A Case Study of the Development of Science, Technology and Innovation Policy at the Higher Education Level in Ghana

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I hereby declare that this thesis has not been and will not be submitted in whole or in part to another University for the award of any other degree

Signature

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Doctor of Education

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Summary

It has been nearly fifty-four years since Ghana nursed the dream of rapid social and economic development through science, technology and innovation. Ghana is yet to experience technological transformation to the level of other countries with which she was at par at the time of her independence. Gaps in understanding still remain in the Ghanaian experience in the development of Science, Technology and Innovation (STI) policy. As such, a radical reform of the systems to help in the restructuring and transforming the economy is still lacking. In 2010 the government of Ghana developed an STI policy. The aim of this policy is to address all sectors of the economy in order to achieve growth and economic transformation.

Analytically, the thesis takes a critical perspective to situate Ghana's socio-economic and political history in the discourses of the dependency theory framework and to examine how the STI policy at the higher education level in Ghana was formulated and how this had privileged different interests and what the implications are for the country.

Mindful of the gaps and historic policy flows, the study took advantage of the researcher's insider position as an education expert and experience as the government policy developer. With this position and experience, the researcher orientation from the perspectives of policy-makers in Ghana was qualitative research methodology that focused on a case study approach, documentary analysis linked to a critical discourse analysis, observations, semi-structured and informal interviews and the use of a research diary to collect field data. The field data collected for the empirical analysis were documentary data, interview transcripts, interview notes, observation data and field notes. In a constructivist analysis, the interpretive paradigm approach, the notion of triangulation and reflexivity helped not only to privilege the multiple perspectives but to also illuminate the complexity and differences among the participants and other data sources to improve the quality of the data analysis.

The research found that in Ghana's trajectory to modernity through education, the country was marginalised in technology by the advanced capitalist nations to produce low-skilled personnel to be exploited by corporations. Further, the government subcontracted the World Bank and UNCTAD to produce the 2010 STI policy to the neglect of its established institutions. This makes it difficult for the country to pursue an independent reflationary STI policy. Moreover, the documentary analysis of the policy revealed that the government of Ghana had focused mostly on basic education to the

detriment of higher education and STI policy to further marginalise the country in technology to produce a low-skilled Ghana to be exploited by corporations. The implication is Ghana to restructure the content of education to build a solid foundation for the development of the STI policy in the country.

The study, therefore, provides a solid critique of the country's economic policy and international commitments that perpetuate a dependent model of development to the neglect of STI policy in Ghana. In the wake of the new STI policy development paradigms, the study suggests the need for a shift in paradigm from poor interactive learning space to rich interactive learning space, an interactionist model approach underpinned by a rich interactive learning space as an analytical tool and a guide for STI policy formation in Ghana.

Acknowledgement

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List of Abbreviations and Acronyms

AERC   African Economic Research Consortium

AESOP   Annual Education Sector Operational Plan

AfDB   African Development Bank

ATPS   African Technology Policy Studies

COTVET   Council for Technical and Vocational Education and Training

CPP   Conventional People's Party

CSIR   Council of Scientific and Industrial Research

CSOs   Civil Society Organisations

DA   District Assembly

DACF   District Assembly Common Fund

DFID   Department for International Development

DSA   Debt Sustainability Analysis

EdSep   Ghana's Education Sector Project

EFA   Education For All

E-HIPC	Enhanced Highly Indebted Poor Country
EPDF	Education Programme Development Fund
ESAR	Education Sector Annual Review
EMIS	Education Management Information System
ERIC	Education Resources Information Centre
ESP	Education Strategic Plan
EU	European Union
FDI	Foreign Direct Investment
FPMU	Funds and Procurement Management Unit
FTI	Fast Track Initiatives
GATS	General Agreement of Trade in Services
GATT	General Agreement on Tariffs and Trade
GBDC	Ghana Book Development Council
GCM	Ghana Chamber of Mines
GDP	Gross Domestic Product
GES	Ghana Education Service
GETFund	Ghana Education Trust Fund
GIHOC	Ghana Industrial Holding Corporation
GIL	Ghana Institute of Languages
GLSS	Ghana Living Standard Surveys
GPEF	Global Partnership for Education Fund
GPRS	Ghana Poverty Reduction Strategy

GSGDA	Ghana Shared Growth and Development Agenda
HIPC	Highly Indebted Poor Country
ICT	Information, Communication and Technology
IDA	International Development Agency
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
KNUST	Kwame Nkrumah University of Science and Technology
LPA	Lagos Plan of Action
MDAs	Ministries, Departments, Agencies
MDBS	Multi-Donor Budget Support
MDG	Millennium Development Goal
MDRI	Multilateral Debt Relief Initiative
M&E	Monitoring and Evaluation
MEST	Ministry of Environment Science and Technology
MOE	Ministry of Education
NAPTEX	National Board for Professional and Technician Examination
NCTE	National Council for Tertiary Education
NDPC	National Development Planning Commission
NLC	National Liberation Council
MN	Methodological Notes
MNCs	Multinational Corporations
NFED	Non-Formal Education Division

NAB	National Accreditation Board
NPP	New Patriotic Party
NPV	Net Present Value
NGOs	Non-Governmental Organisations
NSS	National Service Secretariat
OAU	Organisation of African Unity
OECD	Organisation for Economic Co-operation and Development
PNDC	Provisional National Defence Council
PP	Progress Party
PSTA	Professional Science and Technology-Based Associations
R&D	Research and Development
SAP	Structural Adjustment Programme
SME	Small and Medium –Sized Enterprises
STEPRI	Science and Technology Policy Research Institute
STREFund	Science and Technology Research Endowment Fund
STI	Science, Technology and Innovation
TA	Technical Assistance
TAI	Technology Achievement Index
TALIF	Teaching and Learning Innovation Fund
TIMSS	Trends in Mathemtics and Science Study
TVET	Technical Vocational Education and Training
UBE	Universal Basic Education

UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNICEF	United Nations International Children's Fund
UNIDO	United Nations Industrial Development Organisations
UP	United Party
UPE	Universal Primary Education
USAID	United States Agency for International Development
WAEC	West African Examination Council
WASSCE	West Africa Senior Secondary Certificate Examination
WFP	World Food Programme
URC	University Rationalisation Committee
WTO	World Trade Organisation

Chapter One: Introduction

1.1 Introduction

This thesis is a case study of the development of Science, Technology and Innovation policy at the higher education level in Ghana. It is nearly fifty-four years that Ghana invested heavily in education, science, technology and innovation (STI) to develop and transform her economy. Yet, Ghana has not been transformed technologically as the countries in South East Asia even though the level of development of Ghana was at par with countries like Malaysia, India, South Korea and Singapore at independence in 1957 (NDPC, 2008; NDPC, 2010b). The aforementioned countries are now comparatively more technologically advanced than Ghana (MEST, 2010a). For example, 'South Korea has the unique experience of developing from one of the poorest countries in the world to one of the most economically advanced' (King, 2013, p. 148). Yet, Ghana is now among the most marginalised countries in technology (Gudyanga, 2011) and productivity (UNCTAD, 2011) with low and stagnant technology capability (UNCTAD, 2003). In terms of the marginalisation of the country in technology, Ghana had a very low technology achievement index, value added per agriculture worker and manufacturing value added per capita. An extra year of education in Ghana had produced low output per worker (UNCTAD, 2003; UNCTAD, 2011; Gudyanga, 2011).

This disparity in technology and productivity raises questions about Ghana's STI policies. The structure of Ghana's economy, with an over-reliance on primary products (such as, agriculture, timber, gold) and a large informal economy has also changed little with little value addition since independence (MEST, 2010a). Moreover, 'university graduates who actively searched for work six months after graduation but were unemployed' (Mason et al. 2009, p. 24) stood at 51 percent in 2008 (Government of Ghana, 2011a) with a third of polytechnic graduates remaining unemployed (Government of Ghana, 2010). Twenty years ago, the University Rationalisation Committee (URC) reported the upgrading of the polytechnics to meet middle level management requirements of the nation but employers still question the quality of polytechnic education in Ghana (Effah et al. 2010).

1.2 Rationale for the Study

In 2010 the Government of Ghana developed a National Science, Technology and Innovation Policy (STI) for implementation (MEST, 2010a). The STI policy addresses all sectors of the economy (MEST, 2010a) to drive the country's growth and economic transformation (NDPC, 2010a). The STI policy at the higher education level is to provide modern skills derived from investment in science, technology and innovation to drive the country's growth and transformation. The policy aimed not only at the proportion of corresponding age groups enrolled in higher education as science and technology students and their acquisition of knowledge as scientists, engineers and technologists but also their active involvement in the innovation processes and centres in the country and their interactions with the firms in the country to apply creatively what they have learnt to be more productive (Government of Ghana, 2011a; MEST, 2010a).

1.2.1 My Professional Responsibility

The development of this policy is linked to my professional responsibility and experience as the government policy developer. I also developed interest in this policy when I pursued a professional training in the development of policy at Korea Development Institute (KDP) in 2010; training programme in education and training for sustained growth in Africa in 2008; and education management and decentralisation training at the Centre for the study of International Cooperation in Education (CICE) at Hiroshima University in 2006. In these training programmes, the puzzle to me was that Ghana at Independence to some extent was at par with some of these South East Asian countries but now lagged behind. It was also difficult for me to understand that, in spite of the investment made in education in Ghana to transform the country technologically, the country still was comparatively developing slowly.

Between 2003 and 2005, I was the Strategic Planner for the Ghana Education Service (GES). From 2005-2012, I was the Head of Monitoring and Evaluation Unit of the Ministry of Education. I had problems with some of the policies that were developed by the Ministry of Education for the GES, the implementing agency for pre- tertiary education in Ghana. I therefore, developed interest in the processes involved in the

development of education policies; as explained by Budd et al., (2006), the development of a policy could affect implementation. My additional responsibility was a Coordinator of the development of the Education Strategic Plan (ESP 2010-2020) from 2008-2012. I worked with eighteen (18) implementing agencies in the education sector (provided in Appendix V), local and external consultants, interest groups, the government, donors, political parties, civil society organisations, think tank groups, opinion leaders and the media. In the process, I experienced the incoherence and complexities in the policy process as noted by Dunne et al. (2005) and Budd et al. (2006). In most cases, I used a participatory approach, lessons and experience sharing as key techniques to coordinate most of the activities.

In my previous assignments in the International Professional Doctorate in Education (EdD) programme at the University of Sussex, I have developed for engagement with multiple stakeholders in the development of educational policies. The experiences gained from this engagement have also positioned me very well to provide unique wealth of information and understanding of the development of the STI policy. In this experience, I noted again the complexity of the policy process and I developed interest in the case of STI policy at the higher education level in Ghana. My main professional and research interests therefore hinge on STI policy in Ghana.

1.3 Purpose of the Study and Research Questions

My aim in conducting a case study in the development of Science, Technology and Innovation policy at the higher education level in Ghana is to have an in-depth insight and understanding of the development of the policy in the Ghanaian context. To achieve this purpose, I chose to examine multiple understandings of the historical and political contingencies surrounding the development of the policy: how the policy was formulated, how this has privileged different interests and what the implications are for the country. To frame the study, I developed the following key research question with sub-questions:

1. How was the 2010 STI policy developed in Ghana, whose interests were privileged and why, and what are the outcomes and implications of the policy?

The sub-questions are as follows:

    1.1 What is the history of STI policy development in Ghana?

    1.2 What are the mechanisms through which STI policy is formulated?

    1.3 Whose interests prevail through these processes and whose are marginalised?

    1.4 What are the implications of this data for STI policy formation in Ghana?

1.4 Analytical Approach

From the perspective of policy-makers in Ghana, selected references were carefully scrutinised to identify and develop relevant theories that offer a good framework for the study. The Education Resources Information Centre (ERIC) and other databases including academic journal articles and other key International and Bilateral Agencies including the World Bank, UNESCO and DFID were accessed using Library Home page and the electronic library of the University of Sussex print and Google Scholar. Further, based on the available literature in Ghana from the Balme Library at the University of Ghana, Legon, Padmore Library, Accra, and the Documentation Centre at the Ministry of Education, Accra, the outcome of the theoretical approaches was contested with the contextual realities in Ghana to identify the theoretical space for further investigation.

Given Ghana's colonial history and its ongoing inter-relationships with the World Bank and range of bi-lateral donors, this study has used dependency theory framework to critically examine the Science, Technology and Innovation (STI) policy at the higher education level in Ghana. Against this background, the dependency theory thinking framework was used to critically analyse the limitations of the policy while a further set of research questions were chosen to critically analyse the dynamics of the current strategy in the development of the policy and its final shape.

1.5 Thesis Organisation

The thesis is organised into seven chapters. Chapter 2 will unpack the case of Ghana from the international debates on Enlightenment thought and aspirations to develop the theoretical framework to critically examine the Science, Technology and Innovation (STI) policy at the higher education level in Ghana. The theories that emerged from the literature review suggested to me that the assumptions under the dependency theory have greater explanatory power than the modernisation theory to guide the study. Chapter 2, therefore, focuses on the dependency theory as the theoretical framework to guide the study. Following this, is the methodological framework that models on how influences beyond the State come to influence the development of the STI policy at the higher education level in Ghana. The focus of chapter 3 is to develop a research approach to apply to the case of Ghana to critically examine the development of the Science, Technology and Innovation (STI) policy at the higher education level in Ghana. The complexity of the STI policy process and development suggest to me to use the qualitative approach to data collection. The field data collected for the empirical analysis are documentary data, interview transcripts, interview notes, observation data and field notes. The interpretive paradigm approach, the notion of triangulation and reflexivity were used not only to privilege the multiple perspectives but to also illuminate the complexity and differences among the participants and other data sources to improve the quality of the data analysis.

Chapters 4, 5 and 6 focus on empirical and data analysis. Chapter 4 tracks the historical perspectives of education and STI developments and the development of STI policy in Ghana in 2010. Chapter 5 tracks and analyses the mechanisms through which the STI policy is formulated while Chapter 6 critiques the interests which shaped the STI policy development in Ghana. The final stage of the research (Chapter 7) is the summary and conclusion. The focus is on the perspectives that have emerged from the empirical data and analysis. These perspectives have emerged as themes and categories to explain the development of the STI policy at the higher education level in Ghana. The perspectives also provide a claim of knowledge to add to the development of STI policy at the higher education level in Ghana and their practical implications to suggest an analytical tool and a guide for future STI policy formulation in Ghana.

Chapter Two: Background to STI Policy Debates and Discussions

2.1 Introduction

This chapter opens with depiction of modernisation theory and dependency theory. These theories are related to a wider philosophical framework associated with Enlightenment thought and epistemologies as well as the association of (positivist) scientific knowledge with assumptions that these will lead to progress (Lushaba, 2006). Against this background, this chapter sets out to discuss in detail the Enlightenment thought and aspirations, the new imperialism and modernisation theory. On modernisation theory, there are further discussions on education and the rates of return analysis as the main rationale for education investment. Further, there is a discussion on learning divide, STI policy and economic growth and development and the East Asia experiences in growth and development policies. This is followed with a detailed discussion on dependency theory. On dependency theory, the historical development of Africa and Ghana's experience from the perspective of dependency theory are explored. Finally, the chapter explores STI policy and how STI Policy is understood to work. Following these discussions, dependency theory is seen as a useful and appropriate theoretical framework to guide the study. The methodological framework is also built on Dale's mechanisms and categories of funding and ownership to structure and shape the analysis of the empirical data (Dale, 1999, 2005).

2.2 The Enlightenment Thought and Aspirations

The European project called the Enlightenment Thought started in the 15th century and reached its intensity in the 18th century (Lushaba, 2006). The claim is that this project promoted the industrial revolution, the philosophy of liberalism and development of science, public education and the extension of the Western powers and influence on other colonies (Smith, 1999). The modernist project promoted the establishment of colonies in the 18th and 19th centuries (Smith, 1999; Waite, 2012). Europe was an example for the world to emulate and develop and transform their economies. However, in this equation, the contextual realities in the colonies with different traditional values,

structures and cultural backgrounds appeared not to have been taken into consideration (Lushaba, 2006).

Further understanding of the modernisation concept according to Shahidullah (1977) was that the Third World societies can prevent underdevelopment if they become an integral part of the modern industrial societies, capitalistic systems of economies and pursue policies like that of the societies of Western Europe and North America. According to the author, this assertion was not based on any methodical evaluation of the system of capitalism. Modernisation was also linked with development aid (Matunhu, 2011). However, to the author, whatever form or order aid that had been given has had strings attached and had tended to benefit the Meteropolitan states more than the recipient countries (Africa). Theoretical insight of Ndi (2010) had also pointed out that aid given by Western countries and Multilateral Institutions to meet the real needs of the masses in Africa under the canopy of modernisation had shifted to the interests of the donors rather than the needs of the recipient countries. Therefore, to Ndi (2010) aid had been packaged to create dependency relations and the provision of aid to Africans had made millions become poorer.

Gold Coast/Ghana, for example had received all kinds of loans and grants such as the Highly Indebted Poor Country (HIPC) initiatives and other International Development Assistance Support, Multilateral Debt Relief Initiative (MDRI), Multi-Donor Budget Support (MDBS) and the United States funded Millennium Challenge Account programme among others (UNDP, 2010). Yet, Ghana is among the underdeveloped countries in the world. It is, therefore, suggestive to question the kind of loans/aid Gold Coast/Ghana had benefitted. To this effect, the theoretical insight of King (2013) suggests 'an ethical aid policy' for Africans to become 'self-reliant' and to have an 'independent economic development' (p.64). The questions, therefore, posed by Moyo and Gonye (2011) was: 'Is there really one trajectory to modernity?' 'If so why had the majority of African countries failed to catch up with Euro-America?' 'What and who are the change agents in society?' (p.89)

2.2.1 The New Imperialism

After the end of World War II, a new phase of development, the new imperialism, also emerged out of the Enlightenment thought and aspirations and development as modernity (Tikly, 2004). The author contended that the new imperialism had sought to bring on board the low-income countries and regimes previously under the older forms of European imperialism into a new regime of global governance. This, according to the author was done in the interests of the USA, its western allies and of global capitalism. Therefore, according to Tikly (2004), "imperialism" in a general sense means, the practice, theory and the attitude of a dominating metropolitan centre ruling in a distant territory. As such, it is a process distinct from colonialism, which is that settlements are implanted on a territory which is distant. To Waite (2012), 'imperialism as a policy, is the extension of country's power and influence through means such as establishing colonies or by military force' (p.162). Against this background, Foster (1965) had defined colonialism in Africa 'to involve the establishment of political hegemony over groups of people whose social structures and culture were radically different from that of the metropolitan power' (p.3). Hornby (2010) also defines colonialism the situation in which one powerful nation takes absolute political and social dominion over another country or countries while Waite (2012) rather defined colonialism as 'the practice by which one country acquires control over another, occupying it with settlers and exploiting it economically'(p.134). From these perspectives, Hornby (2010) had also defined independence as 'freedom from political control by other countries' (p.291) while Waite (2012) had defined independence as 'free from outside control or influence' (p.368).

Thinking through Tikly, Hornby and Waite suggests that the Enlightenment thought and aspirations and development as modernity provided the influence and powers in the form of 'neo-liberal theories and policies' (Dale & Robertson, 2002, p. 15) to the Western countries to exploit the Third World countries economically. It was also used as a vehicle to position the Third World countries as low-skilled countries to 'play a peripheral role' (Yeh, 1989, p. 4) not only by being primarily the supplier of raw materials and market for the manufactured goods of advanced capitalist societies; but also in all negotiations to be exploited by corporations (Dale & Robertson, 2002; Tikly, 2004; Islam, 2009; Matunhu, 2011).

2.3 The Modernisation Theory

Over the decades, modernisation theory and dependency theory had been two dominant theories that had focused on development and underdevelopment (Chicote, 1974). These theories, according to Lushaba (2006) have had their roots from the European Enlightenment project with the aims to helping Africans break away from traditional culture, styles or ideas that might not have helped them to develop and transform their economies. To this effect Yeh (1989, p.3) had explained the modernisation theory from the perspectives of the sociologists, psychologists, demographers, political scientists and economists. This had further pointed out the factors that had made the Third World Nations to be economically backward. According to the author, to the psychologists, their problem had been their 'low achievement motivation'. The demographers point to their 'population explosion'. The political scientists opined that the Third World Nations are underdeveloped because of their 'inefficient and corrupt bureaucracies' while the economists contend that it is due to their 'lack of productive investment'. The modernisation theory according to Dale (2005) is, therefore, understood as 'individual states following the path to growth, and adopting the values, that had been adopted by the developed nations' (p.126). Islam (2009) claims that in the colonial era, under the guise of modernity, modernisation or development in modernity, Africa was partitioned, disintegrated and exploited and their resources were used to develop Europe. Therefore, from the perspective of Tikly (2004) the concept 'development in modernity' (p. 173) had been used as a vehicle by the West to control the non-West.

To Islam (2009) the solution to take Third World countries out of poverty is large revenues from global taxes such as the 'Tobin Tax' to pay debt or fund development projects in these countries. Matunhu (2011) also contends that:

> The modernisation theory posits a deterministic reason which states that within the linear model of socio-economic development, changes are initiated externally. This premise places value on external aid and foreign powers to prescribe the route to Africa's development rather than placing value on Africans initiatives and creativity. Yet the theory had ignored the inhibiting conditionalities attached to such aid. This may suggest the hidden hand behind the Metropolitan States' application of the theory to Africa (Matunhu, 2011, p.68).

2.3.1 Education

Education had variably been the centre-stage of the Enlightenment thought and aspiration, the new imperialism and the modernisation theory (Smith, 1999; Dale & Robertson, 2002). The work of Theodore Schultz to develop the human capital theory through education in the 1960s and 1970s, further gave education the recognition, priority attention and focus. It became the World Bank and the Multinational development agencies vision of 'development' (Tikly, 2004). Attributes of education included the skills, values and attitudes it produced (World Bank, 1995; World Bank, 2008) to increase the human capital in the labour force and innovative capacity of the economy to drive and transform the economy (Hanushek and WoBmann, 2007).

In the context of education and human capital theory, Tikly (2004) contends that the rates of return analysis were used as the rationale for expenditure in education to prioritise primary education in Third World countries to reduce poverty. This understanding, according to the author, made the Multinational agencies to link the human capital theory and the rates of return analysis to the structural adjustment programmes and other disciplinary mechanisms such as poverty-conditional lending, poverty reduction strategies and international target setting as the vehicle to reduce poverty. The author, however, contends that 'the human capital theory was another means to institutionalise western education in the post-independence era' (p.190). The author, therefore, noted that the new imperialism through education, human capital and rates of return analysis were means to limit the capacity of low-income countries to determine their own education and STI agendas to be exploited by corporations (Tikly, 2004)

This notwithstanding, the understanding from the World Bank (1995) was that primary education was the largest single contributor to the economic growth rates of the high-performing Asian economies. Investment in physical capital was second, followed by secondary school enrollments and population growth. The rates of return analysis were achieved by comparing the cost and benefits to determine the yield in investing in a level of education (World Bank, 1995; Tikly, 2004).

2.3.1.1 The Rates of Return Analysis

Against this background, in the 1980s the rates of return analysis suggested that on public spending of education, basic education in general and primary education in particular should be given priority attention to reduce poverty in the Third World countries (Bennell, 1996; King and Palmer, 2006a). For this reason, priority attention was not given to holistic education in the Third World countries and Universal Primary Education (UPE) was made the priority target to be achieved to the neglect of technical, secondary and higher education (World Bank, 1995; Bennel, 1996; King and Palmer, 2006a). But further, user-chargers were introduced in higher education (World Bank, 1995). The understanding of the rates of return analysis as 'the main rationale for education investment' from the perspective of Bennell (1996, p.240) is that 'in economies where Universal Basic Education (UBE) has not been attained, rates of return are highest for primary Education, followed by secondary education and then higher education'. The analysis suggests that 'basic education should usually be given priority for public spending on education in those countries that are yet to achieve near-universal enrolment in basic education'. This policy of 'rates of return analysis' has had impact on economic and social effects on higher levels of education with regards to national development (Robertson et al. 2007). Bloom et al. (2006) to this effect pointed out that from 1975 to 1989 about seventeen (17) percent of the World Bank's worldwide education-sector spending was on higher education. But from 1995 to 1999, the proportion allotted to higher education declined to just seven (7) percent.

2.3.1.1.1 The Critical Weaknesses and Absences in the Rates of Return Analysis

There were, however, critical weaknesses and absences in the calculation of the rates of return analysis. This included selection of samples that were biased (Bennell, 1996) and data such as basic research in technology and development and transfer were also not included (World Bank, 1995). The labour markets were also heavily regulated to suggest that the earnings did not reflect marginal productivity (World Bank, 1995). Further, there were also gaps in the literature in using 'years of schooling to measure the links in education and economic growth to the neglect of the qualitative differences in knowledge' (Hanushek & Woβmann 2007, p.4). Moreover, there was the 'failure of the

measure to take into account the quality of education at different levels in different countries' (Green et al. 2007, p.17).

Against this background, other quantitative estimates for returns of education from the perspective of Palmer (2007a) rather contended that private returns to education were higher for higher levels of Education. Palmer, for instance, noted that, in Ghana, the returns of Education were lowest at Primary and highest at the post-basic level. The author further noted that Canagarajah and Porter (2003) using data from Ghana Living Standards Surveys (GLSS), GLSS 3 (1991/92) and GLSS 4 (1998/99) pointed to the importance of post-basic education as major determinants of welfare. Arocena & Sutz, (2000, 2001, 2003), therefore, contend that higher education in this era of globalisation had created a learning divide between the developed and underdeveloped countries. Tikly also wrote:

> The over-emphasis on Primary Education at the expense of other levels of Education removes the indigenous capacity for research and innovation which is centrally important if countries are to link education to indigenously determined future development (Tikly, 2004, p.190).

Rao & Jani also contends that:

> -----Primary Education attainment would not be sufficient for many countries to compete in the era of globalisation. The experience in Malaysia has revealed that offering Secondary and Higher Education has enabled its people to compete globally which eventually brought about the current economic growth (Rao & Jani, 2009, p.130)

2.3.2 The Learning Divide Concept

Accordingly, there is a learning divide when there is an access to education and opportunities are also created to apply creatively what have been learnt (Arocena & Sutz, 2000, 2003). Therefore, in a problem solving activity, the interactive learning space is rich when opportunities are created for the actors to apply creatively what they have learnt through education to exercise their respective skills, values and competencies (Arocena & Sutz, 2000, 2003). Rich Interactive Learning Space suggests that the interaction is devoid of control, manipulation or dependency relations. Further

opportunities are created for the actors to engineer more 'successful engagement with the global economy' (Green et al. 2007, p. xi). Successful engagement of a country with the global economy includes 'independent economic development' (King, 2013, p.13), 'export-led growth, income equality and peace' (Green et al., 2007, p.xi). Theoretical insight of Green et al. (2007), therefore, suggests that rich interactive learning space had contributed to make the East Asian countries to achieve successful engagement with the global economy. Ghana is yet to achieve this. To this effect, Arocena & Sutz (2002, 2003) suggest rich interactive learning space and interactionist model as an analytical tool and a guide for policy making.

2.3.2.1 The STI Policy and Economic Growth and Development

From the perspective of Enlightenment thought and aspirations, new imperialism, modernity and education, Arocena & Sutz (2003) further provide matrices of learning divide between the developed and underdeveloped countries. The matrices for the learning divide is 'a combination of the proportion of corresponding age groups enrolled in higher education (as an indicator of acquisition of knowledge), with the proportion of expenditures on research and development (R&D) on the gross domestic product or with the proportion of engineers and scientists engaged in industry (as indicators of the opportunity to apply creatively what has been learned)' (Arocena and Sutz, 2003, p. 177). A table constructed with these matrices resulted in a learning divide between the North and South with the developed countries grouped around the 'high-high' corner and the underdeveloped countries grouped in the 'low-low' corner, as shown in Figure 1. The understanding, therefore, is that in the South East Asian countries there had been wide spread of high skills in science, technology and innovation at the higher education level (Green et al. 2007) with the enabling environment to enhance the utilization and diffusion of these high skills (King and Palmer, 2006b). This had ensured not only a high proportion of engineering graduates but provision of opportunities to apply creatively what had been learnt (Arocena & Sutz, 2003). Latin America on the other hand had produced a lower output of engineers (Arocena and Sutz, 2003).

Figure 1: Learning Divide Based on Higher Education
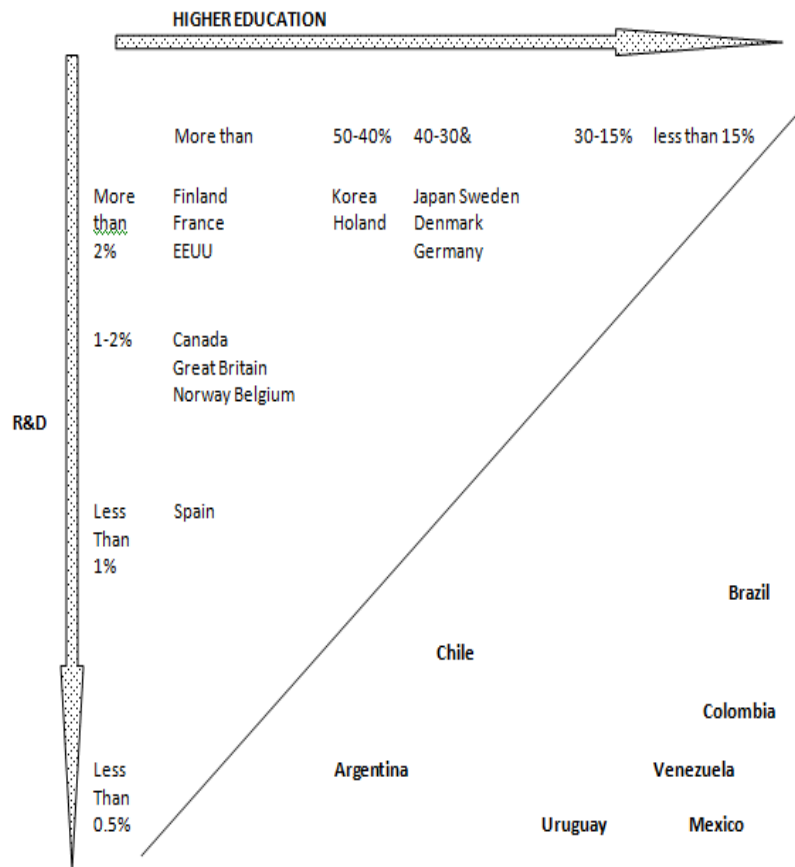
Source: Arocena & Sutz, (2003, p. 177)

2.3.2.1.1 The East Asian Experiences in Growth and Development Policies

The understanding that have emerged from the Enlightenment / modernisation theory and the learning divide concept is that the underdevelopment of the Third World countries can be explained by the underdevelopment and underutilization of skills, values, competencies and experience acquired through science, technology and innovation at the higher education level (Arocena & Sutz, 2000, 2001, 2003). Therefore, to the modernisation theorists the Western capitalist development model serves as a model for the underdeveloped countries to develop and transform their economies. Modernity, therefore, suggest one path to development. To the dependency theorists, the Third-World countries had been exploited economically to cause their underdevelopment (Yeh, 1989; Lushaba, 2006; Islam, 2009; Matunhu, 2011).

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Thus whereas the modernisation theorists may posit that education, science, technology and innovation to be the unique development in the East Asian countries, the dependency theorists rather contend that though education and science, technology, innovation played the expected role, underpinning the East Asian's success was their strategic location, culture and traditional values, unique contextual development model and experience, strategic trade policies, their development at a time international agreements allowed flexible trade and manpower planning approach (Green et al., 2007; Wade, 2008; World Bank, 2008).

For example, Green et al., (2007) contend that Japan and the four East Asian tigers-Hong Kong, South Korea, Singapore and Taiwan strategic location on major trading routes; as islands and peninsular states had historically contributed to their development as centres of entrepot. Further, the authors noted that during the 1950's when Japan became industrialised and the tiger economies also started industrialisation, the world trade was booming. Again trade agreements worldwide became relaxed and allowed flexible trade while Japan and tigers had in addition strategic trading policies. The authors, for example, pointed out that 'industrial policies were adopted in Japan, South Korea, Taiwan and Singapore which flouted neo-classical economic wisdom about letting markets determine investment decisions. These policies were substantially at variance with free-trade principles' (p.32).

Yeh (1989), however, noted that while 'Ghana and Latin American countries strictly followed the Washington Consensus or the global policy of liberal free market policy prescription, the East Asian tigers rather used a system of exchange rate and hidden subsidies to encourage exports and discourage imports' (p. 30). Wade for instance noted:

> The highly successful East Asian 'tigers' did not limit state policies to making market work more effectively; they used selective intervention extensively to steer markets and accelerate diversification and upgrading (Wade, 2008, p.17)

Ghana, on the other hand, opted for not only the Structural Adjustment Programme (SAP) in the 1980s but also the Enhanced Highly Indebted Poor Country Initiative (E-HIPC) in 2001 to reduce external debt and release resources to pursue poverty-reducing programmes (UNDP, 2010). However, while the World Bank (2008) contends that the shield and selective intervention policies in the East Asian 'ti*gers*' helped them to mirror and customise their education delivery and STI policies to economic development, the African Development Bank (2008) noted that the higher education system in most of the African countries on the one hand and STI on the other, operated in parallel, without much connection to each other and with little linkage with the productive sector, Ghana is not an exception. Wade (2008) had also pointed out to 'the case of Mongolia, a star pupil of the Washington Consensus that also experienced a collapsed industrial sector' (p.14).

Again at the vocational and higher education level in Singapore, manpower planning had been used to determine the country's skill needs every quota. Further, apart from Britain, 'the first industrializer' (p.17), Wade (2008) contends that it is difficult to point out any developed country that developed on the basis of free trade. Moreover, 'there is substantial body of evidence from the East Asian experience that protection and more active government promotion policies have historically been associated with good economic performance' (for example, Posco the Korean integrated steel Firm) (Wade, 2008). The World Bank in the early 1970s advised the Korean government on the grounds that Korea had no comparative advantage in steel (Wade, 2008). By 1987 the World Bank described Posco as 'arguably the world's most efficient producer of steel' (Wade, 2004a, 319 cited in Wade, 2008, p.19).

2.3.2.1.1.1 The East Asian Development Model

Against this background Green et al. (2007) research had revealed that the East Asian state developmentalism was driven by their culture: 'the need for survival'. This had been nurtured and developed to be the East Asians unique development model, 'a

nationalist project of self-affirmation of cultural and political identity in the world system' (p.34) and 'a political project of national survival' (p.44).

According to the authors, in the 1960s, Asia culture, for example, the 'Wa' had contributed to the loyalty, the harmony and the success exhibited in large enterprises, for example, the Toyota enterprise in Japan and other enterprises in the East Asia countries. King (2013) also contends that 'the core values of hard work, commitment and clarity about what should be prioritised, for example, for borrowing and adapting to Japan' also evolved from the Japanese values and belief in the ' Wakon Yosai-Japanese spirit' (p. 148).   Yeh (1989), therefore, posits that 'the East Asian development model was developed out of their cultural context to be a 'second case' of the capitalist modernity' (p.28). According to the author, the East Asian development model is, therefore, different from the well known Western model (Yeh, 1989).

2.4 The Dependency Theory

To my understanding, modernisation theory suggests that 'education is to play a key role to unlock the door to modernisation' (Robertson et al. 2007, p. xii & 19) with its 'trickle down' (Ferraro, 2008; p. 63) effects as posited by the traditional neoclassical model, 'an appendage of modernisation theory' (Ferraro, 2008, p.58). Interrogating these concepts and theoretical perspectives, suggest that 'growth in advanced countries would lead to growth in poorer countries' (Ferraro, 2008, p.63) with the development in the West as a model to guide the development of the poorer countries (Yeh, 1989). However, according to Ferraro (2008) studies by dependency theorists such as Prebisch and his colleagues in the late 1950s rather revealed that 'economic activity in the richer countries had often led to serious problems in the poorer countries. This to them was not 'predicted by the neoclassical theory' (p.58). Robertson et al. (2007) also contended that:

> Within the dependency theory research, an educational strand emerged which viewed educational structures and content rather as the means by which the centre (developed countries) exercised control over the periphery (less developed countries), reproducing the conditions for the centre survival and advancement (Robertson et al. 2007, p.20).

Robertson et al. (2007) further opined that the promotion of the modernisation theory in the poorer countries had meant the disappearance of their culture. In the 1960s the dependency theory, therefore, emerged out of this understanding, problems, challenges and contradictions in the modernisation theory. It is worthy, however, to note that in both the modernisation theory and the dependency theory the state was made to play a leading role in the development of the poorer countries. This notwithstanding, the dependency theory addressed the issues of imperialism and colonialism that modernisation theory had neglected (Robertson et al. 2007).

To the dependency theorists, the western advanced countries enslaved and exploited the colonies to develop (Yeh, 1989; Robertson et al. 2007). With this understanding, Yeh (1989) posited that:

> Third World nations remain economically backward not because they have traditionally values and institutions but because they are exploited by advanced capitalist nations (Yeh, 1989, p.3)

Ferraro (2008) rather had contended that while 'the Marxist theories had explained the reasons why imperialism had occurred, the dependency theories had further explained the consequences of imperialism' (p.62). To this effect, the dependency theorists draw a clear distinction between undeveloped and underdevelopment countries to suggest that an undeveloped simply refers to 'a condition in which resources are not being used. For example, the European colonists viewed the North American continent as an undeveloped area: the land was not actively cultivated on a scale consistent with its potentials. Underdevelopment refers to a situation in which resources are being actively used, but used in a way which benefits dominant states and not the poorer States in which the resources are found' (p. 63).

Further 'under the dependency framework, far greater attention is paid not only to measures of economic growth such as the GDP or trade indices but to indices such as life expectancy, literacy, infant mortality, education and the like. Dependency theory,

therefore, emphasizes social indicators far more than economic indicators' (Ferraro, 2008, p.64).

This study further draws a clear distinction between diffusion model and dependency model. Development through outside influence and assistance is defined as diffusion model while foreign penetration and exploitation as a consequence of underdevelopment is defined as the dependency model (Chicote, 1974; Ferraro, 2008). Therefore, from the perspective of Ferraro (2008), it is, however, a mistake for one to think that there could be only one unified theory of dependency. The core common characteristics of dependency theorists, however, led Sunkel (1969) to define dependency to explain Third World countries' poverty by external exploitation.

Against this background, the dependency theorists point out that the poor countries had been positioned through education, science, technology and innovation to play a 'peripheral role in all negotiations' (Yeh, 1989, p.4) and to also 'export their resources to the rich countries as primary products' (Matunhu, 2011, p. 67). The rich countries get the primary products and add value to them and export to the poor countries at a cost higher than the primary products. In this equation, the poor countries would always be in a deficit and would continue to be in a greater depth of underdevelopment (Ferraro, 2008; Matunhu, 2011). Ferraro (2008), therefore, suggests that the dependency States need to 'pursue policies of self-reliance' (p. 64).

From this understanding while the dependency theorists (Ferraro, Matunhu); the liberal reformers (Prebisch); the Marxists (Andre Gunder Frank); and the world systems theorists (Wallerstein) had pointed out that the poverty of the poorer countries were due to the capitalist exploitation of the poorer countries, export earnings, the traditional neoclassical theory rather suggests that if the less endowed countries acquired the knowledge and the skills in modern day economics, they would come out from that condition (Ferraro, 2008).

2.4.1 Historical Development of Africa

On the historical development of Africa, Matunhu (2011) noted that colonialism, imperialism and education had reduced the value of African culture to make Africa poorer. The author, for example, noted that before the introduction of the western education, Africans could use their indigenous knowledge to read and forecast weather and deal with crimes, deviance and conflicts including using different herbs to treat different ailments. Yet traditional medical practices were degraded by modernity and modern medical practice was promoted for Africans to lose their identity and development path (Matunhu, 2011).

According to the author, the failure of the 'IMF-imposed economic structural adjustment programme (ESAP), for example, was due to the total neglect of traditional values including the cultural, social and political of the recipient countries in the design and conceptualisation of the project. According to the author, it may now be the turn of the East to take away Africa resources such as oil and minerals. From these perspectives and understanding the author pointed out that:

> Africa is positioned to specialise in marketing raw materials while the developed world market the finished products. There is no convincing explanation as to why Africa is not manufacturing airplanes considering that the continent has aluminum and copper which can be alloyed for aircraft construction. However, it would be grossly unfair to think that Africa has always been a victim of external influence. On the contrary, African leaders have allowed developed countries to exploit it. By signing the World Trade Organisation (WTO) agreement in 1995, Africa has abdicated a lot of its power to map its way to development (Matunhu, 2011, p.69).

Uche (1994) also noted that:

> The technological and economic heights European have attained as well as the degree of political stability they now enjoy, credit is partly due to the Marshall Plan implemented by the United States for the reconstruction and rehabilitation of Europe after the World War II (WWII) in 1945. Africa participated in WWII. Africa was also a victim of the slave trade; traumatised by, and deprived of its raw materials, agricultural products and mineral results for the industrialisation of Europe. Yet it was denied its own fair share of the Marshall Plan for the development of the Continent. Africa, thus, joined the comity of nations handicapped, short-changed and cheated (Uche, 1994, p. 41)

Matunhu, (2011) accordingly, noted that Africa was not born into poverty but is man-made. Uche (1994), for example, pointed out to a memorandum purported to have been written in December 12, 1991 by Mr. Summers, Chief Economist of the World Bank. The memorandum suggested that the World Bank promotes dumping of unwanted industries from the industrialised world to the Less Developed Countries' (LDG). The author contends that Summers' memo suggests the hidden agenda of the World Bank, International Monetary Fund (IMF) and other similar institutions of the West to systematically constrain the development of Africa and the Third World (Uche, 1994).

Aryeetey (1992) to this effect noted the unfulfilled promises in Africa. Biney (2008) accordingly noted that the First President of Ghana, Dr. Kwame Nkrumah had attributed Africa's poverty to the corrupt ruling class in Africa and in partnership with the Western multinational corporations and Western leaders had siphoned Africa's wealth out of the continent. To Nkrumah Africa may be politically free but lacks genuine economic freedom.   Therefore, the dependency theory unlike the modernisation theory, had made it possible for me to look at development from the period of colonialism, imperialism, Pan-Africanism and the Neoliberalism. It suggests, therefore, to me, that the dependency theory had greater explanatory power for my study. The common assumption that had emerged from the understanding of the dependency theory is that:

- The relationship between policy and practice is not linear, mechanistic and deterministic as posited by the modernisation theory;

Further underdevelopment is not an original condition but is the result of the penetration of the Western capitalist system in the underdeveloped countries. There is, therefore, no one trajectory to modernity as posited by the modernisation theory and that the dependency States should attempt to pursue policies that put them on the road to self-reliance and independent economic development (Uche, 1994; King, 2013).

2.4.1.1 Ghana's Experience from the Perspective of the Dependency Theory

Therefore, according to the dependency theory it is not Ghana's traditional values, structures and institutions that had made Ghana to be economically backward. Rather the advanced capitalist nations had economically exploited Ghana to the extent of continuous reliance on products or commodities such as cocoa, gold and now oil that continue to face problems on contracts and payments of royalties as well as the volatility and unpredictability of price (Yeh, 1989; Aryeetey, 1992). This trend of development in Ghana from the perspective of the dependency theory is further situated in the historical and cultural context of the country which is further situated in the discourses of external exploitation and ideology of the country.

2.4.1.1.1 External Exploitation of Gold Coast / Ghana

For example, Uche (1994) contends that 'the former name Gold Coast is not only suggestive but also reminiscent of the height of the state of the ecstasy of the Europeans in their exploitation and looting of Ghana's gold for the development of Europe' (p.41). The author noted that at 'Independence in 1957, Gold Coast/Ghana produced 10% of the World Gold' (Uche, 1994, p.47). Khapoya also noted that there is a saying that has been repeated quite often which to the author carries some truth:

> When Europeans came to Africa, they had the Bible and the black African had the land. They gave the Bible to the black African and told him to hold it in his hand, close his eyes, and pray. When the black African opened his eyes, he had the Bible and the European had his land (Khapoya, 1994, p.116)

2.4.1.1.2 European Colonialisation and Chattel Slavery

According to Khapoya (1994) the European colonialisation in the 1990s took millions of Africans as slaves to work in the Americas. This according to the author disrupted Africa's initiatives and creativity to create wealth for their countries. Afford accordingly pointed out to the 11 million slaves that were exported to the new world and twice of that number that had died in the high seas.

Thompson (2002) to this effect noted that:

> The Portuguese came with Christianity in 1471. Yet, it took another three
> hundred and fifty years before Christianity actually succeeded in Ghana. The
> Europeans were making fortunes from the sale of human beings and this took
> precedence over the saving of one's soul. It was, therefore, not that the British
> had suddenly realised how inhumane chattel slavery was at that time but there
> was a shift in demand from labour to raw materials in the Western world
> (Thompson, 2002, p, 5)

To Ayensu (2006) the slavery and its oppression also had effect on the imaginative
thinking and prosperity and the development of science, technology and innovation in
Gold Coast/ Ghana.

2.4.1.1. 3The Indoctrination of Ghanaian

Further, it is understood that before the contact with Europeans the natives used water
as 'mirror'; and 'kyenkyen' (the bark of a tree), as cloth. 'By and By' the typical
Ghanaian began to do away with traditional beliefs and practices. Within the context of
tradition, they even came to accept that the gods of the land preferred Dutch schnapps to
locally produced gin. To date, Dutch schnapps is used to perform most traditional rites.
The native gin called 'akpeteshie' and palm wine called 'nsa fufuo'; both of which are
manufactured locally from the palm tree, had been relegated to the background.
Intuitively, it seems to me that this trend of affairs from the pre-colonial and colonial
era could continue to affect the psyche of the people in Ghana.

For example, the indoctrination of our forefathers and even educated Ghanaians from
the pre-colonial to colonial era has created the philosophy that everything from the
white man is good. This led to the perception that white men were closer to God.
Quoting, an adage:

> When you are going to church to worship God and you meet White man on the
> way return home because you have seen your God who will provide you with all
> your needs (Thompson, 2002, p.17)

In the current globalisation and imperialism era, most Ghanaians still prefer anything that is imported to home – produced items irrespective of the quality or how it impacts on the economy (MEST, 2010a, 2010b). The preferences span from knowledge to technology (MEST, 2010a, 2010b). This makes it difficult for local industries to survive (NDPC, 2010a, 2010b, 2010c; MEST, 2010a, 2010b) to enhance the development of STI policy at the higher education level in Ghana (MEST, 2010a).

2.4.1.1.4 Childhood Memories

I can, for instance, recollect my childhood stories of how Christianity was introduced in the country by the 'Whiteman' from the West and at the same time exchanging ammunition, guns for gold and alongside human trafficking to the western land. Thus, history also has it that the Ashantis, highly developed artistic craftsmanship, fiercely resisted the colonialisation of the country and in the process, King Prempeh I, the King of the Ashanti Empire, was taken to Seyschelles Island. An attempt was also made to take the original 'Golden Stool' of the Ashantis from them.

But when all the men in Ashanti were chased into the bush, a woman called, Yaa Ashantewaa, the queen mother of Ejisu in the Ashanti region stood up and fought fiercely with other women to defend the Ashanti Golden Stool (McWilliam and Kwamena-Poh, 1975).

The question that keeps on agitating my mind is, "why did the 'Whiteman' want to take the Ashantis' Golden Stool' away?" Not any other stool but the one with gold which was also the embodiment of the Ashantis' soul. These stories kept agitating my mind, even at a tender age, until I read from Sifuna (2001) that 'colonialism was not a developmental process but a mechanism of exploitation' (p. 21) to create and put Ghana in a dependency relation (Sifuna, 2001).

2.4.1.1.5 The Ideology of the Country

Table I, therefore, tracks the ideology of the country from 1842 to 2012. Table 1 suggests that the forty-six years (1966-2012) after Ghana had nursed the dream of rapid social and economic development through science, technology and innovation (STI) had been controlled by the Bretton Woods.

The table depicts that in the Ghanaian context the State is rather aligned ideologically to the Bretton Woods instead of the Bretton Woods aligning to the State to help it in its development agenda. For example, Table 1 points out that Dr. Kwame Nkrumah's government (1957-1966) was socialism imbued with Africanisation of the economy while Professor Kofi Abrefa Busia who ruled from 1969-72 practiced the capitalist ideology. Dr. Hilla Limann's government from 1979-81 was an offshoot of Nkrumah's party and sympathetic to Nkrumah's socialist ideals. But Bretton Woods' institutions rather forced the government to shift from the socialist ideals to the capitalist principle. Mr. John Agyekum Kuffour's government from 2001-2008 on the other hand followed the model of capitalism. The development plans, however, were strictly initiated as condition for IMF-World Bank support. Professor John Evans Atta Mills and John Dramani Mahama's 'government from 2009-2012 shares socialist ideals but in reality it was under the strong influence of the Bretton Woods.

Table 1 also depicts that within a period of fifteen years, four Coup d'états also intermittently spanned Ghana's democratic dispensation from 1966 to 1981. These are the Kotoka/Afrifa Coup d'état (1966-69); Akyeampong Coup d'état (1972-78); Rawlings Coup d'état, 1979; and again, Rawlings Coup d'état (1981-1992), still the country's ideological position was controlled by the Bretton Woods. The ideology defined as organised collection of ideas (Kvale & Brinkmann, 2009) suggests that the ideological positioning of Ghana would necessarily determine what its STI policy at the higher education level should be. Against this background theoretical insight of King (2013) suggests that 'ideological and cultural fields are the focal areas or locus of the West long-term infiltration in Africa' (p.195).

Table 1: A Track of Ideology in Ghana

Era	Regime	Kind of Rule	Ideology
Pre-colonial and colonial period (1842-1950)	Portuguese, Dutch, Danish and British Rule	Colonial rule	Capitalism
Independence era	Nkrumah's government (1957-1966)	Democratic Rule	Socialism imbued with Africanisation of the economy
Post-Independence era	Kotoka/Afrifa government, 1966-69	Coup/Military	Capitalism
	Busia government, 1969-72	Democratic Rule	Capitalism
	Akyeampong government, 1972-78	Coup / Military	Sympathetic to socialist and africanisation principles of Kwame Nkrumah
	Rawlings government, 1979	Coup/ Military	Coup to stop Military intervention of the governance of the country. No ideology in mind
	Limann's government, 1979-81	Democratic Rule	It is an offshoot of Nkrumah's party. Sympathetic to Nkrumah's socialist' ideals though Bretton Wood institutions forced them to shift from socialist ideals to capitalist principles
	Rawlings government (1981-1992)	Coup/ Military	Capitalist and under the guise of privatization sold the state enterprises
	Rawlings government (1992-2000)	Democratic Rule	Inclination towards socialist ideals but in reality practised Bretton Wood ideals
	Kufour government (2001-2008)	Democratic Rule	Model of capitalism and confidence in the private sector as the engine of growth.
	Mills government (2009 to date)	Democratic Rule	Socialist ideals but in reality under the strong influence of the Bretton Woods.

Source: (McWilliam & Kwamena-poh, 1975; Aryeetey, 1992; Appiah-Kubi, 2008; The Author's Field Data, 2013)

2.5 The STI Policy

2.5.1 Introduction

This section discusses the framework in the first, second and third generations that have followed the Enlightenment thought and aspirations to address the question on how policy is understood to work to further guide the study.

2.5.2 Conceptual Frameworks developed (1945-2005)

Eight conceptual frameworks have been developed for policy purposes in the study of science, technology and innovation over the years (1945-2005). Science policy is also about sixty years old. In the 1960s, the Organisation for Economic Co-operation and Development (OECD) also started to publish policy documents. This had impacted on member countries (Godin, 2009).

According to Godin (2009) the linear model of innovation had been one of the first conceptual frameworks developed for understanding science, technology and innovation and its relation to the economy. The author posits that this model postulates that innovation starts with basic research, then adds applied research and development and ends with production and diffusion:

Basic research ⟶   Applied research ⟶ Development ⟶ (Production and)
  ⟶   Diffusion

As a consequence, science policies had carried a linear conception of innovation for many decades. According to Godin the precise source of the linear model of innovation had not been clearly defined and documented. Several authors who have used, improved or criticised the model in the last fifty years have rarely acknowledged or cited any original source. In the 1960s the academics had also subjected the linearity of the model to criticisms. The criticisms of the lineal model of innovation notwithstanding, there are other STI frameworks that had informed the development of the STI policy. These

included the national innovation systems, knowledge-based economy, information economy and globalisation (Godin, 2009).

Recent developments since 1980 also included academic entrepreneurship (Yusof et al. 1969) at the university level in the developed countries (Rothaermel et al. 2007). On academic entrepreneurship, theoretical insight of Rothaermel et al. (2007) also suggests to ask whether the universities would be able to accommodate a third vision of 'enterprise development' (p.19) on top of primary roles of Education and intellectual discovery?

2.5.3 How STI Policy is understood to Work

Questions have also been raised on how STI policy is understood to work. These questions had informed the analysis of STI policy and the understanding of the relationship between policy and practice. Godin (2009), for example, opined that gone are the days when the analysis of STI policy was based on rational choice and instrumental rationality as well as the study of policy cycles:

Agenda→Setting →Policy Formulation→ Adoption → Implementation →Evaluation

From the perspective of Godin (2009), policy –makers had constructed their problem through conceptual frameworks that had structured policy action. Generally, the author contends that a frame constructs the situation, defines what is problematic about it, and suggests what courses of action are appropriate. Yet this STI framework has methodological challenges. For instance, the national innovation system is seen to have had too little operational value and difficult to implement. The framework had emphasised the relationships between government, university and industry and their environment as the 'cause' that had explained the performance of innovation systems.

The concept of knowledge-based economy suggests that we examine (measure) the production, diffusion and the use of knowledge. Knowledge in all forms according to the author is tangible, intangible, formal and tacit. Further, the author posits that in reality, the concept of knowledge is also not clear. These three dimensions in practice

are very difficult to measure. A look at the statistics collected in measuring the concept is a witness to this fact. Existing statistics are simply shifted to new categories (Godin, 2009).

The information economy or information society is one of the key concepts that emerged in the 1960s-70s to explain structural changes in the modern economy. It has given rise to many theories on society, conceptual frameworks for policy and statistics for measurement. The story behind the framework suggests that information, particularly information and communication technologies (ICT), is the main driver of growth. With time, the concept evolved from an understanding of information as knowledge, to information as commodity or industrial activity, then information as technology. Like knowledge, information is a difficult concept. For example, it took three decades to develop a methodological manual or guide for measuring the information economy at the OECD (Godin, 2009).

On globalisation the problem is the fuzziness of the concept and inadequacy of indicators. Globalisation is a term or label assigned to the growth of internationalisation. To its new forms it measures trade, flows of direct investments and technology. With regard to technology, three sets of indicators were suggested: Research and Development (R&D), technological balance of payments and high technology (Godin, 2009). To date the OECD has made very few uses of its new statistics on globalisation (Godin, 2009). Tikly (2001) also points out that the term globalisation lacks precise definition and it is difficult to assess the usefulness of the concept.

Therefore, as explained by Blackmore and Lauder (2011), the relationship between policy and practice is not deterministic, linear and mechanistic as posited by the modernisation/Enlightenment theory. Policies do not follow rational or technocratic models to work. To Parsons & Mary (2002) human organisations are complex system and do not operate in a mechanistic way. For any one problem, Parsons & Mary

(2002) contend that there are a multiplicity of incompatible perspectives and solutions and a vast array of different local conditions and forms of knowledge. According to Parsons & Mary (2002), knowledge in STI is inherent in interactions between people. It is the products of relationship, not something discrete, locked away in individual heads.

According to Blackmore and Lauder (2011) 'the rational or technocratic models have dominated with quantitative analysis such as large scale statistical models because of its perceived generalisability and a belief that 'hard quantifiable data' has greater validity than what is perceived as 'anecdotal' case study or qualitative research' (p.190). The complexity of the STI problem, however, suggests an in-depth qualitative analysis to explain the STI policy (Blackmore and Lauder, 2011). To Flyvbjerg (2006), human activity is situated in local contexts of practice. Context-dependent knowledge is more valuable than a vain search for universal predictive knowledge. 'In postmodern epistemology', Kvale and Brinkmann (2009) contend that 'there is a shift from individual mind to relations between persons' (p. 53). Therefore, from the perspective of Blackmore and Lauder (2011), the new approach highlights the importance of theorising STI policy making in terms of local/global relations.

2.6 Theoretical Gap

The theories that have emerged from the Enlightenment thought and aspirations suggest to me that the assumptions under the dependency theory have greater explanatory power than the modernisation theory. I, therefore, think the dependency theory is a useful and appropriate theoretical framework to guide my study. From the perspective of the dependency theory seen as a useful and appropriate theoretical framework to guide this study; it appears in the Ghanaian context that little analytical work has been done on STI policies in Ghana which may lead to the growth and development of the country. This study in the Ghanaian context: a case study of the development of Science, Technology and Innovation policy at the higher education level in Ghana fills this yawning gap. Therefore, with the development of an STI policy in Ghana for implementation, the question is: Who is promoting what type of STI policy in Ghana?

2.7 The Methodological Framework

2.7.1 Introduction

The main theme that has emerged from the literature review is development theories and discourses, in the concept of modernity. From the perspective of the dependency theory that guides this study, the application of the development theories and discourses in the concept of modernity through education in Third World Countries has aimed at low- skilled Third World countries to be exploited by corporations (Woolman, 2001; Tikly, 2004; Lushaba, 2006; Matunhu, 2011). This makes the development of STI policy in Third World countries very complex.

The methodological framework in Figure 2, therefore, builds on Dale's work to model how influences beyond the national come to influence national policies on education, science, technology and innovation (Dale, 1999, 2005). The methodological framework aims at unpacking the case of Ghana from the International debates and discussions on the development of STI policy at the higher education level. From this perspective the concept of modernity, the Ghanaian context, mechanisms, educational governance and the actors are discussed to inform the development of the methodological framework.

2.7.2 The Concept of Modernity.

The literature review posits that development theories and discourses that emerged from the Enlightenment thought and aspirations from the understanding of the concept of modernity are the new imperialism after the end of World War II, modernisation theory in the 1950s, human capital theory in the 1960s and 1970s, rates of return analysis in the 1980s and finally the concept of learning divide through education, science, technology and innovation. In this development theories and discourses it is understood that the Third World nations could through education, science, technology and innovation adapt the developed nations' models to develop (Dale, 2005). However, this recognition of the 'processes of diffusion' (p.121), notwithstanding, it is also a fact that the nature of

education nationwide has been undermined by the new supranational forms of education (Dale, 2005).

In spite of the impact that some developed nations' models had been made on the Third World nations, in the global capitalism most of the regional groupings had also sought to protect their interest by the changing global economic circumstances. This also has had some detrimental effects on the Third World nations (Dale, 2005). In Europe, America and Asia the groupings include European Union (EU), the North American Free Trade Agreement (NAFTA) and the Asia Pacific Economic Cooperation (APEC) respectively (Dale 1999, 2005; Dale and Robertson, 2002). These global challenges and interests notwithstanding, 'education for Asia literacy' (p.118) was introduced globally as policy by Australia, Canada, New Zealand and the USA (Dale, 2005). Yet the East Asian countries rather chose to follow their own unique contextual development policy. China also followed its own unique contextual models and policies (Dale, 2005).

2.7.3 The Ghanaian Context

In the Ghanaian context, the country had acknowledged the influence of the global policies, international target setting and other policy mechanisms on the national policies. Yet, there is little analytical work on them before they are incorporated, copied, adopted or adapted into the national policy framework. Many of the debates on these mechanisms have also been somewhat confused and poorly informed. Therefore, from the perspective of Dale (1999) 'while it is widely acknowledged that globalisation does affect national policies in a range of areas, precisely how is rarely questioned, let alone analysed' (p. 2).

To this effect, 'a policy study framework that might be useful in disentangling how some of the STI policies have been developed' (p.22) is suggested by Lall (2007). It suggests asking: what are the precise mechanisms through which global dynamics affect Ghana's education, science, technology and innovation policies?

This study builds on Roger Dale's analysis as depicted in Figure 2, Section 2.7.5. The framework offers a structure through which policy development and implementation can be explored at different levels. The framework models how mechanisms beyond the control of the state have come to influence the country policies on education, science, technology and innovation and how a policy from the North becomes a policy in the South and its effect thereof (Dale, 1999, 2005).

2.7.4 The Mechanisms

The mechanisms through which education and STI policy are formulated are categorised into traditional models and those associated with globalisation.

2.7.4.1 The Traditional Models

Externally, two traditional mechanisms that had been used to transfer policies from the supranational to national had been 'borrowing' and 'policy learning'. In both policy borrowing and learning there is an understanding between the supranational and the national that the policies in question may work without any conflicting interests and the locus of assessing the relevant of the policies or how successfully the policy may work is at the national level. The recipients initiate the process of borrowing or learning to imitate, emulate or copy 'bilaterally' from another country. For example, many countries have shown interests in borrowing or learning from the German apprenticeship. Another clear example of 'borrowing' and 'policy learning' is the transfer or emulation of practices recognised as successful, for instance, the case of the 'tiger' economies (Dale, 1999).

However, a very clear distinction between policy borrowing and policy learning is that the latter is very complex. Policy learning takes place in almost at all the levels of policy transfer mechanisms: either at the supranational, national, organisation, programme or policy level. From the perspective of Keynesianism, ' on policy learning

there is a higher level of 'voluntarism' on the part of the recipient country to initiate the change to get the policy from the supranational level' (Dale, 1999, p.10).

To this effect theoretical insight of Lall (2007) had drawn attention to the loss of 'Keynesian Capacity' (Dale, 1999, p.10): 'the loss of the ability of countries to pursue independent reflationary policies due to the activities of Multinational Corporations (MNCs), international organisations such as the United Nations (UN), the World Bank and other countries from which policies are being borrowed in order to help reform national education systems' (Lall, 2007, p.2).

2.7.4.2 The Globalisation Models

In the globalisation mechanisms the locus of the relevance of the policy and success in the policy process is primarily considered at the supranational level rather than at the national level (Dale, 1999). Blackmore and Lauder (2011) however, opined that policies that are formulated by the multinational agencies in New York or Washington may not be suitable in promoting the solution to domestic problems in other countries. This notwithstanding Dale (1999) pointed out that:

> The central point about globalisation mechanisms is the diminution of the nation state as the ultimate locus of viability over range of policies. The change expected in the country as a result of the investment in that policy is initiated outside the recipient country. Thus globalisation mechanisms assumes that the viability test of policy is carried out at a supranational level and that policies have to demonstrate their compatibility with the supranational expectations (Dale, 1999, p. 10)

On globalisation mechanisms this study focuses on harmonisation, dissemination, standardisation, installing interdependence and imposition. In the harmonisation process there are collective agreements by the member nations to cede and pool some of their national policy making capacity to the regional organisations. The harmonisation mechanisms had drawn experiences from the European Union model. The compatibility and the viability of the policy in question are determined at the supranational level rather than the national level (Dale, 1999).

In dissemination mechanisms, international indicators are provided at the supranational level to set the agenda, goals, process of the policy and the future of the policy in question. Clear examples are the OECD international indicators and the EFA/MDG goals by 2015. The policy goals are set at the supranational level. Yet the nationals are expected to achieve the target and goals. Further, the compatibility and the viability of the policy in question are determined at the supranational level rather than the national level (Dale, 1999). In the standardisation mechanisms, the targets and goals are set to depict 'defining characteristics of modernity' (p.14).

The understanding is that a national achieving the targets and goals set at the supranational level make the national to be recognised in the comity of modern state. Yet achieving the targets and goals may not necessarily bring benefits, in particular to the smaller and poorer countries. Further, underneath the standardisation mechanisms, it is worthy to note that in order for the nationals to meet the target set and achieve their goals, they are also pressurised by imposing costs and violation on them (Dale, 1999). The compatibility and the viability of the policy in question are also determined at the supranational level rather than the national level (Dale, 1999).

The installing interdependence mechanisms focus is on 'global civil society' in particular the non-governmental organisations (NGOs). This is to achieve concern for issues such as environmental, human rights and peace and poverty reduction that go beyond the capacity of any nation state. Therefore, the focus is on policy goals. It operates from the 'bottom up'. One of the crucial features of this mechanism is that it has no effective locus of viability (Dale, 1999).

'Imposition' is the final mechanisms. It does not need 'learning, persuasion or cooperation to initiate the desired change'. It also 'compels recipient countries to take on particular policies' (p.15). A clear example is the structural adjustment programme.

The viability of the policy in question is also determined at the supranational level rather than the national level (Dale, 1999).

It is, however, worthy to note that this is not to suggest that the globalisation mechanisms had eliminated the traditional mechanisms. The traditional mechanisms rather may be shaped by the globalisation mechanisms (Dale, 1999). The various globalisation mechanisms discussed may also be linked with installing interdependence mechanisms to achieve policy outcomes (Dale, 1999; Thompson, 2002; Government of Ghana, 2011a).

The framework in Figure 2, therefore, presents the key mechanisms through which the STI policy at the higher education level in Ghana was 'formed, shaped and directed' (Dale, 1999, p.1).

Figure 2: The Methodological Framework

	Mechanisms					
Actors	Traditional Mechanisms		Globalisation Mechanisms			
	Borrowing	Learning	Harmonisation,	Dissemination,	Standardisation	Imposition
Supranational						
National						
Sub national						

Institutions of Co-ordination	Governance	Activities				
	Funding		Provision	Ownership	Regulation	
State						
Market						
Community						
Family						

Source: Derived from Dale (1999, p.6) and Dale (2005, p.132)

2.7.5 Educational Governance

The framework in Figure 2 further shows that the activities or functions of education governance can be divided into four categories namely funding, provision, ownership and regulation. These activities or functions are not mutually exclusive. It is also important to note that these activities are not necessarily carried out by only the state or any other single agency. Rather, they may be carried out by the state, market, community and household (Dale, 2005). This according to the author is what in governance is referred to as the coordination of coordination. Therefore, based on the framework in Figure 2 this study has also drawn on the Dale's categories of funding and ownership to structure and shape the analysis of the empirical data on the development of the STI policy at the higher education level in Ghana.

2.7.6 The Actors

From the perspective of Dale (1999), the actors depicted in the methodological framework in Figure 2 are the supranational, national, sub-national, the state, the market, the community and the family. Supranational includes the multinational corporations (MNCs), international organisations such as the United Nations (UN), the World Bank and other countries from which STI policies are being borrowed to help reform national education systems. The national includes the country and the government in power, the different ministries and agencies formulating and implementing the STI policies including the Ghana Academy of Arts and Science and Council for Scientific and Industrial Research (CSIR). The sub-national includes the ten regions in Ghana and the established institutions such as the universities and polytechnics in particular, the faculties of science and engineering and technology. The State includes the Districts and District Assemblies. The market includes the industries and trade unions, in particular, the Associations of Ghana Industries. The community includes the parliamentarians, opinion leaders, the media and civil society in the communities, consultants and the think tanks such as Professional Science and Technology-Based Associations. The family includes the household.

Chapter Three: Research Approach

3.1 Introduction

The complexity of the STI policy process and development as depicted in the literature review and the methodological framework in Chapter 2 suggest the use of qualitative approach to data collection. Therefore, in this chapter the methodological framework is followed with the research approach. From the literature review, policy is also understood to be human activity situated in a context-dependent knowledge. This suggests the use of case study approach. Therefore, the rationale for using case study approach with its ethical implications is discussed before describing in detail my research methods.

My understanding by earlier experiences in my work place and studies had been that policy development was simple and linear (Harman, 1984; Blakemore, 2003). Currently I see policy development as very complex and messy (Sutcliffe & Court, 2005; Dunne et al. 2005; Budd et al. 2006; Lall, 2007; Little, 2008). This understanding of a policy changed my position from positivism to interpretivism. Positivism, according to Usher (1996), strives to test research hypotheses to establish prediction and generalisation that lead to scientific laws of society. Interpretivism strives to build understanding of the motives and intentions that underpin social behaviour (Usher, 1996). To Usher (1996), Budd et al. (2006) and Blaikie (2009), for the researchers who believe in positivist empiricist culture their main research strategy, orientation towards the conduct of the study, was to use quantitative research methods to discover knowledge. The constructionists or interpretivists believed that realities exist in the form of multiple mental constructions and their main research strategy was to use qualitative research strategy to construct knowledge.

Usher (1996) also suggests that confining my study to the observable or empirically 'given' as the positivist/empiricist epistemology posits was to miss out the most important dimensions in the social enquiry. To the author, 'the prediction and generalisation posit by the positivist/empiricist could only be achieved if the openness

of the social world is closed to get a determinate world. 'Closure of the openness of the social world according to the authors was an imposition that raises questions of power which in turn will raise questions about the objectivity of my research process and the resulting knowledge claims' (p.14). With the understanding and experiences gained in my position as education expert, my experience as the government policy developer and my previous assignment in the EdD programme as noted earlier and further thinking through Usher (1996) perspectives, I now see myself as a critical social scientist.

As a critical social scientist and a researcher, the logic of enquiry demands interpretive paradigm to get inside the actors (Robson, 2002; Dunne et al.2005; Cohen et al.2007; Blaikie, 2009) and multiple perspective to construct knowledge and retain the integrity of the phenomena being investigated (Dunne et al. 2005; Arvast, 2006). I, therefore, engaged the actors with an open spirit of critical enquiry about what went on in the formulation of the policy to collect the data to understand the multiple social constructions of meaning and knowledge of the actors on the development of the policy (Groenewald, 2004). Taking this position, my research orientation was to take a largely qualitative approach to data collection focusing further on the rationale for using case study approach with its ethical implications.

3.2 Rationale for Using a Case Study Approach

The case of Ghana and the STI policy at the higher education level is contextual. Ghana as pointed out earlier, has yet to experience technological transformation to the level of other countries such as those in South East Asia, even though the level of development of these same countries was at par with Ghana when the latter achieved independence (MEST, 2010a). The usefulness of a case study approach to support this study takes advantage of my insider position as well as using multiple research methods that are selected on a fit for purpose basis to provide in-depth insights and analysis of the policy (Punch, 2005). Flyvbjerg (2006) from the perspective of the theory of human learning contends that case study research methodology produces context-dependent knowledge.

To Blaze et al. (2004) context-dependent knowledge will help me to 'go deep' into understanding what works and what does not work in the development of the policy. To Flyvbjerg (2006) my advantage in using case study against all other approaches is not only the complexity of the policy process (Dunne et al. 2005; Godin, 2009) that demands the use of the case study approach but depth to 'close in' to real-life situations with its multiple wealth of details which are important for the development of a nuanced view of reality as they unfold in practice in Ghana.

Therefore, the case study research approach was found to be useful to me to present a rich picture of a 'real life' situation, and explicitly privileging the particularistic and unique aspects of what was happening on the ground in my data collection to have an in-depth insight and understanding of how the STI policy was formulated and how this had privileged different interests. My professional responsibility as the government policy developer to have an in-depth insight and understanding of the development of the STI policy at the higher education level in Ghana is, therefore, linked to the use of case study approach to provide a unique wealth of information in the Ghanaian context.

3.3 Ethical Issues

My research is linked to my professional position as a policy developer within a Ghanaian government agency. It is therefore inherently political. Ethical considerations, therefore, pervaded the whole research process (Cohen et al., 2007). The Ghanaian Ministry of Education gave the permission for me to conduct the research. Cluster Based Research Ethics Committee (C-REC) of the University of Sussex also approved the study. Appendix VI provides the University of Sussex C-REC Ethical Approval. I took care to use pseudonyms to anonymise the reporting of my data and reported my findings in a way that respects the persons of my respondents and their confidentiality. These ethical considerations and approaches, notwithstanding, there are difficulties in guaranteeing anonymity (Hammersley and Atkinson, 2007).

For instance, because of the nature of my research (small-scale, qualitative insider research), it was not possible to guarantee anonymity to all respondents particularly within my own professional context (Kvale & Brinkmann, 2009). I explained this clearly to the participants on my information sheet (provided as Appendix 111) and also when requesting their participation (Kvale & Brinkmann, 2009). Groenewald (2004) rather suggests the development of informed consent 'agreement'. From the perspective of Groenewald the specific informed consent 'agreement' that I would have developed in order to gain the informed consent from participants would have taken the form: 'that they are participating in the research; the purpose of the research (without stating the central research questions); the procedure of the research; the risk and benefits of the research; and the voluntary nature of the research participation' (Groenewald, 2004, p.9) and the procedure used to protect confidentiality (Kvale & Brinkmann, 2009).

In the Ghanaian context, however, individual signatories from respondents are affected by historical and political factors and make Ghanaians suspicious and very wary of such practices to affect the natural construction sites of knowledge. However, my study was adjudged low risk probably. Given that signed consent has been provided regarding statistical data in Ghana, the reviewers of my ethical application form could not initially entirely accept the argument that signed consent for participants might raise suspicion and fear. The reviewers thought in my context there might be other ethical issues at play such as power relations between me as the researcher, my professional role and the informants. Finally, the understanding was that individual signatories from respondents were different from gaining consent from anonymised statistics.

I, therefore, first gained ethical clearance from the relevant authorities in the Ghanaian policy context. I introduced myself to the potential participants using the information sheet about my research and the University of Sussex ethical approval letter. I invited them to contact me to signal verbal consent to participation in meetings where I was an observer and to semi- structured interviews. The briefing and debriefing also included information about confidentiality and who will have access to the interview or other material and the participant's possible access to the transcription and the analysis of the

qualitative data through what Kvale and Brinkmann (2009) referred to as 'member validation' which is used to check the accuracy of the data (Cohen et al. 2007; Fraenkel and Wallen, 2008). On member validation, I shared the first version of the transcripts with my respondents. They submitted their comments and I used them to make the necessary corrections. Reflecting on their comments also provided me with a deeper understanding of my study.

3.4 Research Methods

In specific reference to my case study approach through purposive sampling and the collection of qualitative data; data about the perspectives of 'knowledgeable' and experience, policy makers in Ghana were gathered to examine the development of science, technology and innovation (STI) policy at the higher education level in Ghana. My research methods are documentary analysis linked with critical discourse analysis, observations, interviews and research diary. I now describe each of these in more detail.

3.4.1 Documentary Analysis

The focus of this section is the analysis of the STI policy documents. Documents are relevant source of data in some type of written or printed form (Dunne et al. 2005; Fraenkel and Wallen, 2008), factual to help to seek information in the past and throw light on the present and future trends (Cohen et al. 2007) and in a permanent form that can be subject to re-analysis to allow reliability checks and longitudinal analysis (Robson, 2002). The STI policy as discussed earlier has a historic link to the past. The main target of the researcher is to investigate through the documents to have a preliminary in-depth understanding of the policy and the process in the development of the policy at the higher education level.

To this effect, I first collected documents relevant to the research questions. The documents were mainly STI policy documents at the Ministry of Education (Government of Ghana, 2011a), the Ministry of Environment, Science and Technology (MEST, 2010a) and the derivatives of the policy documents as provided in Table 12.

They were classified according to the themes (for example, the actors involved in the development of the STI policy, their interests and how the policy is developed).

They were reviewed in order to gain an insight into the study, to guide in the observation and development of the interview questions including the probe questions and to conduct the semi-structured and informal interviews. Selected internal texts such as agendas and minutes of meetings, memos, contract documents, minutes of seminars and workshops and white paper reports were also reviewed (as provided in Table 13). The documentary analysis helped to present a detailed description of the meetings in the development of the STI policy at the higher education level in Ghana. Critical Discourse Analysis (CDA) was also linked to document review to provide a critical and reflective account of the development of the STI policy at the higher education level in Ghana.

3.4.1.1 Documentary Analysis linked with Critical Discourse Analysis

Dijk (1993) contends that theoretically and methodologically Critical Discourse Analysis (CDA) has a historic root from Aristole, Marx, Members of Frankfurt School (Adorno, Benjamin), Gramsci and his follower's (Corcoran, 1989; Hall, 1981) and the influence of the work of Althusser (1971), Foucault (1980) and Pecheux (1982). From these perspectives, Dijk (1993) again notes that one way of enacting power is to control the context or manage the minds of others through text and talking. Power dominance in this context is defined as control of action. CDA from the author's perspective focuses on what structures, strategies or other properties of text, talk, verbal interaction or communicative events play a role in these modes of reproduction.

CDA as a tool, the text is the focus of analysis (Dunne et al., 2005). 'It is also about how and why certain policies come to be developed in a particular context, by whom, for whom based on what assumptions and with what effects. On whose authority is a policy produced and disseminated, what are the principles of allocations, whose values are being promoted, who wins and who loses' (Blackmore and Lauder, 2011, p. 190). Wodak & Meyer (2008) in the sense of Frankfurt School interpreted this to mean that

social theory should be oriented towards critiquing and changing society as a whole in contrast to traditional theory oriented to understanding or explaining it. From the perspective of Usher (1996) it is about detecting and unmasking beliefs and practices that limit human freedom, justice and democracy.

CDA from the perspective of Dunne et al. (2005) 'looks at the concrete forms of discourse and describes discursive practices at the policy level, analysing the way rhetoric of politicians is produced and what effect this has had' (p.103). From Arvast (2006) it means 'fashioning out the "truth" which is neither stable nor eternal but is provisional and socially constructed' (p.2). To Dunne et al. (2005), CDA involves the scrutiny and interpretation of language which is being used to some purpose and therefore bringing into the field of play the purpose intended and the effect of language on both those who produce it and its audience. Wodak & Meyer relate CDA to the term "critical'' and "critical theory' while Usher relate Critical Theory to ideology critique.

It follows that the four pillars on which CDA theory stands are critique, ideology, dominion and power. Therefore, I interrogated the STI policy document developed in 2010 to uncover the unspoken and unstated assumptions underpinning the development of the STI policy and focused on the nature of reality. The focus was also not so much on what was written down as a text, the actors involved in the development of the policy and the responses of the participants but why those texts were put down and other things were not recorded. Further focus was on the missing actors and why they were missing. The common understanding of the STI policy in the Ghana Education Strategic Plan (ESP)(2010-2020) document and their derivatives was compared and contrasted. How the understanding of the STI policy fits into the state agenda for social programmes was also analysed. Further analysis was the extent to which institutional framework could help to re-interpret foreign ideas to fit into the national framework of institutions and social practices.

3.4.2 Observation

Guided by Robson (2002), Punch (2005), Dunne et al. (2005) and Fraenkel & Wallen (2008), I identified meetings linked to the development of the STI policy at the higher education level in Ghana (provided in Table 11). For example, for the meeting on the development of STI policy at the higher education level in Ghana held in 12 February, 2012, the main agenda was funding mechanisms in the development of STI policy at the higher education level. The meeting was organised by the Planning, Budget, Monitoring and Evaluation (PBME) directorate of the Ministry of Education. PBME is the nerve centre of the Ministry of Education in the formulation of the education sector policies including STI policy at the higher education level in Ghana (Government of Ghana, 2008). Ghana's quest for competiveness to attract international investment was also an internal meeting organised by PBME directorate for the agencies under the Ministry of Education on 22 February, 2012. The focus was to identify indicators for the development of STI policies in the education sector to enhance the competitiveness of the country.

The 17th Colloquium of the Faculty of Science, University of Ghana, Legon, Accra was held on 21-23 March, 2012. Apart from the opening ceremony, there were plenary presentations. I participated in the opening ceremony to listen to the presentation by the Minister of Environment, Science and Technology and the keynote address by the Director-General, Council for Scientific & Industrial Research. The participants were mainly policy makers, science students and scholars in the country. In these meetings, I participated by watching the participants, listening, sometimes by speaking and writing my field notes.

I also observed the demeanour of the participants at the meetings and interviews to have insight of the development of the STI policy at the higher education level in Ghana. It also enabled me to understand how and why the actors in the development of the policy and the participants for the interview acted and the way they chose to act to enable me to have core meanings and understanding of their experiences (Punch, 2005; Dunne et al.2005).

It is important also for me to note that observation as a research method does not necessarily imply the use of field photos to record those observations and that the photographs do not speak for themselves. I, however, included the photographs in the text to reflect on my professional insider experience and my experience as a researcher on the historical perspectives of STI policy developments in Ghana [See photograph 1, p.94; photograph 2, p.95]

3.4.3 Interview

3.4.3.1 Introduction

Guided by interview schedule or guide as depicted in Appendix IV, I first used pilot testing to identify irrelevant and redundant interview questions and further identified weaknesses in the research methodology (details provided in Appendix II). It helped me to gain experience to strengthen my skills in interview, on how to prompt the interviewee and ask them probing questions when more information are needed on a particular issue (Cohen et al. 2007).

3.4.3.2 Preliminary Pilot Phase

Key senior officers who are knowledgeable and experienced: one each from the Ministry of Environment, Science and Technology (MEST), Ministry of Education (MOE) and the National Council for Tertiary Education (NCTE) were selected for the pilot study to refine my interview questions. The principles of informed consent were applied (Cohen et al. 2007; Kvale & Brinkmann, 2009) to test the applicability of the principles in the Ghanaian context. Ethical considerations were strictly followed (Cohen et al. 2007). The preliminary pilot phase helped me to identify the strength and weaknesses in using my insider experiences and position productively to inform the study.

3.4.3.3 Semi-Structured Interview

Semi-structured interview is valued for its structure and flexibility to collect information from powerful people (Cohen et al. 2007) and has the potential of providing rich and highly illuminating data (Robson, 2002). The topic also emerged gradually to

establish trust and help the participants address the issue in the preferred way (Cohen et al. 2007). This understanding from Cohen et al. (2007) and Robson (2002) provided me with the conviction and a guide to use semi-structured interview. I identified meetings (provided in Table 11) linked to the STI policy at the higher education level as the focus of my data collection. I identified and approached possible respondents for consent. My intention was to conduct nine (9) semi-structured interviews but eventually succeeded in conducting (8) eight of them. In collecting data to answer my research questions, I was focused and quite selective. Guided by an interview schedule (provided in Appendix IV), I focused my interviews on a small ongoing area of STI policy development at the higher education level in Ghana and followed this through for a specific time frame (six month period from the point of my ethical clearance).

With the consent of the participants, details mentioned in the purposeful sampling techniques section, all the interviews were audio-taped. With their consent forty five minutes was suggested for each interview. All the participants chose to be interviewed in their offices and homes where and when they felt relaxed and had the natural frame of mind to respond to my interview questions and interacted with me freely on the topic. Almost all the participants felt my area of research was an interesting topic and relevant to the Ghanaian context and this understanding and feeling helped me to get their full participation. Though, forty five minutes was tentatively agreed on, more than half of the participants spent not less than ninety minutes with me on the interview, probing questions to elicit further information (Robson, 2002) and freely charting on the topic. As a 'traveller' (Dunne et al. 2005; Kvale & Brinkmann, 2009), this approach enabled me to have an in-depth insight and understanding of the development of the STI policy at the higher education level in Ghana.

3.4.3.4 Informal Interview

Guided by Kvale & Brinkmann (2009), I included informal interviews in my study. This approach of supplementing the semi-structured interview with the informal interview enabled me to find out the thinking of the participants and how the views of one individual are compared with those of others. It was a conscious effort and an

attempt on my part to find out the participants' in-depth insight and understanding of the STI policy at the higher education level in Ghana (Groenewald, 2004). At meetings linked with the STI policy development (provided in Table 11), the participants were also purposefully identified and their consent was sought to be interviewed and also audio recorded. I used an interview guide (provided in Appendix IV) to guide me in the interaction but focusing much more on probing questions to further have an in-depth understanding of the STI policy.

Voluntarily, it turned out that some of the participants interviewed were audio-recorded while others were verbally recorded based on their convenience and time. Focusing on probing questions, the question was to what extent should I dig deep into how an interviewee feels about the policy? Guided by Kvale & Brinkmann, Fraenkel and Wallen and Groenewald, I made use of non threatening questions to put the respondents at ease before coming out with probing questions. I also tried to establish an atmosphere of trust, cooperation and mutual respect to obtain accurate information. From the perspective of Kvale & Brinkmann (2009), I adopted a 'traveler' metaphor to see interviewing and analysis as intertwined phases of Knowledge construction.

3.4.4 Research Diary

My secondary data storage method was the field notes in my research diary as opined by Groenewald (2004). It enabled me not to forget easily, areas I should follow up further in my interview and observations to have a critical reflection on my own involvement in the scene of the research and my understanding of what went on in the construction site of knowledge and reflection on my analysis of data (Fraenkel and Wallen, 2008). As understood from Dunne et al. (2005), I also used the field notes to monitor and evaluate the whole research process to enable me to achieve the purpose of the study. Therefore, borrowing words from Groenewald (2004), I disciplined myself to record subsequent to each interview, as comprehensively as possible, what happened and what was involved? Who was involved? Where did the activities occur? Why did an incident take place and how did it actually happen? Guided again by the author, I made field notes such as observation notes on what was deemed important to me as a researcher, theoretical notes to reflect on my experiences, methodological notes to

critique myself as a researcher and analytical memos to provide end-of –a- field –day summary or progress review (Groenewald, 2004).

With lessons learnt from Fraenkel and Wallen (2008), I also used the researcher diary to record hunches, insights, observations and personal statements of my feelings, opinions and perceptions about the participants. I also observed and recorded what I was thinking about to help me in my data analysis. The field notes also helped me to reflect on ethical dilemmas and conflicts, my frame of mind such as my thinking as the study progressed (for instance, my attitude, opinions and beliefs) and how these were affecting the study, and putting down points for clarification (for instance, things that needed to be checked later) (Fraenkel and Wallen, 2008). Guided by Robson (2002), the kind of things that I entered included notes on things I had read (for example, references, thoughts relevant to the research, appointments and stocktaking of where I was in relation to each phase of the research). Therefore, on the implication of the field data for STI policy formulation in Ghana, the field notes helped me to write a reflective account on the stages of my research strategy.

3.4.5 Purposeful Sampling Techniques

3.4.5.1 Introduction

Purposeful sampling is the process by which a researcher uses his/her judgment to select a sample that will provide the data needed (Fraenkel & Wallen, 2008). Purposeful sampling was used to enable me to gain access to powerful people, who have in-depth knowledge about the development of the STI policy at the higher education level in Ghana (Cohen et al. 2007; Fraenkel & Wallen, 2008). I provide in detail the rationale for choosing the organisations, criteria for selection of participants and participants identified and interviewed.

3.4.5.2 Rationale for Choosing the Organisations

The following were the organisations which I focused my purposeful sampling: Under the presidency, the Ministry of Environment, Science and Technology (MEST) is to

ensure coordination and harmonisaation of STI policies and collation of relevant data to track the progress towards the implementation of the policy (NDPC, 2009; MEST, 2010a). The Ministry of Education (MOE) is charged with the responsibility to formulate educational policies including the STI policies for the education sector in Ghana (Government of Ghana, 2011a). The National Council for Tertiary Education (NCTE), one of the agencies under the Ministry of Education oversees the implementation of higher education policies and the proper administration of higher education in Ghana (Government of Ghana, 2011a). The institutions of higher learning are required to develop human capital for the implementation of STI programmes and activities (MEST, 2010a).

3.4.5.3 Criteria for the Selection of Participants

Guided by Cohen et al. (2007), the participants chosen from these ministries and agencies were those with great responsibilities and whose decisions have significant effects on a large number of Ghanaians at the policy and implementation levels. In a research of this nature, there is little benefit in seeking a random sampling when most of the participants of the random sample may be largely ignorant. With this conviction, purposeful sampling techniques were used to select nine informants at the supranational, national, sub-national, state, the market, the community and the family (as depicted in the methodological framework, Figure 2 in Chapter 2). The criteria for selection were based on the senior management team. In the absence of any of the members of the senior management team not meeting the criteria, the most experienced and 'knowledgeable' officer was selected and interviewed.

The criterion used was that where the most senior person had not been in that position for more than three years, the next senior person was selected for the interview. Interviewee with such an experience provided insight and in-depth understanding of the development of the policy. Therefore, from the perspective of Dale (provided in Figure 2 in Chapter 2) while the empirical study covers all the actors and for this reason nine informants were selected, the focus of the empirical study had been primarily at the national and sub national level.

3.4.5.4 Participants Identified and Interviewed

Guided by Dale's mechanism and categories of funding and ownership (provided in Figure 2 in Chapter 2), for the semi-structured interview, the participants identified and interviewed were a Senior Research Officer from the Science, Technology and Innovation Directorate of the Ministry of Environment, Science and Technology (MEST); a Director of Education with a portfolio as the STI policy advisor to the Ministry of Education (MOE); a Senior Planning Officer of the planning, research and development of the National Council for Tertiary Education (NCTE); a Senior Lecturer from the department of mechanical engineering at the Kwame Nkrumah University of Science and Technology (KNUST); an Industrialist, an immediate past president of the Institutions of Incorporated Engineers. From the perspective of the professional science and the technology-based associations, district assemblies and household, three senior officers including a District Chief Executive were interviewed.

At the supranational level the focus was on the World Bank; because of their involvement in the development of the STI policy and education in Ghana. There was, however, no response for the interview. No reason was also given. For the participants interviewed, three were female and five were male. They were all Ghanaians. However, participants interacted and interviewed informally included an External and International Consultant with more than seven years proven experience in the education Sector in Ghana. The Consultant had worked for many years with Development Partners in Ghana including the World Bank. Ten key informants were identified for the informal interview. Five were male and five were female. Those interviewed informally included the Executive Director for the Council for Technical, Vocational Education and Training (COTVET) in Ghana.

3.4.6 Data Handling and Data Analysis

3.4.6.1 Introduction

On data handling and data analysis, the focus was on the storage of the data, data handling and data analysis. The storage of the data included recordings, field notes and filling of hard copies. The focus on data handling and data analysis was on the transcription and coding of the data and analysis of the field data namely documentary data, interview transcripts, interview notes, observation data and field notes.

3.4.6.2 Data Analysis

Transcriptions are constructions from an oral conversation to a written text (Kvale & Brinkmann, 2009). Robson (2002) notes that the fact that a study is a case study does not in itself call for a particular approach to the analysis of the qualitative data which it produces. However, in this study, I trained officers working with me at the PBME directorate to transcribe the recorded interview (Kvale & Brinkmann, 2009). I took a close look at the data and further looked for frequency of concepts, themes, patterns, re-occurring words, phrases or issues and assumptions underlying the responses of the participants to generate categories, themes, relationships and summary (Cohen et al. 2007).

This approach demanded that I got closer to the data and for this reason a manual approach helped me to ensure the commonalities, inter-relationships between the responses as well as the context, substance of the patterns and principles embedded in the data. The manual approach involved high lightening of text, cutting out bits to file them together, reading and re-reading. The focus on the data analysis was on capturing the emerging critical themes, typical recurring issues, infrequent and single events that offered a huge important insight, counting frequencies of occurrence (of ideas, themes, pieces of data, word) and noting patterns and themes. Following this, the data were categorised into four groups relating to the research questions. They were also used for my interview questions (Cohen et al. 2007). The whole study in particular the analysis of the observation data, documentary evidence of the internal meetings, interview data and content of the STI policy document were also firmly located in Dale's mechanisms and categories of funding and ownership (provided in Figure 2 in Chapter 2) to structure and shape the analysis to have an in-depth insight and understanding of the development of the STI policy at the higher education level in Ghana.

3.4.6.3 Interpretive Paradigm Approach

Based on my understanding of the interpretive paradigm approach as opined by Blaikie (2009), the participants' inner experiences and competencies provided the first interpretation of how the policy was developed. Following this, I tapped on my inner experiences and competencies to interpret the participants' interpretation of their experiences. Constantly subjecting things to critical reflection (Dunne et al. 2005),

further interpretation was done in the context of the literature to provide more insight into the development of the policy. Further the notion of triangulation was used not only to privilege the multiple perspectives but also to illuminate complexity and differences among the participants and other data sources from the document review and critical data analysis. Reflexivity was also used to help me to further improve the quality of the data analysis, whether the supporting evidence in the literature supports the analysis to use diplomacy again to re-interview the participants to illuminate possible differences (Robson, 2002).

3.4.7 Reliability and Validity

Fraenkel & Wallen (2008) define validity as the appropriateness, meaningfulness, correctness and usefulness of the inferences a researcher makes while reliability focuses on consistency. To Kvale and Brinkmann (2009) issues of reliability and validity go beyond technical or conceptual concerns and raise questions about the objectivity of knowledge and the nature of interview research. The question raised by the authors is whether knowledge produced through interviews can be objective. Usher (1996) points out that in critical theory there is a rejection of the assumption that there can be "objective" knowledge.

Kvale and Brinkmann (2009) also see objectivity as a very ambiguous term. This makes reliability and validity appear, therefore, to have contentious definition and understanding. Consequently, 'some qualitative researchers have ignored or dismissed questions of validity, reliability, and generalisation as stemming from oppressive positivist concepts' (Kvale & Brinkmann, 2009, p.244). Cho and Trent (2006) to this effect suggest transactional and transformational as two general approaches to validity. Transactional validity in qualitative research is 'an interactive process between the researcher, the researched and the collected data that is aimed at achieving a relatively higher level of accuracy and consensus by means of revisiting facts, feelings, experiences and values or beliefs collected and interpreted' (p. 322). On transformational validity, the authors noted that 'it makes sense that meanings are social constructions and multiple perspectives on a topic yield multiple meanings' (p.325). Therefore the question of validity in itself is convergent with the way the researcher self-reflects, both explicitly and implicitly, upon the multiple dimensions in which the

inquiry is conducted. Therefore, I shared my draft text with my key respondents to validate my interpretation of my field data. This helped me to get a reliable data for my analysis of the STI policy at the higher education level in Ghana.

3.4.8 Limitations of the Study

Accessing knowledge from personnel at the policy level in the public sector, I experienced the distinctive civil service voice with protocols concerning what may or may not be disclosed (e.g. under a government's Official Secrets Act or privileged information) as opined by Cohen et al. (2007). The absence of the voices of some potential respondents such as the World Bank employee who declined to be interviewed was also a limitation to the study. However, as noted earlier I informally interviewed an external consultant who had worked for many years with other multinationals including the World Bank. Further limitation might be that my research is a small –scale qualitative insider research. However, from the perspective of Cohen et al. (2007), this case study does not aim to make statistical generalisations because it is not based on a random sampling from a population and the data is not quantified. Kvale & Brinkmann (2009), however, point out that 'if we are interested in generalising we may ask not whether interview findings can be generalised globally, but whether the knowledge produced in a specific interview situation may be transferred to other relevant situations' (p.261). To this effect, Cohen et al. (2007) suggest transferability: studying the typical for its applicability to other situations with commonalities. I, being the instrument and at the same time the sole interviewer and guided by the above-mentioned convictions from the authors, aimed at having an in-depth and unique insight and understanding in the development of STI policy in the Ghanaian context at the higher education level to serve as a guide to what might occur in other situations with commonalities. Therefore, using a case study approach as posited by Flyvbjerg (2006) and Blaze et al. (2004) helped me to have a unique wealth of knowledge in the Ghanaian context: an in-depth insight and understanding of the development of the STI policy at the higher education level in Ghana.

Chapter Four: Background to the History of Education and STI Policy in Ghana

4.1 Introduction

Chapter 2 has unpacked Ghana case from the International debates on STI policy to develop dependency theory as the theoretical framework to guide the study. The chapter further models how influences beyond the state come to influence national policies on education, science, technology and innovation. Chapter 3 has orientation towards qualitative research strategy. This chapter is the starting point to address my research questions through my analysis of the empirical data. The chapter has been developed through reviewing of the literature to address the research question: what is the history of STI policy development in Ghana? Dale's mechanisms had been used to structure and shape the analysis of this chapter. While this chapter tracks the indigenous education in the Gold Coast/ Ghana prior to 1800, the growth of formal education in Gold Coast/Ghana (1800-1950), Ghana at Independence (1951-1966) and the post-independence era (1967-2002), it is worthy to note that in the Ghanaian context there had been much analytical work on the history of education in Gold Coast/Ghana. The theoretical gap had been education policy and its effect on the economic development of the country (Foster, 1965; McWilliam and Kwamena-Poh, 1975). This is the focus of this chapter. The chapter is concluded with the limitations of the STI policy, contending theories and the development of the STI policy in Ghana in 2010.

4.2 The Indigenous Education in the Gold Coast/Ghana prior to 1800

Before the arrival of the Europeans in the 1800 in the Gold Coast/Ghana the informal education or indigenous education was based on local or domestic issues (Foster, 1965). The understanding was that the Europeans' interest in Gold Coast/Ghana was when the Portuguese established a fort at Elmina in the 1842. However, the claim was also that the French reached Gold Coast in the mid-fourteenth century (Foster, 1965). This section focuses on Gold Coast/ Ghana's 'indigenous' or 'informal education' with a further focus on the country's traditional values and cultural before the arrival of the Europeans in the country. The understanding was that the Europeans came at a time Ghana had diverse linguistic and was developing a rich culture to enhance the development of the country (Foster, 1965; McWilliam and Kwamena-Poh, 1975).

4.2.1 Analysis of Traditional Values and Social Structures in Gold Coast/Ghana

Foster (1965) contends that before the Europeans arrived in the 1800's, the people of the Gold Coast/Ghana were educated based on their traditional and cultural beliefs. Their educators were the spiritual traditional mediums. These people were highly revered and were called 'traditional elite', 'religious functionaries' or 'intermediaries' between the living and the ancestors and served as a 'unifying-survival force' for their development (p.33). Whereas the traditional beliefs of the East Asians, for example, Japan were respected, adapted and sustained that of the Gold Coast/Ghana's traditional beliefs were looked down upon as evil by the Europeans (Foster, 1965; McWilliam and Kwamena-poh, 1975; Green et al. 2007; King, 2013).

For example, before the arrival of the Europeans, there was a 'highly developed artistic craftsmanship in Asante' (McWilliam and Kwamena-poh, 1975, p.4). There was also 'the great Ashanti Confederacy, an independent political unit with a common ruler (Asantehene)' (Foster, 1965 p.24). Thompson (2002), however, contends that the British administration in Gold Coast / Ghana rather submerged this unifying-survival force through tribal politics. The loyalty name in Gold Coast/Ghana, for example, was changed from 'King' to 'Chief' so as not to make a Gold Coast/Ghana's 'King' had the same title as her Majesty in the United Kingdom. The chief was also made to perform dirty work for the British (McWilliam and Kwamena-poh, 1975). On tribal politics, Lentz (1995), for example, contends that:

> Marxists and dependency theorists consider tribes and tribalism a colonial invention but nourished by the active participation of African actors to also achieve their own interests (Lentz, 1995, p.21)

From the perspective of Okyere-Kwakye et al. (2010), the introduction of tribal politics in the country in the colonial era in Gold Coast/Ghana have had implication on the unification of the country. Foster (1976), for example, pointed out that the Ashanti and Fanti were the majority tribe in Ghana that belongs to one tribe called 'Akan'. The colonial administration created tribal politics between them (Foster, 1976).

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McWilliam and Kwamena-Poh (1975) also noted that the teaching of the missionaries in the 19th century isolated the Christian communities from the 'pagan' influences and this had effect on the schools to produce 'two worlds' separating the literates from the rest of the communities in Gold Coast/Ghana. Hence, before the arrival of the Europeans, the African religion, art, music and other social activities were intertwined. According to the authors, this unifying spirit had been destroyed with the Christian faith. For example, the Dipo[1] custom among the Krobos which was a traditional form of training for the citizenary was regarded as 'bulwarks of Satan' (McWilliam and (Kwamena-Poh, 1975). According to Steegstra (2005), the initiation ceremonies are of much educational and cultural value and their loss could weaken Ghana's culture. Against this backdrop, the understanding was that the 'English-tongue was the heaven-sent medium of religion and civilization' (p.24). 'African dancing and music were also banned from the curriculum' (p.34) (McWilliam and (Kwamena-Poh, 1975) while the Ghanaian tongue was also submerged (Thompson, 2002). Thompson (2002) further noted the extensive documentation in both British and indigenous sources that had condemned the traditional African culture and religion: Kwesi Dickson's book, 'Theology in Africa'; H.A. Guy's book, 'Our Religions'; Adu Boahen's book, 'evolution and change in the nineteenth and twentieth century'; J.S. Pobee's 'Invitation to be African Anglican'; H. Debrunner's book, 'A History of Chritianity in Ghana' and M. Crowder's book, 'West Africa Under Colonial Rule' (p.1).

However, to Thompson (2002), 'the problem had not necessarily been Christianity or formal education in Gold Coast/Ghana'. Rather 'the problem was that Christianity or formal education in Gold Coast/Ghana had been made to protect the western imperialism' (p.18).

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[1] The state sees the dipo rites as part of a rich cultural heritage. The importance of dipo in constituting a person and reaffirming ties to the family and hometown in particular remains very important (Steegstra, 2005, p.2).

This notwithstanding McWilliam and Kwamena-Poh, (1975) noted that:

> The traditional education was important for its moral, practical and vocational approach: often it is the lack of these qualities in the modern schools in Ghana which people regret today (McWilliam and Kwamena-Poh, 1975, p.9)

Therefore, the question one may ask is on the motive behind colonialisation of the Gold Coast/Ghana; was the motive based on imposing their own interests or reciprocal benefits for the good of both countries (Thompson, 2002; King, 2013). Thompson (2002) to this effect cited Professor Britwum who suggested that 'the tragedy is that colonialism in Gold Coast/Ghana allowed the Europeans to move their 'material base' - 'the western imperialism'- 'outside based interest'- into the country' (p.19). This according to Matunhu (2011) was achieved with the understanding that the culture of the African people would have to give way to that of the foreigners in order that there would be development in Africa. Thompson (2002) to this effect contends that this material base introduced into Gold Coast/Ghana through colonialism, 'had manifested itself in the form of foreign ownership, monopolies and the IMF/World Bank, 'all of which are also western imperialism to control the economic base of the country' (p. 19). In this study the term 'outside based interests' is referred to and defined as Metropolitan state interest in a Third World country based on the principle of outside influence that may aim at foreign penetration, control and exploitation (Waite, 2012) to make it difficult for the country to pursue an ethical aid policy to achieve self-reliance and an independent economic development (King, 2013).

It is worthy to note that the people of Gold Coast/Ghana would have developed on her governance institutions if her own traditional and cultural values had been maintained and nurtured (Yeh, 1989; Matunhu, 2011; Nweke, 2012). Therefore, while one does not, however, rule out the possibility of the country benefiting from western education, the hard question that had remained was the impact of Ghana's trajectory to modernity through Western education? The question was whether this had been an asset or liability to the development of the country?

4.3 The Growth of Formal Education in Gold Coast/Ghana (1800-1950)

The Portuguese first settled at Elmina in 1842, followed by the Dutch, Danish and English. In 1844 a bond was signed to begin the colonial era of British jurisdiction in the Gold Coast now Ghana. This was a follow-up of the European Enlightenment project in the 15th century and the Berlin Conference of 1884-85 that partitioned Africa among the European powers. The growth of formal education in Gold Coast/Ghana started with the castle schools established by the European trading nations. The focus was on numeracy and literacy in English to enhance their trading activities. The schools were also used to enhance Christianity in Ghana as a means to control the mind of Ghanaians (McWilliam and Kwamena-Poh, 1975; Foster, 1976; Smith, 1999). To this effect Thompson (2002) pointed out that:

> The British believed that once they controlled the mind of the Ghanaian they would control their entire body. The school structure and content were designed in a way that in their very first day of the school, the Ghanaian began to view the world in the eyes of European and oriented to western educational thought and goals (Thompson, 2002, pp 8-9)

4.3.1 Development of Higher Education in Gold Coast/Ghana

Against this background the growth of higher education in Gold Coast/Ghana started from the Dutch period. It started with the mulatto children who were sent to Europe to further their studies. Three 'personalities' emerged from this group that benefited from the Western education. The first category was those who returned to Gold Coast/Ghana to help in the development of the growth of education and the economy of Gold Coast/ Ghana (for example, J.E. J. Capitein in the 1740s). The second category returned to Gold Coast/ Ghana to support actively the slave trade activities in the country. For example, Jacobus Capitein graduated from Leyden University in Holland in 1737 and ordained the first Protestant African priest. 'Interestingly on completion of his University education, one of his literary works included a speech in Latin on the theme that slavery is not contrary to religious liberty' (p.19) (McWilliam and Kwamena-Poh, 1975).

Philip Quaque also benefited from the British and trained to be the first African to be a Church of England minister. He became fully acculturated with European tradition to the extent that he taught and made the African youth to believe and accept slave trade as a source of wealth to the country (McWilliam and Kwamena-Poh, 1975; Thompson, 2002). The third group was those that achieved academic distinction in Europe but made no contribution to the life of their people. Anthony William Amo crowned his academic career in Europe with a doctorate degree at the University of Wittenberg in 1734. He was awarded the title of Counsellor of State at the Court of Berlin. After thirty years in Europe he returned to Axim in Ghana but took no part in public life for the people and the communities in Axim to benefit from his education, experience and competency.

The development of higher education in the British West African colonies was, however, a post-second World War thought. In I844, Lieutenant Governor H.W. Hill proposal to start 'higher school' so that African merchants particularly, should not have to incur the expense of sending their sons to England for further education was rejected by the Colonial Office. According to Atuahene (2006) the fear of the colonial administration was that higher education would produce nationalist who could be vanguards. Governor Guggisberg plans in 1920, however, made provision for university education. Achimota was established to have kindergarten, secondary, teacher training and university classes departments in Accra, Ghana. The first Engineering school in Gold Coast/Ghana emerged from Achimota and produced the first engineers to become heads of government departments in 1957.   The departments were transport, housing, technical education and the locomotive department of the Ghana railway.

However, in October 11, 1948, University College at Legon now the University of Ghana, Legon was established with D.M. Balme as the first principal. This was the first maiden university in Gold Coast/Ghana. It started with 90 students as an autonomous institution under a Council. In 1961 the number of students increased to 670. The female population was 46. About 148 out of 166 candidates were successful in their final degree examination.   The university had a 'special relationship' to London

University to maintain the degree awarded while adapting the syllabuses to the local needs. The establishment of the university was as a result of the Acquith Commision set up by the British Government in 1943 to cover the general field of university of education in Gold Coast/Ghana. The Kumasi College of Technology now known as Kwame Nkrumah University of Science and Technology was also established in 1952 to provide courses of technological and vocational training (McWilliam and Kwamena-Poh, 1975).

Thompson (2002), however, posits that the products of higher education included pockets of 'Western minded Ghanaians' (p.18) who had been acculturated to oppose the traditional structures and models rather than develop them to produce a unique contextual development model to transform Gold Coast / Ghana's economy. Biney (2008) had also cited Dr. Kwame Nkrumah, the First President of Ghana to suggest that this group of Ghanaians with imperial interests had in partnership with Western multinational corporations continued to siphon Gold Coast /Ghana wealth out of the country to develop Europe to the detriment of Ghanaians.

4.3.2 The Science, Technology and Innovation Policy in the Colonial Era

The Science, Technology and Innovation (STI) policy in the colonial era in Gold Coast/Ghana was contained in the report of the Education Committee of the Privy Council in 1847. This report amongst others sought to the 'development of a thriving agricultural economy in Ghana' (p. 56). 'The focus was building the capacity of the teachers in chemistry and its application to agriculture, the theory of national phenomena in relation to agriculture, land surveying and practical mensuration, the theory and practice of agriculture and gardening, and the management of farm stock' (including the treatment of disease)' (Foster, 1976, p. 56). This was to enhance the teaching and learning of these subjects in the classroom. My understanding from the perspective of Foster (1976) suggests that the content of the report focusing on science, technology and innovation policy was rejected and not implemented. Prior to the Privy Council's report, Winniett's proposal for technical education and mechanical knowledge in the 1846 was also rejected (McWilliam and Kwamena-Poh, 1975).

Sifuna (2001) further on the colonial curriculum pointed out that:

> In talking about vocational education, the colonial curriculum placed no premium on professions such as engineering, technology and allied subjects. Most often the so-called vocational education carried a racial overtone, which stressed that Africans should be trained so that they would fulfill tasks appropriate to their presumed intellectual and social inferiority.----- In short colonial education was designed to serve the needs of the colonial state (Sifuna, 2001, p. 25).

This may support Thompson (2002) view that the Ghanaian education system in the colonial era promoted western culture and their material base to the detriment of Ghanaian traditional values, structures and development models.

4.4 Ghana at Independence (1951-1966)

At Independence in 1957 Dr. Kwame Nkrumah, the First President of Ghana, however, declared to the world Ghana's domestic and foreign policy:

> We must seek an African view to the problems of Africa. This does not mean that Western techniques and methods are not applicable to Africa. It does mean, however, that in Ghana we must look at every problem from the African point of view (McWilliam and Kwamena –Poh, 1975, p. 94).

On the eve of Independence, 6th of March, 1957, Nkrumah further provided a clear vision for Ghana:

> --A system of education based at its university level to study concrete problems of tropical world to produce scientifically-technical minded people for a rapid development of the country (McWilliam & Kwamena-Poh, 1975, p. 94).

On the First and Second Five Year Development Plans, Dr Kwame Nkrumah, the First President of Ghana wrote:

> ---In developing these plans foundations were to be laid for the modernisation and industrialisation of Ghana---.We had to work fast. Under colonial rule, foreign monopoly interests had tied up our whole economy to suit themselves. We had not a single industry. Our economy was dependent on one cash crop-cocoa. Although our output of cocoa is the largest in the world, there was not a single cocoa processing factory in the country (Nkrumah, 1976, p.78).

4.4.1 The Establishment of Scientific and Technological Institutions in Ghana

Following Nkrumah' vision on the modernisation and industrialisation of Ghana through science, technology and innovation (McWilliam & Kwamena-Poh, 1975), many scientific and technological institutions were established in the 1950s and 60s. The Kwame Nkrumah University of Science and Technology (KNUST) established in 1952 as the Kumasi College of Technology was upgraded in 1961 to university status (UNCTAD, 2011) to produce high-level scientific human resource for the country. The Ghana Academy of Arts and Sciences, established in 1959 as a learned society with Nkrumah as its first chairman also had as its chief aim of maintaining 'proper standards of endeavour in all fields of science and learning in Ghana' and to promote scholarship locally and internationally. Membership was 'limited to persons who have made an original and significant contribution to any branch of 'Science or Learning'. The Council for Scientific and Industrial Research (CSIR) has thirteen (13) research institutes. It is a central scientific and industrial research organisation established in August 1958. The Ghana Atomic Energy Commission was also established in 1963 to explore the potential exploitation of nuclear energy for peaceful and socio-economic use (MEST, 2010a). Ghana at Independence can be said to have had a substantial institutional capacity for human resource development in science, technology and innovation.

4.4.2 Ghana's Achievement at Independence

At Independence, Ghana had the highest living standard in Africa in per capita and the highest literacy rate and was the nearest to achieving genuine economic independence (Nkrumah, 1976). As depicted in Table 2 University students increased by 478.8 percent from 208 to 1,204. The table depicts similar increases in the numbers of children in Primary and Middle schools, and of students in Secondary and Technical schools and in colleges of higher education.

Table 2: Education at Independence

EDUCATION	1951	1961	% Increase
Primary Schools	154,360	481,500	211.9
Middle Schools	66,175	160,000	141.7
Secondary and Technical Schools	3,559	19,143	437.8
Teacher Training Colleges	1,916	4,552	137.5
University Students	208	1,204	478.8

Source: Nkrumah, 1976, p.77

In Table 3, for example, Doctors and Dentists increased by 220.5 percent (from 156 in 1951 to 500 in 1961)(Nkrumah, 1976). The achievements also included the nationalisation of 63 State Enterprises, Ghana Airways and Black Star line. In addition the only Nursing school which existed in 1945 produced only 8 nurses a year by 1950. Between1961-62 the six schools of nursing established turned out 265 new nurses and midwives (Nkrumah, 1976).

Table 3 Basic Services at Independence

Transport and Communication	1951	1961	% Increase
Roads (in Miles)			
Class I (Bitumen)	1,398	2,050	46.7
Class II (Gravel)	2,093	3,346	59.8
Post Offices	444	779	75.4
Telephones	7,383	25,488	245.2
Electricity			
Installed electrical capacity (kW)	84,708	120,860	42.7
Electrical power generated (kw'000	281,983	390,174	38.4

Health	1951	1961	% Increase
Number of Hospital beds	2,368	6,155	159.9
Roads and Urban Clinics	1	30	
Doctors and Dentists	156	500	220.5

Source: (Nkrumah, 1976, p. 78)

Source: (Nkrumah, 1976, p. 78)

Against this background, Nkrumah (1976) noted:

> The problems Ghana faced at Independence were similar to those which confront most States emerging from colonialism. Ghana once dependent territory if it is to survive in the modern world must try to accomplish in a single generation what it has taken developed nations 300 years or more to achieve. There is the need for radical change in practically every department of national life (Nkrumah, 1976, p.67)

4.5 The Post- Independence Era (1967-2002)

Yet in the post-independence era (1967-2002) Ghana's fork on the road had not been to mirror the East Asian countries but to perpetuate a dependent model of development that had been unhelpful (Uche, 1994; Karikari-Ababio, 2000; Aryeetey, 1992; Tikly, 2004; Green et al. 2007; Wade, 2008; Pedley and Taylor, 2009).

In the period between 1967-2002 the literature had posited that the East Asian countries had used unique contextual development model (Green et al. 2007), selective intervention policies (Wade, 2008), systems of hidden subsidies (Yeh, 1989), more active government promotion policies and manpower planning (Wade, 2008) to support their holistic education policies (King and Palmer, 2006b) to technologically transform their economies (Green et al. 2007; World Bank, 2008; Wade, 2008). Ghana rather had strictly followed the philosophy of enlightenment, modernisation, liberalism to pursue the Washington Consensus or the global policy of liberal free market policy prescription. From the perspective of the methodological framework in Chapter 2, Figure 2, the structural adjustment programmes including 'disciplinary' mechanisms such as poverty-conditional lending and poverty reduction strategies was imposed on Ghanaians (Fitzgerald, 1992; Ninsin, 1992; Aryeetey, 1992; Uche, 1994; Tikly 2004).

Further imposition was that the rationale for spending in the education sector in Ghana was based on the rates of return analysis. Based on this educational policy, Ghana took a unilateral decision to target on primary education in particular and basic education in general to the neglect of secondary education, technical education and higher education in Ghana (Karikari-Ababio, 2000). In this equation the installing interdependence mechanisms were also used to link this policy to aim at poverty reduction in the country (Tikly, 2004; Government of Ghana, 2008).

This was to be achieved through dissemination mechanisms such as 'achievement of universal primary education (UPE) by 2015 and gender parity by 2005' (King and Palmer, 2006b, p.7) in Ghana (Government of Ghana, 2008). As part of the

standardisation mechanisms, user-fees were also introduced at the higher education level in Ghana for the country to achieve expenditure norms as required by the International standard (World Bank, 2002; Government of Ghana, 2008). This was further linked to the imposition mechanisms to suggest that these conditions had to be fulfilled before the country could access the donor funding in the country (Karikari-Ababio, 2000).

Pedley and Taylor (2009) also posits that 'in the 1987 reforms of the Provisional National Defence Council (PNDC), even though the overall education expenditure had declined from 6.4% of GDP to 1.5% of GDP, the support from the development partners such as funding and intellectual capital in the form of policy advice and technical expertise were targeted to primary education' (p. 64).

Karikari-Ababio (2000) also contends that as a result of this policy the basic education component of the national Government of Ghana (GOG) education budget was 66.3 percent in 1999 and increased to 72.66 percent in 2000 leaving scanty resources for secondary, technical and higher education. This was stipulated in International commitments, fulfillment of which was required before the country could access donors' funding (Karikari-Ababio, 2000). Empirically, King and Palmer (2006a) had also questioned whether China and the South-East Asia countries unilaterally targeted poverty to succeed in their poverty reduction?

The understanding was that an all encompassing policy framework including trade and technology policies, holistic education and capacity building was developed to get them out of poverty. Ghana is yet to achieve this. Accordingly, King and Palmer (2006b) contended that for Ghana to just target one sub sector such as primary education would be difficult for the country to achieve education goals. The understanding, therefore, was that the forty-six years (1966-2012) that the Bretton Woods had controlled the economy of Ghana had not helped the country to be transformed technologically (McWilliam & Kwamena-poh, 1975; Aryeetey, 1992; Wade, 2008).

For example, 'in the 2005 publication from the World Bank, called Economic Growth in the 1990s: Learning from a Decade of Reform' (p.13), Wade (2008) contends that:

> The 360-page report makes just one reference to 'industrial performance' and one reference to 'industrialization' policy. The lessons from the 1990s do not include lessons about 'industrialisation' or 'industrialisation policy' or technology policy which from a Schumperian perspective should be central'. At the operational level, since the early 1980s when the neoliberal policy prescription known as 'the Washington Consensus' and the neoliberal ideas came to constitute 'global policy' the Bank had hardly allowed any projects or work that squarely focused on technological development (Wade, 2008, pp.13-14).

Against this background, the theoretical insight of Wade (2008) suggests that 'the new developments in trade theory and growth theory had questioned the theoretical basis of the Washington Consensus, structural adjustment, or the neoliberal policy prescription of the free market kind of 'global policy' advocated by multilateral actors like the World Bank, the Asian Development Bank, and the IMF and a large swathes of developing elites' (p.15). King (2013) also cited JICA (2010:2) to point out that:

> Recognising the importance of education as the base for its development, Japan advanced scientific and technological development and industrial growth by enhancing people's capacity through education-especially during the process of modernization from the mid-19th century (JICA (2010:2) cited in King (2013, p. 148)

However, it is important also to note that the theoretical insight of King (2013) suggests that 'there is no such thing as a Western donor. They differ hugely from each other, even within their support to education. Germany and France, for example, according to the author allocate a considerable amount of their educational aid (over 70%) to higher education, whilst others such as USA, UK, Netherlands, Canada and Sweden allocate to basic education over 69% of their total aid to education' (p.3). To my understanding in the Ghanaian context, the dissemination mechanisms had been used for the country to target on universal primary education (UPE) by 2015.

The installing interdependence mechanisms had also been used to link this policy to poverty reduction in the country. This could shift Ghanaians interests (civil society, the media, NGOs, the ministries, agencies, district assemblies) to outside based interest to target on basic education to the detriment of STI policy at the higher education level. Yet the development of science, technology and innovation at the higher education level and diffusion and utilisation of the products such as the scientists, engineers, technologists and innovators in the advanced economies had contributed immensely to the divide between the developed and underdeveloped countries (Arocena and Sutz, 2003). This may support Tikly (2004), Wade (2008) and Matunhu (2011) views that Ghana's path to modernity may marginalise the country in technology development. This has further implications to support the thinking of scholars, policy analysts and academic commentators such as Yeh (1989), Dale & Robertson (2002), Tikly (2004), Islam (2009) and Matunhu (2011) that this may aim at a reproduction of a low-skilled Ghana to be exploited by corporations. This to my understanding may suggest a dearth of knowledge and understanding of the dominant development theories, discourses, policies and practices at the leadership position in Gold Coast/Ghana.

4.5.1 The Trend of Ghana's Economic Growth

NDPC (2010a) for example, contended, as depicted in Table 4 and Figure 3, that the real GDP growth rate of the economy was 4 percent in 1995. It increased to 7.3 percent in 2008 and reduced to 4.1 percent in 2009 while the structure of the economy remained basically unchanged (Palmer, 2007a).

Figure 3: Trend of the Real GDP Growth Rate in Ghana (%) Table 4: Real GDP Growth Rate in Ghana (%)
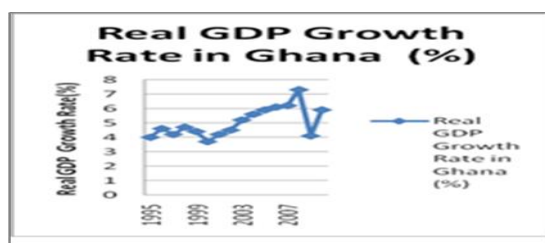
1995	1996	1997	1998	1999	2000	2001	2002
4	4.6	4.2	4.7	4.4	3.7	4.2	4.5
2003	2004	2005	2006	2007	2008	2009	2010
5.2	5.6	5.9	6.1	6.2	7.3	4.1	5.9

Source: Derived from ISSER, MOFEP, NDPC

4.5.2 Demographic Trend of STI Policy at the Higher Education Level in Ghana

The demographic trend of higher education participants as depicted in Figure 4 and Table 5 suggests that very little progress on the STI policy has actually been made at the higher education level in Ghana.

Figure 4: Trend of Ratio of Higher Education Science/Technology and Humanities Enrolment

Public Polytechnics   Public Universities

Source: Ghana Statistical Service; National Council for Tertiary Education (NCTE)

	Public Polytechnics				Public Universities			
Year	Total Enrol	Science /Tech	Humanities	Ratio (ST/H)	Total Enrolment	Science/Tech	Humanities	Ratio (ST/H)
1996/1997	7,420	4,057	3,363	55:45	23,125	9,853	13,272	43:57
1997/1998	9,942	5,122	4,820	52:48	26,684	11,08	15,636	41:59
1998/1999	12,963	6,382	6,581	49:50	31,501	12,288	19,213	39:61
1999/2000	16,956	7,874	9,082	46:54	36,221	16,045	20,176	44:56
2000/2001	18,459	8,161	10,298	44:56	40,673	14,809	25,864	36:64
2001/2002	20,442	9,117	11,325	45:55	46,184	16,650	29,534	36:64
2002/2003	23,117	9,804	13,313	42:58	53,895	18,120	35,775	34:64
2003/2004	24,353	9,908	14,445	41:59	63,576	21,341	42,235	34:66
2004/2005	24,983	9,946	15,037	40:60	73,408	25,596	47,812	35:65
2005/2006	24,664	8,747	15,917	35:65	84,078	29,623	54,455	35:65
2006/2007	28,695	9,137	19,558	32:68	88,445	33,395	55,050	38:62
2007/2008	34,448	10,289	24,159	30:70	93,973	35,401	58,572	38:62
2008/2009	38,656	11,207	27,449	29:71	102,548	40,827	61,721	40:60

Table 5: Higher Education Enrolment by Programmes

Source: Derived from Ghana Statistical Service; National Council for Tertiary Education (NCTE).

For example, in Figure 4 and Table 5, in the Public Polytechnics in 1996/97 academic year, 55 percent of the students were offering science/technology while the humanities

recorded 45 percent of the students. By 2008/09 academic year the proportion of science/technology students had reduced to 29 percent while the humanities students increased to 71 percent. In the Public Universities 43 percent of the students were studying science/technology subjects and 57 percent were offering humanities in the 1996/97 academic year.

By the 2008/09, the proportion of science students had reduced to 40 percent while the humanities increased to 60 percent (Ghana Statistical Service, 2005). Going by the current rate of regression, theoretical insight of Somuah (2008) suggested that it would take more than 57 years for the country to achieve the government targets set in the ESP (2010-2020). This suggests the need for a radical reform of the structure and systems in place.

4.5.3 Technology Achievement Index

On Technology Achievement Index (TAI) (refer Table 6) Ghana is among the marginalised countries with a TAI of 0.14 and ranked 63th position out of 67 countries. In Table 6, South Korea was ranked 5th position with TAI of 0.67. Malaysia was ranked 28th position with TAI of 0.40. Finland topped the list with TAI of 0.74 while the world average was 0.40. This Technology Achievement Index (TAI) had focused on the creation of technology, diffusion of recent innovations, diffusion of old innovations and human skills. The author did not just use gross enrolment ratio at the higher education level but students enrolled in science, mathematics and engineering to reflect on the human skills needed to create and absorb innovation. Further details of the indicators of the Technology Achievement Index are provided in Appendix 1. Finland, the United States, Sweden and Japan had the highest achievements of 0.5 and were the leaders in technology creation, diffusion and skills. Republic of Korea and Singapore achieved the fifth and eight positions respectively. The potential leaders had ranged from 0.35-0.49 (Gudyanga, 2011).

Table 6	Technology Achievement Index (TAI)										

Leaders			Potential Leaders			Dynamic Adopters			Marginalised		
Rank	Country	TAI	Rank	Country	TAI	Rank	Country	TAI	Rank	Country	TAI
1	Finland	0.7	18	Spain	0.48	34	Urugay	0.34	60	Nicaragua	0.19
2	USA	0.7	19	Italy	0.47	34	Thailand	0.34	61	Pakistan	0.17
3	Sweden	0.7	19	Czeck R.	0.47	34	South Africa	0.34	62	Senegal	0.16
3	Japan	0.7	21	Slovenia	0.46	37	Trinidad &Tobago	0.33	63	*Ghana*	*0.14*
5	South Korea	0.7	21	Hungary	0.46	38	Panama	0.32	64	Kenya	0.13
6	Netherland	0.6	23	Slovakia	0.45	39	Brazil	0.31	65	Tanzania	0.08
7	United Kingdom	0.6	24	Greece	0.44	40	Phillipines	0.3	65	Napal	0.08
8	Canada	0.6	25	Portugal	0.42	40	China	0.3	67	Sudan	
8	Australia	0.6	26	Poland	0.41	42	Bolivia	0.28	67	Mozambique	0.07
10	Norway	0.6	26	Bulgaria	0.41	43	Peru	0.27	World Average		0.40
10	Germany	0.6	28	Malaysia	0.4	43	Columbia	0.27			
12	Ireland	0.6	29	Mexico	0.39	45	Tunisia	0.26			
13	New Zealand	0.6	29	Croatia	0.39	45	Jamaica	0.26			
13	Belgium	0.6	31	Romania	0.37	45	Iran	0.26			
15	France	0.5	32	Costa Rica	0.36	48	Paraguay	0.25			
15	Austria	0.5	32	Chile	0.36	48	El Salvador	0.25			
17	Israel	0.5				48	Ecuador	0.25			
						51	Syria	0.24			
						51	Eqypt	0.24			
						51	Dominica	0.24			
						54	Zimbabwe	0.22			
						54	Algeria	0.22			
						56	Indonesia	0.21			
						56	Honduras	0.21			
						58	Sri Lanka	0.2			
						58	India	0.2			

The Unit of indicators used in the calculation of the TAI are patents granted per 100, 000 people and royalties in US$ per 1000 people for creation of technology; internet hosts per 1000 people and exports in % for diffusion of recent innovations; telephone lines per 1000 people (log) and electricity in kwh per capita (log) for diffusion of old innovations; Mean years of schooling (age15 and above) and gross enrolment ratio of higher education.

The four groups of countries with TAI values range from 0.744 for Finland to 0.066 for Mozambique. These countries can be considered leaders, potential leaders, dynamic adopters or marginalised.

Source: (Gudyanga, 2011, pp 3-4)

These were countries that had invested in high levels of human skills comparable to those in the top group, diffused widely old technologies, but innovated little and ranked low either in the diffusion of recent innovations or old invention. The dynamic adopters ranged from 0.20-0.34. These countries are dynamic in the use of new technology. Most of them are developing countries with significantly higher human skills than the fourth group. Many of these countries have important high-technology industries and technology hubs, but the diffusion of old inventions is slow and incomplete. The marginalised are below 0.20. The technology diffusion and skill building have a long way to go in these countries. Large parts of the population have not benefited from the diffusion of old technology. Most African countries including Ghana are in this group (Gudyanga, 2011).

4.5.4 Manufacturing Value Added Per Capita

In the share of manufacturing value added (MVA) in GDP, Ghana recorded, as depicted in Table 7 MVA per capita (in US$) to be 43 compared to 3434 in South Korea and 1258 in Malaysia (UNCTAD, 2003). South Korea had invested in technical manpower to achieve the world's highest proportion of its population enrolled in engineering and other technical subjects (UNCTAD, 2003).

4.5.5 Agriculture Value Added Per Worker

Ghana's productivity gap, value added per agriculture worker (refer Table 8) would have to increase by a factor of 3 to match the Philippines or by a factor of 10 to reach Brazil's productivity level. Philippines and Brazil compete with Ghana on a range of agricultural products (UNCTAD, 2011).

Table 7: The Share of MVA in GDP	
Country	MVA per capita (in US$), 2000
Zimbabwe	156
Ghana	43
Uganda	26
Tanzania	13
South Korea	3434
Malaysia	1258
Thailand	650
China	347
Source:	UNIDO International Year book of Inustrial Statistics (1997, 2002) cited in UNCTAD, 2003, p.9

Table 8: Agriculture Value Added Per Worker	
Country	Agriculture value added per worker 2008 or latest (in constant 2000 US$)
Uganda	197
United Republic of Tanzania	326
Kenya	345
Ghana	401
Malaysia	611
Philippines	1,211
South Africa	3,839
Brazil	3,858
Costa Rica	5,457
New Zealand	25,712
Source:	World Development Indicators 2010 cited in UNCTAD, 2011,p.2

4.5.6 Debt Sustainability Analysis

Through the application of development theories and discourses in the concept of modernity, the country had also received all kinds of loans and grants (UNDP, 2010). Yet UNDP (2010) pointed out that a debt sustainability analysis (DSA) conducted in 2001 showed Ghana's external debt as unsustainable, recording net present value (NPV) of debt to budget revenue of about 571% and NPV of debt to exports of about 157%. The public debt to GDP ratio stood at about 181% with the domestic debt component of 28.9% of GDP. Public debt servicing accounted for 32% and 39% of total government expenditure in 1999 and 2000 respectively. The 2008 debt sustainability analysis, the stress text analysis by the World Bank (2009) also suggests that Ghana remains at moderate debt stress.

This has implications on Ghana's saving rate which remain low compared to many African countries (UNDP, 2010). Savings as a proportion of GDP, pointed by the UNDP was 5.4% in 1990 and increased to 7.8% in 2006. For a country to achieve

sustained accelerated growth, UNDP pointed out that it must save at least 20 percent of its GDP and invest an equally higher amount. This is yet to happen in Ghana.

UNIDO (2010) contended that on average in the case of a Ghanaian worker, an extra year of education increases output by 2 percent while in the case of a worker in South Korea an extra year of education increases output by 12 percent. To my understanding this low output in Ghana may be attributed to the low content of the literacy rates in science, technology and innovation in the education policy in Ghana (Government of Ghana, 2011a). Bawumia (2010) also contended that:

> Ghana's income per capita was almost exactly to South Korea's at $490 (in 1980 dollars). Fifty three years later, there is a significant difference between the economic fortunes of the two countries. The World Bank's purchasing power parity calculations show that South Korea's gross national income per capita was $28,120 while Ghana's was at $1,430 at the end of 2008 (Bawumia, 2010 p.1).

The author further suggests that on the average Ghana's GNI/Capita since the 1950s had averaged US$20 compared to South Korea which had been US$545. With this pace of development it may take Ghana about 500 years to achieve South Korea's per capita in 2008 (Bawumia, 2010).

4.5.7 The Structure of the Economy

The Service sector of the economy is expanding much more than the industry or manufacturing sector (refer Figure 5 and Table 9). On foreign direct investment registered by the Ghana Investment Promotion Centre (GIPC) as depicted in Table 10, the Service sector again has increased from US$6.71Million value of estimated project in 2002 to US$ 608.73Million in 2011, a significant change of about 4 times in percentage point compared to the manufacturing sector from US$20.71Million in 2002 to US$ 512.59 Million.

Yet the Service sector has shown ambiguous results on growth while the manufacturing that was behind shows a positive impact on growth (Alfaro, 2003). The foreign direct

investment (FDI) is to augment domestic savings in the process of capital accumulation and the main conduit through which technology transfer takes place to develop an economy (African Economic Research Consortium, 2006).

Figure 5: Sectoral Contribution to GDP, 2000-2008 at Constant 1993 Prices (%)
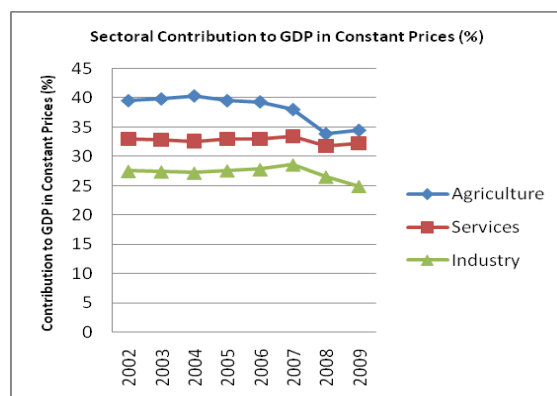
Source: Field Data:
(ISSER, 2009, p. 112)

Table: 9	Sectoral Contribution to GDP, 2000-2008 at Constant 1993 Prices (%)		
	Agric.	Services	Industry
2002	39.5	33	27.5
2003	39.8	32.8	27.4
2004	40.3	32.6	27.2
2005	39.5	32.9	27.6
2006	39.3	32.9	27.8
2007	38	33.4	28.6
2008	33.9	31.8	26.5
2009	34.5	32.3	24.9
Average			
2002-2004	39.8	32.8	27.4
2005-2009	36.3	32.4	27.2

Table 10	Foreign Direct Investments for the Period January 2002 to December 2011									
Item/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Estimated Value of Projects (US$M)	69.7	118	205	213.7	2,367.87	359	3,540.13	627.7	1,278.59	7,686
Sector Breakdown (US$M)										
Agriculture	20.8	8.4	5.76	4.28	6.45	36.39	57.45	102.4	345.19	512.59
Manufacturing	20.7	21.4	28.3	37.41	2,172.78	156.9	236.41	98.06	108.9	358.43
Service	6.71	69.2	97.9	39.72	61.07	54.76	292.96	210.7	609.39	608.73
Other Sectors	21.5	19.5	73.2	132.3	127.57	110.9	2953.31	216.6	215.11	6206

Source: Field Data:

(Ghana Investment Promotion Centre (GIPC) and Ministry of Trade and Industries (2002 to 2011)

4.5.8 The Existing Structures in the STI Policy Environment

The STI policy environment had been characterised by abandoned factories that had sprouted out in the country. For example, the Jute factory sited in Kumasi in the Ashanti

region of the country was built to produce enough cocoa sacks for the country's cocoa industry [see photograph 1, p. 94].

Photograph 1: Abandoned Jute Factory in Kumasi

Source: Author's Field Photos

At the Jute factory site, for instance, it was pointed out that in 1962-1991 the factory had 2000 workers. The factory has now collapsed resulting in Ghana having to import cocoa sacks from Bangladesh and India. Modern gold production in Ghana also started as far back as in the 1860s. Yet the country has had no 'assaying plant' or 'refinery' to add value to the gold production in the country. There had also not been any cost-benefit analysis on the mining sector to inform the development of the STI policy in the country (Chief Executive Officer [GCM]: 21/03/2012). It appears also that the country had lacked mitigation plans on environmental degradation, forest depletion and health hazards due to the mining activities in the country [See photograph 2, p. 95]

Photograph 2: Depletion of Forest in a Mining Area

 Source: Author's Field Photos

4.5.9 The Limitations of the STI Policy

Therefore, in spite of the fact that Ghana had made much investment in science and technology infrastructure at the time of Independence, these investments had not yielded the expected improvement in economic growth and development (MEST, 2010a). This may question the modernity concept, Ghana's investment in science, technology and innovation through the Western model of education, the model of capitalism and Ghana's ideological position with the Bretton Woods Institutions?

To this effect Woolman (2001) had drawn attention to an inherited educational system that had functioned to maintain the colonial order of dependency. Hanushek & Woβmann (2007) had also noted that schooling had not fully delivered its promise of economic success. Coombs and Hallak (1972), however, noted that 'education is

clearly a very important part of every development package, but it is still only a part and cannot produce development by itself' (p.11).

Therefore, to Lewin (2000) the argument needs to focus on the kind of science, technology and innovation that underdeveloped countries like Ghana could afford and would be beneficial to them. Metcalfe (2000) opined that STI policies play an important role but a secondary role in the development process. Kerr (2001), to this effect drew attention to the former Soviet Union that was strong on education to produce scientists and engineers yet experienced a basket-case economy. Godin (2009) also draws attention to the statistical and methodological limitations of the links between investments in science, technology and innovation and economic growth.

4.5.9.1 The STI Policy and Contending Theories

Einaudi (2004), however, points to the vision for the Americas in the Twenty First Century (21st) to suggest that investment in STI is for the improvement in quality of life and economic development of a country. Arocena & Sutz (2002) also noted that in an era of transition to the knowledge economy, the economy of developed countries was solidly based on science, technology, innovation and advanced education. Stevens and Weale (2003) also drew attention to the link between scientific advance and the way in which education had facilitated the development of knowledge. African Technology Policy Studies (2010) also opined that STI policy is the key to foster productivity growth. From the perspective of Schaeper (2009), the increasing investment dedicated to Research and Development (R&D) in STI made by some Asian countries during the decade contributed to the region's surpassing many other developing countries including those of Latin America and the Caribbean. The author further said that the Chinese innovation-oriented policy was strongly tilted towards engineering and applied research in high-technology areas to play an important and active role in science and technology diffusion.

4.6 The development of the National STI Policy in Ghana in 2010

However, while there have been long-standing national recognition of the importance of Science, Technology and Innovation policy in national development, the STI policy in Ghana had been pursued implicitly through the mandates of technical government departments (UNCTAD, 2003) with no definitive and prescriptive National STI policy document in the country before 2000 (MEST, 2010a, 2010b).

Based on the assumption that many industrialised countries of the world such as China, South Korea, India, Malaysia and Singapore and a few other countries had successfully applied science and technology to transform their economy, Ghana's fork in the road to develop an STI policy in 2010 was to mirror the East Asian's path of development to develop and transform its economy from a resource-based economy (cocoa, gold, now oil and gas) to a knowledge- based economy (MEST, 2010a).

With this understanding in 2000, a technology document was adopted by Cabinet (MEST, 2010a). In 2001, a working document on the STI policy linked to the various development plans from 1951 to 2000 was prepared, but became a 'still born' policy document.

In 2005 a significant move was made to hold a high profile conference dubbed the first National Forum on Research, Science and Technology to show case science and technology as a major tool for development. The conference was attended by the key policy makers in the country and closed with a communiqué which spelt out activities and programmes to advance science and technology in the country. The popular application of ICT in Ghana through the Kofi Annan Centre of Excellence, emerging trends in biotechnology and other technologies such as nanotechnology made it imperative for Ghana to review the STI policy for a more effective scientific and technology policy in 2010. In 2010 a National STI policy was developed in Ghana.

Chapter Five: Mechanisms through which STI Policy is formulated

5.1 Introduction

The analysis in Chapter 4 suggests that Ghana is marginalised in technology in spite of the heavy investments made in education at the time of Independence to develop Science, Technology and Innovation policy at the higher education level in Ghana. In this chapter, it is worthy to note that in Ghana, 'the country's educational system is to develop the human resource base of the country. This includes the development of the critical mass of the requisite scientific human resource for the national development' (MEST, 2010a, p.16).

Therefore, the development of the Education Strategic Plan (ESP), the education policy document in Ghana, covers the development of professionals such as the scientists, technologists and innovators in the country (Government of Ghana, 2011a). The education policy document, the 'ESP' was therefore developed to cover the development of Science, Technology and Innovation (STI) policy at the higher education level in Ghana (MEST, 2010a; Government of Ghana, 2011a). It follows that in the Ghanaian context the STI policy at all levels of education including STI policy at the higher education level in Ghana was developed in the Ministry of Education and were contained in the education policy of Ghana which was the Education Strategic Plan (2010-2020). This is the rationale for analysing the STI policy in Ghana through the lens of the education sector.

This chapter is further located in Dale's mechanisms and categories on funding and ownership (Figure 2 in Chapter 2) to structure and shape the analysis to address the research question: what are the mechanisms through which STI policy is formulated? It starts with the locus of the development of the STI policy, funding of the STI policy, Dale's mechanisms, ownership of STI policy developments and finally, on reflection on my Insider Experience and Position.

5.2 The Locus of the Development of the STI policy

Therefore, in this study the locus of the development of the science, technology and innovation policy at all levels of education including higher education was at the Ministry of Education (Government of Ghana, 2011a). Against this background data from the Ministry of Education were classified as the main 'primary source data'. The Ministry of Environment, Science and Technology under the presidency had coordinated and harmonised the STI policies in the country including the STI policies at the Ministry of Education which included the STI policy at the higher education level in Ghana to produce the National STI policy in 2010. Consequently data from the Ministry of Environment, Science and Technology (MEST) were classified as 'the secondary data' (MEST, 2010a).

At the Ministry of Education, the primary source data is the analysis of my observation data and documentary evidence of internal STI policy meetings I participated in during a six month period from the point of my ethical clearance (Table 11), the derivatives of the ESP (Table 12), wider documentation in the periods 2003-2012 that provided useful insights into STI policy development in Ghana (Table 13) and the education sector working group meetings (Table 15) that provided a reflection on my insider experience and position. It is also worthy to note that the education sector policies prior to 2002 were in a fragmentary form.

There was, therefore, the need in 2002 to harmonise all the education policies in the education sector including STI policy at the higher education level in Ghana as Education Strategic Plan (ESP) (2003-2015). This plan was revised in 2010 as ESP (2010-2020). The education policy in Ghana now is, therefore, the ESP (2010-2020) which includes the STI policy at the higher education level in Ghana (NDPC, 2009; MEST, 2010a; Government of Ghana, 2011a). At the Ministry of Environment, Science and Technology, the data collected was the development of the National STI policy which also included the STI policy at the higher education Level in Ghana (Table 14).

5.3 Funding of the STI Policy

This section reports more explicitly on my fieldwork data on observation and documentary evidence that had taken place six month period from the point of my ethical clearance. Apart from the conferences I participated, I selected and provided in details my observation and documentary analysis of one of the meetings (provided in Table 11) in which I participated as part of my fieldwork, where in my professional capacity, I simultaneously wore my professional hat, and my hat as a researcher. This meeting had focused on the development of the STI Policy at the higher education Level in Ghana (as depicted in Table 11). It was conducted on 12 February, 2012 at the Planning, Budget, Monitoring and Evaluation (PBME) directorate of the Ministry of Education (MOE). I participated in this meeting by watching the participants, listening to them, freely chatting with them on some of the issues raised to put the participants at ease and writing my field notes. In writing my field notes, I watched and listened to the message they seem to carry through their interaction and their interest.

The PBME directorate represents the Ministry of Education. It is the nerve centre of the Ministry of Education in the formulation of the education sector policies in Ghana including STI policies (Government of Ghana, 2008). The agenda of the meeting was set by the PBME directory. The main agenda was funding mechanisms in the development of STI policy at the higher education level in Ghana. The different actors involved in this key point of policy formation were national represented by PBME directorate and the Ghana Education Service, sub-national represented by the Universities and the Polytechnics, the state represented by the District Assemblies and the market represented by the Associations of Ghana Industries and the community represented by Professional Science and Technology Based Associations. Absent in the meeting was the development partners' representatives.

In the meeting, I observed that PBME dominated the discussion. The District Assemblies voices were silenced. However, in general I observed the interest of the participants in the funding of the STI policy in the Education Strategic Plan (ESP), their interests in the texts in the ESP, their interests in the different texts in the ESP and the aspect that related to science, technology and innovation and finally their interests to

understand the interests of those who produced the text in the ESP in the way it was done.

On funding for example, in the STI policy documents, there is a political commitment to increase government budgetary allocation to STI policy, at least 1% of GDP. For this to happen, the steps to be taken were preparing bill on funding STI, obtaining Cabinet approval for the STI funding bill and passage of the bill by Parliament. In the meeting, it came out that this was yet to happen. Against this background, the question was what had been factored in the ESP for science, technology and innovation? This was also against the background that the proportion of the national budget allocated to STI has been very low and fluctuating between 0.3 percent and 0.5 percent of the GDP. This is below the one percent target stated in the Lagos Plan of Action target adopted by the African Union. Korea, Singapore and Taiwan for example spend as much as 2 percent of their GDP on science and technology (MEST, 2010a, 2010b).

At the meeting we observed that the Education Financial Simulation Model (EFSM) of the PBME directorate used to cost the Education Strategic Plan (ESP)(2010-2020) had no cost earmarked for the implementation of the STI policy at all levels of education (Ministry of Education, 2011). In spite of the fact that the locus of the STI policy was at the Ministry of Education, it was also noted in the meeting that there was no dedicated funding in the Education policy like the Ghana Education Trust Fund (GETFund), District Assembly Common Fund (DACF) or part of the oil revenue to fund the STI policies in the country. It was also observed at the meeting that there was also no dedicated funding in the National STI policy document produced in 2010.

On the participants' interest in the texts in the Education Strategic Plan (ESP) and their interest in the different texts in the ESP and the aspect that related to science, technology and innovation, first and foremost it is the Education Strategic Plan (ESP) that defines the goals and targets in the education sector. It also guides the Development Partners in supporting education delivery in the country. The ESP, therefore, serves as a guide and provides direction in the development of internal mechanisms and texts

(Government of Ghana, 2008). In the meeting, it was noted that, though the STI policy was one of the strategic objectives of the ESP (2010-2020), the focus of the ESP was rather on access, equity, welfare, quality, skills development, efficiency and effectiveness. The STI policy was subsumed under quality and skill development. This suggested the down play of the importance of the STI policy. This also suggested that the STI policy comparatively was not given the necessary priority in the ESP (2010-2020) (Government of Ghana, 2011a).

Table 11: List of Meetings Participated

Date	Meeting/ Conferences/ Fairs	Status
12 February, 2012	Development of STI Policy at the Higher Education Level in Ghana	Meeting organised by PBME of the Ministry of Education
22 February, 2012	Ghana's Quest for Competitiveness to attract International Investment	Meeting organised by PBME of the Ministry of Education
21-23 March 2012	Reaching for Greater Heights in Science and Technology for National Development 17th Colloquium of the Faculty of Science, University of Ghana, Legon, Accra	17th Colloquium of the Faculty of Science, University of Ghana, Legon, Accra
16-21 April, 2012	3rd Ghana Policy Fair	3rd Ghana Policy Fair
23 May, 2012	Meeting on the Plenary Session of the 2012 National Education Sector Annual Review	Meeting organised by PBME of the Ministry of Education
21-22 June 2012	National Conference For Civil Society in Education in Ghana	National Conference on Civil Society in Ghana

Source: Ministry of Education; The Author's Field Work

While in the Education sector SWOT (Strength, Weaknesses, Opportunities and Threats) analysis in the ESP, the focus was on access and equity, decentralisation, skills development, teaching and learning and tertiary education, the selected key findings of the SWOT analysis table that informed the development of the ESP had no emphasis on the STI policy (Government of Ghana, 2011a). This notwithstanding, in the ESP the STI policy was discussed in the context of science, technical and mathematics education (STME) and in the context of making efficiency gains. Yet, out of the 49 pages only four of the pages contained some elements of the STI policy. Including the content and abbreviations, out of the total 15, 928 words in the policy document, only 259 words were used for the STI policy related issues. This amounted to only 2 percent coverage of STI policies in the ESP document (Government of Ghana, 2011a). Corroborating the interests observed in the discussion, the outcome of the meeting provided insight and understanding of the development of the STI policy in the education sector in Ghana. The strain of thought that emerged from the discussion was that the government of Ghana policy commitment to achieve Education For All (EFA) had led to the neglect of STI policy in general and in particular at the higher education level in the country (Ministry of Education, 2011).

In my field work as a researcher there were also analysis of observation data and documentary evidence of other internal meetings, conferences and fairs on STI policy (provided in Table 11). The observation data focused on participants absent, participants that dominated the discussions or voices that were silenced. For example, in my participation of the 17th Faculty of Science Colloquium organised by the University of Ghana depicted in Table 11, there was nobody from Export Development and Investment Fund to present on the topic *"funding opportunities for Science and Technology'*. The question that agitated my mind was why that missing presentation? Listening to the comments and observing the reactions of the students at the Colloquium suggested that there might not be any funding opportunities for science and technology in Ghana to serve as incentive for the students to learn science. Similar observations were made in other internal meetings I participated.

Following my participation of the internal meetings, I collected the derivatives of the ESP (provided in Table 12) as part of my fieldwork data and analysed to provide further insight in the development of the STI policy at the higher education level in Ghana. These derivatives of the ESP had been translated into agendas, minutes, meetings, workshops and seminars to further inform the development of the STI policy at the higher education level in Ghana. These included the Multi Donor Budget Support (MDBS), Teaching and Learning Innovation Fund (TALIF), the Aide Memoire, the Annual Education Sector Operational Plan (AESOP, Volume III) and the Education Financial Simulation Model (EFSM) used to cost the ESP (Government of Ghana, 2008; Government of Ghana, 2012b). The MDBS was a pool of funds with contributions from 11 different donor agencies working with the Government of Ghana as Development Partners (Government of Ghana, 2008; MDBS, 2008; Ministry of Education, 2011).

It is worthy to note that the focus of the MDBS, PAF, MDG /EFA was at the basic education level. Yet there were no STI indicators at the basic education level. There was also no focus on mathematics and science results at the Basic Education Certificate Examination (BECE) and West Africa Senior Secondary Certificate Examination (WASSCE) (MDBS, 2008; Ministry of Education, 2011). For example in the status report on the implementation of MDBS Performance Assessment Framework (PAF), 2008-2010, the focus was on:

> Net enrolment, gender parity and core text book ratio at the Basic education level and skill development through the expansion of scope and delivery of Technical and Vocational education while the new PAF proposal 2011-2013 focused on pupil contact time, the upgrading and deployment of teachers and gender parity to achieve MDG/EFA targets (MDBS, 2008, p.1).

Further, in the Multi Donor Budget Support (MDBS) arrangement the Development Partners use performance targets and triggers to deduct a percentage of their performance based budget support for targets not achieved. For example, if 1 out of 10 triggers have not been met, the donors were to deduct 10% of their performance linked tranche (Government of Ghana, 2008; MDBS, 2008). The MDBS was supported with

matching and counterpart funding from the government of Ghana. This arrangement also had drawn much attention of the internal mechanisms such as meetings, workshops and seminars to the achievement of the MDBS targets which basically focus on the achievement of the EFA/MDG targets (MDBS, 2008; Ministry of Education, 2011). The 'triggers', according to King (2013), 'are a new form of conditionality, and can be highly confrontational' (p.153).

Moreover, under the World Bank's education sector project (EdSep) strategically aligned to Ghana's ESP, resources were also provided to enhance Ghana's participation in Trends in Mathematics and Science Study (TIMSS) (World Bank, 2012). This was a World Bank support to science, technology and innovation at the basic education level. However, the success story recorded in the evaluation report by the World Bank was that Ghana now has sector level disaggregated data and benchmark for measuring learning outcomes (World Bank, 2012). Yet, these outcomes were not part of the MDBS triggers to enhance the teaching and learning of the STI at the basic education level in the country (MDBS, 2008).

Table 12: Derivatives of the ESP

Dates	Text	Status
8 November 2008	Education Sector SWOT Analysis	Report
February 2012	Education Financial Simulation Model	Financial Model
February 2012	Annual Education Sector Operational Plan	Plan
18 September, 2012	Aide Memoires Priority Activities for 2012/2013	Aide Memoire

Source: Ministry of Education

The World Bank (2012) also contended that seven studies were commissioned prior to the Teaching and Learning Innovation Fund (TALIF) launch or shortly after the implementation process began, to guide the conceptualisation and design of the project namely:

- The Labour Market for Tertiary Graduates in Ghana;

- Expenditure and Revenue Analysis of Tertiary Institutions;

- A vision of Postgraduate Education in Ghana;

- A Strategic Plan for Information and Communication Technology Development;

- Priorities and Strategies for Capacity Building in Tertiary Distance Education;

- HIV/AIDS in Tertiary Institutions;

- Socio-economic background of tertiary students.

Yet there was no study conducted on Science, Technology and Innovation (STI) policy. It is, however, interesting to note that even if an interest in higher education has clearly emerged, the particularly vocabulary or discourses which frame the issue still potentially excluded a focus on STI. This notwithstanding, the success stories on TALIF implementation on improved learning facilities included 39 laboratories and suggest itself to ask: what studies informed the selection of these laboratories and what informed the success story as posited in the World Bank evaluation report on TALIF (World Bank, 2012). TALIF was envisioned as a demand-driven, competitive fund aimed at fostering innovation, relevance, quality and efficiency in higher education. Yet there was little emphasis and analytical work on STI policy at the higher education level in Ghana (World Bank, 2012).

The Government of Ghana represented by the Ministry of Education, the Ghana Education Service, National Council for Tertiary Education and all other subvented agencies including the donors prepared an Aide Memoire after the education sector

review as a reference document to the commitments made by all partners; as a guideline for future policy and strategy; as an opportunity to identify emerging priorities for assistance; document progress made and areas of continued need; and make commitments to the Government of Ghana on the way forward over the coming year (Government of Ghana, 2008).

The Aide Memoire drives the internal mechanisms such as agendas, minutes, meetings, workshops and seminars to the achievement of the key targets in the ESP focusing much more on International commitments such as the EFA/MDG targets. This makes the STI policy at the higher education level in Ghana depend on the Aide Memoire which also depends on the ESP controlled by the donors using external mechanisms like MDG/EFA/FTI process. The signatories to the Aide Memoire are the Chief Director of the Ministry of Education and one Development Partner on behalf of the Development Partners.

The documentary analysis suggests that despite claims that the process in the development of the Aide Memoire was Government led, in reality it was donor led with the Government 'acquiescing' in what the donors broadly want (Government of Ghana, 2008). The Annual Education Sector Operational Plan (AESOP, Volume III) is also one of the derivatives of the ESP to enhance effective implementation of the plan. The Development Partners committed themselves to provide Technical Assistance (TA) to develop the AESOP with much analytical work on basic education but with little emphasis on higher education and STI policy.

5.4 Dale's Mechanisms

Therefore, from the perspective of Dale (Figure 2 in Chapter 2), Ghana's experience in the development of the ESP and STI policy at the higher education level provide some useful insights into the ways that policy developments were influenced by supranational EFA (basic education) objectives, to which nation states signed up, and were then taken forward with their complicity at the national and sub-national level to the detriment of

higher education and STI policy. For example, one of the benchmarks for Ghana to access the Education for All (EFA)- Fast Track Initiative (FTI) Catalytic Fund was:

> On the average teachers' salary in 2002 was equal to approximately 4.0 times the GDP per capita, figure that lies considerable above the EFA FTI benchmark of 3.5. In the proposal it is expected that by 2015, the average salary can be brought to 3.5 times the GDP per capita (Government of Ghana, 2003b, p.5).

The challenge in Ghana was poor remuneration of teachers, in particular science and mathematics teachers to attract them to the teaching profession (Government of Ghana, 2011a). According to Bawumia (2010), the GNI/Capita in Ghana had for long periods stagnated. Therefore, the use of EFA/FTI benchmark on Ghanaian teachers had implications in particular on science and mathematics teachers in the country (Government of Ghana, 2011a).

Therefore, based on the dissemination mechanisms there had been 'strong emphasis on expanding basic education, specifically attainment by 2015 of the Six EFA goals and the two MDGs, relating to education to form the basis for Ghana's bid for additional resources under the EFA Fast Initiative' (Pedley and Taylor, 2009, p.67). This to my understanding had constrained the country to pursue a holiest education including STI policy at the higher education level in Ghana. For example, following the introduction of the government of Ghana new education reforms in 2007 that might had aimed at holistic education in Ghana, Pedley and Taylor (2009) contends that:

> Donors concerns were that the new reforms were not consistent with the ESP and were moving away from the FTI 'indicative guidelines that 50% of the education budget should be devoted to primary education (Pedley and Taylor, 2009, p.67)

Against this background, the EFA-FTI Catalytic Fund was a conditional fund that had been ring-fenced for basic education in general and primary education in particular (Government of Ghana, 2003a, 2008; GLEDG, 2011).

Further, quantitative indicators were also used as mechanisms to steer national policy evaluation and development. For example, following Ghana's membership of the EFA Fast Track Initiative (FTI) and recipient of financial assistance from the EFA FTI Catalytic Fund (CF), Ghana pledged to achieve tangible and quantifiable progress by 2015 in key development areas, as embodied in the six goals of the Education for All (EFA). Ghana further adopted the Millennium Development Goals (MDG) by the United Nations (Government of Ghana, 2008; GLEDG, 2011). Yet, disentangling the EFA/MDGs goals, there was little emphasis on STI policy at all levels of education in general and at the higher education level in particular (Government of Ghana, 2003b; Ministry of Education, 2011). The Millennium Development Goals aim for Universal Primary Education (UPE) by 2015 (i.e. the Universal Primary 6 completion rate by 2015) and gender equality in enrolment at all levels of education by 2015 in particular, gender equity at the Primary level by 2005). The Education for All (EFA) initiative lays out a strategy for achieving these goals (World Bank, 2004; Government of Ghana, 2008). Further, for Ghana to achieve standardisation and to be part of the comity of the modern states, the level of investment in education as a share of gross domestic product (GDP) were to be between 4 and 6 percent (World Bank, 2002).

> In this context, expenditure on tertiary education would generally represent between 15 and 20 percent of all expenditures on public education (The World Bank, 2002, p. xxiii).

Based on these International norms and Ghana's membership of the EFA Fast Track Initiative (FTI) and recipient of financial assistance from the EFA FTI Catalytic Fund (CF), GLEDG contends that in Ghana:

> Expenditure on the tertiary sector as proportion of the MOE budget is to decline by nearly a third over the plan period of the ESP (2010-2020) (GLEDG, 2011, p. 9).

This financial constraint imposed on the development of higher education in Ghana through International norms has implications on the development of the STI policy at the higher education level in Ghana. This is against the background that the policy with the weakest coverage among the donors in the education sector in Ghana was the STI

policy in general at all levels and in particular at the higher education level in Ghana (Ministry of Education, 2011).

5.5 Ownership of STI Policy Developments

This section further locates the development of the STI policy in the framework (Figure 2 in Chapter 2) to draw on Dale's category on ownership. As a researcher, I also collected field data on a wider documentation (2002-2012) (provided in Table 13) and analysed to also provide some useful insights into Ghana's experience on ownership of the STI policy developments.

Table 13: Wider Documentation (2002-2012)

Dates	Text	Status
20 February 2012	Memo on National Conference on Education	Memo
13 March 2003	Education Sector Support Programme (ESSP) Review Recommendations	Letter
25 August 2008	Minutes of Sector Group Meeting in the Education sector	Minutes
12 November 2008	Report on the Implementation of MDBS/PAF, 2008-2010	Report
19 October 2009	Agenda and Minutes of Sector Group Meeting in the Education sector	Agenda and Minutes
7 May 2011	Invitation letter to Technical Group Meeting: Annual Review	Letter
2 August 2011	Statement by the Honouable Minister for Environment, Science and Technology (MEST) (1st Ghana Science Congress)	Statement
2 August 2011	Keynote Address by His Excellency President of Ghana (1st Ghana Science Congress)	Keynote Address
7 May 2012	Invitation to Plenary Session Meeting on National Education Sector Review	Invitation Letter

Source: Ministry of Education; Ministry of Environment, Science and Technology

These wider documentations depicted in Table 13 have also informed the agendas, minutes, meetings, workshops and seminars to further inform the development of the STI policy at the higher education level in Ghana. In 2003 an Education Strategic Plan (2003-2015) was developed for the education sector in Ghana. This became the education policy in Ghana and it included an STI policy at all levels of education. The ESP (2003-2015) was prepared as the EFA section in Ghana (Government of Ghana, 2003c). The process of developing this education policy was also to harmonise all education policies in the education sector in Ghana including all STI policies at all levels of education. This education policy was to inform the education policy direction of the country for government of Ghana and Development Partners to buy into it (Government of Ghana, 2003a).

In 2008 there was the need to revise the ESP (2003-2015). The preparation of the new ESP (2010-2020) commenced in 2008. In the development of the ESP (2010-2020), the donors also not only committed themselves to provide the necessary Technical Assistance (TA) and to channel existing research and analysis into TA programme, but the concept paper underpinning the development of the ESP was also driven by them to achieve the MDG/EFA targets.   A key source of the TA was the Education Programme Development Fund (EPDF) controlled by the World Bank which was also linked with EFA FTI process (Government of Ghana, 2008).

 In February 2010, the Government of Ghana developed a National Science, Technology and Innovation Policy (STI) for implementation (MEST, 2010a).   As depicted in Table 14, the government of Ghana subcontracted the United Nations Conference on Trade and Development (UNCTAD) and the World Bank at the supranational level in collaboration with a consultant from the Science and Technology Policy Research Institute (STEPRI) of Ghana's Council on Scientific and Industrial Research (CSIR) to conceptualise and develop the National STI policy for the people of Ghana in 2010 (UNCTAD, 2011; Senior Research Officer [MEST]: 24/03/2012).   A key input in the development of the National STI policy from the perspective of the education sector in Ghana was the STI policies in the education sector including the STI

policy at the higher education level in the ESP (2003-2015) and its revised ESP (2010-2020). Table 14 provides concrete data on the kind of interactive learning space in which the STI policy at the higher education level was formed.

Table 14: Development of the National STI Policy

(Interactive Learning Space)

Item	Stages of Development of the STI policy	Interactive Learning Space	Gaps
1.	Education Strategic Plan (ESP) 2003-2015 development in 2002 and ESP 2010-2020 development in 2008 including STI policy at the Higher Education level in Ghana.	STI policy development at the education sector level influenced by Supranational EFA (Basic education) objectives.	Complicity at the national and sub - national level to the detriment of Higher Education and STI policy. Yet the ESP was a key input in the development of the National STI policy in 2010 including the STI policy at the Higher Education level in Ghana.
2.	Proposal development and funding to initiate the development of the national STI policy including STI policy at the Higher Education level in Ghana.	The Ministry of Environment, Science and Technology initiated the process in 2009 to develop the proposal and to seek for funding to develop the National STI policy including STI policy at the Higher Education level in Ghana.	Problem with funding to initiate the development of the National STI policy. The World Bank representing the Supra national, however, provided resources to initiate the process. This may suggest lack of Government of Ghana commitment. It also questions leadership role of the government to the development of the STI policy.
3.	Development of the National STI policy	Government of Ghana subcontracted UNCTAD and the World Bank to develop the National STI policy including the STI policy at the Higher Education level in Ghana.	Established institutions representing the national, sub-national, state, market, the community and the family were not involved in the conceptualisation and drafting of the STI policy. This suggests poor interactive learning space in the development of the National STI policy including the STI policy at the Higher Education Level in Ghana.

Source: Author's Field Data derived from Ministry of Education; Ministry of Environment, Science and Technology

The locus of the STI policy at all levels of education including higher education in Ghana at the education sector in Ghana as noted earlier is the Ministry of Education. However, as depicted in Table 14, in the development of the National STI policy in 2010, key actors at the national level like the National Council for Tertiary Education (NCTE) and the Ghana Academy of Arts and Science, sub-national, for example the established institutions like the Universities and Polytechnics in particular, the Faculties of Science and Engineering and Technology, the market, for example the Associations of Ghana Industries and the Professional Science and Technology-Based Associations including Ghanaian scientists and engineers in the Diaspora were absent in the conceptualisation and drafting of the National STI policy.

Table 14 suggests that the World Bank provided the funding for the country to initiate the process to develop the National STI policy including the STI policy at the higher education level. Table 14 may suggest not only poor interactive learning space in the development of the STI policy but the lack of Government of Ghana's commitment and leadership role in the development of the STI policy. This could project outside based interest to the detriment of the national interests in the development of the National STI policy in Ghana.

In line with the harmonisation mechanisms, Ghana was invited to join the EFA FTI and was endorsed for Fast Track Initiative (FTI) in 2004. Ghana has also been voted a Developing Country's Representative on the FTI Steering Committee (Government of Ghana, 2008). It is also important to point out how Ghana also becomes implicated in the governance structure of this initiative (Government of Ghana, 2003b; GLEDG, 2011; Ministry of Education, 2011). This notwithstanding, a key policy intervention in the February 2010 National STI policy Document as posited and encapsulated in the ESP (2010-2020) was to ensure that:

> By 2020, 60% of all students in the Universities and 80% in the Polytechnics and Vocational institutions are registered in science and technology-related disciplines (MEST, 2010a, p.22).

This policy intervention in the ESP (2010-2020) and the National Science, Technology and Innovation Policy (STI) was one of the key strategies to achieve science, technology and mathematics education (STME) objectives and also make efficiency gains in the education sector in particular and the economy in general. For example, based on this STI policy intervention, the ESP (2010-2020) posits that granting of scholarships for University fees was to be reviewed to make efficiency gains.

For example, the policy aimed to cap scholarships at 40,000 students in science and 27, 000 students in the humanities per annum. Polytechnic scholarships were similarly capped at 24,000 technical students and 16,000 non-technical students per annum (Government of Ghana, 2011a). Non–beneficiaries who were eligible for higher education could either obtain private scholarships or pay their own fees. This was to promote the training of scientists and technologists at the Universities up to the level of PhD. A high level of technicians and technologists in large numbers were also to be trained at the Polytechnic level to provide a high skilled human manpower (Government of Ghana, 2011a). Yet the outlined strategic framework of the policy document that provided the strategies by thematic areas across all the sectors of the education in Ghana including the management of education delivery had no word on STI policy.

5.6 Reflection on my Insider Experience and Position.

In my fieldwork as a researcher, I also collected and analysed data as shown in Table 15 on my insider experience on the Education Sector Working Group (ESWP) meetings I attended as the Head of Monitoring and Evaluation Unit of the Ministry of Education (2005-2012) and with the additional responsibility to coordinate the development of the Education Strategic Plan (2010-2020) from 2008 to 2012. The focus of the discussion was on the development of the education policy in Ghana. As pointed out earlier, this includes the discussion in the development of STI policies at all levels of the education sector in Ghana including the STI policy at the higher education level in Ghana. However, reflecting on these meetings provided in Table 15 suggest that the discussions at the Education Sector Working Group meetings in the development of the

ESP (2010-2020), the education policy in Ghana, also focused on basic education to the detriment of higher education and STI policy.

The attendance in Table 15 also suggests that the Development Partners with total attendance of 37 were very active in the Education Sector Working Group meetings that guided the development of the ESP (2010-2020). This was followed by the Ministry of Education (MOE) (34), the Ghana Education Service (GES)(10), the Ministry of Finance and Economic Planning (MOFEP)(2), Non-Governmental Organisations (NGOs)(2), the National Council For Tertiary Education (NCTE)(2) and the Council for Technical and Vocational Education and Training (COTVET)(1).

On the kind of actors involved in the development of the STI policy, the attendance sheet suggests the male voices might have dominated while the female voices were silenced. Out of the total attendance of 88, the male attendance was 56 while the female attendance was 32 (for example, 36 percent of the total attendance). It is also important to note that though external consultants were contracted to develop the ESP, they reported to the Chief Director of the Ministry of Education, Director (PBME) of the Ministry of Education and the Development Partners to accept the work done. In most cases, the Director (PBME) then reports the outcome of the work of the consultants in ESWP meetings.

Therefore, tapping on my insider professional experience, Table 15 may depict that the external consultants were in the minority. However, in terms of the funding, the text, content and the discourses in the ESP, their voices were not silenced and appeared dominated in the development of the ESP and STI policy at the higher education level in Ghana (Government of Ghana, 2008; GLEDG, 2011). For example, the external and local consultants were contracted by the Development Partners to support the development of the ESP and their mandate was to focus on the achievement of the EFA/MDG targets (Mason, 2003; GLEDG, 2011).

Consequently, the text, content and the discourses in the ESP were skewed towards the achievement of the EFA/MDG goals and targets. It made the National Council for Tertiary Education (NCTE) responsible for the Universities and Polytechnics and the development of the STI policy at the higher education level in Ghana not active in the Education Sector Working Group meetings (provided in Table 15). Yet, it was at these meetings that education sector policies on human resource development including STI policy at the higher education level were initiated (Government of Ghana, 2008; Ministry of Education, 2011).

Table 15: The Education Sector Working Group Meetings Revision of the ESP (2010-2020)															
	Date of Meetings	MOE		NCTE		GES		MOFEP		DPs		COTVET		NGOs	
Item		M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	5 May 2008	5	4			5	1		1	6	4				
2	22 May 2008	4	3	1	1	3	1		1	5	3	1			
3	3 November 2008	4	2							4	2				
4	25 August 2009	4	2							4	2			1	
5	19 October 2009	4	2							4	3			1	
	Total Attendance	21	13	1	1	8	2		2	23	14	1		2	

Source: The Author's Field Data (derived from the Education Sector Working Group meetings attendance Sheet)

Note: M=Male   F=Female

Appendix V presents the organogram of the Ministry of Education to show how these different national agencies, directorates and subvented organisations depicted in Table 15 (for example, NCTE and GES) relate to each other. On Education Sector Working Group Meetings, the Ministry of Education lead and coordinate monthly sector meetings involving Development Partners, the Implementing Agencies under the

Ministry of Education and other key stakeholders in the education sector (for example, the Civil Societies and NGOs).

Apart from the regular briefing and debriefing meetings for the Management of the Ministry of Education to assess the status of work in the development of the ESP by the International consultant, the Education Sector Working Group meetings were held to assess the status in the development of the ESP (2010-2020). Among the monthly Education Sector Working Group meetings, Table 15 depicts key sector review working group meetings that informed the development of the ESP (2010-2020) and STI policy at the higher education level in Ghana.

It is important also to note that through the dissemination, standardisation and imposition mechanisms discussed in this chapter, the installing interdependence mechanisms had also been used to link the EFA/MDG agenda to poverty reduction in Ghana (Government of Ghana, 2011a). This is to the detriment of science, technology and innovation to further marginalise the country in technology to produce a low-skilled Ghana to be exploited by corporations (Tikly, 2004; King and Palmer, 2006b; Government of Ghana, 2011a).

This may re-orient the thinking as posited by Robertson et al. (2007) and Thompson (2002) including other scholars, policy analysts and academic commentators that education structures and content had been the means through which Third World countries are controlled, manipulated and exploited to the advancement of the developed countries.

Chapter Six: A Critique of the Interest which shaped the STI Policy Development

Process

6.1 Introduction

Chapter 5 suggests that the underdevelopment of Science Technology and Innovation policy at the higher education level in Ghana can be explained by the overdevelopment of basic education in the country. Chapter 6 is developed through my observation notes in my research diary, interviews and documentary analysis linked with critical discourse analysis (CDA) to address the research question: whose interests prevail through these processes and whose are marginalised? On the interview, the study used multiple perspective approach to interview different actors. The framework (provided in Figure 2 in Chapter 2) was used to structure and shape the analysis; but in a triangulated form to also increase accuracy and quality of report.

The interviews were also not just interview but were more like observation, watching and listening to the participants, their interests and the messages they carry to enable me to probe further to have an insight in the development of the STI policy at the higher education level in Ghana. The chapter first starts to critique the funding mechanisms, the ownership of the STI policy, the policy dumped in the STI policy document and the infant industries in the country. Following this it suggests the way forward for Ghana to develop a more robust STI policy. The chapter is concluded with the role of Ghanaian agency in the development of the STI policy.

6.2 Funding Mechanisms

Locating the interview in Dale's category of funding (provided in Figure 2 in Chapter 2), most respondents believe that the development of the country should be underpinned by scientific model. Yet the country had always been waiting and sitting down for Development Partners to put their money in developing STI policy for the country.

At the national level, the Senior Research Officer in the science, technology and innovation directorate of the Ministry of Environment, Science and Technology, for instance, pointed out that:

> As a country, we are not investing in science, technology and innovation to give us the top best engineering techniques in road construction, the best technology in infrastructure development, housing and waste management' (Senior Research Officer[MEST]: 24/03/2012).

The Industrialist also opined that:

> The government of Ghana since independence have not realised that without initiative drive of the country to develop STI policy, no Development Partner will give Ghana funding to develop STI policy that is competitive(Industrialist [Accra]: 30/03/2012).

When asked further how the STI policy had been developed. At the national level, the Senior Research Officer in the science, technology and innovation directorate of the Ministry of Science, Technology and Environment (MEST) noted that:

> Presented with a draft STI policy report we did not have resources to initiate the process but a copy of the proposal was sent to UNCTAD and the World Bank. The World Bank responded positively for MEST to initiate the process and develop the policy (Senior Research Officer [MEST]: 24/03/2012).

When probed further how the academic institutions survive with the teaching of science, technology and innovation, the Senior Lecturer from the Kwame Nkrumah University of Science and Technology (KNUST) noted:

> As academic institutions it is difficult to survive in science related areas. The government does not give the institutions enough funding for science, technology and innovation. We sustain ourselves based on the enrolment and fees the students pay (Senior Lecturer [KNUST]: 28/03/2012).

Further probe was on the leadership role in the development of the STI policy. The Director of education with a portfolio as STI policy advisor to the Ministry of Education also pointed out that:

> There is a leadership problem in the development of STI policy from the universities up to the government level. We need somebody who can integrate all the departments, medicine, engineering, pharmacy and agriculture to figure out which areas of the economy we need to train the students. We need good leadership to do that. As at now we do not have such a leadership and lack the team work and the institutions are all fighting for the few available resources (Director [Ministry]: 10/04/2012).

The Senior Lecturer from the Kwame Nkrumah University of Science and Technology (KNUST) also noted:

> In the United States they have Science Foundation that plays the leadership role, manage and search for funding in STI. In Ghana we should also have Science Foundation outside the Ministry of Environment, Science and Technology (MEST) (Senior Lecturer [KNUST]: 28/03/2012).

Against this background, GLEDG (2011) contends that a policy that is not resourced cannot be taken seriously. Little (2008) also contends that 'broad statements of goals, objectives and means cannot be taken seriously as policy if resources for their implementation are neither identified nor allocated' (p. 3). To Budd et al. (2006) 'policies can only be developed when actors make their resources available. Without a budget there is no policy to bring the policy process to fruition to provide a justification and direction for various specific initiatives' (p.31). The respondents also suggested the lack of initiative, funding and leadership problem in the development of the STI policy at the higher education level in Ghana.

6.3 Ownership of the Policy.

On the ownership of the policy, most respondents believe that the development of the policy must involve broad consultations of key actors and the government must take the initiative and leadership role. The industrialist from the industrial sector contended that:

Everything is wrong with Ghana's initial approach to use the World Bank, UNCTAD and a consultant to develop the STI policy for the country. The industrialist further posed the question: do the World Bank and UNCTAD know what we need more than us? Further he opined: 'it means we are not thinking and they are thinking for us (Industrialist [Accra]: 30/03/2012).

When asked further whether there could be the need for external expertise in the development of the STI policy? To the industrialist nobody is a customer of knowledge and the country needs team spirit to develop an STI policy (Industrialist [Accra]: 30/03/2012). The Senior Research Officer in the science, technology and innovation directorate of the Ministry of Environment, Science and Technology also contended that:

All the countries that develop STI to enhance the competitiveness of the country and achieve results, the government of those countries first took the initiative to develop the policy before the Development Partners (DPs) came in to support them (Senior Research Officer [MEST]: 24/03/2012).

Further probe on the ownership of the STI policy developed, at the national level, the Senior Officer of the planning, research and development of the National Council for Tertiary Education (NCTE) noted:

I managed to obtain a copy of the STI policy document but I do not remember NCTE being part of the committee that developed the policy. If a consultant is used to develop a policy rather than using the local key stakeholders and their staff to develop the policy, it makes it difficult for the key stakeholders and their staff including the people of Ghana to own the policy. This is one of the weaknesses of the STI policy developed for the country (Senior Planning Officer [NCTE]: 26/03/2012).

At the sub-national level, the Senior Lecturer from the Kwame Nkrumah University of Science and Technology (KNUST) also pointed out:

In developing an STI policy, I think we had first to call for stakeholders meeting, those in government, industry and those in science and technology and hospitals including the universities and research institutions to develop a strategy to develop the policy. In STI policy it is not just one person coming out with the policy or draft to be disseminated at workshops, seminars and websites for comments (Senior Lecturer [KNUST]: 28/03/2012)

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The Senior Lecturer from the Kwame Nkrumah University of Science and Technology (KNUST) further noted that:

> Even though we have all used STI policy, we are all trained for different purposes and we are not going to get consensus from just one person especially on why existing policies did not work (Senior Lecturer [KNUST]: 28/03/2012)

At the national level, the Senior Officer of the planning, research and development of the National Council for Tertiary Education (NCTE) also noted:

> There should have been a general consensus of the policy, the direction and co-operation from the higher education institutions in analysing the policy and own it----Since there were no mechanisms to incorporate the STI policy in the day to day activities, I do not use the STI policy document but use the NCTE strategic plan. Most of the institutions under NCTE such as the Universities and Polytechnics do not quote the STI policy and do not use it in their strategic plans. Higher education is indifferent to the National STI policy produced in 2010 (Senior Planning Officer [NCTE]: 26/03/2012).

The lack of the grass root ownership and the real national identity in the development of the STI policy raise many questions. The question arises as to the role of Ghanaians in reproducing the inequalities? Why is it that the government by passed its institutions and subcontracted the World Bank and UNCTAD to develop the National STI policy? Is it due to the lack of faith in the local –or is it that the government is aligned ideologically with the World Bank or is it just pragmatism? Could it also be a question of loans and grants (MEST, 2011b) with strings attached (NDI, 2010; Matunhu, 2011)? Could it be the government of Ghana strategy to buy the development partners confidence and trust in the development of the STI policy in the country (Pedley & Taylor, 2009)? The question also arises of the World Bank's real interest in developing an STI policy for the country (Wade, 2008)?

6.4 STI Policy and Document Analysis

The key mechanisms intended to inform the development of the STI policy was borrowing and learning from the East Asians experience. The National STI policy document, for instance, noted that:

> The more industrialised countries of the world applied science and technology to develop their economies. ---- South Korea-----Singapore followed their footsteps and have also successfully applied science and technology to transform their economies (MEST, 2010a, p.8).

The National STI policy document is, however, silent about the East Asian's unique contextual development model and experience, strategic trade policies, their development at a time International agreements allowed flexible trade (Green et al., 2007; Wade, 2008; World Bank, 2008). While the East Asian 'tigers' education and STI policies had mirrored and customised to economic delivery with manpower planning and the skills flow to meet future demand (Wade, 2008; World Bank, 2008), it appears in the Ghanaian context, the National STI policy document for 2010 is not informed by any blueprint economic policy for development in the country.

For example, the STI policy document is silent about the number of engineers, scientists, technologists and innovators to be trained in the productive sectors of the economy. The Senior Lecturer from the Kwame Nkrumah University of Science and Technology (KNUST), for instance, pointed out:

> I was a member of the Team that planned and developed the mechanical engineering syllabus and training for the mechanical engineering department of Kwame Nkrumah University of Science and Technology. We could not get any input from our political leaders of the direction and the productive sectors of the economy to determine the number of engineers, scientists, technologists and innovators to be trained (Senior Lecturer [KNUST]: 28/03/2012).

The Senior Lecturer from the Kwame Nkrumah University of Science and Technology (KNUST) further noted:

> Sometimes we ask questions what we were training the students for and we could not answer those questions. The universities expected the government and the politicians to provide answers while the government and the politicians expected the universities to provide answers (Senior Lecturer [KNUST]: 28/03/2012)

The lecturer further pointed out that if we take a place like the United States all their departments have policy and research areas to know where the country is going. To be able to know the areas of the economy where students need to be trained to fill existing vacancies is difficult in Ghana. There is leadership problem in governments and in the universities.

6.4.1 The Protection of the Infant Industries in the Country

Further understanding from the respondents was that the Chinese enterprises including their retailers have flooded in the Ghanaian market. It was therefore difficult to nurture the local infant industries in the country to grow. The problem facing the local manufacturers was the 'Chinese price' (Wade, 2008, p.15) with the cost of production in China about half the price of the cost of production in Ghana. This makes it difficult for the local products in Ghana to compete with the products from China on Ghanaian markets. Questions are also raised about the neo-liberal approach to exchange rate and national economic management (Fitzgerald, 1992) and the 'effect of ultra trade liberalisation measures on the domestic industry that liberalise trade with no limits to what could be imported with the small-scale industries hardest hit' (Ninsin, 1992, p.273). Karikari-Ababio (2001) also contends that this had affected the small-scale industries, destroyed local production and the industrial base of the country.

Fitzgerald (1992), however, pointed out that 'in the case of the industrialised countries agreeing to adopt generalised floating in 1973, their economy was buttressed by sound macroeconomic policies and strong central banks and other institutions of monetary

management which guaranteed an element of stability to their currency' (p.101). Ghana is yet to achieve this. Yet the 2010 National STI policy document is silent about these constraints in the development of STI policy in the country and appeared to lack any mitigation plans to address these challenges confronting the infant industries in the country.

This notwithstanding, 'the multiple equilibrium theory suggests the protection of infant industries even at the cost of short-term inefficiency' (p.21) to build the industrial base of the country (Wade, 2008). The Association of African Universities (2004) also contends that the Universities in the North had been resourced to enjoy tax exemptions and subsidies. The STI policy document is silent on the local universities in Ghana.

6.4.2 The National STI Policy Target

The policy intervention for the humanities/science and technology ratio at the University level as mentioned earlier had been 60/40. The report of the Visitation Panel to the University of Ghana in December 2007 suggested that this humanities/science and technology ratio of 60/40 quoted as a national target has no scientific basis and should be reviewed or discarded (Government of Ghana, 2007). One, therefore, would have thought that with the starting of the TALIF financed by the Government of Ghana and the World Bank, there would have been much analytical work on some of these meaningless national targets after the University Panel's Visitation recommendation. This has not been done and this STI policy target has just been dumped in Education Strategic Plan (ESP) (2010-2020) and the National STI policy document developed in 2010 (MEST, 2010a; Government of Ghana, 2011a).

This may raise questions on the kind of inputs in the STI policy document developed in 2010. It may also suggest that the content and text in the policy document may not be focused and backed by scientific analytical work to achieve relevance of STI policy for the country.

6.4.3 The STI Policy Review

The government of Ghana again subcontracted UNCTAD to conduct STI policy review to inform the development of the National STI policy for the country in 2010 (UNCTAD, 2011; Senior Research Officer [MEST]: 24/03/2012*).* The humanities/science and technology ratio of 60/40 in the STI policy document (MEST, 2010a) was not reviewed in the review document.

Besides, it appears that the STI review document made no reference to the Visitation Panel's report. Yet in the STI review report it was stated that:

> This report reviews Ghana's STI policies and is part of the Government's effort to ensure that policy is supported by practical programmes. Initiated at the request of the Government, and prepared by a team of Ghanaian and International experts, the Review presents recommendations on measures to reform and strengthen Ghana's STI system (UNCTAD, 2011, p.iii).

This suggests asking: Is the humanities/science and technology ratio of 60/40 not part of the area that needs review to strengthen Ghana's STI system? It may suggest that little analytical work might have been done on the content and text in the STI policy review document.

6.4.4 The STI Policy Review Document

The review document produced by UNCTAD has Symbols of United Nations documents. Such symbols indicate a reference to a United Nations document. It suggests asking: is the review document that informed the development of STI policy, Ghana government's document or United Nations' document? These questions have implications to suggest a problem with the ownership of the National STI policy developed in 2010 in Ghana including the STI policy at the higher education level in Ghana.

6.5 The Policies Dumped in the STI Policy Document

Under the National STI vision, goals, objectives and principles, the plan in the policy document amongst others stipulated that:

> Ghana in the 21st Century should not export its Gold, Cocoa, Diamond, Bauxite, etc, unprocessed and unrefined but Ghana must use the skills of a trained and skilled workforce to produce high value-added exports to generate more wealth (MEST 2010a, p.16).

One of the key guiding principles to ensure effective implementation of the STI policy is realism. In the National STI policy document the short-term objectives (up to five years from 2010-2015) was to restructure the entire science and technology machinery, infrastructure and programmes in order to make them more responsive to national needs and priorities in all sectors of the economy. This included:

> Acquisition of skills in high technology areas such as ICT, biotechnology and nanotechnology and their integration into known technologies (MEST, 2010a, p.18)

The implementation plan of the STI policy programme also stipulates the establishment of an effective National Innovation System (NIS) (MEST, 2010b). Moreover, the STI policy aimed at a knowledge-based economy as posited in the development plans in the country (MEST, 2010b). Again the National STI policy states that:

> Ghana's effort to articulate the policy framework for STI applications is linked to the sub-regional commitments as defined by ECOWAS Revised Treaty as well as NEPAD (MEST, 2010a, p.14).

With the over focusing on Basic education to the detriment of the STI policy in the education sector in general to produce a low-skilled personnel in the country it suggests to ask: how can the country get the skilled workforce to refine its primary products, acquire skills in high technology areas, implement an effective National Innovation System, aimed at a knowledge-based economy or commit itself to achieve the objectives in STI policies set by ECOWAS and NEPAD?

The reservation of the respondents was that the country has not even reached the micro level and wonder how Ghana with a weak education and training base in STME and inadequate industrial base can get to the nanotechnology level within a period of five years as posited in the STI policy document.

Against this background, Matunhu (2011) suggests that the New Partnership for Africa's Development (NEPAD) was drafted by the international community and packed for Africa to implement. This according to the author was condemned by many African Head of States and Government. According to Sifuna (2001) the Bretton Woods Institutions also rejected the two Africa initiatives adopted by the Organisation of African Unity (OAU) and UN General Assembly in 1989 as the African Alternative Framework to Structural Adjustment Programme (SAP). Uche (1994), however, contends that 'the executives of the multinational companies, their local cohorts and foreign investors only benefited from the World Bank and International Monetary Fund Structural Adjustment Programme (SAP) in Ghana' (p.47).

6.5.1 The National Innovation Systems

On the establishment of the National Innovation System (NIS), Godin (2009) posits that the concept has had little operational value and therefore has been difficult to implement. In the literature review, the focus of establishing an NIS is on the University Community, the Industry and the Government (Godin, 2009). Yet the Universities and the Industries were not part of the conceptualisation and initial draft of the STI policy document. From the field data, the role of the Government in the development of the STI policy appeared not to have been clearly defined. It suggests asking: what kind of NIS is going to be developed in Ghana?

6.5.2 The Knowledge-Based Economy

With respect to a knowledge-based economy, the understanding from the perspective of Cortright (2001) is that the East Asian tigers took advantage of the new growth theory, through a shift from a resource-based economy to a knowledge-based economy. Ghana can also take advantage of the New Growth theory to shift to a knowledge-based

economy rather than relying on products or commodities such as cocoa, gold and now oil and gas that continue not only to face the problem of diminishing returns but contracts and payment of royalties as well as the volatility and unpredictability of prices. According to Cortright (2001) while the neoclassical model suggests that Ghana can grow rich by accumulating more and more pieces of physical capital (for example, cocoa, gold and now oil and gas), the New Growth theory challenges with the underlying reason that any kind of physical capital is ultimately subject to diminishing returns.

The essential part of the New Growth theory is that knowledge drives growth. The increasing returns to knowledge project economic growth. However, to Metcalfe (2000) all economies are knowledge –based. The difference is the nature of the knowledge, how it is accumulated and applied to practical use. These contending theories on a knowledge-based economy notwithstanding, the concept of knowledge from the understanding of Godin (2009) is not clear and difficult to implement and measure. It appears there is little analytical work done on this concept in the STI policy document. The Industrialist accordingly pointed out that:

> We have abundant solar energy in the country and instead of developing solar panel to produce energy to support the country's infant industries to add value to the productive sectors of the economy, Ghana's attention is being drawn in the STI policy document to produce an atomic rector to produce energy in the country (Industrialist [Accra]: 30/03/2012).

6.6 The STI Policy

It is worthy, however, to note that without a clear commitment to the STI policy in Ghana, it would be difficult for Ghana to achieve the MDG target (Juma, 2004; NDPC, 2010a) and develop (Ayensu, 2006). Yet as noted earlier, the policy with the weakest coverage among the donors in the education Sector in Ghana is the STI policy in general at all levels and in particular at the higher education level in Ghana (Ministry of Education, 2011).

Against this background Kofi Annan, the former United Nations Secretary-General in 23 September 2003 addressing the United Nations-General Assembly 'expressed clearly but in few words (Hornby, 2010, p. 1545) 'of a possible danger or problem in the world' (Waite, 2012, p. 832) to the world body that:

> It has 'come to a fork in the road' to look at globalisation through the eyes of the people to capture faithfully the hopes and fears of our shared humanity (ILO, 2004, p.vii)

This notwithstanding, following the appraisal and acceptance of the revised ESP (2010-2020) in 2011 by the Development Partners as a credible policy document for implementation, Ghana is selected as one of the 50 countries in the Post-MDGs 2015 to benefit from the Global Partnership for Education Fund Project (GPEF) (2012-2016). This project is translated into a World Bank facility of US$75.5 Million. Yet the focus is on quality, access, gender and management at the basic education (Government of Ghana, 2011a; GLEDG, 2011; Ministry of Education, 2012). Ghana's inclusion in the GPEF may suggest itself to ask: is this part of the scheme of work to position Ghana as a country with low- skilled personnel to be subjected to the exploitation by corporations? What future do we envisage for Ghana? What is the future of STI policy formation in Ghana?

6.7 Development of the Best Scientists, Technologists and Innovators

Therefore, on the future of the STI policy formulation in Ghana and on the question of how to get the best scientists, technologists and innovators at the higher education level, the reservation of the respondents was that in the short-term and medium-term, the focus should be on the industrial needs to support science and technology to build the capacity of the institutions to enable them build a solid foundation in science, technology and innovation through reverse engineering to master existing technologies. The capacity of science and technology Officers from the higher institutions is also to be built to train, for example the technicians and electricians to acquire simple scientific standards. Ghanaians are also to be educated on the environment such as the effect of dumping plastic waste in the country's water bodies.

The consensus among the respondents is that, in the long-term (for a period of 15 or 20 years) the focus should be at the Nursery level and it will only take the country 15 years to get the best scientists at the higher education level. From the perspective of higher education funding regime and employment conditions of science lecturers, the respondents contended that science is for the industry and if one is a science lecturer and does not have consultancy in the industry, one loses one's job since as a science lecturer one must not only read, but improve on what others have done to add value to the systems in place. They noted that at the moment the factories are not there. They, therefore, suggested the need for a trade and investment policy so that within this period of 15 years, the country also thinks of factories the children and students will practise and work in and also how they will be connected internationally.

Most of the respondents' contention was that the scientific basis in the country is wrong and if science is developed from the base, the country would not need external resources to develop the STI policy because we have all the facilities in the country. Besides, if we trained the pupils and students well from the start of the education ladder and continued through-out the education ladder and provided them with factories to practise, they would build their own equipments to further enhance the teaching of science and technology in the country to demystify science (Senior Research Officer [MEST]: 24/03/2012; Senior Planning Officer [NCTE]: 26/03/2012; Industrialist [Accra]: 30/03/2012); Senior Lecturer [KNUST]: 28/03/2012).

Reflecting on the reservations of the respondents, I drew lessons from Djangmah (2009) when he wrote:

> Equipment and other resources are required to establish and run any scientifically based enterprise; it does appear, however, that with competent staff and very good students Ghana was able to establish a world class Medical school in 1964 from local resources and personnel. ---With limited resources and from local resources without state of the art equipment Korle Bu Medical School ended up producing competent Ghanaian doctors and in the process had trained more doctors for America than Ghana (Djangmah, 2009, pp.3-4).

The respondents noted that at the foundation level the focus of education could be broadened to include, for example the Montessori type of education to create the

interest in science, technology and innovation. Instead of teaching only rhyme, the children are taught how to use logo and zigsaw puzzles. From the respondents' perspective, they are not being trained to become only technicians but to become adaptive, useful and do things on their own. The industrialist, for instance, chimed in that:

> Technology is changing but if we start the development of STI policy at the Nursery level they will grow with the system to adapt to the changes at the University level (Industrialist [Accra]: 30/03/2012).

The respondents further stated that until we develop the basis, it is just like pluming the tree. We need to grow a new tree. Taking a typical Nursery school in the country we could analyse the number of doctors, engineers, nurses and scientists from that school and grow. They, however, iterated that somebody will say this is the communist way of doing things and they further pointed out that even the British and Americans do it. From this perspective, the Industrialist again shed light on Newton's experience:

> When Newton sat down and saw the gravity pulling the apple down and it does not go up, he sat down and thought about it and explained. This is how we need to train our children to observe our environment, think about it, explain scientifically and apply to solve problems in the country to demystify science in the country as posited by the vision of the first president of Ghana, Dr. Kwame Nkrumah to solve the practical problems in the country (Industrialist [Accra]: 30/03/2012).

The consensus among the respondents was that the priority of the country in developing the STI policy should not be buildings but on product and process development. A senior lecturer from the Kwame Nkrumah University of Science and Technology, for instance, opined that:

> It has taken us a long time to develop an effective STI policy because of the country's priority. --- We want products and the priority should not be building but be much more on product and process development and people who develop product and process rewarded (Senior Lecturer[KNUST]: 28/03/2012).

6.8 The Role of Ghanaian Agency in the development of the STI Policy

The field data suggests that the National STI policy including the STI policy at the higher education level developed in 2010 lack grass root ownership and real national identity. From the perspectives of Bich-Thuy and Freire (2004) and Budd et al. (2006), a policy that lacks grass root ownership and real national identity pays little attention to its technocratic problem-solving part and dwells much more on divergent societal interests as depicted in Figure 6 to affect the efficacy and predictive power of the policy.

Figure 6: Parts of a Policy

Technocratic problem-solving part of the policy

Divergent societal interests (e.g. inheritance)
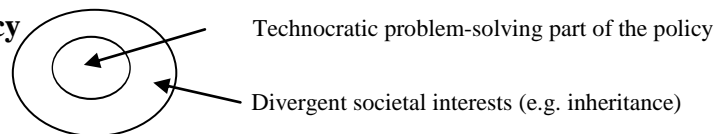
Source: Derived from (Budd et al. 2006)

As I understood from Budd et al., (2006), producing a policy with no technocratic problem - solving part or with little attention drawn on this part is like a hen producing an egg without an egg yolk which provides food for the embryo (chick) and as such no fruition. This from the perspective of Friedmann & Wayne (1977) could lead to external control. It could also lead to direct controls and dependency relations (Bollen, 1983) including mechanisms of exploitation (Sifuna, 2001) that could subject the country to foreign penetration and controls (Rossem, 1996). This from the perspective of Matunhu (2011) could lead to the country to lose its identity and development path.

This notwithstanding, however, limited the role of Ghanaian agency in the formulation of the STI policy, the Senior Research Officer [MEST]: 24/03/2012) contends that a series of workshops were organised for the key stakeholders for their comments and inputs in the draft STI report produced by the World Bank and UNCTAD to be factored in the draft STI report. According the senior research officer the draft was also sent to the various ministries, agencies and departments to receive their comments. Feedbacks were also sent based on their comments.

The draft policy documents were also on the website and people on the Diaspora also gave their comments to be fed in the report. There were also individual institutions which were identified as key stakeholders and experts to form a quorum to review the draft. These individual institutions included the universities such as the Kwame Nkrumah University of Science and Technology and the research institutions. The public were also informed by selecting some experts with a letter and a draft copy for their comments. At least one comment was received from each of the Ministries such as the Ministry of Education and Ministry of Trade to be factored in the report and they were given feedback on their comments (Senior Research Officer [MEST]: 24/03/2012). However, from the perspectives of Uche (1994), Thompson (2002) and Matunhu (2011) the use of the UNCTAD and the World Bank to the neglect of the established institutions in Ghana to conceptualise and produce the draft 2010 National STI policy in Ghana may rather promote the western imperialism interest to the detriment of the national interest.

Educators had also viewed policy problem or rhetoric much more with implementation than the process of generating or developing the policy (Budd et. al. 2006; Lall, 2007). With this understanding, the conventional knowledge in Ghana had attributed the problem of a policy in Ghana to implementation of that policy than the development of the policy (Government of Ghana, 2008).

The weaknesses that had been unearthed in the development of the education policy and the National STI policy in general and STI policy at the higher education level in Ghana in particular, had also critiqued this conventional knowledge in Ghana or assumption. This may suggest that the factors that affect the outcome of a policy may include how the policy is developed, its implementation, the government economic policy, the international commitment and the dominant development theories, discourses, policies and practices in the country.

Chapter Seven: Summary and Conclusion

7.1 Introduction

This thesis is a case-study, a small-scale, qualitative insider research, an ongoing development of Science, Technology and Innovation policy at the higher education level in Ghana. In the 1950s, Ghana emerged as a model of decolonialisation on the African continent. On some parameters, her level of development was at par with countries in South East Asia. Ghana at Independence can be said to have had a substantial institutional capacity for human resource development in science, technology and innovation. Yet Ghana is marginalised in technology and productivity. The current state of STI policy in Ghana, therefore, had raised many questions.

Ghana's fork on the road had not mirrored the East Asian experiences and practices characterised by their unique contextual development model and experience and strategic trade policies such as promotional, selective intervention, shield policies and manpower planning that had ensured that the flows of skills from the education and science, technology and innovation system met their future demand. Ghana had rather perpetuated a dependent model of development that had been unhelpful and made it difficult to synergize education and the economy to technologically transform the economy and improve the living standard of Ghanaians.

This notwithstanding, Ghana's fork on the road to develop an STI policy in 2010 was to mirror the East Asian's path of development to develop and transform its economy from a resource-based economy (cocoa, gold, now oil and gas) to a knowledge- based economy. The focus of the thesis is how the 2010 STI policy was developed and how it privileged different interests and what are the implications for the country. This study has used a framework of dependency theory as the theoretical framework to analyse the limitations of the STI policy. Dale's mechanisms have been used as the methodological framework to structure and shape the empirical evidence to link the theory with the empirical evidence. Following this the interpretive paradigm approach had been used to provide an in-depth insight and understanding of the STI policy.

7.2 Summary

The chapters (2 and 3) have covered International debates on the STI policy. The chapters have moved on to unpack the Ghana case. A theory of dependency emerged out of the literature review. Following this, a framework and strategy were developed to apply to the case of Ghana. In the empirical and data analysis chapters (4, 5 and 6), in a constructivist analysis, the interpretive paradigm approach, the notion of triangulation and reflexivity has not only helped to privilege the multiple perspectives but to also illuminate the complexity and differences among the participants and other data sources to improve the quality of the data analysis. The field data analysed were documentary data, interview transcripts, interview notes, observation data and field notes. In the process of the analysis of the field data, perspectives that have emerged as themes and categories to explain the development of the STI policy at the higher education level in Ghana were critiqued and discussed. This has helped to highlight the importance of human action, experience and perspectives of policy-makers in Ghana.

7.2.1 The Significance of the Thesis

Guided by my research matrix plan (details provided in Appendix II) the theoretical gap identified in the literature was little analytical work on Science, Technology and Innovation policy at the higher education level in Ghana that may lead to the growth and development of the country. The use of the dependency theory had helped me to explore colonialism and imperialism in Ghana which could have been ignored if modernisation theory had been used. It had distinctively emphasized the cultural aspect of the research from colonialism, to independence, post-independence to neoliberalism. This had situated the study in Ghana's socio-economic and political history. Further, the case-study approach and qualitative data had provided an in-depth insight and understanding in the development of Science, Technology and Innovation policy at the higher education level in the Gold Coast/Ghana. It had also provided an in-depth insight and understanding of the motives and intention that had underpinned the underdevelopment of Science, Technology and Innovation policy at the higher education level in Gold Coast/ Ghana.

Moreover, from the perspective of the learning divide concept that suggests that Science, Technology and Innovation policy at the higher education level, its acquisition and utilisation had contributed immensely to the divide between the developed and underdeveloped countries, the unique wealth of information provided in this study in the Ghanaian context could serve as a guide to underdeveloped countries, in particular in the sub-Saharan Africa that may share commonalities with Ghana. The thesis has also been the first research work on the revised current education policy in Ghana and the current National STI policy in Ghana developed in 2010. It would, therefore, contribute to education and development in Ghana and further contribute to the global debates on educational policy and STI policy in this period of rapid globalisation.

7.2.1.1 The Main Theme in the Thesis.

The main theme that had run through the thesis was that the over focusing on basic education to the detriment of Science, Technology and Innovation policy at the higher education level in Ghana had marginalised the country in technology to produce a low-skilled Ghana to be exploited by corporations. On the low-skilled Ghana to be exploited by corporations, Gold Coast/Ghana was among the marginalised countries with technology achievement index (TAI) of 0.14 and ranked 63th position out of the 67 countries. South Korea was ranked 5th position with TAI of 0.67. Malaysia was ranked 28th position with TAI of 0.40. Finland topped the list with TAI of 0.74 while the world average was 0.40. On manufacturing value added (MVA) in GDP, Ghana recorded MVA per capita (in US$) to be 43 compared to 3434 in South Korea and 1258 in Malaysia. Ghana's productivity gap, value added per agriculture worker had to be increased by a factor of 3 to match the Philippines or by a factor of 10 to reach Brazil's productivity level. These countries had competed with Ghana on agricultural products. Further understanding in the thesis was that with the low literacy rate in science, technology and innovation in the content of education in Ghana, extra year of education to a Ghanaian worker could only increase output by 2 percent. South Korea had a high literacy rates in Science, Technology and Innovation in their content of education. Consequently an extra year of education could increase their output by 12 percent.

7.2.1.1.1 Exploitations by Corporations

At Independence the study suggests that Ghana's output of cocoa was the largest in the world. Yet there was not a single cocoa processing factory in the country to add value to her cocoa products. Gold production had been in the country for more than 100 years. At Independence, Ghana produced 10% of the world's gold. Modern gold production in Ghana started as far back as in the 1860s. Yet the country has not had any 'Assaying Plant' or 'Refinery' to add value to Gold Coast/Ghana's gold. The country had continued to export gold with little value addition since the colonial era. There has also not been any cost-benefit analysis in the mining areas in the country to suggest mitigation plans that could really address the environmental degradation, forest depletion and health hazards as a result of the mining activities in the country. For more than forty-six years (1966-2012) the ideology of the country had been under the control of the Bretton Woods. The study suggests the difficulties the country may face in pursuing an independent reflationary Science, Technology and Innovation policy. It would also be difficult for the country to pursue an independent economic development to develop and transform the economy of Ghana.

It is, therefore, worthy to note that improving the living standard of the Ghanaians under these conditions would be very difficult. The implication of this had been greater attention paid to measures of economic growth such as the GDP with little attention paid to life expectancy, literacy, infant mortality, holiest education and the like. Moreover, from the historical perspectives, academic commentators and policy analysts had also drawn attention to the looting of Ghana's gold for the development of Europe, the inhuman chattel slavery, Ghanaian labored as chattel slaves in the Americas producing the cheap raw materials that helped to generate Europe's commercial and industrial revolution rather than producing the goods and services needed for economic development in Ghana. Against this background, the understanding was also that the Executive of the Multinational Companies and their local cohorts rather had benefitted from the international programmes introduced in the country since the 1980s. These programmes included the structural adjustment programmes.

7.2.2 Ghana's Experience in the Development of STI Policy

The study, therefore, suggests that there is the need for a radical reform of the structure and systems in Ghana, in particular to restructure the content of education to build a solid foundation for the development of the STI policy in the country. The problem with the current annual growth of GNI/per capita as far as in the 1950s to date suggests that it would take Ghana about 500 years to reach that of South Korea in 2008. The thesis had, therefore, provided a solid critique of the country's economic policy and International commitments that perpetuate a dependent model of development to the neglect of Science, Technology and Innovation policy at the higher education level in Ghana. The study, however, had made a clear distinction between diffusion model and dependency model. Development through outside influence was defined as the diffusion model while foreign penetration and exploitation that lead to underdevelopment was defined as the dependency model. This helps to provide a clear understanding in the study not to suggest that all outside influences lead to underdevelopment in Ghana.

7.2.3 The Research Questions

Chapter 4 was developed through the reviewing of the literature to address the research question: what is the history of STI policy development in Ghana? This chapter had tracked Gold Coast/Ghana's indigenous education prior to 1800, the growth of formal education (1800-1950), Ghana at Independence (1951-1966), the post-independence era (1967-2002) and the development of the STI policy in Ghana in 2010. This chapter suggests that the kind of the material base colonialism introduced into Gold Coast/Ghana from 1800-1950 through education were western imperialism interests which were outside based interests that led to foreign penetration, control and exploitation. Against this background, the science, technology and innovation policy in the colonial era by the Education Committee of the Privy Council in 1847 was not implemented. Though, the policy sought to the development of a thriving agricultural economy in Ghana. Further, the outside based interest in Ghana made it difficult for the country to develop its own unique development model to develop and transform its economy as experienced in the East Asian countries. This notwithstanding, at the time

of Independence (1951-1966) Ghana invested heavily in science, technology and innovation at its university level to transform its economy.

However, the infiltration of the West in Ghana's ideology and culture for about 46 years (1966-2012) rather marginalised the country in technology. This was achieved through the structural adjustment programmes introduced in the 1980s to implement disciplinary mechanisms such as poverty-conditional lending and poverty reduction strategies. These programmes gave priority to basic education to the neglect of secondary, technical and higher education. It was in fulfillment of this condition before Gold Coast/Ghana could access donor funding. In this equation the rates of return analysis was made the rationale for investment in education to target primary education as the priority to reduce poverty in Ghana. In 2000, however, a technology document was adopted by the government. This document was reviewed in 2001 but became a 'still born' document. In 2005, a significant move was made to develop a National STI policy and in 2010 a National STI policy was developed in Ghana.

The focus of chapter 5 was the analysis of my observation data and documentary evidence of the internal STI policy meetings I participated six month period from the point of my ethical clearance to address the research question: what are the mechanisms through which STI policy is formulated? In Ghana the Education Strategic Plan (ESP)(2010-2020) is the current education policy in the country. The development of this policy document for the education sector in Ghana includes the development of the science, technology and innovation policies at all levels of education including science, technology and innovation policy at the higher education level in Ghana.

Against this background, the country's education system was to develop the human resource base of the country. This included the development of professionals such as the scientists, technologists and innovators in the country. The locus of the analysis was, therefore, on the Ministry of Education responsible for the formulation of education sector policies including STI policy at the higher education level.

Further focusing on the education policy and the Education Strategic Plan (ESP)(2003-2015) and its revised version ESP (2010-2020). This was supported with data from the Ministry of Environment, Science and Technology responsible for collation and development of the various Ministries, Agencies and Non-Governmental Organisations' science, technology and innovation policies. With the application of Dale's mechanism and categories on funding and ownership to structure and shape the analysis (Figure 2 in Chapter 2), it was revealed that the EFA/MDG agenda, a policy from the North to the South had further marginalised Ghana in technology. For example, in line with the harmonisation mechanisms, Ghana was invited and joined the Fast Track Initiative in 2004 and voted a Developing Country's Representative on the FTI Steering Committee. The EFA FTI Catalytic Fund was a conditional fund ring-fenced for basic education in general and primary education in particular. Following this, the education policy in Ghana developed in 2010 was purposely earmarked to achieve the EFA/MDG targets, focusing on basic education to the detriment of STI policy at the higher education level in Ghana.

For example, the education financial simulation model (EFSM) used to cost the education policy in Ghana had no cost earmarked for the implementation of the STI policy at all levels of education. Out of the 49 pages of the education policy in Ghana, only four of the pages contained some elements of the STI policy. Including the content and abbreviations, out of the total 15, 928 words in the policy document, only 259 words were used for the STI policy related issues. This amounted to only 2 percent coverage of STI policies in the education policy in Ghana. The multi donor budget support (MDBS), the focus on the performance assessment framework indicators also neglected STI policy indicators. The selected key findings of the SWOT (strength, weaknesses, opportunities and threats) analysis table that informed the development of the ESP also had no emphasis on the STI policy. The Teaching and Learning Innovation Fund (TALIF) was one of the derivatives of the education policy in Ghana. It aimed at fostering innovation, relevance, quality and efficiency at the higher education level. Yet in conceptualising and developing this derivative, seven studies were conducted without a study on science, technology and innovation policy.

Chapter 6 was developed through the observation notes in my research diary, interviews and documentary analysis linked with the critical discourse analysis (CDA) to address the research question: whose interests prevail through these processes and whose are marginalised? The multiple perspective approach used to interview the different actors and the data analysed in a triangulated form including the documentary analysis suggested that the supranational interests prevailed while in particular the national and the sub-national interests were marginalised. For example, in the development of the STI policy at the higher education level in Ghana; the Development Partners in particular the United Nations Conference on Trade and Development (UNCTAD) and the World Bank were subcontracted by the government to produce the STI policy document. Established Institutions like Ghana Academy of Arts and Science, the Universities and Polytechnics, the Faculties of Science and Engineering and Technology, the Associations of Ghana Industries and the Professional Science and Technology-Based Associations were neglected and marginalised in the development of the STI policy at the higher education level in Ghana. It was revealed through documentary analysis that the policy document lacked mitigation plans to address the challenges confronting the infant industries. Policies were also dumped in the policy document. This notwithstanding, workshops, website, quorum, universities such as Kwame Nkrumah University of Science and Technology, research institutions, ministries in particular Ministry of Education and Ministry of Trade and technocrats subjected the National draft STI policy to critical review to produce the National STI policy in 2010.

On the question: what are the implications of this data for the STI policy formation? The material base colonialism introduced into the country and nurtured through Western education in Gold Coast/Ghana have had implications to promote the western culture to the detriment of the Ghanaian traditional culture, values, structures and development models. The economic base of the country had also been controlled by the foreign ownership, monopolies, and the IMF/World Bank all of which are outside based interests. In the 1980s the use of the installing interdependence mechanisms to focus attention on the rates of return analysis as the rationale for education expenditure in Ghana to further focus on poverty reduction had shifted Ghanaians interests (civil

society, media, NGOs, ministries, agencies and district assemblies) to outside based interests to target on basic education to reduce poverty in Ghana to the detriment of STI policy at the higher education level in Ghana. This notwithstanding, the draft 2010 National STI policy was internally subjected to critical review and participatory approach. Yet the government to subcontract the World Bank and UNCTAD to produce the STI policy to the neglect of its established institutions in the country may rather promote the western imperialism interest to the detriment of the national interest.

7.3 A Claim to Knowledge

The study has first demonstrated the importance of science, technology and innovation policy and its neglect in Ghana at least since the 1980s. Secondly, the study has demonstrated that Ghana's fork in the road has not led it to mirror Asia but to perpetuate a dependent model of development that has been unhelpful. The study, therefore, suggests an ethical aid policy to lead Ghana to the road of self-reliance and independent economic development. Thirdly, the study has demonstrated that Ghana's trajectory to modernity through education had produced low-skilled personnel in Ghana to be exploited by corporations. This gap had been perpetuated with the over focusing on basic education to the neglect of STI policy at the education Sector in Ghana.

This has had implications to perpetuate and create a gap of inadequate number of scientists, engineers, technologists and innovators in the productive sectors of the economy to transform the economy from a resource-based economy (cocoa, gold, now oil and gas) to a knowledge-based one. The study, therefore, suggests a dearth of knowledge and understanding of the dominant development theories, discourses, policies and practices at the leadership position in Gold Coast/Ghana that had further positioned Ghana to play a periphery role in negotiations and make it difficult for the country to have successful engagement with the global economy.

Further, there is the lack of a blueprint economic policy for development with lack of manpower planning of skills flow to meet future demand, clear-cut ideology and

direction of the country. This has implications to make it difficult to subject the foreign ideas to rigorous analytical review to develop an STI policy with real national identity and ownership to serve as an incentive to ensure effective implementation of the policy. The poor interactive learning space in the development of the 2010 STI policy (for example, the government to subcontract the World Bank and UNCTAD to the neglect of its established institutions) has implications to make it difficult for the country to also pursue an independent reflationary STI policy at the higher education level in Ghana.

The weaknesses unearthed in the development of the education policy and the National STI policy in Ghana had also critiqued the conventional knowledge in Ghana that the problem with policy in Ghana had been much more with the implementation than the development of the policy. To this effect, the study suggests that policy outcomes may be looked at holistically: from the perspectives of how the policy was developed, its implementation, the government economic policies, the international commitments and the dominant development theories, discourses, policies and practices in the country.

It may, however, also appear to be a paradox that although I have critiqued the focus on primary education in EFA, my conclusions advocate further focus on primary education, in particular at the nursery education level, rather than the development of secondary and higher education, or alternative systems of education or apprenticeships for those who are beyond the traditional schooling age, and whose basic education was inadequate. It needs, however, to point out that my main argument have not been a critique of primary education in EFA agenda, but a critique of primary education in EFA to the detriment of STI policy at all levels of education and, in particular at the higher education level in Ghana: a critique of the country's economic policy and International commitments that perpetuate a dependent model of development to the neglect of STI policy in Ghana. Therefore, my argument about the primary education in EFA agenda would have lacked substance, if in the EFA agenda in Ghana priority had been given to STI policy developments in Ghana.

The question may also be: whether professions like scientists, engineers, technologists and innovators can be developed at the nursery level. The question again is: what about using the EFA agenda to create interest and build a solid foundation in science, technology and innovation at the base of the education ladder in Ghana? To develop the best scientists, engineers, technologists and innovators at the higher education level to enhance the country's competitiveness, I have, therefore, advocated in the long-term, the need to broaden the base of the education policy in Ghana to include science, technology and innovation. This is also a claim of knowledge I am adding to the EFA agenda in Ghana to grow and nurture the interests in science and technology and innovation from the base to the higher education level in Ghana. This is to enhance the literacy skills in science, technology and innovation in the education policy in Ghana to technologically enhance the transformation of the country.

7.3.1 STI Policy Formation in Ghana

For Ghana to develop a more robust STI policy, the study suggests a paradigm shift from poor interactive learning space to an interactive learning space that is rich to establish the Science Foundation outside the Ministry of Environment Science and Technology to provide leadership drive to support the development of the STI policy at the higher education level in Ghana. In the short and medium term (at least within the next five years) the focus should be on the industrial needs to support science and technology to build the capacity of the institutions to enable them build a solid foundation in science, technology and innovation through reverse engineering to master existing technologies. The capacity of Science and Technology Officers from the higher institutions is also to be built to train, for example the technicians and electricians to acquire simple scientific standards. Ghanaians are also to be educated on the environment such as the effect of dumping plastic waste in the country's water bodies. The country also builds the capacity of the Universities and Polytechnics and tap on their internal capacity, a regeneration approach, to develop in interest in science at the foundation level of the education ladder in Ghana to progressively produce good scientists, engineers and technologists at the higher education level.

Therefore, in the long-term, the study suggests that within a period of 15 or 20 years the country should develop interest in science at least at the nursery education level to progressively produce good scientists, engineers and technologists at the higher education level in Ghana. Within this period the country should also think of how to connect them internationally to get the needed exposure and build industries and factories to provide the students with gainful employment to make them productive in Ghana. The focus of the training in STI development in Ghana is to be on product and process development with students, lecturers and the institutions rewarded accordingly. To achieve this, an interactionist model underpinned by a rich interactive learning space is recommended as an analytical tool and a guide for STI policy formation in Ghana to build the capacity of higher institutions in science, technology and innovation in the short, medium and long-term. The study, therefore, suggests an interactionist model with independent relations involving higher education, donors, industry, scientists, engineers and technologists in the country and in the Diaspora and civil society to provide rich interactive learning space for STI policy formulation in Ghana to enhance the country's competitiveness and development in science, technology and innovation.

7.3.1.1 Enhancing the Country's Competitiveness

To enhance the country's competiveness, the concept paper, the conceptualisation and the initial draft of the STI policy, for example need to be developed with the active participation of internal experts and technocrats such as the Ghana Academy of Arts and Science, the Universities and Polytechnics, the Association of Ghana industries, the Professional Science and Technology Based Associations and the Faculties of Science, Engineering and Technology including the Ghanaian Scientists and Engineers in the Diaspora and the Industrialists in the country. There is also the need for leadership and initiative drive and commitment of the government to develop the STI policy to achieve global competitiveness for the country also to be at the top of globalisation.

The STI policy document needs also to include a long-term manpower and development policy plan linked to a clear-cut economic policy with credible labour statistics (the

number of scientists, engineers and technologists needed in the productive sectors of the economy) to not only enhance the development of definitive programmes for job market readiness but get the requisite skills needed in the productive sectors of the economy. There is also the need for the STI policy to give priority to shield, protection and promotional policies to discourage imports and encourage exports and the development of the infant industries in the country to add value to primary products in the country. This is to enable the country to retain the surplus value of production in the country for further development.

7.4 Future Research

7.4.1 Attitudes of Ghanaians

The fundamental question that appears to have emerged from the field data is: Is the attitude of the policy makers in the education sector in Ghana a threat to the development of the STI policy at the higher education level in Ghana? The field data suggests that Ghana fork in the road has not led it to mirror Asia but to perpetuate a dependent model of development and neglect of the STI policy that have been found to be unhelpful. The gap of inadequate number of scientists, engineers, technologists and innovators in the development trajectory and agenda in the country is further perpetuated with the over focusing of basic education to achieve International commitments such as the EFA/MDG goals and targets to the neglect of STI policies in the education Sector. The structure of higher education and STI policy funding had also been critiqued. The attitude of the policy makers in the education sector in Ghanaian is, therefore, a fundamental question that may need further investigation to further enhance the development of the STI policy at the higher education level in Ghana. It will therefore be very constructive to carry out research on the attitude of policy makers in the education sector in Ghana in the development of the STI policy at the higher education level in the country.

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Appendix I: **Indicators of the Technology Achievement Index (TAI)**

Type of Indicator	Indicator	Unit	Definition
Creation of Technology	Patents	Patents granted per 1000,000 people	Number of patents granted to residents to reflect the current level of invention
	Royalties	US$ per 1000 people	Receipts of royalty and license fees from abroad per capita so as to reflect the stock of successful innovations of the past that are still useful and hence have market value
Diffusion of recent innovations	Internet	Internet hosts per 1000 people	Diffusion of the Internet indispensable to participation in the network age
	Export	%	Exports of high and medium technology products as a share of total goods exports
Diffusion of old innovations	Telephone	Telephone lines per 1000 people (log)	Number of telephone lines (mainline and cellular), which represents old innovation needed to use newer technologies and is also pervasive input to a multitude of human activities
	Electricity	Kwh per capita (log)	Electricity consumption which represented old innovation needed to use newer technologies and is also pervasive input to a multitude of human activities.
Human Skills	Schooling	Years	Mean years of schooling (age 15 and above) which represents the basic education needed to develop cognitive skills
	University	%	Gross enrolment ratio of higher education students enrolled in science, mathematics and engineering which reflects the human skills needed to create and absorb innovation

Source: Gudyanga (201

Appendix I1: Research Matrix Plan

Research Questions	Methods/Instruments	Data Source
QI: What is the history of STI policy development in Ghana?	Literature review linked with documentary and Critical Discourse Analysis (CDA) and observation of empirical data on the ground.	Literature review
Q2: What are the mechanisms through which STI policy is formulated?	Observation and Documentary Analysis linked with Critical Discourse Analysis.	Participation in STI Policy Meetings. Policy documents and Internal Texts such as Agendas and meeting minutes, memos, contract documents, observation of meetings, seminars and workshops
Q3: Whose interests prevail through these processes and whose are marginalised?	Documentary analysis linked with Critical Discourse Analysis, Informal interviews and Semi-Structured Interview and observations	Policy documents, observation notes in the Research Diary and Interview Data
Q4: What are the implications of this data for STI policy formation in Ghana?	Interpretive paradigm approach, the notion of triangulation and reflexivity	Documentary data, interviews transcripts, interview notes, observation data and field notes.

Source: The Author

Appendix III: Participant Information Sheet

1. **Study Title**: '*A case study of the Development of Science, Technology and Innovation (STI) Policy at the Higher Education Level in Ghana'*

2. **Invitation**: Please, I have identified you as one of my potential participants for my doctoral research study. Kindly read the information carefully before you decide whether or not to take part. You need to understand why the research is being done and what it would involve.

3. **Purpose of the Study**: Ghana has yet to experience technological transformation to the level of other countries such as those in South East Asia, even though the level of development of these same countries was on a par with Ghana when the latter achieved independence. This study is an in-depth, insider case study on the development of science, technology and innovation (STI) policy at the higher education level in Ghana, specifically how STI policy is formulated and what the implications are. The aim of the study is to have an in-depth insight and understanding of the development of STI policy in Ghana. It will contribute to my University of Sussex Doctor of Education thesis.

4. **Participation**: I have identified you to participate in the study because of your involvement and contribution to STI policy development in Ghana. Your participation in my research could be through involvement in policy meetings which I will be a participant observer, and / or through interviews. Your participation is entirely voluntary. You are free to withdraw at anytime and without giving a reason. The

interview focus would be to tap on your experience and understanding of the development of STI policy in Ghana. Approximately 45 minutes will be used for each interview. I would also be grateful for your permission to record and transcribe the interview. I will do my best to respect your anonymity and confidentiality in all reporting of the data (e, g. By using pseudonyms for all names of people and places), although because of the insider nature of the study, some identification of respondents at the local level may be possible

5. **Review of Study**: The Ghanaian Ministry of Education has given its permission for me to conduct the research. Cluster Based Research Ethics Committee (C-REC) of the University of Sussex has approved the study.

6. **Contact for Further information** and to signal verbal consent to your participation you could kindly contact me through my email or telephone: m_karikari_ababio@yahoo.com or 233 244 888 236

7. **Thank you**

Date: 16th December, 2011

Appendix IV: Indicative Interview Guide

1. What is your understanding of STI policy in Ghana?
2. Why are the existing STI policies not working?
3. How was the policy developed?
4. Who were the actors involved in the development of the policy?
5. Why were they involved in the development of the policy?
6. How were they involved in the development of the policy?

Appendix V: Organogram of the Ministry of Education

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   │   Minister   │                 │   Minister   │    ┌──────────────┐
   │              │                 │              │    │    NCTE      │
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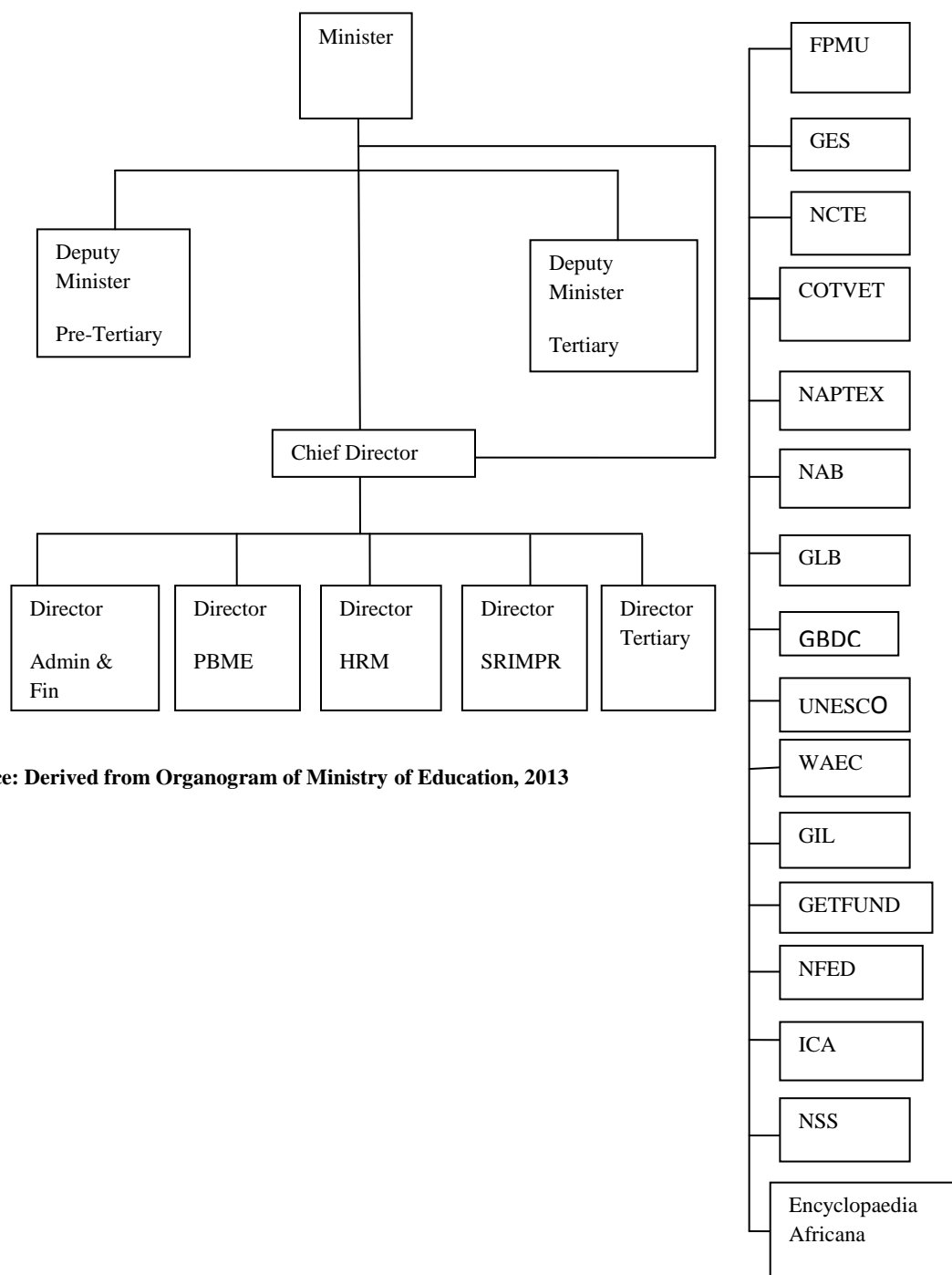
Source: Derived from Organogram of Ministry of Education, 2013

Appendix VI: Ethical Approval

Social Sciences Research Ethics Committee **CERTIFICATE OF APPROVAL**	
Reference Number:	1112/12/09
School:	ESW
Title of Project	A case study of the development of Science, Technology and Innovation Policy at Higher Education level in Ghana
Principal Investigator: **(Supervisor)**	Matthew Karikari-Ababio (Dr M Novelli/Dr B Crossouard)
Expected Start Date:*	06/02/2012
*NB. If the <u>actual</u> project start date is delayed beyond 12 months of the <u>expected</u> start date, this Certificate of Approval will lapse and the project will need to be reviewed again to take account of changed circumstances such as legislation, sponsor requirements and University procedures	

This project has been given ethical approval by the Social Sciences Research Ethics Committee (C-REC). *Please note the following requirements for approved submissions:*

Amendments to research proposal - Any changes or amendments to the approved proposal, which have ethical implications, must be submitted to the committee for authorisation prior to implementation.

Feedback regarding any adverse and unexpected events - Any adverse (undesirable and unintended) and unexpected events that occur during the implementation of the project must be reported to the Chair of the Social Sciences C-REC. In the event of a serious adverse event, research must be stopped immediately and the Chair alerted within 24 hours of the occurrence.

Authorised Signature	*Elaine Sharland*
Name of Authorised Signatory **(C-REC Chair or nominated deputy)**	Dr Elaine Sharland 02/06/2012