Third World will be ‘developed’ when it looks, thinks and works like the West. Modernisation Theory proposed that one key component in aiding this development was to help the people of the Third World become scientists, engineers, teachers, accountants and businessmen. By doing this their development could be accelerated and this would help them to ‘catch up’ with the Western world and reach the desired destination.

The rhetoric of genetic inferiority is a feature of Western accounts of the rest of the World. Much like the ‘European Miracle’ which placed Western society categorically ahead of the rest of the world, the Caucasian race was also seen to be the most advanced and superior to other races. In the eighteenth and nineteenth centuries ‘scientific’ theories,
such as crainometry and polygeny, were used to explain racial differences (Gould 1993). These theories did not create racism, but rather were used to reinforce and offer ‘evidence’ for existing, deep rooted racism which existed in society. In this context science is far from an ‘unbiased’ and ‘objective’ subject and instead is employed to reinforce existing racial views, prejudice and inequality. In these accounts ‘evidence’ was often exaggerated or fabricated to suit and conform to the racial ideas of the West. These theories were widely accepted in society at that time, so much so that in the nineteenth and into the twentieth century they were used in explaining sexual and gender difference also. Analogies were drawn between women and the ‘lower race’ and this argument further promoted the position of superiority held by the Caucasian male. It was claimed that;

women’s low brain weights and deficient brain structures were analogous to those of lower races, and their inferior intellectualities explained on this basis. Woman, it was observed, shared with Negroes a narrow, childlike and delicate skull, so different from the more robust and round headed characteristics of males of “superior” races. Similarly, women of higher races tended to have slightly protruding jaws, analogous to, if not as exaggerated as, the apelike, jutting jaws of lower races. Women and lower races were called innately impulsive, emotional, imitative rather than original, and incapable of abstract reasoning of white men

(Leys Stepan 1993, p361)

Gould (1993) stresses that in order to understand the impact of science upon society’s views of race during this period we must recognise that racial conceptions were widespread during this time, and even the leaders and intellectuals did not doubt the racial ranking which placed Indians below whites, and black people below everyone else (Gould 1993, p85). Examples of explicit racism can be found in the writings of such prominent figures as Benjamin Franklin, Thomas Jefferson, and in the following extract from a speech of President Lincoln;

There is a physical difference between the white and the black races which I believe will forever forbid the two races living together on terms of social and political equality. And inasmuch as they cannot so live, while they do remain together there must be the position of superior and inferior and I as much as any other man am in favour of having the superior position assigned to the white race

(Gould 1993, p87)

The two main differing standpoints of this time dealt with the role these ‘inferior’ people should play in society. One group believed that the biological inferiority of black people justified enslavement and colonisation. The competing discourse agreed that blacks were inferior, but believed that a lack of intelligence should not impinge on a person’s freedom. “Whatever be their degree of talents,” wrote Thomas Jefferson, “it is no measure of their rights” (cited in Gould 1993, p85). The ideology of the West as an advanced society
informed development and was a key factor in introducing development policies that would ‘aid’ Third World countries make the move from ‘uncivilised', 'savage' and 'primitive' peoples to civilized, or to ease ‘the white man’s burden’. These policies propagated the myth of Western and white supremacy and placed the West at the forefront of society and as responsible for bringing (Western) civilisation to the Third World. According to Victor Hugo “In the nineteenth century, the White made a man of the Black; in the twentieth century, Europe will make a world of Africa.” (cited in Andreasson 2005, p971). The superiority of White men and racial ranking can also be seen in the following extract from Reade’s book ‘Savage Africa’ (1864);

England and France will rule Africa. Africans will dig the ditches and water the deserts. It will be hard work and the Africans and will probably become extinct. We must learn to look at the result with composure. It illustrates the beneficent law of nature, that the weak must be devoured by the strong

(cited in Andreasson 2005, p974)

This ‘beneficent law of nature’ disregards the value of cultural diversity, ethnicity, local knowledge, other systems of knowledge and instead only values the Western way. It also offers an insight into the type of thought that prevailed in the west. The evidence of this philosophy also helps to show how the people in the Third World were oppressed as the Westerners considered themselves superior and entitled to rule. It also helps to show the disregard taken for the lives of these Africans and how little value Westerners held for them. Other examples of this ideology can be seen in advertisement, such as that for ‘Pear’s Soap’, which claims “The first step towards lightening The White Man’s Burden is through teaching the virtues of cleanliness” (quoted in Tormey 2006, p247), as well as in the writings of British Colonial writer Rudyard Kipling who in a poem while addressing the need to bring civilization to the colonies wrote, “your new-caught sullen peoples/ half devil and half child” (quoted in Tormey 2006, p247). These examples clearly show that non-Western races were seen as subservient to White Europeans and that the invented distinction, based on colour and geography, played a major role in the interactions between these peoples. These views were also widely accepted and exhibited at all levels.

Tormey and Haran (2003) discuss the appearance of many of these attitudes in the modern world. Although racist views are no longer carried in the same way, there are still racial inequalities in society. Despite the fact that within the same society people may be subject to the same conditions it does not necessarily mean that all groups are on an equal footing. They refer to this as institutional racism and argue that equality and sameness
cannot be equated with fairness, and that certain rules and regulations benefit some groups more than others (Tormey and Haran, 2003, p30). In terms of education they point to the Freirean notion that education is a political act and that “education either deals with cultural diversity and justice issues or it hides from them” (Tormey and Haran 2003, p33). This inequality has been documented in terms of science education with evidence suggesting that people from non-Western cultural bases have a more difficult task in learning about Modern Western Science and the inadequacies of “Science for All” (Mutegi 2011; Sutherland and Dennick 2002; Knain 2001; Aikenhead and Jegede 1999; Aikenhead 1996). For students from non-Western cultures, learning science may involve detaching themselves from their own culture and reattaching to that of Western Science (Emdin 2011, p8). Therefore, curriculum designed with no allowances for ethnic differences could not be seen to be ‘fair’, and would favour dominant groups (such as white, Western males) more than others. Theorists such as Andreasson maintain that although the form of racism has changed that in the West, Africans are still seen as inferior human beings; while rhetoric of racial and cultural inferiority has been transformed, the notion of African deficiency remains at the conceptual and discursive levels (Andreasson 2005, p971)

The maintenance of this racial inequality, between whites and others, and the West and other nations, coupled with the failure of development policies (“many Africans and peoples elsewhere are today living in similar or worse conditions to those endured half a century ago” [Andreasson 2005, p976]) are perfectly evident in the Western justification for the failure of these policies. In the West one of the reasons for development not having been achieved as effectively as planned is because the native African wanted to develop too quickly. When dealing with this defence Fanon makes sure to point to the previous European depiction of Third World nations; “Now, let us never forget that only a very short time ago they complained of their slowness, their laziness, and their fatalism” (Fanon 1968, p75). In President Truman’s inaugural address in 1949 he illustrated the USA’s version of the goals of ‘development’:

…we must embark on a bold new programme for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas… the United States is pre-eminent among nations in the development of industrial and scientific techniques… I believe that we should make available to peace-loving peoples the benefits of our store of technical knowledge in order to help them realise their aspirations for a better life. And in cooperation with other nations, we should foster capital investment in areas needing development

(cited in Rist, 1997, 71)
Within this statement the undertones of Western superiority are evident as the President depicted the Western way of life as desirable and the USA as ‘pre-eminent among nations’ and identified ‘scientific advances and industrial progress’ as the means to achieve the betterment of all mankind. It does not account for the interests, traditions, needs or desires of the Third World and also does not offer them a voice in deciding upon their future. According to Escobar ‘development’ is a Western project that sought to extend its control over certain regions of the World;

Development, according to this critique, has to be seen as an invention and strategy produced by the “First World” about the “underdevelopment” of the “Third World”, and not only as an instrument of economic control over the physical and social reality of much of Asia, Africa and Latin America

(Escobar 1992, p22)

Western reductionist methods have contributed many important findings, such as in Newtonian physics and also in development interventions, for example in the effects of Vitamin A supplements reducing child mortality (Chambers 2003, p42). However, there are also problems associated with these methods which arise where complex, diverse, dynamic and uncontrollable systems are subject to reductionist simplifications, controls and standardisations. Western development projects, authors such as Frank, Esteva and Shiva argue, have not yielded the desired results. Esteva (cited in Escobar) claims that “Every development ‘strategy’ or ‘approach’ has been tested, again and again, under widely different conditions but with the same frustrating results” (Escobar 2005, p27). Andre Gunder Frank believes that none of the available models of development are suitable for the present, let alone the future (Frank 1996, p46). Repeated attempts to introduce Western values and structures into non-Western countries have proven futile and have been associated with damage where they were introduced;

rooted in the experience of those for whom the spread of what was called “enlightenment” has been the spread of darkness, of the extinction of life and life-enhancing processes

(Shiva 1993, p303) Escobar summarises the failure of ‘Modernisation Theory’ by saying “The production of theory in one place and its application in another is no longer an acceptable practice” (Escobar 2005, p35). Despite the unsuccessful duplication of Western systems in the Third World, the attempts have made many lasting impressions. Many Western constructs have been established in the Third World, such as poverty, the need for material goods and industrialisation. Part of the reason for the creation of these constructs and problems is the Western approach of separating society into its separate parts, and then attempting to cure them separately in the name of development;
Development proceeded by creating abnormalities (“the poor,” “the malnourished,” “the literate,” “pregnant women,” “the landless”) which it would then treat or reform. Seeking to eradicate all problems, it actually ended up multiplying them to infinity. Embodied in a multiplicity of practices institutions and structures, it had a profound effect on the Third World: social relations, ways of thinking, visions of the future are all indelibly marked and shaped by this ubiquitous operator.

(Escobar 1992, p25)

All analysis of this type owes a debt to Foucault who described this process of surveillance first. In this view Western society created many social and cultural divides between the populations as they applied their own standards to these countries. The people themselves likewise began to see themselves in a different light and this had a major cultural effect, as discussed by Fanon.

Due to Western influence the ways society operate and social interests and ambitions have been radically transformed and there has been a loss of traditional culture and values. Due to the perceived failure of development, modernisation and Westernisation certain theorists (especially feminist, postcolonial and postmodernists) are calling for a new model of development, allowing for nations to develop differently and more organically, in line with their own cultural norms and values;

Countries in the South should ‘aim not for development but for disentanglement – removing the obstacles that prevent them from developing differently’. Otherwise ‘development’ may mean only ‘a weak mixture of lost tradition and unaffordable modernity’ for peoples in the south.

(Andreasson 2005, p979)

2.3.10 Relevance of these Concepts for Education
The postcolonial ideas such as those of Foucault and Said discussed in this literature review have highlighted the idea of discourse, and thus dismiss the notion of science as a natural assemblage of knowledge. This approach stresses the need to examine the construction of categories such as science to identify their biases, interests and the knowledge they can produce. Science as a subject discipline is important to examine as the discourse presented at this level will frame the way it is viewed by students. Certain themes have been found to exist within Western accounts, such as Modernisation Theory, the superiority of the west, industrialisation as 'progress' and 'development', the inferiority of non-white races and cultures. Theorists such as Fanon (2008) have shown the problems, especially concerning identity, which can arise from the perpetuation of these ideas. Other scholars who have examined the teaching of Modern Western science to non-Western cultures have shown how the cultural biases impede learning (Aikenhead and Jegede 1999; Mutegi 2011; Emdin 2011).
This chapter will now look more closely at curriculum change and will particularly focus on the Irish system. It will also examine the cultural aspects of education and how culture and society impact upon education. This chapter shows that curriculum contestation and reform have not been key features in the Irish system, and while authors such as Jim Gleeson and Roland Tormey have done much work in this area, questions and issues dealing with curriculum have not been prioritised in Irish education.

2.4 Curriculum and Science Education in Ireland

This section will examine curriculum and the formation of curricular subject disciplines. It will show that education is a political activity, and following on from the work of Foucault it will show that it is not a natural assemblage of knowledge (Apple 1996, p22). It will also discuss how curriculum is established in a certain tradition and operates within this tradition favouring and neglecting certain concerns. This perspective is especially evident in the view of curriculum as a selection of culture (Lawton 1975; Gleeson 2009, p933). This section focuses on educational discourse and examines wider educational issues such as the power/knowledge relation in education. These issues all relate to the wider discussion of how there are manifold relations responsible for the silencing of the voices of minority groups, advancing a particular system of education and preserving a certain type of knowledge and discourse (Nola 1998, p112).

2.4.1 Research in the Irish Education System

This section should serve to highlight the value of this study as it identifies a lack of qualitative research conducted in education, while also showing the influences in the dominant system. As this study focuses on feminist and postcolonial concerns it provides a distinctive approach to educational research in Ireland. Within the Irish system there is seen to be a deficit of research being carried out, and many important educational and curricular issues are not being addressed. Gleeson (2009) has shown that in Ireland the debate on education centres on technical issues, such as literacy, numeracy and lifelong learning, rather than critical issues, such as analysis of the economic, political, and social realities outside and within the classroom (Gleeson 2009, p138; Gleeson and Ó
Donnabháin 2007, p32; Nicol and Crespo 2006, p332). There is a history of neglect of this area of research in Irish education as the Curriculum and Examinations Board (CEB) in the 1980s indicated that educational research was not been a priority in Ireland and particularly identified the lack of qualitative research, with only one qualitative study out of one hundred carried out on primary education (CEB, 1985). The current mindset in the Irish system is within the context of the technical paradigm, and education and curriculum are viewed as neutral, apolitical and immune from ideological and political influences (Gleeson 2009, p141). Gleeson identifies this lack of curriculum contestation as a worrying sign for the welfare of the education system in general, and it highlights the absence of analysis examining education from standpoint epistemologies, and examining education from outside the dominant discourse. While authors such as Gleeson as well as Kathleen Lynch, Anne Lodge, Roland Tormey, Audrey Bryan and Denis O'Sullivan have discussed the Irish system at length, and despite the fact that the NCCA itself co-hosted a conference with the Educational Studies Association of Ireland (ESAI) in 2004 titled 'Curriculum Contestation', these issues still have not become primary issues in education. These curriculum issues and concerns link to a Foucauldian understanding of power which emphasises the need to examine those at the margins of society whom the powerful groups have identified as 'the other' in order to understand the effects of power. Examining these issues is essential to understand the education system in its entirety.

2.4.2 Cultural Aspects of Curriculum and Education

As curriculum sets forth the goals, values and aspirations of education it is central to how education will function. Therefore curriculum is central to education. However, despite the importance of curriculum there is contestation about the meaning of curriculum, especially regarding a definition. The Department of Education in their 1995 White Paper gave the following definition of curriculum;

The term ‘curriculum’ encompasses the content, structure and processes of teaching and learning, which the school provides in accordance with its educational objectives and values... The curriculum in schools is concerned, not only with the subjects taught, but also with how and why they are taught and with the outcomes of this activity for the learner

(Department of Education 1995, p. 18)

Others see curriculum as “the story we tell our children about the good life” (Gleeson 2009, p133) and this understanding places a greater importance upon the power/knowledge relation, political dimensions and socialisation (Gleeson 2009, p133). In this view the structure of curriculum in a country is seen to reflect the values and
beliefs of that nation, and the selection of one style of education over another is an indication of what that country values as worthwhile education. This understanding highlights the selective nature of education and also the political influence. Paulo Freire noted; “irrespective of what we teach, education is a political act” (paraphrased in Tormey and Haran 2003, p33). Apple (2006) sees education as deeply implicated in the politics of culture. He sees curriculum as part of a selective tradition which means it is always somebody’s selection and represents some group’s version of legitimate knowledge, it is never simply a ‘natural assemblage of knowledge’ (Apple 2006, p22). This view of curriculum shares many similarities with Shiva’s view of science – both of which are seen as fundamentally political as their production, regulation and continuation are all deeply rooted in political activity;

Picking one group of people (the specialists), who adopt one way of knowing the physical world (the reductionist), to find one set of properties in nature (the mechanist) is a political, not a scientific mode

(Shiva 2002, p30)

The links between feminist science and education do not end here. As with Modern Western Science the voices of people of colour, women and the young lie outside the dominant culture and are thus silenced or marginalised. Apple and Buras (2006) say that this has persisted “despite decades of pressure for change” (cited in Apple 2006, p15). Apple sees the current political agenda as being set by rightist groups and being heavily influenced by business, the New Right and neoconservative intellectuals (Apple 2006, p28). This established a system of education that is concerned with profit, economic interests and growth and discipline, as well as social concerns focused on “returning us to a romanticized past of the ‘ideal’ home, family and school” (Apple 2006, p28). The interests of women and people of colour and increasing chances of labour are not the concerns of this power bloc, which perpetuates the dominant pattern that characterises the majority of social policy, an agenda which affords 20% of the population 80% of the benefits (Apple 2006, p25; Rist 1997, p44-45). The production of multicultural and antiracist curricula poses problems to the New Right body which challenges their core vision. To overcome these challenges largely mono-cultural curricula which centre on the classical core education while offering only minimal and tertiary lip service to the contribution of the ‘others’ are produced. Alternatively a false logic of equivalence is created which serves to limit the cultural differences by offering explanations such as “we are all immigrants” (Apple 1996, p34). This aids the production of a particular spectrum
of knowledge which will help legitimise the interests of the dominant parties, and thus portrays these goals and values as the ‘good life’ and continue the existing hierarchies of what is classified as official knowledge and the current standards and practices of education. These relationships and practices lead Apple to the following conclusion; “one thing is perfectly clear: The national curriculum is a mechanism for the political control of knowledge” (Apple 1996, p35).

Apple sees rightist curriculum as a feature of the United States and “similar nations” and that they have made it “abundantly clear” that a good education is characterised as one that is tailored to economic needs, and of course, these needs are defined by the powerful (Apple 2006, p5). While it has sometimes been argued that Ireland did not suffer from a new-right agenda in education like other English speaking countries such as the US and Great Britain, Tormey (2007) has argued that this is not the case, and in short claims that “Ireland did not need new-right educational reforms when the education system already operated on the basis of old-right principles” (Tormey 2007, p186). In this drive towards economic prosperity Britain and especially Japan are seen to be in the lead and that other nations feel that they must follow these countries lest they be left behind (Apple 2006, p25). Perhaps the greatest indicator of the dominance of the middle class interests and their perpetuation is the lack of contestation of these issues at different levels. Tormey (2007), while discussing the relationship between poverty and educational outcomes, notes that the policies introduced to tackle the problems are aimed at the groups or individuals who are identified as 'failing', rather than at the system itself (Tormey 2007, p191). Within schools curricula are taught with little attention to the make-up of the various class groupings as regards gender, class, ethnicity or religion. Apple and Beane (2007) promote what they term a democratic curriculum wherein young people learn to be “critical readers” of their society and become aware of the impact that issues such as culture, society, gender and geographies have on ourselves and knowledge. Apple says;

What’s most disturbing is that all too many schools have taught this official, high-status knowledge as though it were “truth” arisen from some immutable, infallible source. Those committed to a more participatory curriculum understand that knowledge is socially constructed and, that is produced and disseminated by people who have particular values, interests and biases. (Apple 2006, p15)

Tormey (2007) states that the biases and inequalities that are present in society tend to be reflected in the education system and that policies which focus on raising the levels of low-achievers or the 'disadvantaged' often do not recognise or mask this phenomenon
(Tormey 2007, p194). He also argues that the 'advantaged' members of society will use their extra resources to ensure that their advantage is continued, ensuring their advantage and perpetuating inequalities in society (Tormey 2007, p172).

In light of these considerations the following section will analyse the make-up of the education system in Ireland and will highlight some of the interests and biases within the system. This section will explore the history of education and curriculum in Ireland as well as change and reform in Irish education. It will also examine the role of assessment and examinations in the Irish system. This discussion will highlight the key features of the Irish system and show the influences on Irish education.

2.4.3 Influence of Literature on this study
Thus far, this chapter has outlined the principle philosophies for this work. This study will approach science education as a discourse and will analyse the version of ‘Truth’ that it presents, and also consequently, what versions of ‘Truth’ that it produces. This study has many multicultural implications, including issues dealing with identity and representation, as outlined by Frantz Fanon and Edward Said as well as for contemporary science education, as discussed by Aikenhead and Jegede (1999), Mutegi (2011) and Emdin (2011). The contrasting views of Modern Western Science and the eco-feminist and postcolonial idea that it is a violent and oppressive form of knowledge will also form an important part of the investigation. This discussion has important implications for development policies and the environment.

Emerging from this discussion certain categories have come to the fore and will shape the direction of this research. One of the issues which will be examined is the relationship between Western and non-Western societies. This examination will look at the possible perpetuation of ideas such as Orientalism, a self-imposed position of superiority by Western society, Modernisation Theory and Enlightenment Rationale. The extent to which science is presented as a Modern Western endeavour or as an acultural discipline will also be an important consideration. The examination into the existence of Modernisation theory will look at issues such as how scientific theories and discoveries are made and the way scientists are portrayed, both compared to individuals in other cultures and over time. While science is often presented as a value-free and culturally neutral discipline, another important consideration will be to look at the relationship
between politics and science and the extent to which science is presented as an apolitical endeavour.

As this study will analyse curriculum in Ireland, this next section will explore education in Ireland, beginning with the history of curriculum making and moving to the modern structures. A critique of the Irish education system will serve to show the prevalent rhetoric/reality dichotomy in the system (Gleeson 2009). This study will examine science education in the first phase of Post-Primary education, which is commonly known as the Junior Cycle (O Flaherty and Gleeson 2009, p4). The make-up of the Junior Cycle featuring the key components of the programme, the range of subject disciplines available, the background of the course, its guiding rationale and philosophy as well as assessment will be included in this section. The Junior Cycle science course will also be analysed here.

2.5 Education and Curriculum in Ireland

2.5.1 Background

The introduction of free Post-Primary education in 1966 brought about radical changes to the Irish education system. The numbers enrolled in Post-Primary education rose from 142,983 in 1965 to 270,956 in 1975 (Crooks 1977). As well as the increase in numbers receiving Post-Primary education, there was also a radical change in the demography of the classroom and the ability range. In an attempt to provide suitable curriculum for Irish classrooms coordinated pilot curriculum programmes were launched in 1972 by Curriculum Development agencies based at Shannon (CDC) and Dublin (CDU). These centres first identified the methods of assessment and examination as key components of the type of curriculum change they were attempting to implement (Trant 1998, p25). They focused on establishing direct links between primary and Post-Primary curriculum, the inclusion of cross-curricular elements, active student participation and continual assessment (Crooks and McKernan, 1984). Several agencies have been in control of curriculum in Ireland since the introduction of free Post-Primary education. Beginning with the CDU and CDC, control was then transferred to the Curriculum and Examinations Board (CEB) in 1984 and subsequently to the National Council for Curriculum and Assessment (NCCA) in 1987.
Granville (2004) marks the creation of the CEB in 1984 (and later the NCCA in 1987) as marking “a very significant transfer of authority” (Granville 2002, p68). This agency provided greater transparency to curriculum planning, as the earlier models led by the Department of Education and syllabus committees were often seen to be highly centralised and often mysterious (Mulcahy 1981; Coolahan 1981). Due to a change in government in Ireland and the appointment of a new Minister of Education the life of the CEB was short lived, but it had a lasting legacy none the less. The main impact of the CEB was the creation of ‘The Wheel’ or the ‘Areas of Experience model’ which identified eight key considerations for education;

- Language and literature
- Mathematics education
- Science and Technology
- Social, Political, Environmental Education
- Arts Education
- Physical Education
- Religious Education
- Guidance and Counselling

However, despite the wheel, in fact curriculum have remained tightly subject based and science and technology remained clearly separated, with science as high status and technology less so. McGarr (2008) found that the policies introduced in the past three decades have had little effect on the use of information and communication technology (ICT) in classrooms in Ireland (McGarr 2008, p1104). He also found that it is only commonly used in subjects which contain an ICT component for the state examinations, and in these cases “this use tends to be learning about the computer rather than learning with it” (McGarr 2008, p1104).

2.5.2 Curriculum in Ireland
At present the National Council for Curriculum and Assessment (NCCA) is the organisation primarily responsible for educational change and reform in Ireland. The NCCA is run by the Department of Education and has existed since 1987, and on a statutory basis since 2001 (Granville 2004, p89). The NCCA board is made up of a Chairperson (nominated by the Minister for Education), two deputy chairs (one primary and one Post-Primary) and a ministerial nominee as well as partners are nominated from
the remaining fourteen representatives, which are; the four teacher unions, the Irish Congress of Trade Unions (ICTU), five school management bodies (three of which are Post-Primary), the Irish Business and Employers Confederation (IBEC), the National Parent’s Council and two Department of Education and Skills (DES) nominees. This board reflects the main parties responsible for education in Ireland and is comprised of political bodies, teacher unions, school administrators, the parent’s council and an employer. From this, one could infer that education in Ireland is tailored to suit the demands of these bodies. In managing education in Ireland the key roles of the NCCA are to:

- Review the curriculum
- Advise the Minister on assessment
- Advise Minister on strategies that will assist students make successful transitions from primary to Post-Primary
- Advise the Minister on standards that students should attain
- Advise the Minister on curriculum and assessment needs of students with disability
- Advise the Minister on strategies that will enhance the teaching and use of the Irish language
- Review the in-service training needs of teachers
- Promote research and development in education
- Promote equality of access to education.

It should be noted that in Ireland the education officers are almost all teachers and there is little or no scope for local adaptation and development of curriculum by classroom teachers. While this trend may be gradually changing, teachers’ role in curriculum development is still underdeveloped. Fullan (1991) identifies teacher advocacy as a key factor in the initiation of curriculum change and Hord (1995) also deals with the importance of this feature in his assumptions for the successful implementation of change. The absence of teacher input in curriculum innovation places them in the position of implementing an externally imposed curriculum, perhaps without a deep understanding, or even support for the innovation itself. Gleeson identifies the involvement of schools and teachers as key issues for ‘deep change’ to occur in curriculum (Gleeson 2004).
2.5.3 Resistance to change

Knowledge based system of education were first introduced by the Protestant minority and adopted by the Catholic majority (Apple 1996) and were intended to equip students with the necessary information to develop their knowledge against heresy (Gleeson 2009, p134). At different stages in history, education in Ireland has undergone dramatic changes. For example, the introduction of free education in 1966 made education available to more people and brought greater diversity to the classroom in both background of students and their ability range. However, this change was not reflected by any significant curriculum change and it remained academic in nature (Crooks 1977). Since then, there has been much change in Irish education at every level, however the changes that have occurred have often been conservative rather than radical (Gleeson 2000b, p26).

When the NCCA replaced the CEB in 1987 they retained the framework of the eight key aspects for education, but modified their implementation and defined them in terms of the subject disciplines. This reinforced the technical nature of curriculum nature in Ireland, meaning it remained focused on technological, scientific and commercial interests (Looney 2001, p149; Gleeson 2004, p126). The late 1980s and 1990s were exciting times in Irish educational history, but Looney (2001) notes that by the beginning of the new century little has changed in the landscape at Post-Primary level (Looney 2001, p154-155). While the current composition of the NCCA favours partnership, this structure does not seem to lend itself to maximise change in the Irish system. Granville (2004) in a survey of eighty members of the NCCA one third of these indicated that curriculum development was their weakest or next-to-weakest contribution to committee work (Granville 2004, p67). This is an interesting finding for a curriculum making body and suggests that curriculum would be slow to change and would also reduce the capacity for radical change.

According to Gleeson (2009) change in the Irish system has been extremely limited in recent times, with a ‘fix-the-parts’ mentality prevailing whereby individual subject discipline and small scale reforms have been the order of the day. This fragmented approach to curriculum change has prevented a whole core approach or stocktaking occurring and thus the macro-issues associated with education have largely gone undetected (McKernan’s 1991, p. 171; Gleeson 2000a; Gleeson 2008). From the perspective of marginalised groups, a fix-the-parts mentality is unlikely to bring about the
type of change that would address the power imbalance in education as it would continue in the established framework and would not target deeper, more radical change.

At present both cycles in Irish post-primary education are being reviewed and reforms are being prepared. These reforms have been produced by the NCCA and propose significant changes to the education system. It is suggested that at senior cycle the focus would change to the development of key skills, namely being personally effective, working with others, critical and creative thinking, communicating and information processing (NCCA 2010, p24). Other skills which are identified as relevant for junior cycle students are creating and innovating, using (and learning through) Information and Communications Technology, developing personally and socially, improving literacy and numeracy, behaving ethically and taking leadership (NCCA 2010, p24-25).

These changes are intended to create a curriculum that is “more adaptable and responsive to the needs of learners” as well as moving curriculum debates away from discussing the content of syllabus and the selection of compulsory subject disciplines to debate surrounding the suitability and relevance of the key skills, especially due to “ongoing modernisation” (NCCA 2010, p25). The recommendations for Junior Cycle also include changes to the methods and styles of assessment and a scaling back of the Junior Certificate examination (NCCA 2011, p3). The exact details of the reform have not come to light yet, but the Minister for Education Ruairí Quinn supports the scaling back or removal of terminal examinations (Irish Independent 2011). The position of the Junior Certificate is a key feature of the current model of education in Ireland. The effect and nature of assessment in Ireland will now be discussed further.

2.5.4 The role of assessment and examinations
A key feature of the Irish system is the emphasis placed on the terminal examinations, namely the Junior Certificate and Leaving Certificate examinations and the preoccupation with issues surrounding assessment. The focus on the terminal exam and the acquisition of ‘points’ to fulfil the criteria for University places has been dubbed the ‘sacred cow’ of the Irish educational system (Swan group 2008). This focus has led to didactic learning styles and rote learning of content as opposed to acquiring a deep knowledge or understanding. Irish education is embedded in a technicist and instrumental paradigm which stresses examination techniques and satisfying the examination criteria above all, even more so than objectives relating to academic inquiry and investigation or subject
mastery (Long 2008, p124). The education system thus reduces what is learned to examination material with predictable learning outcomes giving way to ‘more detailed prescriptive outcomes’ (Long 2008, p25).

Bruton (the opposition party’s spokesman for education, 1999) claimed that the Department of Education’s only indicator for the quality of its system was by grades and exam results (Gleeson 2009, p96). Ó Donnabháin claimed that Ireland is dominated by the culture of the textbook and the culture of the exam and as a result questions about other (possibly more meaningful) areas are not being asked (cited in Gleeson 2009, p96). However, despite such criticisms the education in Ireland receives widespread public support as the majority of the public see Ireland as having a very good education system (Gleeson 2009). The education system has not been a main election issue or point of contention between political parties and educational debates tend not to arise around issues of curriculum. The curriculum making bodies (the NCCA and the Department of Education) also seem to have similar education goals and there have been remarkably few recorded of instances of contention between them in relation to curriculum issues. In more recent times these trends have changed. Ireland's poor performance in the Programme for International Student Assessment’s (PISA) 2009 study of literacy and numeracy level has led to a discussion regarding these levels in Irish schools (DES 2011). Also, the rejection of the NCCA's proposals for Senior Cycle education reform proposals by the then Minister for Education Mary Hanafin marks one important dispute which has arisen between the NCCA and Department of Education and Skills (The Irish Times 2011).

Where differences have occurred they have generally dealt with subject disciplines or structures as opposed to the existing underlying curriculum philosophy (Gleeson 2009, p137). These instances show the dominance of the current system of education and the fact that it faces little contestation would suggest that, by-and-large, the system will not face any fundamental changes. In terms of the power/knowledge relation this shows how a certain type of knowledge has gained prominence and established itself as the sole discourse, with little opposition to the ‘good life’ established by this version.
2.5.5 The Structure of lower Post-Primary Education

2.5.5.1 The Junior Certificate
The Junior Cycle is a three year programme which makes up the first of two cycles of Post-Primary education in Ireland. The Junior Certificate was introduced by Minister O’Rourke in 1988 and replaced the Intermediate and Group Certificate examinations. The Junior Certificate was introduced to schools in 1989. Post-primary education in Ireland is comprised of vocational, comprehensive and community schools, and while each type school has its own unique ownership and management structure and have arisen in very distinctive historical contexts they have many similar traits (O Flaherty and Gleeson 2009, p3). Each school follows the same prescribed curriculum and undertake the same State public examinations (O Flaherty and Gleeson 2009, p4). Students in Junior Cycle education are typically aged between twelve and fifteen years of age (O Flaherty 2010, p4). Education in Ireland is compulsory for all students up to sixteen years of age. Students are required to study a range of subject disciplines, usually twelve, and the Junior Certificate is intended to cater for all abilities and aptitudes and offer a broad educational experience (DES 2003). Schools typically offer a subject discipline choice to students and the Junior Certificate thus has compulsory as well as choice subject disciplines. Compulsory subject disciplines are: English, Irish, Mathematics, Geography, History, Religious Education, Civics Social and Political Education (CSPE), Social, Personal and Health Education (SPHE), Physical Education and often Science, while choice subjects can include French, German, Music, Art Craft and Design, Home Economics, Technology, Metalwork, Technical Graphics, Latin, Business Studies, Italian, Greek, Environmental and Social Studies, Typewriting and Classical Studies.

Assessment varies from subject to subject, but the primary means of assessment is through a written terminal exam which is held at the end of the three year cycle. Some subject disciplines involve practical elements and/or coursework while for others the terminal exam is the only means of assessment. While there are more practical assessments in Senior Cycle education (the second of the two cycles) a written terminal exam is also the primary assessment method for this course. Differentiation of level is another feature of the Junior Cycle with all subject disciplines offered at two levels, known as Higher and Ordinary level, while Irish, English and Mathematics are also offered at a third level, called Foundation level. The differentiation of level is intended to meet the needs of all students in second-level education (DES 2003).
When introduced the Junior Certificate was met with some support, especially for the perceived avoidance of the process model and the carefully written and “very laudable” objectives (Gleeson 1992, p26-27). The inclusion of the ‘areas of experience’ from the CEB model was also met with support as it was seen to signify an acknowledgement of the inadequacies of subject disciplines alone (Gleeson 1989, p8). However, Gleeson also warned that “if the main changes at the implementation phase remain at the level of content” then the Junior Certificate would simply signify a cosmetic change (Gleeson 1989, p9). At the time education in Ireland was in need of radical change as Hogan (1983) concluded that curriculum and the style and manner of discipline in Ireland’s Post-Primary schools “signify a resolute censorship of the imagination by the educational authorities” (Hogan 1983, p46) and that the goal of the education system was to produce a generic student and the system is marked by “averageness” and “academic anaemia” rather than maximising the individual potential and talents of the students (Hogan 1983, p46). In analysing the new curriculum development Gleeson pointed to the lack of material in the syllabus which dealt with classroom management and pedagogy (Gleeson 1989, p14). McKernan (1990) was also critical of the NCCA and believed that the Junior Certificate signified a return to the traditional mainline subject disciplines and course, and that the new syllabus did little more than to amend the objectives of the subject disciplines (McKernan 1990, p21). Coolahan (1990) commented that more attention was given to the design and drafting of the new syllabus than to the more complex problem of delivering the intended outcomes of the syllabus into the classrooms and students in the programme (Coolahan 1990, p31). This is often an issue with top-down reforms such as the Junior Certificate, where the scope of the reform is not reflected at classroom level where teachers often resist the implementation and little change is made in pedagogy (Hargreaves 1989, p92). This feature is supported by the research of the Marino Institute of Education which found that many teacher’s pedagogy had not changed to the extent envisioned in the philosophy and specification of the Junior Certificate (Marino Institute of Education 1992, p47), and also by the Report on the National Education Convention (1994) which concluded that the programme featured teacher-centred methodologies and rote learning.
2.5.5.2 Science Education in Junior Cycle Education

Science Education is comprised of three main areas, namely; chemistry, biology and physics. Students are expected to have 240-270 hours of class contact time over the three years of the program, which usually translates as three or four forty-minute class periods per week (DES 2003, p5). The course guide is set out in a dedicated science syllabus which includes the aims and objectives of the course, the syllabus topics and learning outcomes as well as much more information (DES 2003). Overall the syllabus contains thirty-two pages and provides a detailed guide on the course, but also stresses the need for teacher autonomy and it is not intended to be a prescriptive document (DES 2003, p6).

The department also produce a *Teacher Guidelines* document (DES 2003) which is specific to each subject discipline and this is an extra resource for science teachers.

The science course is assessed at two levels, Higher and Ordinary, and each contains a terminal paper and coursework. The coursework is split into two parts. The first requires students to complete and record a range of mandatory experiments from the course and make these available for inspection. Ten percent of the overall marks are awarded for the successful completion of this laboratory notebook. Twenty-five percent of the marks are awarded for the second aspect of the coursework and requires students to carry out two investigations (prescribed or selected) and complete a pro-forma report on these investigations (DES 2003, p32). The remaining sixty-five percent is awarded for the terminal exam.

The syllabus stresses knowledge and understanding, skills and attitudes, and aims to develop scientific literacy and associated science process skills. The syllabus particularly advocates a ‘hands-on’ approach and stresses the importance of laboratory work and assignments (DES 2003, p5) and the development of skills such as manipulation of equipment and manual dexterity and the measuring and recording of data (DES 2003, p4). Therefore, the syllabus addresses needs beyond purely content driven subject matter.

Pupils entering Junior Cycle education will have already had an introduction to science during their primary school education; the primary school syllabus indicates that students should have gained a fundamental understanding of scientific principles and learnt about the scientific explanations of natural phenomena as well as forming an appreciation of the processes of designing and constructing (DES 1999). Theoretically the primary school syllabus also provides the students with a foundation in the knowledge,
skills and attitudes involved in the main sciences, it also seeks to foster an appreciation for scientific practice and provide students with a facility in using them (Department of Education and Science 1999).

Hodson suggests that science education is comprised of three main categories, these are; learning science, learning about science and doing science (Hodson 1992). According to Hodson (1992) learning science describes cognitive activities such as learning theories and definitions, carrying out manipulations, working equations, learning about different characteristics of living and non-living organisms, learning about the different properties of materials and so forth. Learning about science describes activities such as learning about the history of science, the scientific process, political implications of science, social attributes of science, cultural features of science and other material of this nature. Finally doing science involves learning the skills involved in science, carrying out experiments, taking measurements, physically performing calculations, using scientific apparatus, manipulation of equipment and so on. This understanding of science calls for balance between different activities and establishes parity between them.

This section gave a brief introduction to the history of education in Ireland and curriculum formation. These elements are important for this study as a whole as the science course in place in schools is influenced by these factors. It also establishes curriculum design as a social and political construction and as a selective tradition (Apple 2006, p22). This view highlights the importance of examining curriculum and course content to examine the versions that are presented and taught as official knowledge in the education system.

2.6 Conclusion
From an educational standpoint Gleeson (2009) stresses the importance of debates surrounding the contestation of curriculum and that the existence of debates on these issues can be used as indicators of the overall well-being of the system (Gleeson 2009, p133). This study will offer such a critique, and due to its orientation approaches this issue from an alternative perspective. In terms of curriculum analysis Apple suggests that the issue of who is allowed to ask and answer these questions is just as critical in understanding not only the education system, but also how the mechanisms of domination and subordination are altered and reproduced in society (Apple 1996, p22-23). This study
will focus on these questions in terms of science education and will examine the discourse that is produced in this course.

The next chapter is the *Research Methodology* which discusses some important issues in relation to conducting research, such as the philosophy that will be used and the underlying assumptions of research. It will discuss the framework that will be used in the study and will give reasons for its selection. It will also detail how the study will be conducted and the form that the research will take.
Chapter 3: Research Methodology

3.1 Introduction

This chapter will identify the research question and the methodology for this study. This study will examine the discourse of science that is presented in Junior Cycle education in Ireland. Drawing on the terms developed in the Literature Review it will especially focus on Modern Western, Linear, Elitist, Political and Cultural dimensions of the course. The research method that will be used is Discourse Analysis (DA) and this system of inquiry will be discussed in this chapter, including its philosophical roots, its characteristics and its strengths as a research method. This chapter will also contain an analysis of the nature of research and will look at the main research philosophies of positivism and interpretivism. These methodologies will be contrasted and the strengths and limitations of each will be addressed. Qualitative and Quantitative research will receive a similar treatment. In this analysis, qualitative methods were selected as the most suitable style of research and were chosen due to their ability to produce rich, detailed, in-depth analysis (Silverman 2010, p104). They also provide the freedom to explore many different aspects of the texts as well as allowing the achievement of a deep understanding of the issues (Trochim 2001, p152). Both DA and qualitative methods are consistent with the approach to the investigation as outlined in the Literature Review and link to the type of research carried out by Foucault and Said as well as contemporary researchers such as Tormey (2006, 2003), Knain (2001) and Bryan (2008, 2009, 2010).

The suitability of DA for this research and the justification for its selection will also receive attention. Part of this justification stems from the deficiencies of positivist methods in producing conceptually useful findings in social science and especially in education (Cohen and Manion 1997, p25; Cohen et. al 2006, p19). Alternative methods will also be looked at and analysed in relation to this study. The reasons why they were not appropriate are also given. This chapter will also discuss issues relating to the validity of this study and the way it was achieved in this study. In this regard the Analytic Induction method (Silverman 2006) was introduced as a guiding methodology. The specific issues relating to the analysis, collection and organisation of the research data will also be given. This research focused on the use of a checklist to aid with the DA and the steps that were taken to devise this checklist are included. The checklist used here is adapted from Leite (2002) which examined the historical content of science textbooks in
Spain. This chapter also details the coding that was used for the data and the coding scheme is explained. The texts chosen for this study and the rationale for selection, is given at the end of this chapter. These included texts issued by the Department of Education and Science such as the teacher guidelines, exam papers and syllabi, as well as other texts including subject textbooks and workbooks and also a revision book which would be more familiar to students of the course. These texts will present a broad view of the scientific discourse at Junior Certificate Level in Ireland and should serve to provide much material for discussion.

### 3.2 Research Question

The Literature Review explored the idea of discourse and the construction of school subject disciplines and favoured the view of knowledge as dependent on social, political and cultural issues, rather than being natural assemblage. It also introduced the philosophy of Michel Foucault as the guiding philosophy for this study and his idea of approaching issues with *hyper-pessimistic activism* (Rouse 1994, p112). In terms of discourse Foucault was interested in how breaks within certain discourses are produced and with how meanings within discourse change over time. In this sense, Foucault’s understanding of history focused on the breaks, ruptures and discontinuities between one period and another, and in this way his work differed from the dominant trans-historical version which favoured the idea of continuity between eras (Hall 2001, p75). Foucault thought that each period produced its own discourse (of knowledge, objects, subjects and practices of knowledge) which was potentially dramatically different from one period to the next, with no necessary continuity between them (Hall 2001, p74). Foucault’s work is characterised by an unwillingness to accept established categories and established premises. In fact the only grounds Foucault had for recognizing these categorisations was for the purpose of interrogating them;

> First is a systematic scepticism with respect to all anthropological universals—which does not mean that they are all rejected at the outset, only that nothing along those lines must be allowed if it is not rigorously indispensable

(Wicks 1998, p87).

Following a Foucauldian approach, all categorises must be scrutinised and interrogated in an attempt to challenge assumptions and problematise existing structures and not simply or passively conform to accepted ways. In his work, Foucault was careful not to accept as valid any of the unities that others may take for granted, and in doing so ignored no form
of discontinuity, break, threshold, or limit (Rorty 1996, p43). For Foucault the establishment of modern discourses have come about due to continuous transformations or sudden breaks in discourse, and are recent categories in their current incarnations (Rouse 1994, p94). This study will focus on the discourse of science. In order to give a problematic of Western values and aspirations, and Modern Western Science, feminist ideals including the feminine principle (Shiva 2002), standpoint epistemology (Harding 1998) and the interconnectedness of nature were introduced. These arguments provided an alternative approach to Modern Western Science and showed that there are alternative conceptions of what science should be concerned with. These ideas were also linked to the Irish educational system and issues such as the creation of curriculum and high-status knowledge. The view of curriculum as a cultural selection linked to power/knowledge, as discussed by Apple (1996) also ties to Foucauldian philosophy and the functioning of discourse.

The research question for this study is as follows:

- What discourse of science dominates lower Post-Primary Education in Ireland?

In this regard, the study will examine the following issues:

- Is science presented as a Western phenomenon, or are non-Western accounts of science and non-Western contributions to science presented (in both historical and contemporary accounts)?
- What values, attitudes and practices are supported (in both historical and contemporary accounts)?
- Is science presented as apolitical, asocial and distanced from values (amoral), or not (in both historical and contemporary accounts)?

These questions will address the five key headings of Modern Western, Linear, Elitist, apolitical and acultural and their treatment in the course. The Modern Western theme will focus on the extent to which science is presented as a solely Western endeavour and created by Westerners. It will also examine the links drawn between science and Western society and the effect science has had on society and development. It will look at the domination of Western conceptions of science and Western understandings of the subject. This aspect will examine the depiction of modern society and the comparisons made
between modern and past societies. The *Linear* theme will examine the influence of science and the factors that influence science, including political, historical and societal dimensions. It is also concerned with the formation of scientific theories and how they come to be accepted within the scientific community, as well as evidence of displaced and disproven theories. The *Elitist* theme is especially concerned with the portrayal of scientists and the make-up of the subject discipline. The *apolitical* theme will focus on the links between science and politics, the role of science in citizenship, the relationship between science and the environment and the negative effects of science. Finally the *acultural* theme will look more closely at the position of non-Western cultures in the course. It will look at the references made to other cultures, sciences and ways of knowing and understanding mentioned in the course as well as any established Modern Western Scientific theories that are contested in other cultures. It will also examine the contributions made to science by non-Western cultures that are included in the course. Another important aspect of this theme is if developments made are identified as positive in line with the values of non-Western countries and (not stereotypical) judged through Western norms.

### 3.3 Research Method

In order to examine this research question a method must be chosen that will offer the best possible analysis of the problem. This method must produce a useful set of data that allows for insight into the question. The research method should also be in keeping with the philosophical approach to the study and not conflict with its premises. In this sense, the study has a *poststructuralist* orientation which means that it rejects realist views of language and the idea that subjects are unified, coherent wholes (Gill 2000, p174). This idea has been a key philosophy in Western thought. *Realist* views of the world suggest that there is a real and observable world and this real world can be seen and described (Gill 2000, p172). Discourse Analysis (DA) was chosen as the research method as it can give theoretically useful data, its philosophy is comparable to that of the study, and most of all, it is most appropriate for the research question. The following section will explain what Discourse Analysis is and why it is a suitable methodology for this study. Later alternative methods will be examined and assessed and this will further show why DA is the most suitable research method.
3.3.1 Discourse Analysis

Discourse Analysis (DA) represents a radical new perspective and has implications for all socio-psychological issues (Wetherell and Potter 2001, p198). Discourse Analysis has an anti-realist orientation, which means that it rejects the notion that examining texts can uncover reality or identify true or false versions and focuses instead on the role of discourse in constructing social life (Gill 2000, p172). Discourse does not simply deal in the truth value of sentences, meaning it is not concerned with whether statements are true or false (Stubbs 1983, p3), rather DA emphasizes the ways in which versions of the world including society, events, and inner psychological worldviews are produced through discourse (Potter 1997, p146). Discourse analysts are interested in the content and organisation of texts in their own right (Gill 2000, p174-175). Another description of DA states that it is involved in the interpretation of cultural representations treated as text (Lee and Fielding 2004, p542). Unlike another form of text analysis, namely Content Analysis (CA), which focuses on the text itself, and often on particular aspects of the texts, such as word frequency, Key Word in Context (KWIC), column inches, heading size and so on, discourse is defined as text above the level of sentences, which means that discourse analysis tends to focus on the representation of particular phenomena (Krippendorff 2004, p16; Stubbs 1983, p1; Young 2009, p2).

Discourse analysis does not have a prescribed, fixed or well-defined method and cannot be used ‘off the shelf’ like more traditional forms of analysis. The decision to analyse using discourse analysis is associated with a radical epistemological shift due to its poststructuralist and anti-realist orientation (Gill 2000, p177). According to Schekein (1978) DA involves an interrogation of pre-existing assumptions, the ways in which you routinely make sense of things and the development of a spirit of scepticism, or analytical mentality (Schekein 1978, cited in Gill 2000, p178).

As this study follows a Foucauldian approach, text analysis is a suitable methodology to employ as it is associated with Foucault’s own work and his archaeological method. This archaeological method was conducted by analysing texts and, rather than examine what they explicitly said, Foucault examined discourse as a system of representation (Hall 2001, p72). Foucault takes discourse as the way through which the topic comes into being, is maintained and transformed and so analysing discourse can give insights into the construction of the topic. The term discourse denotes the way a particular set of linguistic categories relate to an object, the ways of depicting and framing it and the way we comprehend that object. Foucault sees discourse as the production of knowledge through language. He extends this view by attributing a
discursive aspect to all practices due to the fact that all social practices entail meaning, and these meanings shape and influence what we do (Hall 1992, cited in Hall 2001, p72). Therefore, discourse forms a version of the subject or phenomenon (Bryman 2008, p499) and Foucault, like Saussure, believes it is discourse and not the subject which produces knowledge (Hall 2001, p79). These features of discourse are paramount to understanding the orientation of DA and its approach to research. Discourse is seen to limit and regulate the ways in which the subject can be talked about and discussed and thus how it is practiced. Hall (2001) discusses this feature as he says;

Just as discourse ‘rules in’ certain ways of talking about a topic, defining an acceptable and intelligible way to talk, write, or conduct oneself, so also, by definition, it ‘rules out’, limits and restricts other ways of talking, of conducting ourselves in relation to the topic or constructing knowledge about it.

(Hall 2001, p72)

It is in discourse that Foucault tries to bridge the classical distinction between language and practice; what one says and what one does (Hall 2001, p72). Foucault tries to use language and texts to formulate an understanding of what influences our actions (Dreyfus and Rainbow 1996, p114). Foucault is concerned with the production of what constitutes valid knowledge, and also the meanings which are produced through discourse. In discourse analysis Foucault attempts to illustrate how conventional ways of talking and writing within a culture can serve ideological and political functions. This occurs as statements and writings can serve to constrain or circumscribe the ways people think and act as social beings (Wooffitt 2009, p39).

### 3.3.2 Conducting Discourse Analysis

As mentioned above, Discourse Analysis does not have a fixed method and cannot be used ‘off the shelf’ like some other research techniques (Gill 2000, p177). Also, the anti-realist orientation of DA further separates it from more traditional research methods. DA begins with the idea that spoken and written language act as a form of power and social reality is constructed through them (Bryan 2008, p48). This difference is a key strength of DA as it allows for new approaches to research topics and for the production of a different type of data. Despite the fact that there are different understandings of what constitutes discourse analysis across the social sciences (Potter 2004, p607), the use of DA has certain commonalities which include;

1. a critical stance towards taken-for-granted knowledge, and a scepticism towards the view that our observations of the world unproblematically yield its true nature to us
2. a recognition that the ways in which we commonly understand the world are historically and culturally specific and relative
3. a conviction that knowledge is socially constructed – that is, that our current ways of understanding the world are determined not by the nature of the world itself, but by social processes
4. a commitment to exploring the ways that knowledges – the social construction of people, phenomena or problems – are linked to actions/practices

(Burr 1995, cited in Gill 2000, p173)

These characteristics allow for consistent use of DA and help to explain what it is. In this way DA constitutes a state of mind and world-view rather than a recipe approach to be followed. DA is particularly suited to the analysis of written text, although it can be applied to other media.

As this study examines the make-up of the science course in the education system the version of science that is established needs to be brought to light. In addition the ways in which this presentation excludes alternate version is just as important. DA allows for this type of analysis as it is more concerned with meaning rather than issues more associated with Content Analysis (CA) such as counting or measuring column inches. According to Potter (1997);

DA has an analytic commitment to studying discourse as texts and talking social practices... the focus is... on language as... the medium for interaction; analysis particularly emphasized here is the rhetorical or argumentative organization of talk and text; claims and versions are constructed to undermine alternatives

(Potter 1997, p146 [emphasis in original])

The ability of this research method to allow the claims, versions, construction and the dealings with alternatives within a text illustrates the suitability of DA in this study. This attribute of DA is echoed by Billig (1987, 1991) who proposes that DA treats talk and texts as rhetorically organised. He goes on to say that a principle concern of discourse is involved in establishing one version of the world in the face of competing or alternate versions. The emphasis on the rhetorical nature of texts directs our attention to the ways in which all discourse is organised to make itself persuasive (Billig 1987, 1991, cited in Gill 2000, p176). It is thus by examining discourse that will provide the best insight into the research problem.

In conducting discourse analysis the rejection of a fixed and permanent assemblage of knowledge is important. Rather than trying to uncover how a topic is, what is important is how a topic comes to be seen as a coherent body of information, practices and attitudes. In examining discourse the following four constituting aspects of DA are very useful (Gill 2000, cited in Bryman 2008, p501; Hardy et. al 2007; Luke 1996);

1. Discourse is a topic;

DA does not function like a structured interview whereby ‘reality’ is uncovered through the process of the researcher eliciting answers from respondent/s and thus gaining an insight into their thoughts, rationale, behaviour and actions, but instead
DA operates under the premise that in itself it is a focus of enquiry and not a method through which certain aspects of social reality can be uncovered.

2. *Language is Constructive*

What this suggests is that discourse does not offer a description of a particular area or set of relationships, highlighting how they operate and the key features of each, instead it may in fact act as a vehicle for constructing a particular view of social reality and thus establishing the means for regulation within that discourse. In the generation of this depiction choices are made regarding what is to be included, and conversely, what is to be omitted. This leads to a certain presentation of the discourse and will thus reflect the values of the author/s by examining the content of the texts in question, as it will reflect the choices they made in rendering their view.

3. *Discourse is a form of action*

This aspect of discourse deals with language and the effects and motivation of talk. As Gill (2000, p175) points out language can be an entity in itself, it can be used to serve many different ends, such as to express one's views, recall a situation, place blame, put forward an argument and for many other purposes. However, Gill also proposes that each person’s discourse is affected by the contexts that they are confronting (Gill 2000, p175). What this means is that depending on the audience a person will alter their speech, this applies to a job applicant expressing their reasons for wanting a job which may change depending on whether they are addressing an interview board, family, friends or other group. Another consideration is whether or not a person is expressing their own views or, perhaps if they are playing a devil’s advocate. In terms of the textbooks, what they are trying to convey is that scientific knowledge is trustworthy as it is true knowledge, and subsequently, scientists should be trusted for the same reason (Knain 2001, p323).

4. *Discourse is rhetorically organised*

As many different depictions will exist within a discourse, another aspect of discourse recognises that it is concerned with “establishing one version of the world in the face of competing versions” (Gill 2000, p176). From this we can
infer that when someone presents a version of discourse they are trying to convince others that this is an accurate depiction.

(Gill 2000, cited in Bryman 2008, p501)

This understanding of discourse is essential before DA can begin as it explains how discourse operates and how certain versions come to prominence. This section has dealt with the philosophical assumptions of DA and its key tenets as a research method. Although a specific overview of how to conduct DA could not be given, the principles that must be followed and the material that is central to DA were reviewed. The next section will examine some of the opponents to DA and will discuss some broader issues in research itself, especially regarding the nature of knowledge, the presentation of data, the role of the researcher and competing research paradigms.

3.4 Philosophies of Research

3.4.1 Positivism
The rejection of a knowable real world is a key trait of DA. However, not all research philosophies share this assumption. Many types of research endeavour to establish relationships and attempt to offer conclusive answers to research questions, rather than giving perspectives and alternative viewpoints. Such approaches to research are often based on the philosophy of positivism (later post-positivism) and have realist orientations. This section will discuss these philosophies to show the contrasts between them and DA.

Positivism and post-positivism are centred on the belief that there is an ‘objective’ real world that can be understood as it is orderly and predictable, much like a machine, and in these models science is largely thought of as mechanistic or a mechanical affair (Trochim 2001, p19). The role of researcher is thus to explore the workings of the world and discover nature’s causes and effects (Kane and O’Reilly De Brun 2001, p12). These paradigms are the basis of modern science and essentially involve performing experiments and recording the findings, such as measurements, readings, patterns, variations, analysing, describing phenomena and so forth (Cohen and Manion 1997, p41). However this philosophy can be stretched to include tasks such as eliciting responses to predetermined questions and statistical data, as long as numerical evidence is produced. These philosophies are thus highly recognisable.
The father of this school of thought in social science was the nineteenth century French Philosopher Auguste Comte and many researchers in fields such as social science and philosophy and social theorists Darwin to Freud have drawn inspiration from his principles (Kane and O’Reilly De Brun 2001, p22). Comte’s philosophy led the way to a general doctrine of positivism based upon the idea that genuine knowledge is gained from sensory data and our knowledge can only be advanced by means of analysis and experiment (Cohen and Manion 1997, p11). In this paradigm knowledge of anything beyond the observable is impossible (Trochim 2001, p18). These ideas are summarised in the following passage;

In a positivist view of the world, science was seen as the way to get at truth, to understand the world well enough to predict and control it. The world and the universe were deterministic; they operated by laws of cause and effect that scientists could discern if they applied the unique approach of the scientific method (Trochim 2001, p19)

What this means is that “quantitative researchers accept that the goal of science is to discover the truths that exist in the world and to use the scientific method as a way to build a more complete understanding of reality” (Thorne 2000, p68). Positivistic methods and Modern Western Science are thus closely related and the features of positivistic research can be seen in the scientific method which involves;

(a) identifying a problem that defines the goal of one’s quest, (b) positioning a hypothesis that, if confirmed, resolves the problem, (c) gathering data relevant to the hypothesis, and (d) analysing and interpreting the data to see whether they support the hypothesis and resolve the question that initiated the research (Leedy and Ormrod 2001, p36)

In positivism the researcher is considered to be objective. This objectivity greatly influences how positivistic research functions and also how the results of the research are dealt with. It also has great influence on the role of the researcher. In positivism the researcher or observer of the phenomenon itself is seen as unimportant as the observer is deemed to be objective and, as long as their methods are accurate, any researcher should be able to obtain similar, if not identical results. Cohen and Manion (1997), as with Bassey (2003) depict the process used by positivistic scientists, explaining that they begin with observations of the particular, and then attempt to generalise their findings to the world at large. Again, they do this as they are concerned with explaining phenomena and ultimately advancing the knowledge and understanding of the world (Cohen and Manion 1997, p14; Bassey 2003, p42). Reliability, reproducibility and generalisability are key components of positivistic research. Due to the belief in objectivity, the researcher is seen to be able to stand outside nature and observe it and/or people without influencing what is being observed or compromising the research itself. Therefore, through analysis the researcher can come to understand how and why things occur as
they do and can thus make predictions about future occurrences. This predictive quality is one of the distinctive features of positivistic research and the ability to make these predictions is credited to the experts in the paradigm, namely scientists, whose objectivity is viewed as an internal characteristic (Trochim 2001, p20). Also, as positivists hold that reality is absolute and that nature is orderly, the findings of positivistic research will be true wherever the same circumstances exist (Kane and O’Reilly De Brun 2001, p15). Positivistic research claims to yield stable results which would be unlikely to change over time.

Positivistic methods focus on analysing isolated systems of nature, often attempting to reduce the system to a single variable which can be manipulated, monitored and analysed. This strategy promotes the use of experimental research and the results of this method tend to have high internal validity (valid in that setting) but low external validity (validity in other settings) (Sue 1999). Positivistic research also affords a prestigious place to the expert, placing their methods above those of the general public. Wodak and Meyer note that philosophers, researcher and scientists have all occupied, or occupy superior positions in society (Wodak and Meyer 2009, p7). Theories derived by scientists are thought to be empirically tested, to have a strong empirical backing and are thought to be conducted meticulously and also, as they are seen to be conducted objectively, their results are seen to be more valid than other research techniques. Positivistic methods produce numerical data and are seen as more precise and ‘scientific’ by the general public (Berg 2000, p2). On the other hand, lay-practitioners are seen to only use material that would confirm their suspicions and avoid material that would give evidence counter to their theories (Cohen and Manion 1997, p2).

Positivists, due to their observance of Compte’s philosophy, hold the belief that only observable, objective, provable hard facts count in research (Kane and O’Reilly De Brun 2001, p15). In the Cartesian theory of knowledge the hard, or positivistic science, were seen as mature, objective and rational and the desired model of knowledge, while softer areas (such as the social sciences) were divided into areas which had not yet achieved objectivity or those which could never achieve it, and thus were areas which produced discourses – which may or may not count as knowledge (Rorty 1996, p44). Therefore, statistical data found through research methods such as controlled experiments, and other sensory avenues are the foundation of positivistic research. The preference for this type of material has had many effects for the type of topic studied and the way certain problems are analysed. Positivists’ belief in empiricism favoured only observable and measurable quantities as suitable for research and those that could not be
directly observed they were not regarded as legitimate topics for study. DA offers a markedly different approach to the one discussed here, both from philosophical and methodological standpoints.

3.4.2 Post-Positivism
Since the mid-twentieth century, the positivism paradigm has been restructured and some adjustments have been made to the philosophy (McKelvey 2002, p7). This paradigm is known as post-positivism, and while this paradigm shares certain similar ideas and aspirations as its predecessor, some argue that it is a radically different approach rather than a modified theory (Trochim 2001, p19). The main difference between these two philosophies is that in post-positivism, although a real world is still seen to exist, humans are viewed as imperfect are unable to fully comprehend it (Kane and O’Reilly De Brun 2001, p17-18). Both traditions have a realist orientation, however, post-positivists tend to have a more critical realist orientation to their work. This means that post-positivists recognise that all observation is fallible and has error and they acknowledge that all theory is revisable, rather than continuing the positivistic aspirations of uncovering truth (Trochim 2001, p19). However, post-positivists still strive for objectivity and this is reflected in their approach to research (Kane and O’Reilly De Brun 2001, p18), as can be seen in the following passage;

the post-positivist critical realist believes that the goal of science is to hold steadfastly to the goal of getting it right about reality, even though this goal can never be perfectly achieved (Trochim 2001, p19)

3.4.3 Qualitative and Quantitative Research
Having established DA as the research method and examining some of the limitations of positivism and post-positivism for this study, this section will distinguish between qualitative and quantitative research. The chapter will then focus on the advantages of DA as a research method for this study and issues surrounding dependability in text analysis. Following this, the remainder of the chapter will detail how the data will be collected, coded and analysed and the factors that guide this process.

When conducting research, the methodology followed will result in a certain type of data being generated. The data produced can take many forms such as numerical, spoken, field notes, recordings or photographs. In research data can be broken down into two main categories, namely quantitative and qualitative. A general differentiation is offered by Berg (2000) who states that qualitative research can often be taken to deal with
the meanings, concepts, definitions, characteristics, metaphors, symbols and descriptions of things while quantitative research refers to counts and measures of things (Berg 2000, p3). Positivist research methods, such as the scientific experiment, tend to produce numerical and statistical data and are categorised as quantitative research methods. On the other hand, as DA tends to give observational and in depth data it is a qualitative research method.

Some commentators point to what counts as detail in each of the approaches as the key difference between them, and while quantitative methods overlook certain details in studies in search of correlations between variables, it is in the details and precise particulars of people’s understandings and interactions which inform qualitative work (Silverman 2010, p104). Depending on their epistemological standpoint, some argue that both types of research have their advantages and disadvantages, and in some cases they can be used in conjunction with one another as a mixed-methods approach. However, this is not always the case and depending on the research problem and the philosophical grounding of the author a mixed-methods approach may be unsuitable. Some of the key features of the positivism paradigm have been given above and some of these assumptions are challenged by other groups. The main opponents of positivism are interpretivists and their philosophy is incompatible with positivism on many levels.

### 3.4.5 Critique of Positivism

This section will look at some of the criticisms of positivism and the areas where it has shown shortcomings as a research philosophy. Interpretivism is the name given to the main opponent of positivism and this section will highlight some of the merits of this philosophy. Interpretivism has many different branches, with the four major components being naturalism, emotionalism, ethnomethodology and postmodernism (Silverman 2010). This paradigm has fundamental differences to positivism in its guiding philosophy and in its approach to research. Researchers following an interpretative approach to an investigation attempt to develop an understanding of how individuals perceive and view the world rather than to try to verify a phenomenon (Bryman 1984, p.84). One reason why interpretivism has gained popularity is due to positivism’s inadequacies in fields such as social science which attempt to study less controllable quantities, and so the purported strengths of positivism, namely objectivity and empirical testing, become major problems in fields such as ethnography. According to Andreski (1972):
It seems impossible therefore that our understanding of other minds and their aggregates could ever reach the degree of adequacy of physics and chemistry, made possible by the simplicity and invariance of their objects (Andreski 1972, p18).

So, while one could argue the suitability of objective methods in analysing physical events such as electricity, black holes, and chemical reactions, the appropriateness of a supposedly objective approach when trying to studying such complex matters as human events, interpersonal relationships, social structures, creative products, and so on, is neither desirable nor perhaps, even possible (Leedy and Ormrod 2001, p147). These shortcomings have highlighted the value of research methods, other than the purely ‘scientific’ methods favoured by positivists, and interpretive techniques have gained much support (Kane and O’Reilly De Brun 2001, p13).

The primary debate between these paradigms concerns the issue of objectivity. Interpretivism denies the existence of an objective reality stressing that what is important is reality as people perceive, experience, and interpret it themselves, and not attempting to uncover an absolute reality (Kane and O’Reilly De Brun 2001, p18). Interpretivist researchers hold that there isn’t necessarily a single, ultimate, discoverable ‘Truth’ and instead there are multiple perspectives held by individuals with each having equal validity or truth (Creswell, 1998; Guba & Lincoln, 1998 cited in Leedy and Ormrod 2001, p147). All of these arguments have impacted how research is conducted and indeed the very nature of knowledge and understanding themselves. These developments have led to a rethinking for many people, even within science itself, of the way we see the world and our understanding is now undergoing a profound change (Kane and O’Reilly De Brun 2001, p14).

### 3.4.6 Interpretivism

The interpretivism position itself will now be discussed further. Interpretivism does not incorporate all opponents of positivism, but some of the common themes present in logic of interpretivism will be discussed here. These schools of thought share a common rejection of the positivistic belief that human behaviour and nature are governed by set general laws and that they are characterised by fundamental regularities (Cohen and Manion 1997, p27). According to Marshall and Rossman (1989):

> Positivist notions of reliability assume an underlying universe where inquiry could, quite logically, be replicated. This assumption of an unchanging social world is in direct contrast to the qualitative/interpretative assumption that the social world is always changing and the concept of replication is itself problematic.

(Marshall and Rossman 1989, p147)
Various interpretive researchers hold different epistemological viewpoints about how research should be conducted, the type of information which can be understood and also about the role of the researcher, but all are united by their opposition to and rejection of the principle of objectivity. Interpretivists hold that there is no such thing as objectivity. Instead they propose that there are many, changing perspectives on reality and offer an interpretation or version which is inevitably partial, rather than capture the truth or reality of a situation (Taylor 2001, p11). When conducting this type of research it is essential to generate the entire picture. Context and meanings are most important and it is the researcher’s aim to investigate understandings and significance rather than to predict and control (Banister et al. 1994, p3 cited in Taylor 2001, p12). Understanding the different interactions, the reasons behind them and the influences and consequences is vital in interpretivistic research. Interpretivists hold that phenomena can only be understood in their total context, the neat variables that the positivistic researches may select for study may only serve to limit the research (Kane and O’Reilly De Brun 2001, p19). The observer in interpretive research is seen to be an active participant in the acquisition of knowledge and not separate from the process (Kane and O’Reilly De Brun 2001, p12). Interpretative views of research places the researcher in a different light, because as each is a unique individual with their own views, biases and perceptions all research will be inherently influenced by them (Trochim 2001, p158). Unlike positivists, interpretivists believe that understanding is created through social processes, not discovered by analysing them, and the researcher is thus part of this construction and so cannot be independent of it (Kane and O’Reilly De Brun 2001, p19). The mechanistic and reductionist view of nature taken by science is not accepted by interpretivists as by definition, this stance excludes notions of choice, freedom, individuality and moral responsibility (Cohen and Manion 1997, p23).

Due to these underlying differences the researcher’s role is very different and distinct in each school of thought, and so they would undertake very different research activities. Qualitative methods are typically the chosen tools of interpretivists. These methods include interviews, observation of experimental natural settings, photographic (including videotaping), historical analysis (historiography), document and textual analysis, sociometry, socio-drama and similar ethnomethodological experimentation and ethnographic research amongst others (Berg 2000, p3). In these types of studies the goal of the research is to try to gain an understanding of the situation and attempt to interpret or make sense of these constructions rather than to make predictions (Kane and O’Reilly De Brun 2001, p19).
Another fundamental difference between the paradigms is that in interpretivism theories and facts are not objective as in positivism but are openly value laden from the start, as in the interpretative paradigm the considerations that lead to the selection of one variable to study instead of another – and the definition and interpretation of that variable - reflects values (Kane and O’Reilly De Brun 2001, p19). Subscribers to interpretivism would argue that only individuals who are part of the ongoing social processes that are being investigated are capable of making sense of them, they suggest that their “model of man is an autonomous one, not the plastic version favoured by positivist researchers” (Cohen and Manion 1997, p27). While some analysts claim to be able to “bracket” their beliefs and perspectives towards data, others maintain that we can never be completely free of our biases, for so many of them are unconscious and part of our cultural inheritances and makeup (Strauss and Corbin 1998, p99).

Whereas positivists and post-positivists believe in objectivity as a means for discovering the truth about ourselves, interpretivists believe that we should use ourselves as the key to understanding others and conversely use others as a key to discovering ourselves (Cohen and Manion 1997, p27). Interpretivists see these links as pivotal to understanding while positivists do not acknowledge them preferring to use models as a means of attempting to understand humans. The rationale interpretivists offer for their rejection of this idea is that because humans are themselves the most complex systems in the world, exhibiting traits such as conscience and self-awareness, and also due to our powers of language, no other system either natural, animal or artificial is sufficiently powerful to produce a model that would be capable of advancing our understanding of ourselves (Cohen and Manion 1997, p27). These beliefs have led to pleas from interpretivists, such as that from Burgess (1989) that positivists “For scientific purposes, treat people as if they were human beings” (Burgess, 1989 cited in Cohen and Manion 1997, p27).

3.5 Examination of Discourse Analysis as a Research Method

3.5.1 Alternative Research Methods
This section will look at the various merits of different research methods and examine the suitability of each method for use in this study. Many the research methods discussed here could be tailored to give either qualitative or quantitative results, or a combination of both.
Although DA was chosen for this study, this section will show that other methods were considered for use and will illustrate how the decision to use DA came about.

**Text Analysis**

While text analysis is often associated with DA, it is not exclusively so, and the use of this research method, outside of DA, are discussed here. Text analysis is an unobtrusive and indirect form of inquiry and is also non-reactive as the subject of analysis cannot alter their answer to tailor to the audience as it is unaware that it is being examined (Robson 1993, p272). As opposed to other forms of research such as interviews, focus groups and surveys, neither the sender nor the receiver of the message is aware that they are being analysed. Unobtrusive measures include all methods of collecting data that don’t require the researcher to interact with the subject/s of the study (Trochim 2001, p167). Hence, there is no danger in this case that carrying out the research will be a force for change that alters the data (Webb et. al, 1981). Text analysis is not limited to written data, but can also account for spoken or visual data, provided that they have been produced without the intervention of a researcher (Silverman 2001, p119). Berg (2000) describes unobtrusive measures as ‘particularly interesting and innovative’ strategies for collecting and assessing data. He also praises these techniques as they are often the only method to analyse certain phenomena or groups (Berg 2000, p189). This technique would also allow access to materials used in a large number of schools in Ireland. As teachers may not receive large amount of instruction on certain aspects of science, such as history, politics or culture, they may need to refer to the texts as a guide to implement and included this type of material (Ó Conaill 2003, p58). The students would also rely on the texts as an information source as their school text is one of their key resources available to them throughout the programme. Despite these advantages text analysis would not allow for the examination of individual teacher differences and the other resources that they include in their teaching or how they use the textbook. Text analysis would, however, provide an insight into the aspects of science that the curriculum makers see as important and what areas they give most prestige to and thus offer several perspectives about the design and nature of the course. Potter (2004) gives the following advantages of textual analysis;

1. Texts are naturally occurring and by their very nature tend to be available. Texts are, after all, designed for reproduction, storage and circulation
2. Texts come already turned into words on the page which is the central currency of analysis. They do not require recording or lengthy processes of transcription
3. Some phenomena only exist in this form – novels, newspapers and social work case notes offer no choice. Studying them will involve studying texts.

(Potter 2004, p613-614)
Interviews could be used in this study as the primary research method as interviews can provide rich data and can give both qualitative and quantitative data depending on the style of the interview. Interviews have many applications and can be used in many different contexts. As regards research, the interview can have three main functions. The first of these deals with gathering information, especially about “what is inside a person’s head”, and investigating people’s knowledge or information, values and preferences and attitudes and beliefs (Tuckman 1972, cited in Cohen et. al 2006, p268). The second use is in hypothesis testing or generation or to explore variables and relationships (Cohen et. al 2006, p268). Finally, interviews can be used in conjunction with other methods (Cohen et. al 2006, p268). Many different parties could be interviewed for this study, including key curriculum makers, text book authors, teachers, students or several of these groups. Interviews with key curriculum makers and text book authors would give valuable information about their values and rationale of selection of material included in the course but it may offer little insight to how the course is presented as they are removed from the classroom environment and so does not directly address the research question.

Interviews with teachers and students would give greater insight into the presentation of the course in the classroom but a very large number of interviews would have to be carried out to get a large enough sample to be able to make inferences to how the programme is presented in Ireland, which would be time consuming and expensive. Interviews are also classified as obtrusive methods and so carry the associated difficulties.

Survey
The use of survey would allow for easier access to a wider sample and many of the same questions could be asked. Surveys can be designed to obtain information from populations regarding the prevalence, distribution and interrelationship of variables within those populations... and as such the survey is appropriate for descriptive studies (Parahoo 1997, p148)

However both surveys and interviews would rely heavily on people's own experiences and memories of the material that they have covered, and even if many, for example, cultural issues were dealt with in the class the students would have to recognise this usage and be able to remember it. Questionnaires could also prove difficult to design as due to the multifaceted nature of the research question many different issues would have to be explored which would lead to a very long and complex survey.
**Case Study**

A case study in which the researcher observed a class group/s for an extended period of time could be used. This could provide a very rich data sample as the researcher would be exposed to the same classroom environment for an extended period of time. All of the science teachers working in the school could be observed at different times, within the confines of the school timetable, and all Junior Certificate years could be observed which would allow for variety of teaching style and student types, and thus improve the quality of the research. Through observation the issues to be examined in the research could be carried out and explored. However, although this would give a deep insight into the teaching practices in the school involved in the case study, it would not have great significance for the country and differences in pedagogy would heavily influence the study.

**Focus Group**

Focus Groups can be described as “Organised discussions with a selected group of individuals to gain information about their views and opinions of a topic” (Gibbs 1997, p1). Focus groups would share many of the strengths of the interviews and many teachers could participate at once and so more results could be obtained simultaneously, and this **multiplicity of views** is a key strength of Focus Groups (Gibbs 1997, p1). This dynamic is pivotal as it allows the respondents to express and share their views, attitudes, experiences and beliefs and to react, which is characteristic of Focus Groups (Gibbs 1997, p1). However there are also limitations to this method as it relies on teacher’s honesty, their capacity to understand the research postulates and it may not show how they dealt with these issues in their class or the level of treatment they received (was just mentioned or discussed in detail). Another factor of Focus Groups is that all teachers in the groups may not have the same opportunity to respond due to group dynamics and other phenomena. This method of research would also be more suited to eliciting teacher’s views, opinions and beliefs on the research question rather than examining how the subject discipline is presented in their classrooms.

**The Development and Implementation of modules relating to these issues**

This idea would be more suited in an instance where the use and benefit of these issues was to be examined. In a case where the presentation is being analysed this method is not suited and would not provide insight into the research question for this study.
3.5.2 The suitability of Discourse Analysis in this study

From this discussion the suitability of DA as a research method should have become clear. Positivistic methods have shown inadequacies as research tools in the social sciences, often providing banal and trivial findings (Cohen et al 2006). As this study approaches the research question from a Foucauldian perspective and is examining discourse, quantitative methods would not be in keeping with the research philosophy and would thus be in conflict with the theoretical approach. The realist orientation of positivistic methods would also cause contradictions as discourse favours multiple conceptions of categories, rather than a single ‘true’ version. The anti-realist orientation of DA allows it to analyse meanings and to operate above the level of sentences. This allows greater scope to the research as by examining more than what was said, or how much was said, DA can view discourse as a whole. In addition, DA can also examine omissions and exclusions as well as what is contained within the text.

The nature of quantitative results and methods, typically producing statistical data and numbers, was deemed to be unsuitable as they would not help to illustrate the multidimensional issues raised by the research question. As a qualitative method, DA can deal with the contexts of the material and can offer a broader, richer data set. Trochim (2001) identifies qualitative methods as suitable when aiming to get a high level of experience of the phenomenon or achieving deep understanding, noting that they excel at generating detailed information and so they are especially valuable for investigating complex and sensitive issues. He also identifies quantitative methods as often only being able to do little more than produce a summary of a few key issues of complex phenomenon (Trochim 2001, p152). This opinion is echoed by Franzosi (2004) who criticises quantitative methods of text analysis, such as CA, as follows;

Absorbed in its drive to quantify and to deal with large volumes of data, content analysis has typically had little taste and patience for the subtleties of language (Franzosi 2004, p553)

According to Selltiz et al. (1959), the quantification of certain types of data, especially by reducing to numeric form, can lead to a loss of meaning of text such as definitions, symbols, detailed explanations and pictures (amongst others), and in some cases such data is excluded from the study entirely (cited in Berg 2003, p241); “the implication is that content analysis is more reductionistic and ostensibly a more positivistic approach” (Berg 2003, p242). This places DA as a much more suitable methodology for this study, where discourse is being dealt with.

This study will not produce graphs or other forms of statistical data, but rather will produce textual results. One of the advantages of this type of approach is that it will
afford the reader the opportunity to interpret the results themselves, and so they will not need to rely solely on the researcher’s interpretation. This consideration satisfies the interpretive rationale that an analyst’s reading cannot be taken as the only legitimate one, nor should researchers assume the sole power to determine the form of the analysis (Krippendorff 2004, p31). Text analysis was also shown as a suitable way to approach the research question, and while other methods were considered, it offers to produce in-depth analysis of the research question.

Despite the advantages associated with qualitative methods, they are often viewed unfavourably, and judged from the norms established by quantitative research. Studies which use qualitative methods are often praised in the abstract, the practice is often dubbed nonscientific and so invalid (Berg 2000, p2). The labour intensive nature, the length of time taken to perform studies and the production of results which are often not generalizable for decision and policy making are sited as obstacles to receiving funding for qualitative research projects as they are seen as a ‘frill’ or overly expensive endeavour (Trochim 2001, p153). Another impression of quantitative research and its analytical strategies are that they are not associated with high tech societies as quantitative techniques may be (Berg 2000, p2).

3.5.3 Dependability in Discourse Analysis

Although it is acknowledged that this analysis can only produce a limited, single perspective of the discourse, it is still important to aspire to certain criteria of ‘good’ research. What counts as the criteria for judging research differs between paradigms. In quantitative research the traits of ‘good’ research include internal and external validity, reliability and objectivity while the qualitative paradigm is more concerned with credibility, transferability, dependability and confirmability (Trochim 2001, p162). As this study will use DA the latter criteria for quality are more applicable and the research design will be influenced by these standards. One of the key ways to achieve these standards in research is to clearly state the influences that have affected the research and the research position of the study. This chapter has addressed the conflict between interpretivism and positivism and the nature of research and has also discussed qualitative and quantitative research and examined the suitability of both for this study. Justification for the choice of research method and an analysis of other possibilities has also been given. The following sections will take a closer look at the specifics of how DA will operate in this study and will clearly show how the study will function, and will include a
detailed checklist which will set out the guidelines for examining the texts. This checklist will help clarify what will be looked for in the texts and add an element of transferability to the study. It will also provide insight into the researcher’s understandings and beliefs. Setting these standards for the research will add to its credibility as it will help to avoid ‘cherry picking’, whereby examples are chosen which best fit the assumptions (Wodak and Meyer 2009, p11). Qualitative and quantitative researcher have different aspirations for their work and while the latter attempt to achieve validity, this is not the case for qualitative studies operating within the interpretivist framework;

Discourse analysts, like other qualitative researchers, argue that ‘validity is not a commodity that can be purchased with techniques… Rather validity is like integrity, character and quality, to be assessed relative to purposes and circumstances’ (Brinberg and McGrath 1985, p13) To help provide this ‘integrity and character’ extracts from the texts will be included in the Themes that emerged from the Discourse Analysis chapter. This will allow the reader to gain a sense of the texts and allow them to interpret them for themselves, as opposed to having to rely on the researcher’s word or understanding (Silverman 1993, p163; Silverman 2001, p37). This type of investigation should serve to counter some of the anecdotal criticisms which are levelled against qualitative research (Bryman 2008, p599), as the production of the checklist and the inclusion extracts should provide indications as to how the research was conducted, the type of material that was looked for and the strength of the findings.

3.6 Text Analysis in this Study

3.6.1 How the analysis will function
As previously indicated, this study will adopt an interpretative approach and will discuss the material from a qualitative, anti-realist, postmodernist, poststructuralist, Foucauldian perspective. It is also influenced by feminist and anti-colonial concepts and standpoint epistemology, and will utilise discourse analysis as the primary research method. The use of DA in this study is greatly influenced by work of Michel Foucault and his Archaeological method and the approach to data analysis is influenced by David Silverman Analytic Induction method (1993, 2001, 2006, 2010).

The Analytic Induction method has three central elements. The first of these is the constant comparative method, which “means that the qualitative researcher should always attempt to find another case through which to test out a provisional hypothesis” (Silverman 2006, p296). This consideration further emphasises the need to analyse a
broad range of texts to allow for cross comparisons. The second aspect is deviant case analysis, which involves searching for material that does not conform to the emerging theory. These ‘negative’ or ‘deviant’ cases are an especially important aspect of analysis as it protects against the anecdotal criticisms that are sometimes levelled against qualitative research. The third element of Analytic Induction is comprehensive data treatment, which is concerned with explaining all cases in the study; positive, negative and even omitted (Silverman 2006). The questions offered by Potter (2004) were also useful during the research to help examine discourse, these are;

1. What is this discourse doing?
2. How is this discourse constructed to make this happen?
3. What resources are available to perform this activity?

(Potter 2004, p609)

All of these concepts were central to the devising the checklist that was used to examine the texts in the study. This checklist is a key tool to help guide the research, examine the discourse and also in relation to deviant case analysis (Silverman 2006). This checklist will now be discussed (see Appendix A for Checklist).

3.6.2 Construction of the Checklist
The checklist must be able to gather data that will provide evidence for the Research Question: ‘What discourse of science dominates lower Post-Primary Education in Ireland?’ As discourse relates to many different issues the checklist will need to allow for the examination of a wide range of cultural, political, historical and societal issues as well as the structures of the science course. The checklist needs to allow for analysis in both historical and contemporary accounts. It also has to enable examination of the portrayal of science in the textbooks as well as the structures in Junior Cycle education. The first step towards the creation of the checklist was the identification of five key propositions that would serve as the basis of the investigation. These were:

- Science is presented as a Modern Western phenomenon with non-Western accounts excluded
- Science is presented as a linear process of knowledge development
- Science is presented as an elitist pursuit
- Science is presented as apolitical
- Science is presented as acultural.

These key themes emerged from the literature discussed previously and draw upon the criticisms of Modern Western Science and Western development. Such criticisms include the dominance of Eurocentric thought, Enlightenment rationale and Modernisation
Theory in Western writings (see Kumar 1997; Esteva and Prakash 1998; Rist 1997). Other important influences on the selection of these themes came from eco-feminist and postcolonial authors who have challenged the universality of Western ideals and structures and offered alternative criteria for development and for what counts as progress (Harding 1998; Shiva 2002; Haraway 2004). The relevance of this material in education has been highlighted by those such as Aikenhead and Jegede (1999), Mutegi (2011) and Emdin (2011) who have shown the difficulties faced by non-Western students in studying Modern Western Science. In an Irish context Gleeson (2009), Tormey (2003, 2006) and Bryan (2008, 2009, 2010) have shown the importance of contestation in curriculum and the view of curriculum as a selection of culture (Lawton 1975; Gleeson 2009, p933) is also an important factor in the creation of these themes.

With these premises established the next task was to establish the type of material that would constitute an instance in each of these cases. The following list identifies the extracts that would be taken to be relevant to this investigation. They are;

1. Instances dealing with non-Western science
2. Instances dealing with scientific concerns or justifications for doing science
3. Instances dealing with the history of science
4. Instances dealing with the work and influence of scientists
5. Instances dealing with the status of scientists
6. Instances depicting the subject discipline of science as elite/for all
7. Instances dealing with the Political motivations and consequences of scientific concepts and technological devices
8. Instances dealing with the political influence on science
9. Instances dealing with the scientific influence on politics
10. Instances dealing with contributions made to science by non-Western cultures
11. Instances dealing with the interests of non-Western Cultures

Within all of these areas the following factors were taken into account:

a) Type and organisation of the information
b) Materials used
c) Contexts to which the information is related
d) Status of the content
e) Learning activities dealing with the elements of science as outlined above
f) Internal consistency of the texts
g) Consistency in treatment across the texts
h) Reinforcement of the material in multiple sections
These areas and issues formed the basis of the checklist and it was designed with respect to these considerations. The checklist is adapted from Leite (2002) in a study that analysed the historical content of science. Due to the broader scope of this study many changes have been made to her approach. Leite also approached her work from a quantitative perspective, rather than a qualitative one as used here. This also led to more alterations to her method. Despite this qualitative/quantitative discrepancy Leite’s research methodology was still conceptually useful, while the method of presenting the obtained data was much different. The checklist identifies and defines the Dimensions and Sub-Dimensions of the study (adapted from Leite 2002, p333) and thus shows the criteria that the coding followed. The complete checklist is included in the Appendix (Appendix A).

3.6.3 What texts will be examined?
The materials that will make-up the sample for the study are;

- The Irish Junior Certificate Syllabus (DES 2002)
- The Irish Junior Certificate Science Syllabus (DES 2002)
- The Teacher Guidelines (DES 2003)
- Three core science textbooks
  - A Voyage of Discovery (Dorgan et al. 2003)
  - Science Today (Henley & Quirke 2003)
  - Breakthrough Science (Casserly & Horgan 2003)
- Their respective workbooks
  - A Voyage of Discovery Workbook (Dorgan et al. 2003)
  - Science Today Workbook (Henley and Quirke 2003)
  - Breakthrough Science Workbook (Casserly 2004)
- The Higher and Ordinary Level Examination Papers (State Examinations Commission 2002-2010)
- One science revision textbook
  - Revise Wise (O’Callaghan et al. 2008)
Irish Junior Certificate Syllabus

This one page document contains the overall aims and objectives for the Junior Certificate programme and thus is relevant to all subject disciplines in the course. This document was issued by the Department of Education and Science (DES) and the National Council for Curriculum and Assessment (NCCA) and so shows the approach to education favoured by the curriculum makers.

Irish Junior Certificate Science Syllabus

This document is also issued by the Department of Education and Science and the NCCA and outlines what is to be completed by students in their three years of study in the Junior Cycle. This document is thirty-two pages long and contains sections detailing the Introduction and Rationale, Syllabus aims and objectives, Syllabus structure, Practical activities in science, Syllabus topics and learning outcomes and Assessment for the syllabus. As this document is also produced by the curriculum makers it should provide evidence for the intended approach and learning outcomes for the course and provide insights into how the course itself will be delivered.

Teacher Guidelines:

The guidelines are important as these are also an official government document and will give further insight into the approach that is intended to be taken in delivering the subject discipline. The guidelines contain one-hundred and eleven pages and include material on teaching methodologies, ideas for learning activities, as well as details on content and aims of curriculum and useful resources for the programme. This document supports the approach and direction offered by the syllabi and elaborates on the delivery methods and possible teaching strategies. The guidelines contain the sections Introduction, Course structure and levels, Skills and processes of science, Teaching methodologies, Ideas for learning activities, Assessment, Science in relation to the general curriculum and Suggested useful apparatus and equipment. These guidelines are intended to aid teachers in delivering curriculum and to provide them with extra ideas and methodologies to support the delivery of the programme.

Core Texts

Analysing the instructional documents alone will only provide certain insights into the overall, theoretical design of the course. It is extremely important to look beyond the rhetoric of the course and attempt to gain an indication into students’ experiences. In
doing this the core textbooks are very important documents to analyse as Nicol and Crespo discuss (2006), textbooks are an important aspect of classroom life as they offer a framework for helping to select what will be taught, sequencing and structure (Nicol and Crespo 2006, p331). The textbook used in the classroom may therefore play a larger role in the students’ experience of the subject discipline than any other text. Students and teachers are likely to have a lot of contact time with the textbook as it features in preparation of classes, homework activities and independent learning (Nicol and Crespo 2006, p331). The majority of exposure students get to science comes from these textbooks and so it is important to analyse how these texts deal with the different issues in science and the type of presentation that is given to pupils to gain further insight into the delivery of the programme as a whole. Also, many teaching styles are centred on the use of the textbook and so it is also valuable from this viewpoint. Regardless of their use in classrooms Michael Apple (2000) considers textbooks to be valuable documents of themselves as they embody a particular way of conceptualising the subject discipline and they constitute (and legitimise) a particular selection of knowledge from a wide range of possibilities (Apple 2000, p182). Due to the size of the core text books and the variety of sections which comprise them, the analysis will examine different sections separately, and the results for each section will be compiled together. This will also facilitate comparisons between each section and also aid comparison between the textbooks. The main sections that will be analysed from these texts are:

- **Core Text:**
  The core text occupies the bulk of these books and consists of the main passages of text.

- **Complementary Text:**
  Complementary text refers to sub-contained sections in the texts. These are usually aside from the core text and displayed in boxes. These may include sections on prominent scientists, ‘Did you know?’ sections, ‘Try it yourself sections’, ‘Experiments’, ‘Investigations’, ‘Going further’ sections, original documents such as letters written by scientists, speeches, stories, material on technological devices amongst others. All of these complimentary sections will be analysed individually.

- **Images:**
  The images used in the books will also be analysed. Images may include scientists, students, teachers, equipment and so forth, and can be cartoons, photographs, sketches or any other type of illustration.
End of Chapter Summaries:
Most texts have summaries at the end of chapters identifying the most important issues discussed in the chapter. These will serve as useful analysis as it will give an insight into what material from the chapter is considered to be the most important.

End of Chapter Questions:
From the frequency of question asked and the type of information called for, the end of chapter questions may also serve to indicate the type of material which is considered to be the most important in the chapter and may offer valuable insights.

Bibliographies:
Most texts also include bibliographies which give page numbers of important sections and topics which again will give some indication of as to what sections and type of material are considered to be the most important and privileged in the discourse.

Index/Glossary
Certain texts also contain an index and/or glossary which serve a similar function as the bibliographies and will give similar insights into the discourse.

Workbooks:
These texts are important to analyse as the type of learning activities students receive can be seen from these texts. They will also give an indication of the areas of science which are emphasised by the writers of the texts and by examining the frequency and type of question asked in each area a pattern of what are considered to be the most important issues may arise.

Exam papers:
The type of question asked in the exam papers influence teaching in the classroom so it is important to assess the type of question asked, and the balance between the questions, to gain further insights into the delivered curriculum. As emphasised by Dall’Alba et al. (1993), assessment gives clear messages to students about what the most important aspects of the subject discipline are, and which most merit they attention (cited in Leite 2002, p. 633).
Revision Books:
The revision book is also a useful indicator of the type of material that is seen as important for the students to learn. Examining this text will serve to provide a useful comparison between the core textbooks as it will show the different types and levels of attention given to the treatment of science. The revision book will provide a particularly useful insight into the type of material which is deemed expendable and removed once the course becomes condensed, which may also be influenced by the type of question which appears on the exam papers.

3.6.4 Coding
As these texts were analysed and relevant information extracted, the data needed to be stored and sorted. In order to do this a coding system was created. Coding refers to the grouping of occurrences of certain categories within the texts which are being examined. These sets of data are then broken down into component parts and named (Bryman 2008, p542). In this study the coding consisted of a table with the categories, Modern Western, Linear, Elitist, apolitical and acultural as the primary headings. The coding system was used in conjunction with the checklist. As material was found that applied to one or more of these headings they were stored in the coding system. The primary headings and checklist were derived from the literature but this method is flexible enough to allow for any relevant passage (written or otherwise) to be recorded. As the information was collected certain broad themes began to emerge. These themes became the focus of the Themes that emerged from the Discourse Analysis chapter of this study. This type of investigation is known as Thematic Analysis. Thematic Analysis favours the identification of key ideas or the generation of core themes, or recurring motifs which arise out of a detailed examination of the results and reading of the text materials (Bryman 2008, p554; Trochim 2001, p165).

When coding, every instance or finding for each category was placed in a table under the appropriate heading. In order to reference the codes effectively each code included the page number and the entire sentence/s which is relevant to the theme, the question number, experiment number, figure number, description of an image and the adjoining or associated text where appropriate. This allowed for easy identification and location of the material. This coding system created is comparable to that outlined in Bryman (2008) where it states that;
The idea is to construct an index of central themes and subthemes, which are then represented in a matrix that closely resembles an SPSS spreadsheet with its display of cases and variables (Bryman 2008, p554).

To aid the thematic analysis each extract was also coded in line with the checklist. This additional coding identified the specific area the extra linked to. In addition to direct quotes from the text observations and notes from the researcher were also included in the Coding Scheme. In this study Microsoft Word was used as the software type for storing the data. Word was chosen due to the suitability of the software, the ease of navigation, storage, searching facilities and the researcher’s knowledge and comfort with the programme. Also, due to the qualitative nature of the study no further workings with the data needed to be performed, such as word counts, and so specialised systems such as NUDIST, ATLAS, The Ethnograph or Adobe Pro would have provided no additional useful features. Coding data has many different advantages including transparency, allowing the researcher to revisit their data, prompting the researcher to consider new dimensions to the study, to allow for interaction between the results and analysis sections amongst others.

This method of inquiry allows the key themes to emerge from the study and so reduces the risk of only searching for material that would confirm pre-existing suspicions. It also opens the research up to a broader range of possibilities as it does not confine the study to predetermined issues. In this way the study marks an inductive approach to research, albeit within a deductive framework supplied by the literature, as the key themes or dimensions of the study arise more naturally by the researcher immersing themselves in the texts (Abrahamson 1983, p286). However, in line with Silverman’s guidelines for Analytic Induction (2006) identifying these issues is not the end of the process as the researcher must constantly liaise between their results and their writing to check, recheck, reinterpret and potentially alter their work. To generate the themes for discussion in the Themes that emerged from the Discourse Analysis chapter five posters were made. The posters had the general titles ‘Modern Western’, ‘Linear’, ‘Elitist’, ‘Political’ and ‘Cultural’. By reviewing all the coded information common themes, deviant cases and interesting examples were written on ‘post-its’ and stuck on the relevant poster. These posters also functioned as Venn diagrams as there were overlapping sections on each poster. By studying the completed work the key themes were identified.
3.6.5 The Coding Scheme
In order to facilitate as much cross-comparison as possible, the coding scheme was made as detailed as possible. The size and variety of the different texts dictated the extent and type of subheadings that were needed. The Junior Certificate Syllabus, the Junior Certificate Science Syllabus and The Teacher Guidelines did not need any subcategories beyond the headings Modern Western, Linear, Elitist, Political and Cultural. The Examination Papers were separated into Higher and Ordinary level papers and the subheadings ‘Biology’, ‘Chemistry’ and ‘Physics’ were also used with the year of the paper recorded. The Revision Book used the subheadings ‘Biology’, ‘Chemistry’ and ‘Physics’ and the chapter numbers were included. For the Workbooks, as well being broken down into these three sections other subheadings were added for each different type of text. These extra subdivisions were ‘Main Questions’, ‘Crosswords’, ‘Glossary’ and ‘Word searches’. The textbook required the greatest variety of subheadings as each type of text was coded separately. The subheadings that were used were ‘Main Text’, ‘Experimental Sections’, ‘Scientist Boxes’, ‘End of Chapter Questions’, ‘End of Chapter Summaries’, ‘Index’, ‘Appendix’, ‘Images’, ‘Did you know sections?/ Try it Yourself’ ‘Glossary’ and ‘Going Further Sections’. Notes and comments from the researcher were included in the coding scheme itself, or added in using the comment function in Word.

3.7 Conclusion
This chapter showed how Foucault’s philosophy and Archaeological method were used in conjunction with Silverman’s Analytical Induction Method to design a qualitative discourse analysis to analyse a variety of texts in common usage in Junior Certificate science. Once this study was complete the coding scheme was used to conduct a Thematic Analysis that identified overriding themes in the course. These themes will be discussed in the following chapter. This discussion will show how science is presented in the course and the prominent features of the discourse.
Chapter 4: Themes that emerged from the Discourse Analysis

4.1 Introduction

The Literature Review introduced the idea of knowledge being influenced by the region it was created in. The cultural fingerprints were shown on scientific theories such as Einstein’s (Nanda 1980, p49) and also how certain practices which may have once been taboo in society can come into play at certain points, such as in the case of experimental work (Zilsel 2000, p946; Harding 1998, p30). This influence is seen in all walks as Serena Nanda (1980) points out, the musical works of Mozart were unlikely to have been composed using the musical scale of India (Nanda 1980, 49). This thinking rejects the premise of natural, objective or value-free knowledge as it focuses on how knowledge and society co-construct each other (Harding 1998, p3). In line with this it was proposed that science as it is typically presented in Western countries would be referred to as Modern Western Science in this study as it is seen to be a particular branch and approach to science which is both a recent conception and heavily influenced by Western culture. This discourse was seen to be heavily influenced by certain prevailing notions in Western philosophy such as The Enlightenment, the European miracle (Blaut 1992) and Modernisation Theory (Rist 1997). This study sought to examine the discourse of science that is offered at Junior Cycle and assessed at Junior Certificate in Ireland and in doing so the extent to which these themes are present in the course texts is a key consideration. This chapter shows that the presentation offered is influenced by these concepts and they are evident in the course. As a result this course is mono-cultural and omits any contributions made by other cultures. It also omits alternative ways of knowing and problem solving and the strengths of such methods. As it is influenced by Modernisation Theory and the European Miracle it enforces a certain model of ‘development’ focusing on industrialisation and consumerism. As a result it affords a privileged position to the West and consequently depicts the Third World as inherently inferior.

This chapter is divided into three main sections. The first discusses the findings from the texts dealing with Western influence on the discourse of science. This section is divided into seven sections and discusses the relationship between science and society
and covers issues such as Western bias and domination in the course and a Eurocentric view of development. It also examines the portrayal of the 'Other' in the texts and multicultural science. The second part is titled *Westernisation of science and loss of culture* and draws on the work of Becher and Trowler (2001) to discuss how students are inducted into Modern Western Science and the Westernisation of members. The final part of the chapter examines *Science, Development and the Environment* and the portrayal of these relationships in the course materials. Many of the findings echo the criticisms of eco-feminists and this part matches the varying views of science and nature to O’Riordan’s framework which details different approaches to environmentalism (O’Riordan, cited in Tormey 2006, p65).

### 4.2 Western Influence on the discourse of science

#### 4.2.1 Western Bias in the Course

**4.2.1.1 Enlightenment Rationale**

This section will explore the extent that the course reflects Western interest and attitudes and offers a mono-cultural account of science and development. The first issue that will be dealt with is the Enlightenment rationale in the course. Enlightenment rational rejects the idea that due to the ‘irreversible decline of the world’ the best times for society lie in the past (Rist 1997, p35). This rejection allows for the possibility of a utopian future and for future societies to surpass those of the past. This logic is reflected in many ways throughout the texts and thus the science course can be seen to enforce this style of thought. In line with Enlightenment thinking the texts portray the notion that modern times are better than past times in many ways. Firstly the language used when discussing science is very favourable, containing phrases such as scientific breakthroughs (Dorgan et al. 2003, p398), (indeed one of the key texts is titled *Breakthrough Science*) scientific advancements (Dorgan et al. 2003, p327), developments (Dorgan et al. 2003, p159; Henly & Quirke 2003 p373; Casserly & Horgan 2003, p274), discovery (one of the texts is titled *A voyage of discovery*) (Henly & Quirke 2003 p148, p460; Casserly & Horgan 2003, p213 and so forth, all of which enforce the idea that as (Western) society has moved “forward” it has become “more developed” – meaning stronger, smarter and more capable – and has left behind many shortcomings in terms of knowledge, technology and practice.
This type of language is very similar to that used by Rostow when referring to the United States in his paper on development policy (Rostow 1959; Rist 1997). Secondly, the images used in the textbooks in particular, promote the achievements of modern societies and thus reinforce the idea that modern times are superior. The frequent and prominent use of pictures of modern technologies such as rockets, aeroplanes, race cars and gadgets serve to highlight these achievements and adds to this impression. This depiction identifies technological development and the production of new devices as the means to improving society. This development, therefore, is closely linked to science and science is depicted as the driving force for this development. It does not however, offer any alternative criteria to assess development such as moral dimensions, lifestyle, quality of environment, sense of community or indeed happiness.

The linear treatment of technology, which is depicted as moving from ‘have not’ to ‘have’, also adds to the Enlightenment overtones of the course. The idea of continual advancement does little to celebrate the ingenuity of past generations and, through this
omission, disregards their contributions to knowledge. Another instance which implies the continual development and improvement of knowledge can be seen in the treatment of the technologies of past ages. The Science Today textbook states that;

Thanks to those new metals (Bronze, lead, tin, copper), the lives of the Bronze Age people were greatly improved when compared with the Stone Age people (Henley & Quirke 2003, p389)

This extract offers development in a linear fashion and states that the availability of these new materials made life ‘better’, equating easier with improved. It also favours life in the Bronze Age as categorically superior to the Stone Age. The idea that more is favourable is present in many places in the course and in many instances, and following this school of thought, it attributes a prestigious and sacred position to science, as science is seen to be the provider of more. In another place, the textbook mentions that approximately 7,000 years ago “a great discovery was made” (Henley & Quirke 2003, p388). This discovery was the extraction copper and is credited as the beginning of chemical technology. This narrative resembles those in history education which trace modernity back to a specific event or epiphany in the past, thus establishing modernity as the goal that was chased throughout history (Danaher 2010, p14-15).

Perhaps the most obvious demonstrations of the Enlightenment rationale in the course can be seen in the following example from the text books. The passage in question comes from a section titled ‘Science and Society’ and discusses the reasons for pursuing science, the role of science in society and in people’s lifestyles. The section presents scientific technology as essential in people’s lives and suggests that life without this technology would be almost inconceivable. The justification implied here is that science should be studied and pursued because of the benefits that it has on our lives and lifestyles, and emerging from this appreciation and gratitude, knowledge of science and scientific processes is necessary. Science is depicted as important, relevant and as positive and it distinguishes us from past civilisations. Science is presented as the driving force for development. The passage states;

You might ask yourself, indeed you probably have, why are we studying all this stuff? What has all of this got to do with me? When I go home from school I turn on my computer till about 5:30 p.m. and then I have dinner. After that I do my homework and watch TV or a DVD before going to bed. Fair enough, but what would happen if there were no electricity! You could not do any of these things except eat a cold dinner and do your homework by candlelight!

(Casserly & Horgan 2003, p213)

This passage serves to undermine the credibility of societies and ways of life that existed pre-electricity, or those that live without it now, almost depicting them as impoverished and certainly as unfavourable. It also suggests that things such as hot food were
unavailable before the advent of electricity in the nineteenth century. Such issues are also enforced through end of chapter summaries and end of chapter questions such as; “Mention some items that might be missing in the world without chemistry” (Dorgan et al. 2003, p5), “It is a cold winter’s evening as you arrive home from school. There is a power failure and electricity cannot be restored until the following morning. Mention 3 ways in which the absence of electricity will affect the rest of your evening and night” (Dorgan et al. 2003, p154) and “Name four substances that are used at home and which are made by chemical reactions” (Henley & Quirke 2003, p391) amongst others. This passage clearly highlights an overriding theme in the texts which equates science and technology as desirable. This demonstrates how science is seen as the factor which has allowed for ‘advancements’ and ‘progress’ to be made and thus reflects Enlightenment rationality.

4.2.1.2 Counter Perspective of ‘Advancement’ and ‘Progression’

While Modern Western Science has indeed provided many products and led to many technological devices, the celebration of these and the resultant inferences ignore the potentially positive aspects of life in the past, and also in other cultures at present. They also attribute superiority to the Western way of life and leave this premise unchallenged. One author who offers an alternative perspective on this superiority is Marshall Sahlins (1972). In his book *Stone Age Economics* he analyses the changes in lifestyle and methods of production across history. His first finding was of the widespread belief that life in the Palaeolithic era was extremely difficult and marked by “the spectre of starvation” (p1), “incessant quest for food” (p2) and no surplus time either for leisure or to establish culture. In his examination of textbooks he found that they;

> compete to convey a sense of impending doom, leaving one to wonder not only how hunters managed to live, but whether, after all, this was living

(Sahlins 1972, p1)

The situation and depiction of these peoples is bleak and they are judged as having to struggle to survive, with only a scarce and unreliable food supply. However, Sahlins found evidence contrary to these commonly held ideas. Rather than having a daily grind and struggle for food he found that hunters and gathers actually work *less* than in modern times and their lives were actually abundant in leisure, with more time available in the daytime per capita than in any other condition of society (Sahlins 1972, p14). In fact, when compared to French farming in the period up to World War II Bushman food collecting proved to be *more* efficient (Sahlins 1972, p21), and Sahlins assesses that with the advent of agriculture people, more than likely, had to work harder (Sahlins 1972, 35).
In terms of susceptibility to famine and starvation due to the difference in diversity, agrarian peasants were in fact more prone to natural catastrophes than Alaskan Eskimos (Sahlins 1972, p38). Chambers also discusses how complex and diverse farming systems and livelihoods enhance security and reduce vulnerability (Chambers 2003, p170). This discussion brings new considerations to the assumption in the textbook that depicts life in the Bronze Age as superior to that of Stone Age people (Henley & Quirke 2003, p389).

As regards material possessions hunter/gatherers have less, but having meagre possessions does not equate to poverty. Due to the nomadic nature of such tribes there is no need to keep anything which would prove difficult to carry, nor need to have surplus or duplicates of things. Tribes such as the !kung have not developed means of permanent storage for these reasons. In such societies accumulation of objects is not associated with social standing or status (Marshall 1967, p243-244). Such thinking offers a much different understanding of the World’s most primitive people, indeed they have few possessions, but “they are not poor” (Sahlins 1972, p37). In fact, far from poverty Sahlins refers to these people as affluent. Affluence, understood from the Zen strategy as having a surplus of material possessions, is more easily achieved in subsistence economies where an unparalleled material plenty can be achieved, albeit through a low standard of living (Sahlins 1972, p2). In modern societies the sheer abundance of materials makes affluence impossible as people will always desire more, newer, faster, upgraded products and through the availability of choice can never have everything as choosing one usually prevents having another. In examining the hunters’ conditions and resources we often view his situation as deprived. However, this judgement is typically made from a Western viewpoint. The hunter's tools maybe primitive, but they are often perfectly suitable in fulfilling what is desired of them. With the absence of cares for material things such tribes are more able to simply enjoy life;

We are inclined to think of hunters and gatherers as poor because they don’t have anything; perhaps better to think of them for that reason as free (Sahlins 1972, p14).

This view is in direct opposition to the idea that the production of products is an indicator of improvements in society, a view which is favoured by the course. The following extract shows the perceived importance of these modern conveniences in our lives:

Without chemistry we would have no colourful clothes to wear, no soap to keep us clean – or no deodorant or perfume or aftershave to help us smell nice! We would have no petrol, plastics, modern medicines, CDs, computers or mobile phones! In fact, life would be very dull without chemistry (Dorgan et al. 2003, p3)
As proposed in this extract, without science we would be poorly dressed, dirty, smelly, and unappealing, as well as having limited transport methods, tools and resources. We would be sick, have short life spans and have no means of entertainment. The selection of these items as desirable and the source of improvements in our lives is significant as these items can be associated with violence in different parts of the world. For example, petrol and crude oil have caused air, land and water pollution, inequality, war and exploitation, plastics are also pollutants, modern medicines have contributed to bio-piracy and mobile phones also have ties to exploitation through mining. While instances as explicit as this are rare, the overall tone and style of the texts promote and reinforce many of the notions of Enlightenment rationality and favour the ideals it represents, namely that societies are improving and that modern societies are better than past societies. This presentation promotes a certain type of development and denies the conception of alternatives. Concepts such as E.F. Schumacher’s Small is Beautiful would not be reflected in this view, where the goals of society are production and profit;

Everything becomes crystal clear after you have reduced reality to one—one only—of its thousand aspects. You know what to do—whatever produces profits; you know what to avoid—whatever reduces them or makes a loss.

These goals can also inform social goals and standards as Schumacher continues;

And there is at the same time a perfect measuring rod for the degree of success or failure. Let no one befog the issue by asking whether a particular action is conducive to the wealth and well-being of society, whether it leads to moral, aesthetic, or cultural enrichment. Simply find out if it pays; simply investigate whether there is an alternative that pays better. If there is, choose the alternative.

(Schumacher 1973, p238)

Sahlins has shown the ‘affluence’ of subsistence societies and that in some ways, such as food dependency and diversity (Sahlins 1972, p36), they have advantages over modern societies. For example, James Woodburn (1968) in his study of the Hadza of Tanzania, who are a subsistence economy, estimated that they worked less and exerted less energy obtaining their food than their neighbouring agricultural tribes, and that nutritionally, they appeared to be better off (cited in Nanda 1980, p133). Sahlins’ concept challenges Enlightenment rationale, and while he is aware of the limitations of subsistence economies, his argument offers an interesting alternative perspective. He refers to hunting and gathering as having all the strengths of its weaknesses (Sahlins 1972, p34). Despite this, such groups are portrayed as the bad example, the undesirable “subsistence economy” (Sahlins 1972, p1). Furthermore, hunter-gatherer economies are often compared only to where they are found now, namely rural and desert regions, which serves to further marginalise this way of living. Such people are also possibly the most
vulnerable of societies and would be most susceptible to climate change and pollution and the disturbance of nature’s cycles (Tormey 2006, p64). Such societies are depicted as inferior to modern times, however Sahlins has shown that these societies are not in fact as desperate as some sources would imply and they contain advantages in terms of variety of food, thermodynamics and leisure time, which leads him to question;

If such peoples are now described as poverty-stricken, their resources “meagre and unreliable,” is this an indication of the aboriginal condition – or of the colonial duress? (Sahlins 1972, p9)

4.2.2 Western Domination of the course
Edward Said’s work dealt with the issues of representation and identity. His examination of Western texts led to his concept of Orientalism, which effectively characterised Western people as logical, rational, Christian, sensible, scientific, advanced and masculine and counter to this image created the image of the ‘Other’ as immature, illogical, irrational, unchristian, childish, unscientific, mysterious, backward and feminine (Said 1991). The science course is permeated with many of these ideas and presents Science as an exclusively Western phenomenon. The course is heavily dominated by Western interests and standards and the course functions within a Western framework. This is evidenced by a lack of material dealing with other cultures and models of science, and issues are approached from only one viewpoint. The first issue that will be dealt with here are the portrayal of scientists in the course, where science is shown to be practiced and developed.

In this course science is presented as a Western activity. The images in the textbooks show scientists, science equipment and science at work in Western settings. Typical images in the textbooks show pictures like an atomic clock, a water treatment facility, and scientists in laboratories as well as frequent pictures of scientists working in white lab coats.
These images present science as a Western endeavour. Another Western feature of the course is the selection of scientists included. Across all the texts the names of over seventy-five different scientists were found. Some of these, like Robert Boyle, Niels Bohr and Louis Pasteur are found in multiple places in multiple texts, while others such as Gauss, Kepler and Michelson are found once each. The vast majority of scientists dealt with on the course are from European counties, most typically France, Germany, Great Britain and Italy. Typically scientists are Western, Caucasian and male, with few examples to the contrary. Non-European nations include New Zealand (Ernest Rutherford), Eastern Russia (Dmitri Mendeleev) and the United States of America (Benjamin Franklin, Albert Michelson and William Beaumont). However all of these scientists are also Caucasian males and so tie into the overall demography. Across all of the texts only three female scientists are found, namely Marie Curie (mentioned in many places, including textbooks and Exam Papers), Irène Joliot-Curie (Breakthrough Science, p219) and Dorothy Hodgkin (State Examinations Commission 2008, p3). Marie Curie is from Poland, Joliot-Curie France and Hodgkin Britain and so while these scientists are female, they still hail from Western backgrounds. No scientist mentioned on the course that would offer a multicultural dimension. The fact that the Chinese scientists Zhu Zaiyu, Yuan Longping, Li Siguang and Zhang Heng are all included on the Chinese syllabus (MoE, 2001), along with the work of Needham (1993), shows that contributions from
outside of the West have been made to science and this work is suitable for students of today. This Western monopoly of scientists, coupled with science being predominantly shown in Western society, reflects Said’s concept as it promotes the idea of Western nations as advanced, highly developed and mature while it does little to dispel the idea that the ‘Other’ is inferior.

4.2.3 The Portrayal of the Position of Science in Society
The fourth of the seven themes dealt with in this section examines how the texts portray the position of science in society. In Western societies science and scientific knowledge hold important positions and exert much influence. One theme which emerged from the analysis was that there is a certain reverence towards science, and that is something which society should be thankful for, and also thankful to its main practitioners, namely scientists. This treatment is similar to that held by scholars such as Ernest Gellner, for instance, who admits that belief in Enlightenment reason is ultimately a form of faith (Kumar 1997, p 109) while Nanda admits that at times she treats science as “holy” and that she often appears to hold it beyond any criticism (Nanda 2005, p73).

The Teacher Guidelines state that Junior Certificate science is intended to foster “An appreciation of the impact that science has on our lives and environment” (DES 2003, p4). This appreciation is intended to be a key consideration of the course and is present throughout the texts. Science and society are very closely related in the course as a whole, and indeed one of the main changes from the previous syllabus and this one is in the introduction of a ‘Science Technology and Society’ (STS) element. The introduction of this material is intended to make science more relevant to students, as the inclusion is seen to serve as ‘points of transference’ between scholastic and daily science (DES 2002, p6). The syllabus stresses the importance of science in all contexts (personal, social, economic, environmental), and aims to enforce the links between science and society; “Developments in science and technology play an increasingly pivotal role in our cultural, social and economic lives” (DES 2002, p72). The advancements in technology which have been aided by science are placed at the forefront in this course and celebrated throughout. Science is thus presented as closely linked with everyday life and society, in all contexts, and is identified as something that is “increasingly pivotal” and should be appreciated.

The examination of the course materials shows that it is heavily dominated by Western interests and standards and the course functions within a Western framework.
One factor that reflects this is the lack of material dealing with other cultures and models of science and the vast majority of issues are approached from only one viewpoint. This lack of contestation or alternative voices helps to further establish Western ideas. The Teacher Guidelines suggest that students identify places in their locality that have been improved by science, especially due to knowledge of ecology (DES 2002, p36) as a learning activity. This example further reinforces the idea that science is positive and important in our lives and we should be grateful for its impact. This theme of science improving, helping, aiding, developing and ‘advancing’ society is a persistent message across the texts and there is very little material to counter this impression.

As well a science being portrayed as a pivotal aspect of modern society, it is also depicted as a crucial skill for citizens of these nations. The importance of education in preparing students for citizenship is a feature found in the texts, particularly the syllabi. The Junior Certificate syllabus states that the Junior Certificate Programme should

Prepare the young person for the responsibilities of citizenship in the national context and in the context of the wider European and global communities

(DES 2002).

However, the privileged position awarded to science by the curriculum makers can be seen even more strongly in the following extract from the science syllabus;

The syllabus has three major components, biology, chemistry and physics, and is concerned with the development of scientific knowledge, skills, concepts, and attitudes essential for the responsibilities of citizenship in today’s world

(DES 2002, p3)

Science here is presented as an essential life skill in modern society and the provision of these skills is a key concern of the syllabus. The Teacher Guidelines offers a similar perspective on the importance of science for citizens and states;

In an era of rapid scientific and technological change, the study of science is fundamental to the development of the confidence required to deal with the opportunities and challenges that such change presents in a wide variety of personal and social context

(DES 2003, p4)

The wording in these extracts also provides valuable insights into the discourse of science. As can be seen here, science is considered to be ‘essential’, ‘fundamental’, empowering and a necessity for ‘responsible’ Irish, European and global citizens. The rationale offered for this is that citizen should have the necessary knowledge and experience so that they are equipped to discuss and make personal decisions relating to the impact of science and technology on our lives, society and the environment (DES 2003, p72). This treatment not only affords a privileged position to science, but it also creates a hierarchy whereby only those with a scientific background are given credence in decision making affairs. As will be discussed in the second part of this chapter, it also excludes those who function outside the dominant (Western) model of science. These
political themes promote certain ideas and ideals that are Western in orientation and also serve to exclude those that lie outside of this cultural milieu or model of science. Contestation regarding the effects of science and its influence on development, such as those put forward by Shiva (2002) and Haraway (2004) are absent from the course materials. This discussion will be the central theme in the third part of this chapter.

4.2.4 Representation of the ‘Other’

4.2.4.1 Multi-cultural science in the texts
The lack of representation of the ‘Other’ in the course could have many affects for students who come from different cultural backgrounds. Fanon discussed the inferiority complex that developed as a result of colonisation and the psychological impacts this had on the Antilleans and how it affected their behaviour (Fanon 2008). This section will look at the representation of multi-cultural material in the course and image of the ‘Other’ that is presented.

First of all, as scientific development is shown to have taken place almost exclusively in Europe and the USA, this places the rest of the world outside of this discourse, and thus further established the discourse in this course as Modern Western Science. In addition, almost all the scientific discoveries dealt with in the course are attributed to Westerners. These factors would deny the ‘Other’ any ownership of the subject and there are no role-models for them to identify with. Furthermore, when the ‘Other’ is included the depiction often focuses on the lack or unavailability of resources that characterise Western society and thus places them as deficit; inferior to the West.

Occurrences that deal with Non-Western nations are infrequent and the way they are dealt with differs between textbooks. Instances included are once-off mentions and often seem to be included as possible points of interests or anecdotes. There are no links made across sections and many of the instances are self-contained and separated from the main text. No questions were asked in the Exam Papers and only one from the Workbooks (for comparison, five questions in the Workbooks deal with Isaac Newton [Dorgan et al. 2003 Workbook, p1,5,17,73; Henly & Quirke 2003 Workbook, p11]). The subject discipline syllabus did not contain any learning objectives dealing with other cultures, other ways of knowing or development. No instances were found in the End of Chapter Summaries. All of these findings indicate that multicultural science or the inclusion of other nations are not considerations for curriculum makers or textbook authors.
The *Teacher Guidelines* include suggestions of how to include multicultural science in the course. Their recommendations are found in the ‘Heat’ and ‘Food’ sections and are made up of the following tasks:

- To include an intercultural perspective use examples of foods from non European countries (DES 2003, p29)

- Construct a food pyramid using examples of food from Asia only, from Africa only, etc. (DES 2003, p29)

- Discuss the cooling effect (loss of heat by convection) of wearing loose clothing in hot climates (DES 2003, p50)

- Reference to clothing colours worn in different parts of the world (DES 2003, p50)

Many of the instances found in here could be integrated into the main sections of the textbooks as they could be linked to objectives for the course as outlined in the syllabus such as “describe a food pyramid and give examples of types of food recommended in a balanced diet” (DES 2002, p11). While the inclusion of this type of material is limited, it is not entirely absent. When found instances from the textbooks deal with the ingenuity of certain peoples and their ability to avail of the natural resources available. For example, the use of camel excrement as fuel (Dorgan et al. 2003, p345), the use of roots and leaves as sources of drinking water (Dorgan et al. 2003, p401; Casserly & Horgan 2003, p128) and also the use of a solar cell in obtaining drinking water from leaves and other plant materials (Casserly & Horgan 2003, p128). *Science Today* acknowledges the mathematical and astronomical expertise of the ancient Sumerians and Babylonians, and includes how it was they who divided the day into 24 hours, the hour and minute into 60 parts, divided the circle into 360 degrees and had 12 signs in the zodiac because they counted in units of 6 and 60 (Henley & Quirke 2003, p77). However, once again this instance is self-contained and is not elaborated upon or explicitly linked to science today. The discovery of magnetism offers up an interesting point as the discovery is credited to two different discovers, *Breakthrough Science* credits the discovery to the Chinese (Casserly & Horgan 2003, p283) while *Science Today* recounts how the shepherd Magnes discovered magnetite in Greece in 600 BC (Henley & Quirke 2003, p163). Both texts link these discoveries to the invention of the compass. These instances provide some of the more positive dealings with other cultures and serve to mention regions outside of the dominant West. Certain examples, such as the suitability of distillation and desalination in certain countries, such as France (Henley & Quirke 2003, p402) and countries such as
Thailand (Dorgan et al. 2003, p200) and Saudi Arabia (Dorgan et al. 2003, p204) illustrate how technology can be adapted and used as long as the appropriate conditions apply. There is also a strong contrast between the pictured desalination plants in Thailand and in France. The Thai plant is manually worked and shows women collecting salt and carrying the full baskets on their head. The French plant on the other hand is autonomous and industrialised.

Due to the tertiary nature of many of these examples they could be seen to represent an add-on approach to curriculum as it tries to simply integrate multicultural education into existing structures and thus continue the trend of trying to maximise the multicultural dimensions of existing courses, rather than to reform them (Bryan 2008, p302; Tormey and O’Shea 2003, p4). This is another example of the fix-the-parts mentality that dominates in Ireland, with small scale reforms as standard (Gleeson 2009). This inclusion of multiculturalism is at the surface level only as it does not give a fundamentally multicultural curriculum and does not challenge any of the overriding themes of Western superiority or models of development. It also fails to offer alternative perspectives or multicultural science as it shows the same science, except in different locales.

This study examined a variety of texts and despite the findings above, overall non-Western nations were not well represented in the course. In terms of student’s dealing with this material in the classroom, as Long (2008) has shown Irish education is heavily influenced by the terminal exams, and as there is no material on the Exam Papers which would suggest that this may not be a key consideration for teachers. The absence of material that deals with multicultural issues in the texts would also reduce the exposure to these dimensions of education. The Revision Book is an exam orientated text and looking at the content of this book could give insight into the material that receives the most
attention in the course. There were no instances dealing with cultural issues in this text and the focus of this book is facts and definitions. This would also imply cultural such issues are not seen as important in the science course.

4.2.4.2 Eurocentric view of development
The approach taken to issues in this course comes from a Western standpoint only and Western standards are applied to other countries. There is an assumption that the natural progression for all countries is industrialisation and this is depicted as an unquestioned goal. This view of development establishes the West as the most developed and thus to become ‘developed’ is to become like the West. The Eurocentric view is established as certain resources are evaluated from an industrial and economic perspective, with other considerations, such as environmental or local politics, neglected. For example, the identification of a shortage of water in many Third World countries as an obstacle to the implementation of widespread industrialisation suggests that this deficit is the only reason for lack of industrialisation (Dorgan et al. 2003, p241). While many regions do experience water shortages, the focus of this extract on how such shortages effect industry, or in a sense slow industrial growth, enforces the idea of the European Miracle by identifying European structures as inevitable for all nations. This idea of industrialisation as desirable and desired by all is reinforced in a section detailing the various advantages and disadvantages of energy sources and identifies biomass energy as a low-level technology and thus as a suitable option for developing countries (Dorgan et al. 2003, p69). Elsewhere in this textbook Crude oil is identified as “one of the most valuable mixtures ever discovered” (Dorgan et al. 2003, p184). While this may be true from certain perspectives, from an environmental viewpoint it has proved to be a source of damage due to oil-spills, air pollution and problems associated with the disposal of plastics. These instances identify the desires of developing countries in line with the values of Western countries and stereotypically judge their needs through Western norms. These are Eurocentric findings and fail to recognise the potential needs and uniqueness of individual cultures instead imposing Western standards and expecting them to follow the blueprint laid down by Western nations.

The textbook *Breakthrough Science* mentions the medicinal role that plants have played historically (Casserly & Horgan 2003, p6), but places this in a Western framework as it goes on to mention how many modern “useful” drugs such as painkillers and antibiotics are extracted from plants. Once again this highlights the economic and
consumerist lens that Modern Western Science takes to the World and the association between science and business. This is also evident in the extract below as it identifies the most valuable function of plants as a food source, rather than as a source of oxygen. Another striking instance from this extract is how it compares the risk of famine in Third World countries with 19th century Ireland;

For humans, the most important thing about plants is that they can make food. Do you know what happened in Ireland from 1845-1847 when the potato crop failed? What happens in third-world countries when crops fail? (Casserly & Horgan 2003, p55)

This comparison between Ireland during the famine and Third World countries present day makes an explicit link to the ‘Modernisation Theory’ model of development, popularised by W.W. Rostow, where all countries are seen to develop in the same way, but have progressed at different rates (Rist 1997). This extract could thus be seen to promote Western superiority as modern Third World nations are seen to be at the same stage of development as Ireland in the mid-1800s. It also ignores other contributory factors of poverty, such as exploitation, exportation and economics, as in the case of the Nile Perch (Bryan 2009, p141). The extract also establishes these nations as dependent upon certain types of crops and through their stressing of the risk of famine the textbook adds to the depiction of these people as impoverished and primitive. The texts also fail to distinguish between rich people in dry countries, like Saudi Arabia, and poor people in dry countries. This extract also reinforces the earlier instances which also suggested that the goal for these nations is to ‘develop’ into ‘modern’ nations like Ireland and offers a very non-ecological, pro-production and pro-consumption perspective of development.

4.2.4.3 Depiction of the ‘Other’ as inferior
This section will look at the ways in which the course depicts the ‘Other’ as inferior to the Western person. Extracts from the course materials as discussed thus far could be seen to promote the idea that the Third World is backward, impoverished, primitive, underprivileged and ‘behind’ European nations. It also only includes very limited dealing with multicultural education. Certain extracts such as the one from A Voyage of Discovery which states that rhinos are poached for their horns as some people believe have magical properties (Dorgan et al. 2003, p441) could also promote the idea that these people are irrational or juvenile. Rather than to focus on this reason for poaching the texts could reference how poaching is tied to commercial interest and profits or raise questions about morals and ethics. Another issue is that the lack of dealing with other cultures could lead to the assumption that non-Western people are unscientific, which in the wider context of
the science fuelling progress and development, would make them inferior to Western nations. All of these issues could enforce many of the issues raised by Fanon (2008), such as inferiority, subjugation and racial difference and also cause rejection of tradition culture for students from non-Western backgrounds (Rahnema and Bawtree 1997, p 152). The dealing with water in the texts offers a clear example of the existence of these issues in the course as it enforces the position of Western society as superior and associates disease, hardship and suffering with Africa.

Across the texts many instances arise around the topic of ‘Water’ that deal with the cultural dimension of this study. Many of these issues deal with the lack of available water in developing countries and diseases which result from contaminated water supplies. All three of the textbooks refer to diseases which can be contracted through contaminated water supplies and the prevalence of this problem in Third World countries. While this is a very real and serious problem the presentation offered here includes some generalisations and oversights. For example, the textbooks do not differentiate between specific areas where this is most severe and instead deals with it as a problem of Third World countries, or sometimes as an African problem. This treatment highlights the division created between the West and the rest of the world. This area contains the most material dealing with peoples from other cultures, and much of the material in the textbook presents these cultures unfavourably, typically as without a supply of clean water, diseased and impoverished.

There are several instances from the textbooks that discuss the problem of unclean water in the world at present. It is estimated that approximately one quarter of the people in the world have no access to clean water (Dorgan et al. 2003, p243) and that in developing countries this figure rises to three in five (Dorgan et al. 2003, p244). It also says that the major cause of death among children in Africa is dehydration due to diarrhoea which arises through drinking polluted water (Henley & Quirke 2003, p257) and that bacteria and parasites in unclean drinking water cause millions of deaths in Third World countries (Casserly & Horgan 2003, p149). The Science Today textbook explicitly draws upon the difference between the conditions in Ireland and elsewhere stating:

There is clean water on tap in almost every house in Ireland, but in other parts of the world two million people die each year from drinking dirty tap water. Water can become contaminated with bacteria from sewage and cause diarrhoea and diseases such as typhoid and cholera. By 2015 the United Nations hopes to halve the number of people, 2.4 billion, who do not have access to clean water (Henley & Quirke 2003, p427)

While the problem of potable water in the Third World is a major concern, the problem of unclean water is not limited to the Third World. For comparison, the World Health
Organisation (WHO) estimated the level of safe drinking water in Ireland at over 95 percent, with approximately two percentage points between rural and urban areas (WHO, 2004) while in Uganda in 2005/2006 the data indicates that 66 percent of households had access to clean water. While there is a sizeable difference between these rates, even within Ireland water supplies are not always safe and diseases caused by unfit drinking water do pose a very real health risk. For example, Galway city in the West of Ireland has had two recent outbreaks of serious contaminations to the public water supply, the first in early 2007 due to the parasite cryptosporidium (RTÉ News 2007) and the second in late 2008 due to unacceptable levels of lead present in the water (RTÉ News 2008). The presentation given here offers a simplistic view of the issue and confines the problem of undrinkable water to the Third World and not as a problem for Western countries; “in other parts of the world two million people die each year from drinking dirty tap water” (Henley & Quirke 2003, p427). This presentation serves to further enforce Western superiority and the image of the ‘Other’ as in need of ‘development’.

Further instances surrounding this material arise in images contained in the textbook *A voyage of Discovery*. In the section on water, the textbook contains two photographs of black people. The first shows eight children all of whom have large basins on their heads, which are presumably filled with water. This photograph appears in a ‘Did you know?’ section and beneath the heading it states “Less than half of the population of the world have piped water in their homes?” (Dorgan et al. 2003, p243). In the text beneath the photograph it then says “Many of us take piped water for granted” (Dorgan et al. 2003, p243). The second photograph shows a large group of black people collecting water from a river (Dorgan et al. 2003, p244). There are approximately ten people standing in the river filling containers with water and a large group standing on the river bank with containers, presumably waiting for their turn. From the picture it would appear that people have gathered along a stretch of the river, as no end of the crowd is in sight. The caption under this photograph states “Many diseases are caused by dirty water” (Dorgan et al. 2003, p244). These images are in stark contrast to the subsequent ones which show the stages in the treatment of water, from the river to the home (Dorgan et al. 2003, p244), two photographs showing stages in the treatment process and the captions beneath these details how the stage works to remove harmful elements from the water, another image shows a model filtration bed, another shows a man standing by a piece of laboratory equipment while the caption beneath it states;

This laboratory technician at Inniscarra Water Treatment Plant, Co. Cork is carrying out tests on the eater to ensure that it is fit to drink
The final image in this section shows a photograph of a large reservoir and the adjoining text states ‘This water tower at Cobh, Co. Cork holds two million litres of water’ (Dorgan et al. 2003, p245). The juxtaposition of these images, one set showing the simplicity of the techniques used by one culture, with the other showing the complexity and rigour of the system used in Ireland draws a clear distinction between the two and serves to show the purported superiority of Western countries, who use science and scientific procedure to overcome problems faced in other parts of the world, in this case the problems of disease associated with unclean water. The text which appears with these pictures also offers an interesting discussion point, as while the scientist in Co. Cork tests the water to make sure it is safe to drink the people collecting the water from the river are linked to disease and dirty water. The convenience of Western ways is also evident in this section.
The examples dealt with here depict the ‘Other’ as inferior as they are associated with disease, hardship and a struggle for survival. Students who are studying this material could have racial ideas enforced and view ‘Others’ as below the West. The existence of these perceptions has been shown by Rosalind Duke (2003), who in a study in Irish schools found that both students and teachers were only able to conceive of the people and countries of the South in Eurocentric terms, and that Western aid and intervention were the only means that could rescue them from poverty and disease (Duke 2003, p208). In line with Fanon’s ideas, people in Ireland who are studying this course and are from non-Western backgrounds could internalise and gradually accept the very ideas and structures that are associated with their subordination. This phenomenon is known as symbolic violence (Connolly 1998, cited in Bryan 2010, p59). Finally, all of the issues dealt with in this section could be seen to support the ideas of Western superiority and depict the ‘Other’ as unscientific, as well as enforcing the idea that modern times in the Third World are comparable to stages in the history of Europe. As science is shown to be a central tenant of Western society and ‘essential’ for local, national and global citizenship (DES 2002, p3) the exclusion of the ‘Other’ from the scientific discourse would also exclude people without a scientific background and from different cultural backgrounds from issues such as policy making and development planning. This would therefore, further silence and suppress the voices of already marginalised people, such as women and the poor, and provide rationale for this exclusion. As the scientific discourse is tied to modernity, technology and industrialisation these issues would be more likely to receive support at such levels and other interests would not be represented.

4.3 Westernisation of Science and Loss of Culture
This section draws upon the work of Becher and Trowler (2001) and their work examining the “links between the academic disciplines into which that knowledge had coalesced and the cultures of the academics engaged in them” (Becher and Trowler 2001, p1). As the title of their book suggests they focus on the “Academic Tribes and Traditions” and the structures of Higher Education institutions. This section examines the structures of science in the course materials and the ways in which students are inducted into the discourse of Modern Western Science. The role and position of the scientist is an important issue to examine in this regard. The scientists represent the expert in this course and thus act as the example to be followed by students. This argument showed the possibility of Westernisation for those pursuing science and how alternative worldviews
could be further marginalised by the ways Modern Western Science conceptualises and deals with research and investigation.

4.3.1 Induction into the Discourse of Science
As well as training students in scientific theories and experiments the course also defines what constitutes science, and begins to socialise students into the culture of Modern Western Science. Becher and Trowler (2001) have conducted research into how this socialisation occurs and how people come to behave in relatively uniform ways within the particular culture they operate in, such as sociology, history or science;

By ‘cultures’ we refer to sets of taken-for-granted values, attitudes and ways of behaving, which are articulated through and reinforced by recurrent practices among a group of people in a given context

(Becher and Trowler 2001, p23)

In examining the culture within a field, Alvesson’s (1993) work is valuable as he identifies the practices, values and attitudes within organisations as the principle ways Great Culture is established (cited in Becher and Trowler 2001, p44). The first part of this chapter has shown many features of the ‘culture’ of science in this course, such as its Eurocentric nature and the dominance of Western ideals. This piece will examine the depiction of the expert in the course (the scientist) and the ways the practices, values and attitudes are identified. From this the induction, and potentially Westernisation, of new scientists into this Great Culture will offer valuable insights into the discourse as a whole. This examination may also offer insights into the role the expert plays in establishing the criteria and definitions of what counts as knowledge and the reproduction of “patterns of knowledge and ignorance” (Harding 1998, p121).

Scientists are afforded a privileged position in the course and the lives and work of prominent scientists are seen to serve as ‘points of transference’ between school-based learning and students’ everyday lives (DES 2003, p6). The privileged position given to scientists is further evidenced by the emphasis given to them in the course and the frequency that they appear and they are included throughout the course. The scientists who appear most are Galileo, Boyle, Mendeleev, Bohr, Newton, Ohm, Hooke, Lavoisier and Pasteur who all are found on at least ten separate occasions, with Newton appearing most frequently with twenty. While these scientists vary in nationality and era, they can be seen to work in a similar culture as Becher and Trowler (2001) suggest that we can conceive of disciplines “as having recognizable and particular cultural attributes” in spite
of “temporal shifts of character and their institutional and national diversity” (Becher and Trowler 2001, p44). As well as the inclusion of scientists and their work, the importance of scientists is reinforced through its inclusion in the ‘End of Chapter Questions’ and ‘End of Chapter Summaries’. One interesting note is that the scientists are less prominent in the ‘Biology’ sections of the texts than in either the ‘Physics’ or ‘Chemistry’ sections. For example, questions dealing with scientists appear frequently in the ‘Physics’ and ‘Chemistry’ sections of *A voyage of discovery Workbook*, but are absent from the ‘Biology’ section.

The types of questions found in the texts are varied and seek very different types of material as responses. These questions show that as well as knowing about the theories of the scientists knowledge about them is also expected. Two contrasting examples of the type of question asked can be seen below;

Why are the following scientists famous: (a) Louis Pasteur, (b) Alexander Flemming, (c) Joseph Lister, (d) Edward Jenner?

(Breakthrough Science, p96)

Professor Bunsen’s middle name [Asked for in ‘Crossword’ section]

(Dorgan et al. 2003 workbook, p86)

The inclusion of different types of material can also be seen on the exam papers where the following questions are found

Robert Boyle introduced the word *element* into the language of chemistry. Complete the table identifying each of the substances as an element or a compound

(State Examinations Commission 2006)

After what scientist is the *unit* of force named?

(State Examinations Commission 2007)

The postage stamp shown commemorates the awarding of the Nobel Prize to Dorothy Hodgkin (1910-1994) for her work on vitamin B_{12} in 1964. Vitamins are part of a balanced diet. Give one function each for (i) vitamins (ii) minerals in our bodies

(State Examinations Commission 2008)

The photograph is of Marie Curie (1867-1934). She showed the existence of the *element* radium and she produced 0.1 g of the *compound* radium chloride in 1902 by processing tons of pitchblende ore obtained from mines in Bohemia. Explain the underlined terms

(State Examinations Commission 2007)

Scientists are thus well represented on the course and are very visible throughout. This places them as important actors in terms of the culture of science and establishes a sense of reverence for them. However, they do not appear frequently in the *Revision Book*, with only two occurrences found, which are in fact in questions copied from the *Exam Papers*. The level of inclusion and the prominence of scientists in the course reflects Taylor’s (1976) analysis of *heroic myths*. Taylor sees these heroes as occupying an important
position in the discipline’s own ideology. While his example focuses on Geography it applies to other disciplines;

other disciplines are portrayed as involving specialist ‘blinders’ not fully appreciating the importance of the spatial dimension. In contrast there is the myth of the geographer as ‘the great synthesiser’ the ‘foreman’ who combines the individually futile ideas of the blind labouring specialists

(cited in Becher and Trowler 2001, p48)

In terms of the discourse presented here, not only other disciplines could be seen to be handicapped by ‘blinders’ but also past scientists and lay people, while the scientist can break free of these limiting devices. In the texts modern scientists are depicted as superior to those of the past, whose work and methods are depicted as inferior;

in 1669 an alchemist called Henning Brandt discovered a substance that glowed in the dark... At the time, it was thought that this substance glowed because it was magical (now known as Phosphorus)

(Dorgan et al. 2003, p2)

Taylor adds that such representations tend to have little empirical evidence and that they constitute “vast generalisations which have the basic role of creating an overall purpose and cohesion’ out of what appears in practice as a highly disparate activity” (cited in Becher and Trowler 2001, p48).

As dealt with previously, the scientists in the course are predominantly Western, Caucasian and masculine, with approximately seventy-five males appearing and only three females. As well as scientists emerging from a similar cultural milieu and having a similar background, they are also often depicted as having shared characteristics, interest and talents. Traits of ‘scientists’ generally include a curious nature and good powers of observation (Dorgan et al. 2003, p6), as well as a keen interest driven by this curiosity and an innate interest in how things operate (Henley & Quirke 2003, p3). Traits typically associated with scientists throughout the course are curiosity, high powers of observation, expertise in mathematics, academic excellence from a young age, diligence and meticulousness. They are shown as individuals who make “breakthroughs”, advance knowledge, provide valuable technology and improve our lives.

The knowledge gained by scientist can be of great benefit to us. Just think how difficult life would be if Michael Faraday (page 252) had not discovered how to generate electricity. Also, many of us would not even be alive were it not for the medicines manufactured by chemists to conquer diseases. Much of our food would not be edible were it not for the skill of biologists in ensuring that it is free from bacteria

(Dorgan et al. 2003, p2)
Often times the discoveries of scientists are also treated as spontaneous moments of great insight or epiphany, William Harvey, for example, “realised” that the heart does not pump out enough blood to account for the amount of blood in the body (Dorgan et al. 2003, p361) and Louis Pasteur also “discovered” how to make vaccines (Henly & Quirke 2003, p379). Very little attention is given to how scientists made their discoveries, or the steps and complications in this process, and the focus is simply given to what they discovered, which further portrays them as heroes of the discourse. In a similar instance one textbook states that “It took Charles Darwin to state that apes and humans have the same ancestor and that they are closely related” (Henly & Quirke 2003, p225). This reference again attributes scientists’ discoveries to internal characteristic and furthers the image of them as great men. This issue is especially noteworthy as Charles Darwin or his theories are not included for study in this course, and yet he is featured (Henly & Quirke 2003, p118 & p225; Breakthrough Science, p53). The same is true of Albert Einstein (Dorgan et al. 2003, p6 & p104), the Archimedes’ Principle (Breakthrough Science, p233) and thermodynamics (Henly & Quirke 2003, p118), none of which need to be dealt with on the course, in fact the Teacher Guidelines explicitly state no treatment of the Archimedes’ principle is needed (DES 2003, p14). This inclusion highlights the reverence held for scientists and the perceived importance, especially evidenced in the textbooks, of scientists themselves. Darwin and Einstein are two of the most widely recognised scientists and their inclusion may suggest that students need to know about these men, even though their work is not dealt with on this course. The inclusion of the picture of Einstein on the wall reinforces the idea of idols and heroes in the culture as it suggests who students should aspire towards and how they should practice science.

The culture of the discipline includes idols: the pictures on the walls and dustjackets of books kept in view are of Albert Einstein and Max Planck and Robert Oppenheimer in the office of the physicist and of Max Weber and Karl Marx and Emile Durkheim in the office of the sociologist (Clark 1980, cited in Becher and Trowler 2001, p45)

These men are firmly entrenched in the world of Modern Western Science and their inclusion reinforces Becher and Trowler’s (2001) concept of the traditions and common practices of different disciplines.

Scientists through their endeavours are credited with improving our lives, curing diseases, providing vaccines, improving medical practice and communications, making our lives safer and providing us with materials such as plastics. The beginning of the Industrial revolution is also credited to James Watt “who improved the steam engine so
much that it became the reason for the Industrial Revolution in Britain” (Henly & Quirke 2003, p76). This link, although present, is not as extreme in *A voyage of discovery* (Dorgan et al. 2003, p145). Although this story could provide the opportunity to explore the links between science and society, showing how the advent of new technology allowed society to operate in a way which was not possible up to that point, none of these issues are addressed. This topic could also allow for discussion relating to a host of issues such as; examining the factors that led to the discovery, other available materials at this time, the impact society can have on the development of technology and especially the social reorganisation and exploitation implicit in this Revolution. However the opportunity is not taken and so this point remains as an isolated reference.

### 4.4 Science, Development and the Environment

This section examines the discourse of science presented in light of the feminist-environmentalist critique of Modern Western Science. In this examination environmental issues come to the fore as the model of environmentalism and development offered demonstrate many of the features that feminists identify in the discourse, namely reductionist, maldevelopment, mono-cultural and mechanistic. In examining environmental issues O’Riordan’s framework dealing with the types of approach to environmentalism was a useful tool. Under this framework the discourse of science as presented in textbooks and syllabus materials was located in the *techno-centric* approach, and exhibited traits of both the *Accommodation* and *Intervention* paradigms (O’Riordan, cited in Tormey 2006, p65). This section also examines the presentation of science as an autonomous and self-regulating discipline where science is seen as capable of limiting environmental damage and seizing control of nature. This issue leads into a *post-nature* discussion which reflects the ideology of the Enlightenment as science strives to surpass nature. This section ends with a discussion of alternative conceptions of development and offers a critique of Eurocentric beliefs and ideals. The need for alternatives, especially arising out of the unsuitability of Western structures and the resultant exploitation and the creation of poverty in the Third World is the focus of this piece.
4.4.1 Models of Development and Environmentalism

O’Riordan suggests that there are four ideologies of environmentalism; Gaianism, Communalism, Accommodation and Intervention. The first two models represent an Eco-centric approach, while the latter are Techno-centric. The Eco-centric “place ecological laws at the centre of their approach and identify humans as subject to these laws” while techno-centric approaches place humans and their needs ahead of nature and centre their beliefs on human’s rights to control the environment in order to serve these needs (O’Riordan, cited in Tormey 2006, p64). These contrasting models carry different values and beliefs and lead to different conceptualisations of development. The research shows that the course promotes a techno-centric model of environmentalism and is predominantly characterised as an Accommodation approach. Tormey (2006) outlines the basic tenets of this model:

- Humans have the right to exploit the earth’s resources for their well-being.
- The earth’s resources are finite and must be properly managed.
- We must carefully assess the potential dangers to the environment and their knock-on effects of humans.
- We must manage human development to accommodate ourselves to environmental limits.

(Tormey 2006, p65)

The chapters in the Biology section of the textbooks dealing with ‘Ecology’ and ‘Conservation and Pollution’ provide most of the material which shows the dominance of the ‘Accommodation’ approach. For example, each of the above tenets are reflected in the corresponding extracts below;

- Animals are useful to humans for food, clothing, medicine, sports and leisure
  (Casserly and Horgan 2003, p7)
- Plants are useful because they supply the materials for timber, food, medicine, clothing and paper
  (Casserly and Horgan 2003, p56)
- Unfortunately the supply of food and fuel is limited. We must plan carefully. Population increases and greater demands for energy cause terrific strains on our resources
  (Dorgan et al. 2003, p66)
- Society has to question what it is doing in order to make sure that we look after our home – planet Earth!
  (Henly & Quirke 2003, p372)
- Scientists have realised that humans are harming the Earth’s capacity to keep doing the things that it has always done. There are limits to how much we can change the Earth to suit our needs, and there are costs involved when we exceed those limits
  (Henly & Quirke 2003, p371)
These extracts show the relationship between science and nature and thus why it is categorised as an accommodation approach. This relationship is characterised by a producer-consumer roles and establishes nature as subservient to man’s needs. Consideration for the environment arises out of the need for a consistent supply and to maintain resources for human use and to maintain modern lifestyles. Sustainability requires that humans do not abuse their rights and responsible behaviour is called for in order to keep the Earth healthy. This approach sees the Earth’s resources and ability to adapt to changing pressures as finite and so a balance must be struck between needs and costs.

It is not particularly surprising to find this approach as the underlying philosophy as this view is shared by the Brundtland Commission report of 1987 and the UN Human Development Reports in 2001 and 2003 as well as 55-70 percent of people according to various opinion surveys (Tormey 2006, p65). However, while this may not be a surprising finding it does place the course within a certain context and once again can be seen to promote a particular discourse.

4.4.2 Limits of Science and the Human Role in Environmentalism

While the Junior Certificate Science Syllabus states that the course should develop an “awareness of the potential use, misuse and limitations of science, and of health and safety issues relating to science” (DES 2002, p4) these limitations are restricted to the areas dealing with the environment. However, these issues are to the fore in these sections and the role of humans in causing pollution is a key theme in these chapters. In fact, human influence in causing pollution is central to the definitions of pollution in the textbook, which state that pollution is “any undesirable change in the environment caused by human activity” (Casserly and Horgan 2003, p84) and that “Pollution is caused when humans damage the environment, harming the plants and animals that live there” (Henly & Quirke 2003, p372). A wide range of issues dealing with environmental concerns are included in the textbooks, such as habitat destruction, global warming, acid rain, conservation, deforestation, endangered species, global warming, incineration, increased Greenhouse Effect, landfill sites, national energy needs, non-renewable and renewable sources of energy. Images in Science Today and A voyage of discovery show pollution as undesirable and images typically feature landfill sites, factories emitting smoke and damaged forests.
Images of Environmental Damage

These instances all serve to show that the course does show aspects of modern society to be unfavourable and does examine the role of technology in some of these cases. This section will explore the type of treatment given to these issues, and will especially look at the causes and solutions offered by the textbooks to them. It will locate environmental
issues within the wider context of Westernisation, development paradigms and the superiority of the Western society and show how they are enforced through these issues.

### 4.4.3 Environmental Damage and Science

Western science and development strategies are associated with environmental changes and degradation. As countries become more urbanised and industrialised their energy needs increase which often leads to the burning of more fossil fuels (Tormey 2006, p63). The GEO-4 report outlines some of the most urgent environmental issues that have arisen over the last century (see table below). This environmental damage has primarily occurred due to globalisation and interdependence in the world which is driven by expanding flows of goods, services, capital, people, technologies, information, ideas and labour. This activity is pioneered in the Western world, but has far reaching effects which even extend to isolated populations (UNEP, 2007b – Summary).
<table>
<thead>
<tr>
<th>Evidence</th>
<th>Impact on development</th>
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<tbody>
<tr>
<td><strong>Climate change</strong></td>
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| The Earth’s surface is warming. The global average temperature increased by 0.74°C in the last century. The IPCC estimates additional warming of 1.8 to 4.0°C over the current century | • Rising sea levels making areas inhabitable  
• More severe flooding and droughts, unpredictable weather patterns |
| **Ozone depletion** |  |
| The “hole” in the stratospheric ozone layer over the Antarctic is now the largest it has ever been | • Decreased protection from harmful UV rays |
| **Air pollution** |  |
| More than 2 million people globally die prematurely every year due to outdoor and indoor air pollution. Indoor air pollution due to the improper burning of solid biomass fuels imposes an enormous health burden | • Increased respiratory diseases resulting in increased mortality |
| **Land degradation** |  |
| Overuse of land and climate change is leading to soil erosion, nutrient depletion, water scarcity, salinity, desertification, and the disruption of biological cycles. 60% of ecosystems are degraded and used unsustainably | • Poor people suffer disproportionately from the effects of land degradation, especially in the drylands, which support some 2 billion people, 90 percent of whom live in developing countries |
| **Contamination of freshwater** |  |
| The per capita availability of freshwater is declining globally, and contaminated water remains the greatest single environmental cause of human sickness and death. Each year, 3 million people die from water borne diseases in the developing world, the majority of whom are children under the age of 5 | • If present trends continue, 1.8 billion people will be living in countries or regions with absolute water scarcity by 2025 and two-thirds of the world population could be subject to water stress  
• Decline of aquatic ecosystems and their services |
| **Loss of biodiversity** |  |
| Aquatic ecosystems continue to be heavily exploited. Global marine and freshwater fish catches show large-scale declines, caused mostly by persistent overfishing. Species are becoming extinct 100 times faster than fossil records show | • Reduction of food supply from aquatic sources  
• Loss of aquatic biodiversity |
| **Loss of biodiversity and deforestation** |  |
| The great majority of well-studied species are declining in distribution, abundance or both. Although the decline in the area of temperate forest has been reversed, with an annual increase of 30 000 km² between 1990 and 2005, deforestation in the tropics continued at an annual rate of 130 000 km² during the same period | • More than 16 000 species have been identified as threatened with extinction  
• Loss of habitat for flora, fauna and indigenous people  
• Loss of carbon sinks, ultimately impacting further on climate change |

**Table 2** - Environmental threats and human impacts - adapted from UNEP, 2007b
This section will examine the treatment of these issues in the course texts and especially the portrayal of Western values and development in light of these issues.

As discussed previously, the course does address environmental damage and the role humans play in this. However, in spite of this damage Westernisation and development are still largely unquestioned and shown in a positive light and also depicted as favourable. Part of the reason for this is because the textbooks do not draw links between science and society and the moral dimensions which also influence environmental damage. This means that the underlying beliefs which lead to these problems are not brought into the discussion. While these sections show the damaging consequences of modernity they do not cite development, science or mass consumption as the main problems, but rather that some ‘unfortunate’ side effects have arisen along the unquestioned favourable path to development, and in future, as ‘responsible citizens’, we must try to reduce their occurrence:

It is an unfortunate fact of life that the common fuels – coal, peat, oil and petrol – all contain a small amount of the element sulphur. When these fuels are burnt, the sulphur present also burns to form the compound sulphur dioxide ($\text{SO}_2$).

(Henly & Quirke 2003, p503)

Other examples of this kind can be found in the textbooks and are more prominent in *Science Today*. In this text the portrayal of these unfortunate side effects and the resulting environmental degradation are taken simply as inevitabilities which have accompanied Western development as can be seen in the following extract;

One of the problems associated with plastic is its disposal. Plastic is non-biodegradable, that is, it does not rot. A walk along any roadside will reveal plastic bottles and bags that have been there for years. Likewise, many beaches are also polluted with bags and bottles that have been dumped in the sea and washed up

(Henly & Quirke 2003, p507)

The next extract has similar connotations and also further promotes the idea of modern society as advanced, favourable and progressive;

As society has become more developed, we have produced greater amounts of waste and it has become necessary to manage the problem (Waste Management)

(Henly & Quirke 2003, p373)

This section directly relates mass-consumption and waste production as hallmarks of modern societies and terms these practices ‘developed’. This places Western development in opposition to harmonious existence with the environment and places their needs as opposites. These sections take as matter of fact that pollution occurs; plastic litters roadsides because it is non-biodegradable rather than the practices of littering and people not cleaning up; the release of $\text{SO}_2$ into the environment is simply an ‘unfortunate fact of life’ rather than as a fundamental critique of modern society and practices. The lack of analysis on modern practices which have led to environmentally catastrophic behaviours,
such as deforestation and habitat destruction can be seen in the next extract where the behaviour is almost shown as neutral, while the results are unfavourable;

When we chop down the tropical forests for teak and mahogany timber, we end up killing the animals that live there. We can make animals and plants become extinct, but we can never replace them. This makes us responsible for looking after all the plants and animals on the planet

(Henly & Quirke 2003, p371)

Were it not for the risk of extinction it seems like these issues would not be problematic, and while it does address the effect that habitat destruction has it does not talk about the motivation behind this activity only the resultant destruction which in future we would be best to avoid. The focus in these texts is upon the role of humans as the caretakers for the environment rather than discussing how modern Western society produces large amounts of waste and is demanding on natural resources, especially timber and fossil fuels. The texts draw a distinction between those responsible for the practices which have led to environmental issues and how ‘responsible’ behaviour can alleviate them. Other recent global activity which has led to the destruction of habitats and endangerment of species has placed scientists in a type of caretaker’s role for the diversity of the species, as to conserve them they decided that certain animals and plants needed to be placed in special sanctuaries such as zoos and botanical gardens (Henly & Quirke 2003, p375). This places scientists in direct opposition to those who have caused this environmental damage and affords scientists a privileged position as esteemed members of society. The undertone of ‘responsible’ practice is therefore to act like scientists and in terms of sustainability and the protection of the environment science seen as a key factor;

This means that we must look after our environment in a more caring away and take responsibility for ending any activities that are causing damage. Keeping the Earth in a healthy state can only be achieved if each one of us takes responsibility for our effects on the planet

(Henly & Quirke 2003, p354)

However, Western practices and science are not always conducive to responsible practice. One example that shows this is the case of the introduction of the Nile Perch to Lake Victoria in East Africa. This case illustrates the violence caused by the tradition of Modern Western Science and the establishment of “a world order dominated by neocolonial exploitation in the guise of globalisation” (Bryan 2009, p141). The introduction of this new species to the lake eco-system caused environmental destruction in the form of a loss of diversity as the Nile Perch became a “voracious predator” in this new environment and has caused the extinction, or near extinction of a number of other species (Tormey 2006, p73). The Nile Perch was introduced to be a food source, but not for the residents of this region. Instead it was to be exported as a delicacy to Europe. Bryan (2009) discusses the film Darwin’s Nightmare and how this case epitomises
Maisha Magumu (a Swahili term meaning ‘difficult life’) which Tanzanians use to describe the deterioration of their conditions and lives due to this neo-colonial exploitation (Bryan 2009, p140-141). Bryan attributes the cause of this poverty and injustice to the political-economic strategies and the ideologies which allow starvation in the shadows of a factory which produces millions of white perch fillets and how locals are forced to survive on “the rotting remains prepared in open-air factories, where ammonia-emitting, maggot-swarmed perch carcasses are repackaged as a local subsistence food” (Bryan 2009, p141). This anti-globalisation example shows the dangers associated with the model of development that dominates the texts and favours a model of development built upon capitalism and industrialisation. This case shows a ‘new imperialism’ and shows globalisation as the cause of, and not the solution to, problems in parts of the Third World (Bryan 2009, p141).

4.4.4 Science as a self-regulating and autonomous discourse
While an accommodation approach is the main philosophy advocated in the course, the Intervention approach is also evident in some areas. Tormey (2006) outlines the key traits of this approach as:

- The earth is robust and can survive human interventions.
- When resources become scarce, the laws of supply and demand will make them expensive and will thereby reduce demand.
- There will then be a market niche for businesses that will make a profit by developing new products that will fill any gaps.
- Businesses will use these profits to fund research, which will find new ways of coping with such scarcity or other potential problems by developing new technologies when needed (such as using nuclear power to deal with a scarcity of fossil fuels).
- There is, therefore no need for major social change, our current way of working will solve any problems.

(Tormey 2006, p65)

This view is the second most popular approach and gains 10-35 percent public support in various opinion surveys (Tormey 2006, p65). The orientation of this outlook marginalises the need for sustainability or the management of resources as it relies on the ‘laws’ of economics and the resourcefulness of scientists to minimise the disruption caused as the reserves of fossil fuels are exhausted.

When the problems facing the environment are discussed the solutions and/or preventions to them are also included. This treatment serves to reduce the impact of the human factors and consequence of Western and technological development as it shows science as able to overcome any troubles experienced. This depiction reduces the need slow down or limit industrialisation as science is seen to reduce any environmental
damage once it is identified. For example, acid rain is one issue which is highlighted as particularly troublesome, however, two texts detail how this problem is being overcome and prevented and thus as a problem which has been reduced due to science;

> Acid rain causes enormous damage to the environment. It can be reduced by removing sulphur dioxide from the exhaust fumes of coal- and oil-burning industries and by reducing the acidic exhaust gases from cars

*Casserly and Horgan 2003, p183*

Another text states;

> Various methods are in use to reduce the amounts of acidic gases which are being put into the environment. Coal-burning stations... and also factories that burn coal, have installed ‘scrubbers’ inside the chimneys

*Henly & Quirke 2003, p504*

Elsewhere the use of catalytic converters in cars to reduce pollutant gases as well the current practice of oil refineries producing low-sulphur fuels and the use of methane as a “clean fuel” are all included (Casserly and Horgan 2003, p183). These extract lead to the impression that even problems which have had serious consequences on the environment can been alleviated through science. It also promotes science as a type of ‘cure-all’ where any problems can be dealt with. The idea that science can solve problems that have arisen through scientific advancement creates the impression that ‘better science’ (or better application of science) can always be employed to overcome any issues and thus that science advancement is limitless and essentially maintainable as all problems can be solved. This treatment is consistent with the presentation of the subject discipline at Primary school level which also discusses the potentially adverse effects of science with the underlying phraseology that science is a positive influence on society, while it is the actions of humans which is questionable (Ó Conaill 2003, p58)

Such material reduces the need to develop alternatives modes of development as science is seen to ‘clean up’ even the most damaging forms of pollution. This further supports the plausibility of the intervention approach as it depicts Western society and development as sustainable due to science’s ability to solve complex problems such as environmental damage. In other cases, the limits of science are also depicted as only restricted by time, and that eventually the abilities of science will be unlimited. This leads to the presentation of science as *post-nature*, as will now be discussed.
4.4.5 Post-Nature Discussion

Science and scientific developments are depicted in the texts as important in all aspects of life and there is a close relationship between science and society. This section will develop this discussion by focusing on the relationship between science, society and nature. Classically science was referred to as the study of nature where “Scientists try to answer questions to explain what is going on in the natural world” (Dorgan et al. 2003, p14). This process of enquiry was one of curiosity and understanding where “One of the reasons we study science is to make ourselves more aware of the world around us” (Casserly and Horgan 2003, p202). In fact, the term ‘scientist’ was first used by George Whewell in 1840, up until that people engaged in ‘natural philosophy’ (Harding 1998, p10). As the quotes above are taken from the textbooks the understanding of science as trying to determine the regulatory rules of nature and to document them is obviously represented in the course. Other scientific pursuits in this version include the categorisation of plants and animals, taking and recording measurements and examining chemicals. The general basis of science here is in answering ‘how’ and ‘why’ questions and this pursuit of “Finding out how and why things work has led to many discoveries and inventions” (Dorgan et al. 2003, p14).

However, along with this understanding of scientific activity there is another paradigm which is evident in the texts. This paradigm is not one of man studying nature, trying to analyse phenomena and predict behaviour, but rather the manipulation of nature by man to serve his needs. This paradigm has political undertones and is tied to the Enlightenment project. Writers such as Harding who view science as a ‘Western, bourgeois, masculine project’ see aspirations to control and manipulate nature as key features of modern science. Shiva (2002) writes that “For Bacon, nature was no longer Mother Nature, but a female nature, conquered by an aggressive masculine mind” (Shiva 2002, p17). This extract refers to Francis Bacon (1561-1626) who is regarded as the founding-father of modern science and the person who introduced the influential scientific method (Casserly and Horgan 2003, p159). Shiva sees Bacon’s Royal Society as;

a specialist programme benefitting the middle class, European, male entrepreneur through the conjunction of human knowledge and power in science

(Shiva 2002, p16)

This new version of science saw older science as passive and weak and this form of science is seen as masculine and associated with the control and subjugation of nature and femininity and the ideologies of science and gender were seen to reinforce one another (Shiva 2002, p18; Harding 1998, p78). In this discourse nature is subservient to science
and the goal of science is to overcome the limits imposed by nature and to dominate over and control it. For Lloyd; “Bacon constructed the mind’s task in knowledge not as mere contemplation, but as control of Nature” (Lloyd 1996, p46). Such controlling behaviour can be seen in the development of artificial methods of contraception such as condoms and the morning after pill (Casserly and Horgan 2003, p50). While these issues are frequently regarded as liberating by some feminists and used as indicators of the rights and choice of women in society, their inclusion here focuses on the attempts made by science to regulate nature and overcome the laws of nature. Other features include intrusive practices such as dissection and also the scientific experiment itself, where the scientist sets up, controls and manipulates the environmental conditions under which the test will take place. The experimental method that is a central part of the scientific method is seen as a reflection of science’s domination over nature and as “formulated and conceived in the language and metaphor of rape, torture and the inquisition” (Shiva 2002, p29).

Sections can be found in the texts which not only promote the manipulation of nature but also delimit the subject by discussing how science is overcoming what are depicted as obstacles imposed by nature. One of the texts praises the advances of scientific knowledge and expertise, which have progressed almost to the stage where they have surpassed nature, as it states; “We do not actually need to have two kidneys… Some people have a kidney belonging to a relation in their bodies” (Dorgan et al. 2003, p375). Another feature of the presentation is how it deals with the advances of science and its future, especially concerning aspirations of science and future concerns. One instance in Science Today brings forth the following challenge for modern science, “Some scientists wonder whether it would ever be possible for humans to produce an artificial organism” (Henly & Quirke 2003, p224). This change in approach to the subject, which is praised and favoured in places in the course, brings science away from trying to understand the mechanics of nature and leads the subject into a post-nature era. The change in understanding within the discourse is evident in these extracts where science now tries to manipulate nature and control it, rather than trying to understand it. Nature is no longer a puzzle to be understood but rather imposes ‘problems’ that science must attempt to work around and overcome, with the ultimate triumph of this ‘progressive contravention’ of the laws of nature taking place when Western culture proved it could support human life even in outer space, “where even gravity and oxygen were naturally lacking” (Sahlins 1972, p37). In this context science, rather than nature is shown as the most powerful force as science acquires the methods to remove the constraints imposed by nature. This feature is
evident in the following extract; “If nerve cells die, however, replacement ones do not grow. Scientists are researching ways to get around this problem” (Henly & Quirke 2003, p308). The pursuit of such tasks is the fulfilment of the goals of the Enlightenment as masculine science surpasses nature and frees us from the ‘constraints’ and ‘limitations’ that it (weak, feminine nature) imposes. While the Junior Certificate Syllabus calls for the development of “all aspects of the individual” the moral dimensions only appear in the Teacher Guidelines which states;

> Advances in medicine and the rapid expansion and development in the pharmaceutical and chemical industries, as well as the ever-expanding knowledge of the human body, will require that decisions which seriously impact on life itself should be influenced by a religious and moral dimension, and not solely by scientific or economic considerations (DES 2003, p71)

Despite this warning, the discourse presented does not feature any discussion of the social, political and moral influence that science can have and so presents science as a neutral discipline and value free.

### 4.4.6 Alternative Models of Development

The depiction of the discourse of science shown by the course has been dealt with in this chapter. It shows Western conceptions of development favourably and offers a technocentric approach to environmentalism, and thus development. Western society is portrayed as the pinnacle of advancement and as the example that should be followed. The dominance of these views and the exclusion of other ways of development and belief systems deny and undermine alternative versions, and thus deny them credibility. The cultural conflict between Modern Western Science and traditional knowledge systems is also an important issue, especially for non-Western students in the science classroom where they need to negotiate border crossings between their own tradition and the culture of science education (Aikenhead 1996, p224). The power of Modern Western Science places it in a powerful position compared to other ways of knowing and often results in cultural transmission;

> Because science tends to be a Western cultural icon of prestige, power, and progress, its subculture permeates the culture of those who engage it (Aikenhead 1996, p220)

As science and an advancement which is reliant on consumerism and technology is shown as the way ‘forward’, any model that would not aspire towards these standards would, by juxtaposition, be ‘backward’. This highlights the reductionist nature of Modern
Western Science and the violence against knowledge therein (Shiva 2002). Harding echoes this violence as she says;

> when graduate schools, disciplinary journals, and conference organisers assume that “science” refers only to what physicists and chemists are willing to think of as science – or even as sciences at all – then many science and technology issues central to the lives of women, especially in cultures that have relied on their own non-Western scientific and technology traditions, will not even be seen as relevant issues for feminist science and technology studies

(Harding 1998, p85)

This Western lens is a powerful one as it establishes both what ‘development’ and ‘science’ are, and what they are not. With the end of colonialism countries achieved the right of self-governance and the ability to control their own destiny. As they began to implement development models Frantz Fanon offered these words;

> If we want to turn Africa into a new Europe, and American into a new Europe, then let us leave the destiny of our countries to Europeans. They will know how to do it better than the most gifted among us. But if we want to bring it up to a different level than that which Europe has shown it, then we must reinvent and we must make discoveries

(Fanon, cited in Bertrand and Regan 2006, p81)

This ‘reinvention’ and difference are seen as essential in order to create their own identity and establish the identity of their nation. One approach which embodied this approach to development is of Ujamaa in Tanzania as led by Julius Nyerere. The word Ujamaa translates to ‘extended family’ and this model of development emphasised personal fulfilment through community service and support and is characterised by self-sufficiency and village-isation (Bertrand and Regan 2006, p81). This is the type of development advocated by feminist such as Vandana Shiva who calls for disentanglement from Western constructs and influence as she links the poverty of Amazonian tribes, the Gonds of Bastar in India and the Penans of Sarawak in Malaysia to the destruction of their natural environment (Shiva 2002, p12). The textbook Breakthrough Science asks the following question relating to the study of science;

> At this stage, if you have any sense, you should be asking, ‘What has all of this got to do with me? How does it affect my everyday life, or anyone else’s for that matter?’

(Casserly and Horgan 2003, p260)

The mono-cultural view taken by the texts confines the answer to this question to a Western context, where the role of science is to maintain and advance Western interests and preserve the Western way of life. Through the Western bias in the texts the course fails to address this question as it does not examine how the values, ethics and models promoted by science truly affect the World and those living in it.
While Modern Western Science is associated with ‘advances’ in many fields such as medicine, infrastructure, agricultural yields and so forth, Shiva (2002) challenges this and points out some of the negative consequences of these practices while also disputing the ability of science to self-regulate as she says;

When antibiotics create super-infection and flood control measures accentuate floods and fertilizers rob soil of its fertility, the problem is not merely between use and misuse of technology. It is rooted in the very process of knowledge-creation in modern science....

(Shiva 2002, p34)

Despite this critique Modern Western Science has positioned itself in a position of dominance to the extent that it is seen as the source of the solutions to the problems it has initiated in the Third World. Certain critiques are opposed to Modern Western Science and dispute its ability to do anything other than perpetuate the models of dominance and oppression that currently reigns in many areas. In addressing the recommendations of the Brundtland commission to promote sustainability, Indian environmentalist Anupam Mishra gave the following critique;

We should not assume that we can look for solutions to our problems within the framework of the current development pattern. It would be folly to think that the Brundtland Commission can find solutions within the ‘counter-productive’ framework of governments, the United Nations, the World Bank and so on. Because the present structure has given us the disease, is it logical that they should also provide the cure? This seems to be the limitation of this Commission, because it itself stemmed from the current framework.

(cited in Tormey 2001, p71)

This view is not restricted to Mishra as the work of NGOs has also noted that any ‘development’ project introduced in the face of gross inequality can only maintain this inequality and discrimination (Bertrand and Colm Regan, p83). Furthermore, Gustavo Esteva “asserts that the sacredness of development has to be refuted because it threatens survival itself” (Esteva, cited in Shiva 2002, p14; Shiva 1993, p304). Such theorists call for new approaches to development and a rejection of the Eurocentric models which have been in place for so long, and which have only destroyed indigenous cultures, reduced the sustainability of natural environments and led to feelings of inferiority among people of the South (Rapley 2004). Escobar (1995) call for new, organic practices to follow the principles below.

- An interest not in development alternatives, but in alternatives to development, and thus a rejection of the entire paradigm of development
- An interest in local and indigenous knowledge
- A critical stance towards established scientific discourses
• The defence and promotion of localised, pluralistic grassroots movements

(Escobar 1995, p215)

The discourse of science presented in these texts is in line with the masculine, reductionist, patriarchal model as critiqued by feminist scholars and it promotes the Western process of ‘development’ that is seen as the primary cause of environmental damage and degradation which is expected to have the most devastating impact on Earth’s poorest people (Tormey 2006, p64). The dominance of this discourse could lead to the proliferation of these views and thus more Westernisation and Eurocentric beliefs. The current drive towards sustainable development also reflects the dominance of Western practices as the focus is “to sustain development itself, rather than to sustain nature or culture” (Esteva and Prakash 1998, p281).
Chapter 5: Conclusions

5.1 Discourse of Modern Western Science
This study sought to identify key features of the discourse of science that is presented in lower Post-Primary education in Ireland. Lawton (1975), Apple (1996) and Gleeson (2008) have discussed how curriculum is a selection of culture and promotes certain conceptions of subject disciplines, and thus curriculum design is a political activity. Others have shown the alienation felt by non-Western students and minorities towards science and the fundamental problems they face in studying the subject discipline (Mutegi 2011; Sutherland and Dennick 2002; Knain 2001; Aikenhead and Jegede 1999; Aikenhead 1997; Aikenhead 1996). These issues highlight the need to examine how science is presented and the selections made in the design of the course, as these selections affect student populations differently. Other scholars (Aikenhead 1996; Shiva 2002, 2005; Harding 1993, 1998; Haraway 2004) discuss the nature of knowledge and how the production of knowledge is subject to cultural influences. This understanding ties knowledge to cultural interests and values and thus has great implications for the study of different knowledge systems. One area that offered great opportunity for discussion was the relationship between Modern Western Science and the natural environment. The position of nature in Modern Western Science, a resource that can be exploited by humans for their needs (as discussed by Tormey 2006, p65), versus the views of eco-feminists such as Vandana Shiva who see the interconnectedness and diversity of nature as science (Shiva 2002, p5) highlights the influence of cultural systems over knowledge.

Another concern of this study was the effect of the dominance of Western models on the world, and the associated oppression and domination. The issues of race, identity and inequality are all important in this study as they inform the discussion on Western superiority and the power/knowledge relation. The powerful position of Western discourses, such as the discourse of Modern Western Science (Harding 1998, p74), can lead to Westernisation and the dominant of Western models. The identification of topics for research and the way in which this research is carried are two ways in which Modern Western Science influences society. The study also draws heavily on critiques of Modernisation Theory (Rostow 1959) and the ‘development’ strategies implemented by
the West as they also highlight both the cultural influence on knowledge production and also the manifestation of power through knowledge systems. These issues emphasise the importance of problematising discourse and looking to the margins to find alternative perspectives and knowledge.

5.2 Summary of Literature Review
One of the key themes in the Literature Review is knowledge. This chapter includes a discussion on the nature of knowledge, knowledge formation, and the relationship between culture and knowledge amongst others. In this discussion the work of Foucault comes to the fore as his idea of discourse illustrates the way in which objects can be continuously transformed (Foucault 1972, p32) and knowledge and understanding can or undergo breaks or changes. Foucault shows the medical discourse as undergoing a radical shift and how this transformed the discipline (Dreyfus and Rainbow 1983, p14-15). This case shows how subjects such as medicine are not unified subjects that majestically unfold and ‘progress’ over time, but rather forms are substituted for one another in different periods (Windschuttle 1998, p13). Foucault calls for us to examine these shifts and the changes in meaning found in discourse, as well as the factors which contribute to its formation and operation and the “tranquillity with which they are accepted must be disturbed” (Foucault 1972, p25).

In the examination of Modern Western Science the ‘Enlightenment’ is a key period in the discourse as it was in this time and with these values that Modern Western Science developed. Nanda (2005) sees the Enlightenment as “a revolt against supernaturalism in all its guises” (Nanda 2005, p162). The Enlightenment established empirical evidence as the basis of knowledge and gave primacy to logic and reason (Nanda 2005, p175). Thus, experimental testing became the chosen tool of the scientist and Modern Western Science gave rise to positivism, a worldview which claims that only hard, observable facts count in research (Kane and O’Reilly De Brun 2001, p15). Critics of Modern Western Science came to see its methods as reductionist as it is limiting human’s capacity to know nature by reducing the focus on a diversity of ways of knowing and other knowers (Shiva 2002, p22). The experimental method requires breaking systems down into their simplest parts and manipulating one variable to determine
relationships. Feminists see this model as particularly unsuited to nature associate violence with Western practices which seek to develop the elements of nature, where forests, rivers, animals and crops are all ‘developed’ independently. In this way, the equilibrium of nature is upset and balance in nature which gives sustainability and equity is destroyed (Shiva 2002, p45). The power of the Western worldview can be seen in this context. The contrasting views and interpretations of eco-feminists and Western views are shown in the table below:

<table>
<thead>
<tr>
<th>Eco-Feminist Values:</th>
<th>Western interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional, manual, organic</td>
<td>Poverty, backward, unproductive</td>
</tr>
<tr>
<td>Clean, stable, harmony, unspoiled, natural</td>
<td>Untapped, undeveloped, underutilized</td>
</tr>
<tr>
<td>Key interests:</td>
<td>Key Interests:</td>
</tr>
<tr>
<td>Diversity, suitability and sustainability</td>
<td>Commercial, mono-species, profit, managed</td>
</tr>
</tbody>
</table>

(Shiva 2002, p4)

Western views of nature depict technology, commercialisation and managed mono-species crops as modern and desirable and ‘development’ takes this form. The replacement of traditional views and the establishment of Western ideals leads Shiva to refer to Modern Western Science and Western practices as maldevelopment as it militates against this equality in diversity and superimposes the ideologically constructed category of Western technological man as a uniform measure of the worth of classes, cultures and genders

(Shiva 2002, p5)

These worldviews draw upon very different philosophies and have very different ontological assumptions. These different ways of coming to know can be referred to as standpoint epistemologies (Harding 1998; Haraway 2004). Harding’s idea places all theories of knowledge as locally-produced knowledge systems (Harding 1998, p74), and thus places Modern Western Science as a subculture of Western culture (Aikenhead 1996; Cobern and Loving 2001). The introduction of alien systems can have far reaching affects for that society. Despite the perceived equality in formation, systems of knowledge are not equally powerful and Western systems occupy the more powerful position. This can lead to Westernisation as Western ideals and values are introduced and popularised. Consequently, this can lead to the delegitimisation of local beliefs and interests. Harding outlines the oppression and subjugation that is associated with this occurrence;
If women, the poor, and racial and ethnic “colonies” are kept illiterate, not permitted or encouraged to speak in public, and excluded from the design of the dominant institutions that shape their lives, they do not have the chance to develop and circulate their own politically and scientifically produced perspectives on nature and social relations. They do not have the chance to provide what could possibly be the most trenchant critiques of the dominant institutions and their discourses (Harding 1998, p142)

Other forms of oppression and domination are also found in the introduction of Western systems to other locales and in the history of the West many instances of racial thought and action can also be found. Frantz Fanon’s work shows the cultural alienation and sense of inferiority that occurs as a result of colonisation. Colonisation and the resultant introduction of Western systems served to place white men ahead of black, and this inferiority was internalised by the black man who “want to prove to white men, at all costs, the richness of their thought, the equal value of their intellect” (Fanon 2008, p3). In order for the black man to achieve this affirmation, Fanon argues they had to prove the power of their own intellect, which of course would be determined through Western categories and norms. This struggle would necessitate the acceptance of Western norms and values and a rejection of indigenous interests and practices, including language. This led Fanon to postulate;

The colonized is elevated above his jungle status in proportion to his adoption of the mother country’s cultural standards. He becomes whiter as he renounces his blackness, his jungle.

(Fanon 2008, p9)

While the Enlightenment set about creating a model of knowledge premised on objectivity, reason and logic and was value-free and free of bias, the cultural interests and attitudes of the West have been shown in practices such as American Polygeny and Craniometry (Gould 1993). These theories enforced and legitimised racist notions and established a social hierarchy which placed white men above those of non-Western descent. Fanon talks of the production of racial-linked theories by scientists which claimed to show the genetic inferiority of the negro based upon the idea that the negro's chromosomes had a few thicker or thinner genes which were said to represent cannibalism (Fanon 2008, p91).

In Orientalism (1991) Edward Said showed how Western societies establish themselves as superior over the Orient and his work shows how this portrayal enforces the Western domination of the East. Orientalism can be understood as a “style of thought
based upon an ontological and epistemological distinction between ‘the Orient’ and (most of the time) the Occident” (Said 1991, p2). This distinction is based on solely Western views and creates an image of the Orient, and subsequently an image of the Occident in contrasting images, ideas, personality and experiences (Said 1991, 1-2). The Orient was typically depicted as immature, illogical, irrational, unchristian, childish, unscientific, mysterious, backward and feminine and through opposition this created the Occident as mature, logical, rational, Christian, sensible, scientific, advanced and masculine. In this way, Orientalism can be seen as a Western style that allows it to dominate, restructure and have authority over the Orient (Said 1991, p3).

In terms of the Irish education Gleeson (2008) has shown the lack of deep change that has occurred in curriculum. He also highlights the prevalence of Rhetoric vs. Reality and ‘fix-the-parts’ mentality in the Irish system. Furthermore he highlights the dominance of quantitative research in Irish education. These findings would suggest that the issues addressed in this study would not have received a great deal of attention. Tormey has discussed social justice and analysed Irish Primary curricula. O Connail has examined the portrayal of science in Primary School education while Bryan has examined multicultural education and representation of multiculturalism in Irish school. While aspects of this study have been dealt with, they have not been examined in a single study.

Internationally, Michael Apple has shown the contested nature of curriculum and its social and political dimensions. Emdin (2011), Mutegi (2011) and Knain (2001) have shown the inadequacies of “Science for All” syllabus and the difficulties faced by minorities and people from non-Western cultures in learning science. Aikenhead has examined the nature of science and its impact on science teaching and learning and the cultural barriers non-Western students face in learning science in schools (Aikenhead 1996; Aikenhead and Jegede 1999). All of these works show the importance of multicultural dimensions in education and the importance of representation in curriculum design in terms of interests, values and ideology.
5.3 Revisiting the Research Question

The research question for this study is:

- What discourse of science dominates lower Post-Primary Education in Ireland?

This study sought to examine the text materials for Junior Cycle education in Ireland and discuss the key themes arising from this analysis. The portrayal of science, especially in relation to multicultural education and the representation of the ‘Other’ were key concerns. The main dimensions examined in the texts were: Western, Linear, Elitist, Political and Cultural. These categories were selected to help discover the biases and prevailing themes that are present in the course. They were especially concerned with the domination of Western interests and ideology in the text materials as well as how science is shown to progress and its effect on society. The portrayal of scientists and their position in the discourse was also an important aspect. The relationship between science and politics was also a main concern. Finally, the position of non-Western societies and knowledge in the course and the cultural dimensions of science education were also pivotal dimensions. This research question has not been the focus of examination, as evidenced by a search on Google Scholar which returned 136 results since 2002 for the search: “Discourse Analysis” “Science Education” “Ireland” ([Accessed 10/08/2011]), and of these the top results dealt primarily with ICT, Scotland, South Africa and Zimbabwe. However, authors such as Audrey Bryan (2008, 2009, 2010) and Tormey (2006) have dealt with multiculturalism and integration in Irish schools, but none of these studies examined science texts.

While the work of theorist such as Needham (1993), Fanon (1990) and Haraway (1996) detailing subjugation and the exclusion of alternative views and non-Westerners accounts of science is not particularly new, this study showed the absence of these issues in contemporary science education. As the debates around sustainability, multiculturalism and development policies continue to intensify the treatment of these issues in education becomes increasingly important. The difficulties currently faced by non-Western students in learning science can only be intensified by the domination of Modern Western Science.

The discourse of science that is portrayed promotes a certain view of the subject and this selection constitutes a political and social activity. All education can be seen as a political act, as Paulo Freire noted. In this context, education is faced with the choice of either dealing directly with issues like cultural diversity and social justice or it
intentionally excluding them (Tormey and Haran 2003, p33). This research question examines the level of inclusion of these issues and how they are dealt with in Junior Cycle science.

5.4 Methodology
In order to analyse the research question this study examined the text materials for science education in Ireland. Discourse Analysis (DA) was chosen as the research method for this study due to its anti-realist orientation (Gill 2007, p172), and its ability to examine the ways in which versions of the world including society, events, and inner psychological worldviews are produced through discourse (Potter 1997, p146). DA was also chosen as it is in keeping with the philosophy of this study and so is a suitable method. DA, like all methods of text analysis, is an unobtrusive and indirect form of inquiry and is also non-reactive as the subject of analysis cannot alter their answer to tailor to the audience as it is unaware that it is being examined (Robson 1993, p272).

Along with the four features of discourse as outlined by Gill (2000 cited in Bryman 2008, p501), Foucault’s Archaeological method and the Silverman Analytic Induction technique were also pivotal in designing the research methodology. Foucault’s method allows discourse to be analysed as a system of representation (Hall 2001, p72), rather than examining texts and focusing on what is explicitly said. In this way DA is able to analyse meanings and to operate above the level of sentences. Another characteristic of the archaeological method is an abandonment of a normative perspective, or the idea that modern thought is advancing closer to the truth (McNay 1994, p54). As this assumption is a feature of the Enlightenment, challenging it allows problematise this premise and see how it affects discourse. The Silverman Analytic Induction technique consists of developing propositions and checking these against the text for counterfactual data (Silverman 1993, p160). This technique helps to counter some of the anecdotal criticisms which are levelled against qualitative research (Bryman 2008, p599).

The texts analysed in this study were the Irish Junior Certificate Syllabus (DES 2002), the Irish Junior Certificate Science Syllabus (DES 2002), The Teacher Guidelines (DES 2003), Three core science textbooks and their respective workbooks, the Higher and Ordinary Level Examination Papers (State Examinations Commission 2002-2010)
and a science revision textbook, Revise Wise (O’Callaghan et al. 2008). These texts were coded using a checklist adapted from a study examining the use of history in science education textbooks in Portugal (Leite 2002). This checklist was modified to code the texts for Western, Linear, Elitist, Political and Cultural material. Following the coding the results were examined and key themes were identified, this process is known as *Thematic Analysis*. Thematic Analysis favours the identification of key ideas or the generation of core themes, or *recurring motifs* which arise out of a detailed examination of the results and reading of the text materials (Bryman 2008, p554; Trochim 2001, p165). These themes became the points for discussion for the *Themes that emerged from the Discourse Analysis* chapter.

### 5.5 Summary of findings

The results were discussed based on three themes. These themes were *Western Influence on the discourse of science*, *Westernisation of Science and Loss of Culture* and *Science, Development and the Environment*. This discussion identified certain dominant features of the depiction of science and detailed the discourse presented in lower Post-Primary level in Ireland. Overall, the dominant discourse reflects many of the features identified by postmodern, postcolonial and eco-feminist scholars such as a mechanistic view of nature, a paternalistic discipline, the dominance of Eurocentric views and Enlightenment rationale. At times these links were explicit while there are implicit links made in many places.

The discourse of science presented in the course strongly favours a certain view of society and development. The course depicts industrialised countries centred on economic interests with high levels of production, consumption and technology as modern and ‘developed’. This type of society is depicted favourably and scientific ‘advancements’ are shown as the source of these advancements;

> Without chemistry we would have no colourful clothes to wear, no soap to keep us clean – or no deodorant or perfume or aftershave to help us smell nice! We would have no petrol, plastics, modern medicines, CDs, computers or mobile phones! In fact, life would be very dull without chemistry

(Dorgan et al. 2003, p3)
In this way science and society are closely tied to one another and Western views are established as the norm. The prominence of Enlightenment rationale can be seen in this treatment where society (through Modern Western Science) is shown to be as progressing or improving. As this progress is driven by science it depicted as unlimited. Not only is science seen as the driving force for progress, but knowledge of science and the associated skills, concepts and attitudes are seen as “essential for the responsibilities of citizenship in today’s world” (DES 2002, p3). This places scientific knowledge, and scientists, as central in decision making and political policies and also excludes those from outside the discourse of Modern Western Science from such discussions.

The position of Western society as superior to others is apparent in other places in the course. The presence of Modernisation Theory and support for the European Miracle serve to place other nations as ‘behind’ the West and place them as inferior. One example compared modern Third World countries to Ireland in the famine (1845-1847 [Casserly & Horgan 2003, p55]) while another cites the unavailability of water as a reason for widespread industrialisation not having occurred (Dorgan et al. 2003, p241). The absence of multicultural interests and contributions also serves to add to the superiority of the West. There are limited dealings with non-Western nations in the course, and where instances are found they represent an add-on approach to curriculum as it tries to simply integrate multicultural education into existing structures (Bryan 2008, p302; Tormey and O’Shea 2003, p4). While these instances do mention other countries and cultures they fail to offer alternative perspectives or multicultural science as they show the same science, except in different locales. A large number of instances which include non-Western people appear dealing with the unavailability of clean drinking water and disease;

There is clean water on tap in almost every house in Ireland, but in other parts of the world two million people die each year from drinking dirty tap water. Water can become contaminated with bacteria from sewage and cause diarrhoea and diseases such as typhoid and cholera. By 2015 the United Nations hopes to halve the number of people, 2.4 billion, who do not have access to clean water (Henley & Quirke 2003, p427). While the availability of drinkable water is a major concern and is identified as one of the Millennium Development Goals and Development (Borg and Johnston 2006, p215), the contrast of haves-and-have-nots here is typical of the depiction in the course where Western societies are celebrated and others are shown as ‘lacking’, ‘behind’ or ‘impoverished’. No allowances are made in the course for traditional societies and the goal of modernity is depicted as a universal;
When I go home from school I turn on my computer till about 5:30 p.m. and then I have dinner. After that I do my homework and watch TV or a DVD before going to bed. Fair enough, but what would happen if there were no electricity! You could not do any of these things except eat a cold dinner and do your homework by candlelight!

(Casserly & Horgan 2003, p213)

This is the vision of the ‘good life’ promoted by the discourse of science in Junior Cycle education.

The importance of scientific knowledge in decision making also raises another significant issue. The people who train in the discourse of Modern Western Science would be training in a Eurocentric, paternalistic, masculine discipline and would have technocentric views of the environment (Tormey 2006, p65). The second theme in the discussion showed how people within certain disciplines operate in a similar fashion and work according to a certain code of ethics and practices. In terms of Foucault’s power/knowledge the focus on certain methods of inquiry will only produce certain forms of knowledge. For Foucault systems of power give rise to different types of knowledge which in turn reinforces the domination of the original power formation (McNay 1994, p63). Harding (1998) states that following the standards set by physics will result in knowledge base on “discrete, isolated, short term, and ‘purely physical’ aspects of the world around us” (Harding 1998, p186). Becher and Trowler (2001) discuss culture and the effects it has on behaviour, especially in academic traditions. The prominence of scientists in the course can be linked to the idea of the heroes of the Academic Tribes and Traditions and the scientists here are afforded a special place. Even the famous scientists Einstein and Darwin are included in the textbooks, despite their work not being included on the course (Dorgan et al. 2003, p6 & p104; Henly & Quirke 2003, p225). While over seventy five scientists appear in the texts, only three of these are female, with only passing reference made to two of these. The course promotes a certain discourse of science and there is little contestation of this depiction or alternatives offered. This creates science as singular and again affords superiority to the West. The study of science could also be seen to create Westernisation as cultural norms and practices are transmitted during the study of science. This could cause cultural oppression as traditional values are challenged by the more powerful discourse of Modern Western Science (Aikenhead 1996).

The third part of the Themes that emerged from the Discourse Analysis chapter deals with the model of environmentalism promoted by the course. Eco-feminists such as Vandana Shiva describe the ways they see Modern Western Science causing violence to
the world (Shiva 2002). Part of their criticism arises from the subservient position of nature in Modern Western Science. The depiction in the course reflects this view, where man is seen to rule over nature, rather than be a part of it. Responsible citizens are called to act as caretakers for the environment (Henly & Quirke 2003, p375) and people are justified in using nature to serve their needs (Henly & Quirke 2003, p371). Practices such as deforestation to get timber (Henly & Quirke 2003, p371), pollution from industry (Henly & Quirke 2003, p503) and problems associated with waste disposal (Henly & Quirke 2003, p373) are not critiqued in themselves, and thus further the impression that modern practices are favourable. The advocacy in the texts of a non-ecological, pro-production and pro-consumption model of development is also in opposition of the feminist’s view of nature, where balance and diversity are the prized qualities.

Science is also shown as a self-regulating discourse as the problems caused by science are shown to be solved by newer or better science. Examples include preventing acid-rain (Henly & Quirke 2003, p504), the use of catalytic converters in cars and “clean fuel” (Casserly and Horgan 2003, p183). This treatment is consistent with the presentation of science in Primary school where the potentially adverse effects of science are discussed with the underlying phraseology that science is a positive influence on society, while it is the actions of humans which is questionable (Ó Conaill 2003, p58).

This section also explores some of the oppressions established by Modern Western Science. While the course discusses solutions that can be implemented to overcome some of the problems associated with industrialisation such as acid rain, eco-feminists see these problems as arising out of the basic assumptions of Modern Western Science and not due to misapplication of science. However, the depiction of science as singular and the omission and marginalisation of other interests establishes Modern Western Science as the only credible discipline. This results in Modern Western Science being employed to provide solutions for problems, which some interpret as arising out of Western interests, attitudes and values – such as environmental degradation and poverty;

Development proceeded by creating abnormalities (“the poor,” “the malnourished,” “the literate,” “pregnant women,” “the landless”) which it would then treat or reform. Seeking to eradicate all problems, it actually ended up multiplying them to infinity. Embodied in a multiplicity of practices institutions and structures, it had a profound effect on the Third World: social relations, ways of thinking, visions of the future are all indelibly marked and shaped by this ubiquitous operator.

(Escobar 1992, p25)
This approach to development reflects the mechanistic nature of Modern Western Science which breaks down systems into its individual parts in order to assess and attempt to understand them. This further enforces the idea that knowledge is bound to culture and that transmitting knowledge also transmits culture.

5.6 Recommendations for Curriculum
The examination of the texts showed that is dominated by Western interested and operates within a Western framework. Science is shown as a Western endeavour and the practitioners of science are mostly Westerners, with science being practiced in the West. The instances which deal with multiculturalism generally deal with difference between the West and non-West, and focus on the unavailability and lack of resources. References to other regions of the World are also found, and these instances show Modern Western Science in work in other regions. The depiction in the course of technological, industrialised and consumer-based societies as favourable creates traditional, manual and subsistence economies as inferior and undesirable. As regards curriculum, the course should offer a more nuanced account and should include more favourable dealings with other cultures. While issues such as pollution and other undesirable effects of modern lifestyle are discussed and dealt with, the role of social interests and decision making in influencing them are not. The depiction presents “this official, high-status knowledge as though it were ‘truth’ arisen from some immutable, infallible source” (Apple and Beane 2007, p15). They call for democratic curriculum where students learn to be critical readers of their society (Apple and Beane 2007, p15). Others call for teaching for social justice, and to address issues such as culture, tradition and development (Emdin 2011; Tormey and Haran 2003, p33). Furthermore, a change in treatment of topics in the course could promote discussion and awareness of not only social justice but also environmental sustainability and human rights (Bryan 2008, p56).

The inclusion of positive contributions to science and addressing issues from a non-Western perspective would also help student’s learning the subject discipline and improving their sense of identity. When science education is more in line with student’s own cultural background this reduces the need for cultural border crossing and cultural conflict as discussed by Aikenhead and Jegede (1999);
Cultural clashes between students’ life-worlds and the world of Western science challenge science educators who embrace science for all, and the clashes define an emerging priority for the 21st century: to develop culturally sensitive curricula and teaching methods that reduce the foreignness felt by students (Aikenhead and Jegede 1999, p269)

It would also reduce the portrayal of the West as superior and the ‘Other’ as inferior by bringing non-Western people and interests into the scientific milieu and not simply focused on Western issues and approached from Western perspectives. Sutherland (2002) believes that science curriculum is assimilative in its own right and favour the view that the Western perspective is the only legitimate way of viewing the natural world. This has the effect of delegitimizing indigenous knowledges and leads to barriers to learning. She points to research which shows the increase of achievement and attitudes towards science experienced by Native American students when culturally relevant materials are introduced to the classroom (Mathews and Smith 1994, cited in Sutherland 2002, p2).

The Exam Papers and the Revision Book showed that multicultural dimensions of education were not important factors in the assessment for the course. The emphasis on the terminal exam and the acquisition of ‘points’ to fulfil the criteria for University places is a driving force for the Irish educational system (Swan group, 2008). This establishes exam content as an important consideration for teachers. The focus on this content can serve to reduce what is learned to examination material with predictable learning outcomes giving way to ‘more detailed prescriptive outcomes’ (Long 2008, p25). This would further reduce the chances of the inclusion of in-depth multicultural education. Within the existing course, there is no external motivation to address these issues and in many ways they are excluded from the discourse itself.

5.7 Areas for Future Study
As this study is set in Ireland the Western attitudes and elements of the course would, to a large degree, be in keeping with the wider social views. Replicating this study in a non-Western education system would provide extremely interesting data and would allow for comparison between the systems. When science education was introduced into many Commonwealth countries the syllabi from Britain formed the basis of these programmes in West and Southern Africa, the Caribbean and South East Asia (Lewin 1992, p15). If
they exist in the same manner, the domination of Western worldviews would have very serious implications in these areas and could be the source of much cultural conflict.

Other studies could be taken to build upon this study. Studies which could give insight into science teacher’s views of science and the role of multicultural education in the classroom would be very interesting. Their level of knowledge, experience and competency of such issues would also be useful. As this study deals with representation and identity a study which would deal with student’s perceptions of science and their views on Westernisation, multicultural education and development could show how the depiction in the texts influences students.

5.8 Conclusions
While some view science as a value-free, objective and culturally-neutral discipline this study has highlighted the view, attitudes and perceptions that accompany this subject. For Pear's soap purposes of this study the term Modern Western Science was used to identify the form of science started during the Enlightenment. The criticisms of this form of knowledge production from postcolonial, postmodernists and feminists were largely found to be evident in the course materials and they are shown to contain elements which promote Western worldviews, development practices and societies. While much current debate centres on multicultural education and the increasing diversity in society the potential for Westernisation as a consequence of the design of curricula and education systems would appear to be an issue that needs more attention. The direction of policies taken by the Brundtland Commission, the ‘Earth Summit’ and Kyoto Protocol (Tormey 2006) as well as the drive towards ‘Sustainable Development’ (sustaining development itself) all show the power and influence held by Modern Western Science.
References:


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Appendix A: Checklist

Type and organisation of the information

— **Instances dealing with non-Western science**
  *Other ways of knowing discussed (instances of other forms of science and scientific methods mentioned)
  *Inclusion of alternate theories on phenomenon
  *Contributions made by other cultures to the modern scientific discourse
  *Inclusion of other leading theories (dominant theories from other countries/cultures are discussed)

— **Concerns and Justifications for doing science**
  *Type of concerns and justifications dealt with (society, economy, health, happiness)
  *Status and role of science (fundamental to, helpful, destructive, neutral)
  *How concerns are identified (chosen by society, linked in historical context, one man's creation)

— **History of science**
  *type of history
  • Mention to a scientific discovery (a discovery or historical idea is mentioned)
  • Description of a scientific discovery (the happening of a certain discovery is described)
  • Mention to discrete periods (two or more periods/discoveries are mentioned but not related)
  • Linear and straightforward (one period is related to the following, keeping the direction)
  • Real history (movement ‘back and forth’ between opinions, including controversies, etc.)
  *responsible people
  • Individual scientists (a scientist is shown as the only person working for the discovery)
  • Group of scientists (two or more known scientists worked together for the same purpose)
  • Scientific community (the scientists of the time are said to be responsible for the happening)

— **Scientists**
  *scientists’ life
  • Biographic data (at least name, and date of birth and death)
  • Personal characteristics (feelings, character, mood etc.)
  • Episodes/anecdotes (married to…, decapitated by…)
  *scientists’ characteristics
  • Famous/genius (intelligent, bright, the most important…)
  • Ordinary (fail exams, need to work in order to survive)

— **Instances depicting the subject discipline of science as elite/for all**
  *Characterisation of 'Scientific'
  • Identification of characteristics of practitioners (inquisitive, curious, meticulous)
• Certain profile of scientist promoted (mathematical, gifted, logical, genius)

*Content of the course
• Type of Learning Outcomes on the course (cognitive, psychomotor, affective)
• Focus of the texts (majority descriptive or discovery or facts and figures or theories)

*Breath and Balance
• Type of breath and balance offered
• Differences between Higher and Ordinary level courses
• Differences in assessment
• Allowances for different aptitudes
• Type of Assessment given (once off exam, continuous assessment, types of skills/knowledge examined, level of knowledge called for)
• Skills needed to be a ‘successful’ student (recall, understanding, manipulative skills, design skills, experimental skills)

— Instances dealing with the Political motivations and consequences of scientific concepts and technological devices
  *Factors which led to the development of concepts and devices are given
  *Scientific devices linked to societies needs and desires discussed
  *Material locating developments in Western context

— Instances dealing with the relationship between political and science
  *Political influences on scientific pursuits mentioned
  *Scientific developments linked to changes in society
  *Links between science, technology, advancement and economy given

— Instances dealing with contributions made to science by other cultures
  *Discussion of contributions made by other cultures
    • Scientists from other cultural backgrounds
    • Technology devices devised in other locales
    • Knowledge transfer and sharing between geographical regions
    • Discoveries made by other cultures
    • Theories/beliefs from other cultures/discourse of science

— Instances dealing with the interests of non-Western Cultures
  *sections dealing with scientific developments made by non-Western cultures
  *developments made identified as positive in line with the values of non-Western countries (not stereotypical) and not judged through Western norms
  *sections dealing with developments acknowledging how they apply to non-Western cultures

Materials used to present the information
— Scientists’ pictures
— Pictures from machines, laboratory, equipment, etc. (once used or discovered by past scientists)
— Original documents/texts (produced/written by the scientists themselves; they may be translated)
— Historical experiments (experiments once done or attributed to past scientists)
— Secondary sources (texts, models, drawings of equipment not done by scientists/textbook authors)
— Text by the textbook author(s) (essays on a topic/scientist; minimum biographic data are not a text)
— Other (e.g. stamps, poetry, paintings)

Contexts to which the information is related
— Scientific (information related to science and maths knowledge available and/or lacking)
— Technological information (related to the technology available and/or to its lack)
— Social (information related to the living conditions and acknowledge values of the time)
— Political (information related to the politics of the time)
  * positive political influences explained (political developments which aided scientific advancements are explained)
  * negative political influences explained (political policies which hindered scientific advancements are explained)
  * Issues dealing with the motivations for doing science (benefits, role in society, positive contributions)
  * influences of science on politics explained (instances where science impacted politics are explained)
— Religious (information related to the religious beliefs of the time)

Status of the content
— Role of the content in science teaching and learning
  * fundamental (content matter to be studies)
  * complementary (optional content, at least for some students)
— Target population
  * all students (when it has a fundamental status)
  * top students (when the authors say it has a complementary role)
  * volunteers (when the author consider it optional or put it in boxes apart from the main text)

Learning activities dealing with the dimensions of the study outlined (asking students to do more than just read)
— Status of the activities (deals with their role in the learning process)
  * compulsory (supposed to be done by all the students)
  * free (directed to volunteers)
— Level of the activities (has to do with purpose/difficulty)
  * normal (nothing is said about the purpose or difficulty level)
  * deepening (activities are said to promote further learning)
— Type of activity (relates to what has to be done to carry it out)
  * guided reading (consists of questions on a text)
  * bibliography search (asks to find information dealing with a theme of the study and write an essay)
  * analysing data dealing with a theme of the study (analyse the claims, values, approach and information contained in the text)
  * doing historical experiments (asks to repeat an experiment once done by a scientist)
  * other (e.g., memorising information)

Internal consistency of the texts
— Homogenous (same sort of information and way of integrating it throughout the chapters)
Heterogeneous (changes type and way of integrating information throughout the
chapters)
* a few organised chapters on the information
* a few chapters with organised sections on the information
* sections on the information of science, in some chapters
* some chapter sections including some references to the information
* chapters and/or chapter sections without information on the topics

Consistency in treatment across the texts

Consistency in treatment between the texts
* The texts give a similar treatment of the issues being examined (similar issues are addressed in a similar fashion)

Consistency in treatment between aims and objectives and learning outcomes
* The issues highlighted as important for study, especially by the syllabi and Teacher Guidelines are reflected in the delivery of the content (within the textbooks, sample teaching activities, syllabus learning outcomes, exam paper questions etc.)

The material is reinforced in multiple sections
* Issues are dealt with frequently and are not isolated in certain areas, or mention once
* Issues are of fundamental importance and not included as asides, notes or as anecdotes
* Links are drawn between areas throughout the course materials

(Adapted from Leite 2002, 344/345, alterations in italics)