UNIVERSITY OF EDUCATION, WINNEBA

THE STATE OF THE SCIENCE RESOURCE CENTRE PROJECT IN SENIOR HIGH SCHOOLS IN GHANA

GEORGINA QUAISIE

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A THESIS IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF PHILOSOPHY DEGREE IN SCIENCE EDUCATION

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DECLARATION

Student's Declaration

I, GEORGINA QUAISIE, hereby declare that this dissertation, with the exception of quotations and references contained in published works which have all, to the best of my knowledge, been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

....

Signature Date

Supervisors' Declaration

We hereby declare that the preparation and presentation of this dissertation were supervised in accordance with the guidelines on supervision of dissertations laid down by the University of Education, Winneba.

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Prof. Kodjo Donkor Taale Date

....

Dr. Emmanuel Oppong Date

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DEDICATION

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TABLE OF CONTENT

CHAPTER TWO: LITERATURE REVIEW

CHAPTER THREE: METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

ABSTRACT

The study describes the current state of the Science Resource Centre (SRC) project introduced into the Senior High School (SHS) system in Ghana by the Ministry of Education in 1995. This study was motivated by reports which focused on under-performance of the SRC project, without comprehensive assessment of the project state. In this study, the current state of the SRCs was assessed through document reviews, which informed the establishment of the SRCs, questionnaires and other instruments to determine stakeholders' perspectives. Twenty out of 110 SRCs were involved in the study. Four self developed instruments used were (1) the Document Analyses Guide; (2) the Resources Assessment Portfolio; (3) the Stakeholders' Perspective Questionnaires and the (4) Stakeholders' Interview and Discussion Guides. The findings indicated that 90% of original centre and satellite schools no longer patronised the SRCs, largely due to growth of students' population, lack of maintenance, replenishment and replacement of materials and obsolete equipments. Additionally inadequate training and retraining of teachers had led to poor teacher knowledge and skills for SRC project delivery. Some teachers had never made use of the SRC in the school term and as many as 32% of teacher-participants could not indicate the percentage of SRC practical activities in West Africa Senior School Certificate Examination. The current state of the SRCs was largely blamed on centralising SRC activities in host schools, without involving the host schools' administration and the central government failing to maintain, replenish, resource and fund the project. The findings of this study would guide policy makers in reconsidering the objective for the centre/satellite system so that schools have ownership of their SRCs with equitable amounts of resources and maintain them as other school facilities.

CHAPTER ONE

INTRODUCTION

Overview

This chapter provides background information on the problem of the current under performance of the Science Resource Centre (SRC) project in Senior High School in Ghana (SHS). The chapter therefore outlines the purpose and the objectives of the study. The research questions from which the issues were investigated, the significance of the study, the delimitations and the limitations are also presented. This chapter also includes definition of terms which have special meaning with respect to the study.

Background to the Study

Overly theoretical approaches to science teaching have been blamed for the poor outcome of education in science in Ghana (Anamuah-Mensah, 1989). According to Babb and Heaford (1962) cited by Anamuah-Mensah (1989), earlier attempt at science practical work in Ghana was not audacious enough. In their assessment of the teaching and learning situation in Ghana, Babb and Heaford alluded that " it was unrealistic to suppose that an exclusive dependence on improvised, primitive equipment, such as packing cases, jars, tins, cans and match boxes could not for long satisfy the education needs or national dignity of Ghana". The initiation of the SRC Project can therefore be seen as a well determined effort towards the study of science at the secondary level. This was seen as befitting the status as Ghana, whose prime objective since independence has been on rapid social and economic development using knowledge and tools derived from Science and Technology (MEST, 2009). The SRC Project, which has been well reviewed

(Ghartey Ampiah, 2004; Anamuah-Mensah & Eminah, 2005; SEU, 1999; SEU, 2000; SEU, 2001; SEU, 2002; SEU, 2003; SEU, 2005; SEU2006; SEU, 2007; SEU, 2008; SEU, 2009; SEU20010; 2011), was introduced to SHS in Ghana by the Ministry of Education in 1995. The project was to provide equal opportunities for all students at SHS level to have access to the programmes of the SRC project and to build their capacity for future performance in the field of science and technology.

The main intent of the project was for the Ministry of Education in Ghana to centralize resources for the study of science at SHS level. A major aspect of the project is the supply of selected schools (which are accessed by other schools) with new and modern equipment for undertaking science practicals in the laboratory. The practical activities are then complemented with modern teaching and learning approaches. Thus, the introduction of the SRC project into the formal school system served as a way of upgrading the existing facilities and supplementing resources for teaching and learning of science. The SRC project was also meant to help bridge the gap between well-endowed schools and less-endowed ones. Several arrangements were put in place which included the following: (1) the establishment of a host (or Centre) school/satellite school relationship, (2) instituting a commuting bus arrangement and (3) the creation of a common timetable to be heeded to by all participating schools. According to SEU (1999), the main features of the SRC project at the time of its implementation include the following:

1. A centre in each of the then 110 Administrative Districts of Ghana, hosted by a Senior High School.

2. A commuting bus to serve a cluster of schools within 30km radius, all accessing the same centre.
3. A common timetable for host and those cluster of schools.
4. Specially trained SRC teachers and technicians who manned the centres.
5. The organisation of science practical lessons by trained SRC teachers only.
6. The presence of centre managers in all centres
7. SRC manual on science practical lessons at the centres to guide and support the delivery of the West Africa syllabuses in Biology, Chemistry and Physics.

An important objective of the project was to prevent the exclusion of students from less endowed schools from studying science, thus providing equal opportunities for all students at SHS level to have access to the programmes of the SRC project. Consequently, based on the original arrangements, an SRC did not belong to the host school.

Ultimately, it has been expected that the SRC programme would lead to increased students' interest in science, improve their performance in the West African Senior Secondary School Certificate Examination (WASSSCE), help bridge the gender gap and eventually increase enrolments in science at higher education levels. The desired outcome of the SRC programme was to increase the number of people who would choose to enter career areas in the field of science and technology as well as impacting on science and technology literacy of the general populace. However, monitoring and assessment reports of the Science Education Unit (SEU, 2005; SEU 2006; SEU, 2007; SEU, 2008; SEU, 2009; SEU, 2010), seem to indicate that it is unlikely that the main objectives of setting

up the SRC project, (which are to expose students to new and modern equipment for carrying out school practical activities in science in the laboratory, complemented with modern teaching and learning methods), are being achieved.

Statement of the Problem

Assessment reports on the SRC project performance indicate that the introduction of the SRC project into the formal school system was initially successful in supplementing the existing facilities and resources for teaching and learning of science, especially in under-served schools (SEU, 2000). However, more recent reports (SEU, 2007; SEU, 2008; SEU, 2009; SEU, 2010), portray a departure from the project goals and objectives. The key objective of the project which of supplementing teaching and learning at the SHS level through exposure of students to modern science equipment appeared not to have been achieved fully (SEU, 2004; SEU, 2005; SEU, 2006; SEU, 2007; SEU, 2008; SEU, 2008; SUE, 2010). Also, only a few of the teachers and technicians who were trained to man the centres are still at work.

Anamuah-Mensah and Eminah (2005) also revealed that the original commuting schools do not patronize the facility. This researcher has personally observed that there have been new arrangements, especially at the national level, where the centre was being used to host other programmes. At the school level, in some of the cases, it appeared that new arrangements existed among schools for the use of the SRCs and the resources. Another prominent problem observed is that the number of science students in some schools with SRCs seemed to have grown beyond what was originally estimated for practical lessons

at the centres. There also appeared to be no improvements in the original infrastructure set up for the centres.

The combined effect of the above situation is that it would be unlikely for the Ministry of Education's goal for establishing the SRC to be achieved in the long run. This is because it might not be possible for students who are being targeted to have the expected hand-on experience which will build their capacity for future performance in the field of science and technology. The study therefore sought to find-out the exact state of the SRCs and come out with recommended solutions to ensure that, at SHS level, all students have adequate access to science resources to enable them perform science practicals more efficiently.

The Purpose of the Study

The purpose of the study was to examine the state of the Science Resource Centre Project in Senior High Schools in Ghana.

Objectives of the Study

The following objectives guided this study:

1. To examine the implementation of the policies objectives for establishing the SRC and the extent of achievement.
2. To investigate the current state of resources at the SRCs.
3. To determine the current level of involvement of schools in the activities of the SRCs.
4. To ascertain stakeholders' present perspectives on the relevance of the SRC project in the current school system.

Research Questions

The study sought to find answers to the under listed questions:

1. To what extent have the policy objectives of the SRC project been carried out and achieved?
2. What is the current state of resources at the SRCs?
3. What is the current level of schools involvement in the activities of the SRCs?
4. What present perspectives do stakeholders have regarding the relevance of the SRC project in the current school system?

Significance of the Study

The study would bring to the fore issues on the current status of the SRC Project and some of the underlying factors affecting the functionality of the SRCs. It is the belief of the researcher that information gathered may aid policy decisions, inform and assist GES management decision making, and offer alternative strategies for maximizing the potentials of the SRC project.

The outcome of the study may lead to the review of the objective of setting up the SRCs and information provided is likely to enhance how resources for science practical activities might be exploited for the maximum benefit of all students.

Delimitations of the Study

Only schools which were considered as host or centre schools and the original satellite schools were targeted. The study was conducted in both urban and rural schools. Interviews and questionnaires were administered only to a sample of science students and

teachers in the selected schools. However, data gathered was extended to personnel who were located outside the defined areas to enrich the information obtained.

Limitations of the Study

The study involved a search into activities at the centres which could expose some managerial deficiencies. There were difficulties in locating past officials and staff of the MOE and GES who were involved in the setting up of the SRC project. This may result in the missing of some important information gathered which could have improved the quality of the study.

Definitions of Terms

Science education is the field concerned with sharing science content and process with individuals not traditionally considered part of the scientific community

Education in science is the aspect of school or academic study of the various components of science which should lead to higher studies of science or specialization in the field of science and technology.

Scientific literacy/acculturation is the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity.

Core science is study in science which is to have an integrated approach for all students

General Science is the study of the individual sciences into more depth (elective biology, chemistry and physics) for laying a firm foundation for future high performance in science.

Science Resource Centre is a project introduced by the Ministry of Education into the Ghanaian Senior High School (SHS) in 1995 to help deal with limitations of unequal access to resources for the study of science.

Abbreviations

ASDC	-	Association for Science and Discovery Centres
CRDD	-	Curriculum Research and Development Division
DAG	-	The Document Analyses Guide
D-G	-	Director-General
Ecsite-uk	-	European network of science centres and museums-uk
ICT	-	Information Communication Technology
ITEC	-	International Training and Education Consultants
INSET	-	In-service Training
MEST	-	Ministry of Environment, Science and Technology
MOE	-	Ministry of Education
MoESS	-	Ministry of Education Science and Sport
NAMES	-	The North Africa and Middle East Science centres network
TOT	-	Training of Trainers
RAP	-	Resources Assessment Portfolio
SACOST	-	School and Community Science and Technology Studies
SEU	-	Science Education Unit
SHS	-	Senior High School
SIDG	-	Stakeholders' Interview and Discussion Guides
SPQ	-	Stakeholders' Perspective Questionnaires

SPSS	-	Statistical Package of Social Sciences
SRC	-	Science Resource Centre
TLM	-	Teaching and Learning Materials
WAEC	-	West Africa Examination Council
WASSCE	-	West Africa Senior School Certificate Examination
YES	-	Youth Exploring Science

Organization of the Study

This thesis is organized into five chapters. The first chapter is the introduction which contains the background to the study, problem statement of the study, the purpose of the study, the research objectives, the research questions and the significance of the study. The limitation and the delimitation of the study as well as the definition of some terms as they are used in this study have also been captured in chapter one.

Chapter two contains the review of literature related to the study, while chapter three provides the details of the methodology that was used for the study including the research design, sample and sampling technique, data collection and analysis procedures.

Chapter four has the presentation of the results of the analyzed data and discussion of the results. The last chapter which is chapter five covers a summary of the research findings, conclusion and recommendations made from the evidence gathered through the study as well as suggestions for further research.

CHAPTER TWO

REVIEW OF LITERATURE

Overview

This chapter reviews literature related to the study. Literature was reviewed under the following headings: Theoretical Framework, Perspectives on Laboratory-Based Practical work in school, the Values and Purposes of Laboratory-Based Science Practical Work, Status of Science Education Policy in Ghana and Prospects for the SRC Project. Additionally, literature on the Justification for the Introduction of the SRC Project, the SRC Implementation Issues, Studies and Monitoring Reports, were also reviewed. The reviewed also covered an assessment of the science teaching and learning situation in Ghana and Opportunities in E-learning.

Theoretical Framework

Certain groups of facilities, programmes and activities are known to provide people with interactive opportunities, leading to building innate capacity for curiosity. (Anamuah-Mensah & Asabere-Ameyaw, 2004; Falk, & Needham, 2011). Furthermore, the opportunities are also viewed as providing participants with prospects for education, broadening their world views on social and global issues and for recreational purposes too. These facilities, resources and programmes come under various descriptions such as science centres, science resource centres, science museums, planetariums, zoos, parks, science weeks, camps, clinics, workshops and others. The Association for Science and Discovery Centres (ASDC), formally known as the European network of science centres and museums (Ecsite-uk) uses the term science centres to refer to all of these types of

facilities, programmes and activities mentioned above (ASTC, 2001; Great Britain: Parliament: House of Commons: Science and Technology Committee 2004). According to Cape Town Science Centre (CTSC) 2011, a science centre is "a hub of science which aims to enrich the school curriculum and equip learners by providing valuable hands-on learning experiences using world class exhibits that are designed to increase learners' skill and understanding of science, technology and maths – demystifying the world of science & technology". Studies from around the world reviewed by Ecsite-uk show commonality among science centres in several countries, even though the nature of individual centres may differs from country to country. (Friedman, A. J. 1995; Garnett, 2001). The variety of activities, programmes, outcome and benefits can be seen as captured in the brochure of South Africa Association of Science Education Centre (SAASTEC). Accordingly, SAASTEC describes a science centre as:

> "an educational facility that uses effective methods to teach science, technology, mathematics and engineering. These methods rely mainly on the use of interactive displays, events and activities, but science centres also use new technologies, such as social media, web-based education programmes and remote teaching and learning techniques". SAASTEC, 2013, p2.

Although an SRC in Ghana may be classified as a science centre, the SRC project is designed primarily to operate within the formal school curriculum. However, unlike a formal school programme, the SRCs programme is not examinable. The Ghana SRC project is equally similar to other science centres because the activities are considered supplementary to formal school programme and also incorporates some aspects of informal learning. Examples of informal learning activities at the SRC are those which

take place when students at Science, Technology and Mathematics Education (STME) Clinics and Innovation (STMIE) Camps and teachers at in-service training use the SRCs in their learning activities processes. Godding (2009), stated that the main purpose of introducing the SRC project, was to provide resources to supplement formal school activities in science practical work. Another important reason for establishing the SRC project in Ghana was to help bridge the gap between well-resourced and less resourced senior high schools in the country. The SRC project was subsequently set up based on some key objectives outlined in the original proposal as stated by Godding (MOE, 2009).

There is however an overwhelming evidence of informal learning in science centres on people's attitudes, knowledge, understanding, concept formation, career choices, the community, job creation and other economic benefits, including money (Friedman, A. J. 1995). It may be more realistic to consider developing and strengthening the informal learning aspects of the SRC project to supplement the overall learning experiences of students, teachers and the general public.

Perspectives on Laboratory-Based Science Practical Work in Schools

The diverse opinions expressed by researchers on school science practical activities and the motivation for doing these activities in the laboratory are well documented (Ghartey-Ampiah, 2004; Adeyegbe, 2005; Hofstein & Mamlok-Naaman, 2007). Several researchers including Hofstein and Lunetta (1982) , Tobin (1990) , Hodson (1993) , as well as Lazarowitz and Tamir (1994) , Lunetta (1998) , Hofstein (2004) , and Hofstein and Mamlok-Naaman (2007) maintain that students derive many benefits from engaging

in school laboratory science practical activities due to the distinctive and central role that the laboratory is made to play in the science curriculum.

Hofstein and Mamlok-Naaman (2007) point out that the National Science Education Standards (National Research Council [NRC], 1996) and also the 2061 project (American Association for the Advancement of Science [AAAS], 1990) endorse the belief in the power of inquiry, and more especially, inquiry in science practical work, which according to them, promotes scientific literacy (Lederman, Lederman & Antink, 2013). What exactly constitutes science practical activities is unclear due to terminologies used to describe the set of activities being referred to. Dillon (2008) identified a range of activities in science in the British National Curriculum which is referred to as "practical work". Dillon however did not give much explanation of their meanings. Some of the terminologies used are: 'Practical and enquiry skills', 'practical and investigative activities', 'independent enquiry' and 'experimental work". In their review, Hofstein and Mamlok-Naaman (2007) came up with more descriptions of the practical activities such as "experiences in school settings where students interact with materials to observe and understand the natural world" and "investigations or projects that are pursued for several weeks, sometimes outside the school". A more classical definition of science practical work is given by Lunetta, Hofstein and Clough (2007) as "learning experiences in which students interact with materials or with secondary sources of data to observe and understand the natural world, for example: aerial photographs to examine lunar and earth geographic features; spectra to examine the nature of stars and atmospheres; solar images to examine living systems" (p. 34).

The argument becomes more intense with the question of the role of laboratories in science practical activities in secondary schools. Many research studies have been conducted to investigate the educational effectiveness of laboratory work in science education in facilitating the attainment of the cognitive, affective, and practical goals (Hofstein & Lunetta 1982; 2004; Blosser, 1980; Bryce & Robertson 1985; Hodson, 1993; Laarowitz & Tamir, 1994).

From their reviews, Hofstein and Mamlok-Naaman (2007) alluded to the fact that research has not been able to establish simple relationships between experiences in the use of school laboratories and student learning, though the science laboratory has been seen as playing a prominent role in science education. Hodson (1990) in criticizing laboratory work, said laboratory work is "unproductive, and confusing, since it is very often used without any clearly thought-out purpose" (p. 25). He called for more emphasis on what students are actually doing in the laboratory. From a different perspective, Tobin (1990), in his support of laboratory work states that, "Laboratory activities appeal as a way to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science" (p. 405). Tobin also suggested that meaningful learning is possible in the laboratory if students are given opportunities to manipulate equipment and materials in order to enable them construct their knowledge of phenomena and related scientific concepts.

A number of researchers in sharing similar views with Tobin attest to the effectiveness of school laboratories in the teaching and learning of science (Hofstein & Lunetta, 2004; Lazarowitz & Tamir, 1994; Lunetta 1998; Hofstein, 2004; Lunetta *et al.*, 2007; Adesoji & Olatunbosun, 2008 cited in Raimi, 2002; Adeyegbe, 2005 and Farounbi, 1998; Raimi,

2002 & Adeyegbe, 2005). The claims being made for laboratory-based practicals include the enhancement of students' understanding of concepts in science and its applications; scientific practical skills and problem-solving abilities; scientific 'habits of mind', understanding of how science and scientists work, and interest and motivation (Hofstein & Mamlok-Naaman, 2007).

Hofstein and Mamlok-Naaman (2007), further contend that inquiry-type laboratories have the potential to develop students' abilities and skills such as: posing scientifically oriented questions, forming hypotheses, designing and conducting scientific investigations, formulating and revising scientific explanations, and communicating and defending scientific arguments. Accordingly, some objectives of science practicals are: to encourage accurate observation and description; to make phenomena more real; to arouse and maintain interest; and to promote a logical and reasoning method of thought. Dillon (2008) notes that the purpose of doing practical science is still very debatable among scientists. Some purposes are stated as: 'to practice seeing problems and seeking ways to solve them'; 'to develop a critical attitude'; 'to develop an ability to cooperate'; 'for finding facts and arriving at new principles'. According to Dillon (2008), there is no clear consensus that the broader science education community agrees on the aims and purposes of practical work in science. Dillon calls for a discussion about the value, aims and purposes of practical work among stakeholders, suggesting that this might be a useful first step in addressing some of the criticisms made by various concerned bodies.

The Values and Purposes of School Laboratory-Based Science Practical Work and the Prospects of the SRC Project

Though the genesis of school laboratory-based science work dates back to the 19th century, it gained more prominence with the Russians landing on the moon and with developments in British and American school curriculum (Downing, 1979). Amid frequent discussions on values and purposes of school laboratory work, research into the Ghana SRC project, becomes relevant. This is because in some respects, the SRCs are seen more as school laboratories than Science Centres (Harding, 1994). In Ghana, a careful study of recent curricula, syllabi and programmes, geared towards the study of science at pre-tertiary level, reveals a well-thought-out plan for laying sound foundations for future performance (Curriculum Research and Development Division [CRDD], 2007). According to McWilliam and Kwamena-Poh (1975), cited in Science, Technology and Innovation (STI) Policy document, Ministry of Environment, Science and Technology (2009), in Ghana the sole object of education is for the production of a scientifically-and a technologically-minded people. The emphasis on the practical aspects of science learning, as argued by Ghartey-Ampiah (2004), is due to the expected outcomes of education in science which are outlined in the teaching syllabus at SHS level and also demanded by the West Africa Examination Council (WAEC). Though the SRC project was introduced into the SHS system to address some deficiencies in approaches to practical science teaching and learning, the project has not gone beyond initial gains, due to several constraints as identified by a number of researchers (Ghartey-Ampiah, 2004; Anamuah-Mensah & Eminah, 2005; MOE, 2009). An important limitation in the SRC project was identified by Anamuah-Mensah and Eminah (2005) as the failure to put in

place initial mechanisms that would deal with the complex mix of difficulties involved in shortages in human, material and financial resources. Later investigations point to the persistent nature of some of the problems associated with the SRC project, suggesting that perhaps the root cause is yet to be unearthed (SEU, 2007; 2008; 2009; 2010). Dahar and Faize (2011) found an association between the availability and use of science laboratories and the performance of students. They concluded in their study that, the unavailability, misallocation and inappropriate use of science laboratory items lead to the wastage of resources, less effectiveness of science laboratory and ultimately lower academic achievement. The policy implications of the study are that the SRC Project can have an enormous effect if science laboratory items are properly allocated, and efficiently used with the standard quantity and quality.

Justification for the Introduction of the SRC Project

Anamuah-Mensah (1989) described the prevailing situation in science teaching and learning in Ghana in the 1980s as follows:

> "Teaching in the higher forms of traditional secondary school is highly examination-oriented. The examination syllabus is normally started in Form 4 but may start in Form 3 in some schools. This examination makes teaching highly teacher-centered with talk and chalk playing highly significant role. Practical work or student experiences are conducted but these are often done to satisfy examination conditions but not to bring about the total development of the learners. Past papers and marking schemes become important learning materials for the students. Attendance at vacation classes has also become an important component in the learning of science at this level. Rote memorization has become the main strategy in the learning of science at this level. The stress here is on the learning of concepts, principles and generalizations. The utility of this knowledge to everyday encounters of the student is a negligible aspect" (p. 7).

The introduction of the SRC project was a clear move away from the vivid description by Anamuah-Mensah (1989) and from the days of improvised, primitive equipment of packing cases, jars, tins, cans and match boxes for science practical teaching in Ghana. Though the previous situation was not found dignified for a sovereign country like Ghana, a British Tutor, by name of Karen Porteus, was purported to have described the SRC project as a very lavish affair of computers, expensive equipment and chemicals which are inappropriate for use at secondary level in a country like Ghana (Anamuah-Mensah & Eminah, 2005). One would then wonder what type of education in science would suit a developing country like Ghana and how science practical lessons should be conducted and where.

Globally, the unprecedented growth in digital, emerging, mobile and new technologies, has called for development of new competencies, especially among the youth. According to Fensham (2008), the purpose for education in science should take into account the need for:

- building sound foundations at basic level to help increase numbers of students who will choose to transition into higher education in the sciences;
- improvements in science and technology literacy of the citizenry for sustainable development and
- Speedy renewal of human capital and building competencies in new technologies to enable the citizens to access the global market which is now very much dictated by new and emerging technologies.

The world in which we live today is being shaped daily by more and more people venturing into science and its applications. With science now being looked on as tentative knowledge, no nation can any longer hold others to ransom in terms of inventions, innovations, other applications and uses of science. Considering developments in science and technology worldwide, the so-called "colonial control" argument, even in learning of science, does not hold any longer. This is because day in and day out, one witnesses how people of eastern countries are venturing into developments in science. Africa has a chance to change the gloomy picture painted by Anamuah-Mensah (2002), in which he assesses the complete dominion of the colonial masters in this manner:

> "These forces have identified the problems, engineered the solutions and provided the means to carry them out. In doing this, the values, customs, and the general cultural environment of the African child were entirely ignored, leaving a big yawning gap between the school and the cultural context of the child. Science and technology education did not address issues raised directly or indirectly by Africans themselves. It brought solutions for problems that, as far as the people were concerned, were non-existent" (p. 12).

From the global perspective, the impetus for policy development in science education in the 21st century should take into consideration capacity building for the citizenry of the country to perform in the global market. Considering the key roles that have to be played by her human resources, Ghana is justified to develop world class citizens who can compete favourably with citizens of other countries. In view of this, the creation of the SRC project is to be applauded.

Documentation abounds on initial gains of SRC project (Anamuah-Mensah & Eminah 2005; SEU, 2001; SEU, 2002; SEU, 2002). As an indicative of national aspiration, Ghana

believed in the use of science and technology for her development agenda. The need for strengthening her science and technology infrastructure is incumbent on the following:

- Promoting competitiveness in productive sectors of the economy;
- Creating job opportunities and employment;
- Expanding industrialization;
- Enhancing the quality of life through innovation;
- Developing scientific human resources;
- Expanding infrastructure;
- Promoting an information society;
- Optimizing on the sustainable use of the natural and environmental resources;
- Commercializing research findings. (MEST, 2009)

The actual objectives for science education and the goals for institutionalization of the SRC project as well as challenges being encountered will be discussed more fully in the following sections.

Status of Science Education Policy and SRC Project Implementation Issues

Among the prerequisites for the study of science outlined are the educational purposes of science (Fensham, 2008). Accordingly, some major considerations are: (a) implicit barriers that limit and exclude some students; (b) what to do to ensure personal and societal interest about contents; (c) pedagogy and assessment; and (d) gender and context-based issues. Whereas these discussions provide a basis for policy decisions on education in science, apart from teacher development issues, not much is said about the impact of other resources on science practical teaching and learning. As noted by Dahar

and Faize (2011) and Hofstein and Mamlok-Naaman (2007), there has not been much previous work which goes beyond discussing issues on pedagogy and performance, to discuss issues of resources, standards, supplies and maintenance. For a sustainable environment in laboratory practical work, perhaps the assertion made by Anamuah-Mensah (1989), on the need to focus on a comprehensive approach to education in science requires careful attention.

As issues of poor performance of the SRC projects were raised over the years, some interventions were put in place to address them (SEU, 2010). These interventions do not seem to have addressed adequately some of the problems raised such as improper allocation and inefficient use of resources, access, exclusion and equal opportunities as well as issues regarding standard quantity and quality, management, maintenance and sustainability of the whole project.

It is common knowledge that although Ghana always ends up with good plans and programmes, several challenges are faced during the implementation stages. It has been suggested that for implementation processes to be smooth sailing, care must be taken to involve all stakeholders and partners (Benneh, 2009). Like most developing countries, Ghana's effort at education in science is to make science more meaningful to the learner and also for the nation to derive benefits for her socio-economic growth and development (MEST, 2009). Further to this is the promotion of science culture in the Ghanaian society to help overcome problems such as the disposal of waste, environmental management, and to address issues such as belief in witchcraft, and prevention of sickness, among others (Benneh, 2009). It has also been noted by several commentators including

Karikari-Ababio (2007) that Ghana, China, South Korea, Malaysia and others were all at the same stage, experiencing economic difficulties in the 1960s, yet most of these countries have well overtaken Ghana, in terms of application of science and technology for the development process. Likewise, most of these countries have improved on their economic status, using their cultural context, having taken advantage of science and technology and produced wealth. It is against this backdrop that the Ghana Government is taking advantage of developments in science and technology as well as innovations for her socio-economic development agenda (MEST, 2009). Ghana therefore has not only made policy statements for development of science and technology, but in her forward-looking strategies, has adopted Science, Technology and Innovation (STI) as the most important inputs, if the country is to survive global demands. For a viable science education policy, the country context is considered key. The mission of the Ministry of Education, referred to in MOE 2010, is "to provide relevant education with emphasis on science, information, communication and technology to equip individuals for self-actualization, peaceful co-existence as well as skills for the workplace for national development" (p. 3).

Two main documents exist on Science Education Policy (MOE, 2004; MOEY&S, 2008). Both of these are derived from policy guidelines, provided for in the Science and Technology Policy documents of the Ministry of Environment, Science and Technology. The education component of the older National Science and Technology Policy document referred to in the Draft National Science, Technology and Mathematics Education (STME) Policy Document (MOE&YS, 2008), states the objective of Science Education as: "To orient all levels of the country's education system to the teaching and

learning of science and technology in order to accelerate the acculturation of science and technology in society to produce a critical mass of requisite human resource and well informed citizenry" (p. 4).

The MOE further makes science one of the four main policy drivers of education in Ghana. Again among the eight policy objectives of education, three directly address the concern for the studies, improvements and promotion of Science, Technical and Vocational Education (STVE).

The argument for quality education in science among other things evolves from the need to improve on science and technology literacy for all, justifying the science curriculum at the basic education level. Another important argument is to ensure that there are a sufficient number of high school students who will go on to pursue science at higher levels, to augment the population of scientists and technologists in the country (Fensham, 2008). Most importantly is the national target to achieve a ratio of 60% to 40% of student in science to humanities at tertiary education level (Addae-Mensah, 2005). The implication for this has been the specialization in science at SHS and subsequently in the various mainstream and allied sciences at the tertiary levels. Yet another imperative is to be able to use modern and new technologies which are emerging at unprecedented rates, and also to build capacity for their development. This last item explains the high profile approach to Information, Communication and Technology developments in the country and institutionalization of SRC in the SHS programme.

Existing schools' documents suggest a 2-pronged approach to education in science at SHS levels: (1) core science studies which is to have an integrated approach for all

students; and (2) General Science, involving the study of the individual sciences into more depth (elective biology, chemistry and physics) for laying a firm foundation for future high performance in science. Commitments to the latter are seen through the science elective curriculum, in which the expectation of practical approaches is clearly demonstrated (Ghartey-Ampiah, 2004).

Furthermore, commitment to the national goals is also made clear by the provision of the equipment for laboratory-based practical approaches to teaching and learning of science in schools through the SRC Project. It is indicative that there was much progress in earlier stages of the SRC, though there appears to be a deteriorating situation as the years go by. The discussion of this is further advanced in later sessions of the literature review.

The Science, Technology and Innovation (STI) Policy was developed to address very pertinent issues, regarding developing capacity for Science and Technology delivery as outlined in the stated objectives (MEST, 2010). According to (MEST, 2010) The STI Policy seeks to:

1. facilitate mastering of scientific and technological capabilities;
2. provide the framework for inter-institutional efforts aimed at developing STI programmes in all sectors of the economy to provide for the basic needs of the Ghanaian society;
3. create the conditions for the improvement of scientific and technological infrastructure for research, development and innovation;
4. ensure that STI supports Ghana's trade and export drive for greater competitiveness; and

5. promote a science and technology culture.

From the objectives outlined above, the agenda for education in science in Ghana is set out. The commitment in terms of providing resource to build capacity for in the study of science is high. What remains is to ensure value for money in allocation of these resources as well as sustained environment in teaching and learning situations.

An Assessment of the Science Teaching and Learning Situations in Ghana

The ultimate goal of the Integrated Science syllabus for SHS in Ghana is to create in the individual the capacity for critical thinking, the ability to assess situations, the ability to make informed choices and the ability to innovate solutions to problems encountered daily for a rapid economic development (MOEYS, 2007). Science Education is therefore provided to every individual of school-going age – from kindergarten through to university. Accordingly, the 2007 Integrated Science syllabus has been developed to be a conscious effort to raise the level of scientific literacy of all students in JHS and SHS to equip them with the relevant basic scientific knowledge needed for their own living. Secondly, scientific literacy is needed for all students in making valuable contributions to the production of goods in the country. MOEY&S (2007) further stresses that at the SHS level, education in science is provided for the development of positive attitudes and values in young people for:

1. Curiosity to explore their environment and question what they find
2. Keenness to identify and answer questions through scientific investigations
3. Creativity in suggesting new and relevant ways to solve problems
4. Open-mindedness to accept all knowledge as tentative and to change their view

if the evidence is convincing

5. Perseverance and patience in pursuing a problem until a satisfying solution is found
6. Concern for living things and awareness of their responsibility toward maintaining the quality of the environment
7. Honesty, truthfulness and accuracy in recording and reporting scientific information
8. Love, respect and appreciation for nature and desire to conserve natural balance.

For science educators and researchers, competencies in relevant areas are pre-requisites for future performance in science and technology and these have accounted for high expectations in school science and in particular school science practical (Hofstein,, & Lunetta, 1982; Ghartey-Ampiah, 2004). The demand from schools for SRCs is formidable, in spite of the declining performance of the project. This is in the face of the fact that West Africa Examination Council (WAEC) has made the availability of a well-equipped laboratory, a pre-requisite in school for students to study elective science subjects (Ghartey-Ampiah, 2004). This tends to create the impression that good performance in science is based on having a well-equipped laboratory, and a well-equipped laboratory is also equated to having an SRC. Whilst some schools feel excluded without SRCs, others do not consider that they stand to lose much without the SRC (SEU, 2008; SEU, 2009; SEU, 20010; SEU, 2011).

In considering the current status of the SRC project, a study of several monitoring reports indicate that, a number of satellite schools have resolved not to regularly commute to host

schools for practical lessons. Some of the satellite schools do not consider the teachers of host schools competent enough to teach their students. Some satellite schools have decided to keep the SRC levies for their own consumables, even if they do not have laboratories. Whilst some schools borrow materials more or less frequently from host schools, others just go to SRCs for science practical lessons when examination time is near. The implementation guidelines for the use of the SRCs have been available yet it appeared no one really adhered to these. Very little is known of the existence of the SRC Management Committees, which were put in place to oversee the proper SRC project implementation.

Another important observation is that the West Africa Senior School Certificate Examination (WASSCE), as a regional programme is not based on SRC programme. Since not all schools have access to SRCs, national examinations also do not test competencies that can be built through the SRC programme. It is unclear as to whether the designated SRC source books and manuals have been evaluated to ascertain the extent to which they are linked to the spelt-out objectives of WAEC. Neither is it known as to whether any of the teaching universities have developed teaching modules based on the SRC type of syllabus and skills acquisition.

Between 2000 and 2010, monitoring, evaluation and assessments reports of the SRC project have made recommendations for improvements in the entire project to ensure its continuity. A key recommendation which was to equip 200 more schools and train about 1000 more teachers and technicians did not come into fruition for a period of over three years ranging from 2008 to 2011 (SEU, 2012). This perhaps suggests that there was a

problem with decision making process to effect recommendations made regarding the way forward to the SRC project's continuity.

In effect, the relevance of the SRC project to the formal school system needs to be clearly assessed. For the SRC project to provide more benefits to both the formal and informal forms of learning, there should be a firm and bold decision on modifications in the project approach to benefit the target groups in formal school environment and some considerations also in the informal learning environment.

Studies and Monitoring Reports on the Ghana Science Resource Centre Project

Monitoring reports and studies on the SRC project abound at the offices of the Head of Science Education Unit at the National ICT and SRC as well as the Country Representative of Philip Harris. (ITEC). Host and satellite schools in the Western, Eastern, Volta and Brong Ahafo Regions were visited (SEU, 2001). Some selected SRCs were visited in Accra, Kumasi, Cape Coast and Sekondi (SEU, 2009). SEU (2010) shows that all SRCs and some satellite schools in all but one region were visited. In 2011, some centres and host schools in Central, and Northern Regions were also visited (SEU 2012). Essentially, the earlier reports virtually demonstrate that the core objectives for setting up the SRC project were being achieved to a very large extent. The reports cited have made references to actual statements by students and teachers which implied positive effect of the SRC project. For example, in one case, 78.3% students said that they liked going to the centres and 81.5% said they enjoyed their lessons at the centres. Some indications of positive impact documented then, include the following:

1. Both teachers and students, especially those in rural areas and schools which did not have science laboratories, have a positive view of the project.
2. There was an observed increase in enrolment of students, both in science and other programmes in host schools.
3. Science results in Senior Secondary School Certificate Examination (SSSCE) kept on improving as a result of increased contact hours in science practical at the centres.
4. The use of the centres during STME Clinic for Girls raised the level of interest in science among girls, resulting in increased numbers of girls who opted for the study of science.
5. Some Junior High Schools make full use of the SRCs for their science activities; this kindles their level of awareness of science at that level. (SEU, 1999; SEU, 2010)

In spite of the above, later successive impact assessments of the SRC Project and monitoring reports portray a gradual downward trend, making the whole project dysfunctional, leading to a total collapse. What is eventually becoming evident is the failure of a major aspect of the project, being the objective to address inequities by sharing facilities for science practicals through the host school/satellite system. There are a good number of pointers to the inability of the SRC project in performing this function.

Major reasons assigned for the break down in the Centre/Satellite system, include the following:

- Several of the host schools used buses for non-SRC activities, leading to early breakdown of the buses. Coupled with lack of maintenance of the buses, the commuting aspect of the project was rendered futile.
- Subsequently, satellite schools also withheld the forty pesewa levy as contribution to the running of the buses. Most heads of the satellite schools considered it better (in terms of practical science lessons) to use this money to stock their own science departments.
- On top of all this was the long time it took to transport students from the satellite school to the SRC School which resulted in time lost for other lessons. Some of the satellite schools are located forty kilometres or more from the SRC School.
- There was also confusion as to whether the satellite school teachers or the SRC teachers were responsible for the teaching in the SRCs. In some cases, the satellite schools considered that they had better qualified teachers to teach their own students.
- The satellite school students were sometimes distracted by unfamiliar surroundings in the SRC School.
- Conflicts in timetable make both host and satellite schools experience time lost, concomitantly affecting time available for other subjects.
- In some cases, the number of students in the host schools has increased substantially and these schools could no longer host any satellite schools.

- Several of the SRC need major repairs and continuous hosting of other schools worsens the situation further (SEU, 2010).

Though the above reasons were made available as far back as 2000, the re-occurrences of several of these collaborate the assertion by Anamuah-Mensah (1989) that there were no mechanisms for addressing issues relating to the SRC. Further revelations through the monitoring reports of SEU depict perhaps more serious conditions of the centres. These reports give a picture of a rapidly deteriorating state of laboratories due to the lack of maintenance and availability of essential supplies for meaningful practical work to take place throughout the academic year (SEU, 2010), rendering the re-equipment of all the 110 SRCs in 2008 and 2009 futile exercises. The 2010 report, in particular, reveals that in a particular region, no centre had the gas supply system working. The gas supply system has been substituted with gas cylinders. In most schools, the fume cupboard extractor fan and the air-conditioning units in the store rooms no longer worked. Though in the Western Region, most air-conditioners in the laboratories were found to be in good condition and working properly, it was observed that cupboards were not labeled in all the centers visited as specified in the technicians' manual; however most schools have structurally sound benches. Likewise it was also found that some schools in the Central Region have good fume cupboard extractor fan and air conditioning units in the store rooms, whilst others do not. According to the SEU monitoring report, not all schools had a water supply via the taps and use is made of buckets to supply water. As at the end of 2010, a good number of the centres needed minor rehabilitation, whilst several others had serious problems with cracks in the buildings and broken windows. Mostly, the laboratories in the school were found to be very dusty, needing floor tiles. In some cases,

there were no places of convenience attached to some of the buildings and there was an urgent need for these. In some schools (names withheld) the preparatory rooms were not well kept and appeared to serve as all-purpose rooms.

State of Equipment, Materials and Chemicals

All centres were fully equipped and supplied with materials and chemicals for science practical work at the onset of the project in 1996. This exercise was repeated, re-equipping all the centres in 2008/2009. From the monitoring reports, most of the old supplies of 1996 were found to be depleted, expired, broken down or obsolete. There were some appreciable amount of materials and chemicals in one satellite school. It was obvious that these were given to the school some years ago. Though these resources could have been used for some science practical work, they were poorly kept in a room in a wooden structure that served as the science laboratory. The teachers in the school did not find the working room very conducive and so told the monitoring officials that equipment, materials and chemicals are removed to the classrooms for practical lessons. However, these are not well kept in the laboratory all the time (SEU, 2010).

Though the report indicated that new equipment and chemicals were found to be in use, it also noted that some still appeared to be in the boxes, giving the impression that they had never been touched. For example, it reported that in the Eastern Region, most schools had the equipment stored either in the individual subject store rooms or in a single store room. The report further indicated that there was no available evidence to suggest that the new equipment is regularly used. The report also pointed out that in two universities, new equipment recently supplied was stored away and brought out when needed for practical

work. This, according to the report, is because the two universities already had equipped science laboratories. The additional SRC equipment given were to enable them prepare teachers adequately for SRC type of activities at SHS. In one case, it was the expectation of the university authorities that some of the rooms in the new laboratories being built would be allocated for SRC activities.

The SEU (2010) monitoring report indicated that all computers had been installed in the science laboratories and were being used by all science teachers in the schools in the Eastern, Central and Ashanti regions. All schools visited in the Western Region and some schools in the Central Region, had started using the computers and the projectors for teaching in the laboratories. It was also found that in general, chemicals were safely stored in all the centres visited. Some schools complained of having problems with the Optical microscope and the camera, which have since been replaced. From the 2010 report, there appeared to be a small number of leftover items of equipment which some schools were not using. These included microscopes and physics power supplies which could be distributed to the satellite schools which need them. However, it was recommended that this was to be done with the cooperation of the heads of schools and science staff, under the supervision of the Regional Directors of Education. The report, however, expressed doubt that equipment thus distributed would be used in the satellite schools by teachers who have not had the benefit of the 2008 training. The monitoring team recommended lists of equipment, materials and chemicals to be removed from SRCs to needy schools for sharing or outright give away (SEU, 2010).

i. The Borrowing System

As indicated in the earlier sessions of this write up, satellite schools were to commute to host schools for their science practical lessons. However, the monitoring team reported of a common practice that existed among the schools. It was discovered that the satellite schools occasionally borrowed equipment and chemicals from the resource centres and returned them after using them. It also came to light that teachers in the satellite schools used the centres during examination periods to prepare chemical solutions and distil water for use in the examination. A school visited in Ashanti Region, the Headmaster of the centre school said that the borrowing system was not allowed because of the failure of the satellite schools to pay the user fees for the maintenance of the centre and the centre bus. The headmaster was reported to have said that students from the satellite and non-satellite schools are taken to the centre schools, a few weeks before the examination season for a rehearsal.

ii. Practical Work

From the initial report of the 2010 monitoring team, it was revealed that a total of 55 SRCs and 45 satellite schools were visited in five of the ten regions by the first half of the year. The impression gained by the monitoring team was that mostly, teaching of science was still by chalk and board and very theoretical in non-SRCs laboratories. In these schools, there appeared to be a lot of copying from the board. In some cases, practical work involved a demonstration from the teacher's desk in front of the class or copying diagrams of the apparatus that would be used if the practical work was actually going to be carried out. In a small number of schools, practical work was timetabled during the normal lesson time. In other schools practical work was carried out after normal class

lessons had finished or on a Saturday morning. In some cases parents paid extra monies for these practical sessions. However, in several SRC host schools, the situation was found to be different. The impressions of the monitoring team was that the training given to teachers in 2008, had made them more capable and confident and improved their performance. It is the view of the SEU staff that with more regular training and refresher courses, there could be much better performance.

iii. Involvement of Female Science Teachers

An important objective of the SRC programme was to encourage females into science and technology. Research indicates that persistent male image of science also serves as deterrent for girls, hence reporting on the involvement of female teachers in SRC programme was important in monitoring female students' participation in science, technology and mathematics education. The 2010 monitoring team reported that out of the 16 SRC schools in the Eastern Region, only 8% of the science and mathematics teachers were women. In six schools, there were no women teachers at all. The school with the highest gender balance had 23% of women teachers in science and mathematics. The situation was similar in all regions and in some cases worse. The report therefore recommended intensified intervention activities to encourage more female students into the study of science at high levels and more women into science teaching.

iv. The International Training and Education Consultancy (ITEC) Trained Teachers Situation

From the 2010 report, teachers found during monitoring in most host schools were enthusiastic in the use of the new equipment which was lately supplied (2008/2009).

However, lack of technicians at the centres put an extra workload on the centre co-coordinators. All schools visited in 2010 had a number of ITEC trained teachers. At one school in the Ashanti Region, all ITEC trained teachers were at post. This includes three (3) science teachers and one (1) technician. In the Eastern Region in general, every school had at least two teachers who had received ITEC training in September 2008. In 50% of the cases, there were three teachers, one from each science subject area. The conclusion of the 2010 monitoring team was that there was a body of knowledge in the schools which could be used for training other teachers in schools where staff did not attend the training course in Accra.

v. Information and Communication Technology (ICT) Literacy

Since competency in ICT is a pre-requisite in the teachers' role at SRCs, the 2010 Monitoring Team also investigated teachers' ICT knowledge and skills. It was discovered that in most schools, some of the science teachers had a level of computer literacy which allowed them to use computers, video projectors, digital microscopes and flexicams to enhance the teaching of science. In most schools, the desktop computers have been located in the store rooms where they were used by science staff and on some occasions by students. In some schools, the computers were located on the front bench and were being used with the projectors. Teachers found it difficult to move the desktop computers around for use with the projector, and staff would benefit if there was one lap-top which could be used with the projector. Some teachers were using their own lap-tops with the projectors. However, the report recommended that all the science teachers should have this level of expertise to enhance the delivery of the science curriculum with ICT integration.

In the Eastern Region, all schools had received the Optika digital microscope and all had encountered problems using this microscope with the Motic flexicam due to the clash of software. The report recommended that all science departments would benefit from connection to the web and that a modem from one of the mobile phone companies be purchased so that each of the desktops can be connected to the web. This would allow limited web access which at least would be sufficient to update the virus protection software as well as enable teachers and students to assess information from the internet to supplement their activities.

Observation and Recommendations from the Monitoring Report

After completing the monitoring exercise in five (5) regions: Greater Accra, Central, Western, Eastern and Ashanti regions, the officials from the National Science Resource Centre (SRCs) in Accra documented their findings from observations made. Among other issues, the findings of the monitoring team, also showed that there are some old equipment, apparatus and chemicals as well as some excess and leftover items in the existing SRCs. The team made recommendations to the Director-General of the Ghana Education, requesting that these surplus items be distributed to needy schools so that they could have minimum number of equipment and materials to work with. This exercise was to be done under the supervision of the Regional Directors of Education and report communicated to the Director-General. Regional Directors were also to encourage centre schools to give out any other equipment/materials/chemicals which they do not have use of. Additionally, Directors were to give instructions to centre schools to allow host schools to borrow from items supplied to SRCs in 2008/2009 with commitment to return them to centres on agreed dates.

In view of the fact that implementation of recommendations made over the years to the Ministry of Education and the Ghana Education Service to adequately resource all schools was still on the drawing board, the monitoring team further made additional recommendations. In addition to these recommendations, a major recommendation of needed interventions for practical science at SHS, in a form of matrix was also submitted by the monitoring team.

Opportunities in e-Learning

It has been observed by this researcher, that there are now available a whole range of e-learning facilities that make use of simulations and animations for virtual laboratories. These could be taken advantage of to supplement, integrate or even totally replace physical laboratories. In a lecture given to GES directors in Accra, the following advantages of e-learning were enumerated by a resource person:

1. They provide uniform materials and are time saving
2. They are easily integrated into already existing ICT readiness of schools
3. They can benefit the physically challenged and deal with the problem of exclusion.
4. They can be used in difficult-to-reach schools and communities, where electricity is a problem because solar energy can be used as a substitute.
5. They can create excitement and capture attention more easily, promoting positive attitudes towards inquiry.
6. They use graphics and real sound.

7. It is possible to go through dangerous experiments without subjecting anyone to danger - e.g. cathode ray experiment, radioactivity and use of radioactive materials, demonstrations with sodium and reactions of metals with acids.
8. They eliminate almost completely the time involved in setting up experiments
9. It is possible to demonstrate experiment with internal organs more easily – e.g. digestion and blood circulation
10. It is cheaper and easier to get through expensive and difficult experiments – e.g. dissecting the human skull. (Quaisie, 2012)

Summary of Literature Reviewed

The literature viewed provided ample background information on effectiveness of science centres. The Ghana SRCs, under the categories of science centres, can be used to improve students' attitudes and achievement in science. The new equipment recently distributed to centre schools in 2008 and 2009, alongside the equipment delivered in 1996 gives teachers an excellent resource, allowing teachers to present some very exciting science teaching. All the schools have teachers who have had the training to use sophisticated apparatus within an investigative pedagogical approach. All that is needed to bring this to fruition is leadership at the school, district, regional and national levels.

CHAPTER THREE

METHODOLOGY

Overview

In this chapter, the research design of the study is described along with details of procedures that were used to conduct the study. This includes the research population, research instruments, validity and reliability of research instruments, sample, sampling techniques and sample size, data collection procedure and data analysis.

Research Design

In assessing the status of the Ghana Science Resource Centre (SRC) project, the study employed mixed methods. Both qualitative and quantitative methods were used but the study depended more on qualitative survey research design. A survey was useful because according to Shuttleworth (2008), in assessing opinions and trends, it enabled the researcher to gather information from a wide range of respondents. A survey also helped in making an in-depth analysis of information gathered within the limited time frame. Specifically, the study employed desk reviews in studying documents and materials relevant to policies on education in Ghana in general, science education in particular and more in-depth into the establishment of the SRC project. Documentation on supplies of equipment and materials, ledgers, training guides and manuals were also critically examined. Site visits to centres, using checklists to ascertain information on conditions of resources, equipment, facilities, infrastructure and other materials, as well as photographs taken, were used to complement information gathered. Questionnaires, interviews and focus group discussions held with students, teachers and others who operate, manage,

supervise and monitor the operations at the SRCs were useful in establishing the current state of affairs of the SRCs.

Population

The target population consisted of all SRCs in the country. Stakeholders targeted included past and present officials of Ministry of Education and the Ghana Education Service, Heads of Science Education Unit, SRC co-coordinators, managers, teachers, students and resource persons.

The accessible population was made up of personnel at centres in five regions of the country, namely; Ashanti, Central, Greater Accra, Northern and Volta Regions and two teaching Universities. Included in the accessible population were officials of the Ministry of Education and the Ghana Education Service, who were intrinsically linked to the SRC project.

The Sample and Sampling Techniques

The sample for the study was made up of 20 SRCs out of the total of 110 SRCs and 20 satellite schools chosen from the Ashanti, Central, Greater Accra, Northern and Volta Regions. In each region, eight schools were purposively chosen to include schools which were involved in the centre/satellite relationship. From each region, participating schools were from urban and rural areas. Two schools in each urban and rural areas were Centre and satellite schools respectively. Personnel from the National ICT and SRC in Accra as well as those from the University of Cape Coast and the University of Education, Winneba were also included in this sample.

As indicated in Table 1, the sample consisted of 40 schools made up of 20 Centre and 20 satellite schools; a total of 336 individuals, made up of 200 students, 40 teachers, 40 teacher/technicians and 56 other stakeholders. The 40 Centre and satellite schools were purposefully chosen from the 5 regions throughout the country. Forty teachers were randomly sampled and forty technicians purposively sampled. In each SRC school, two science teachers were selected randomly using the lottery method. The names of all science teachers in a given school were written on pieces of paper by the researcher and placed in a bowl. The researcher then picked any two sheets from the bowl after mixing the contents thoroughly. The teachers whose names appeared on the sheets of paper chosen were then selected to partake in the study. The 40 technicians however were those available in centre and satellite schools and were thus included. The reason for different reported figures of technicians and selection procedure was that while some schools did not have technicians, in other schools, some of the teachers doubled up as technicians. This explained the overlap, giving a total number of 56 individual teacher/technicians reported elsewhere as the total number of teachers and technicians in actual fact, do not add up to 80. Five students were chosen from each of the selected schools, using stratified random sampling. From each school, student in SHS 3 studying the General Science programme were the main targets. However the study also included few randomly selected science students in SHS Forms 1, 2 and 4 in the study. This was done to gain perspectives of students at different stages in school with different years of exposure to the SRC project. As in the case of the teachers, all the science students provided their names to the researcher on sheets of paper. Five randomly selected names from the bowl were used to select respondents for the study. Other stakeholders, National

Science Resource Centre Coordinators, Centre Managers, Heads of Science Education Unit and Department, Ministers of Education/Chief Directors, Director and Deputy Director-Generals, Heads of Schools, Members of SRC Management Committees, Resource Persons/Experts/Consultants and Service Providers, were included in the study, using purposive sampling techniques based on various roles they played or are playing currently.

Table 1: The Sample Size

S/N	The Sample	Number	Selection Procedure	Status
1.	The Centre/Satellites Schools	40	Purposive	Centre/Satellite
2.	Students	200	Stratified Random	From selected schools
3.	Teachers/Technicians	80	Purposive/Random	From selected schools
4.	Managers	10	Simple Random	From selected schools
5.	National Coordinators	3	Universal	Former Co-ordinators
6.	Former Head of SEU	1	Universal	Former Head
7.	Heads of Schools	10	Simple random	From selected schools
8.	Members of Mgt. Com	10	Purposive /Random	From selected schools
9.	Resource Persons/Experts	10	Purposive/Random	From MOE/GES
10.	Consultants	1	Purposive	Logistic Supplier
11.	Minister of Education.	2	Purposive	Policy-maker
12.	Director-Generals of GES	3	Purposive	Policy Implementer
13.	Heads of Science. Education. Dept	4	Purposive	From the Universities
14.	Service Providers	2	Purposive / Random	Logistic Suppliers

Research Instruments

According to Tobin and Fraser (1998), combining qualitative and quantitative methods of research provides multiple theoretical perspectives to education in general and the classroom in particular. The practice of including a combination of both quantitative and qualitative measures is generally accepted as enhancing a study outcome.

The research instruments used in the study were checklists namely the Documents Analysis Guides (DAG) and Resources Assessment Portfolio (RAP). The other main form of instrumentation used, were questionnaires. The researcher also employed the use of interviews and discussion guidelines to gather information from stakeholders. The questionnaire constituted the quantitative part of the research instruments whilst the others were the qualitative part of the research instrument. The checklists were based on items supplied to the SRCs. Photographs, audio-recordings, transcripts and footnotes were taken to augment the qualitative data as shown on Table 2.

The questionnaires were administered to students and teachers, while interviews were conducted with heads of schools, SRC Co-ordinators, Ministers of Education, Director-Generals of the Ghana Education Service, education administrators, science educationists who were used as consultants, resource persons and managers of the SRC as well as service providers. Discussions were held with student groups and members of Management Committees.

The checklists were based on items supplied to the SRCs and tally cards were examined. Photographs, audio-recordings, transcripts and footnotes were taken to provide information on the state of facilities and infrastructure.

Data Collection

The Documents Analysis Guides (DAG) and the Stakeholders' Interview and Discussion Guides (SIDGs) were the main instruments used to guide responses to research question one (RQ1), that is "To what extent have the policy objectives of establishing the SRC Project been carried out and achieved?". Other data collected with the Stakeholders' Perspective Questionnaires

(SPQ), being questionnaires to teachers and students, also provided more insights into information obtained to answer RQ1. Answers to Research question two (RQ2): "What is the current state of resources at the SRCs?', were guide by data collected with the Resources Assessment Portfolio (RAP) and the Stakeholders' Perspective Questionnaires (SPQ). To guide responses to Research question three (RQ3): "What is the current level of schools' involvement in the activities of the SRCs?", questionnaires to teachers and students (SPQ), were the main instruments used; and finally, data collected with SPQ and SIDGs guided responses to research question four (RQ4): "What present perspectives do stakeholders have regarding the relevance of the SRC project in the current school system?"

Table 2: Administration of Research Instruments

S/N	Sample Type	Number of Individuals	Data Type	Method Used
1.	Centres (facilities, equipment and other supplies.	40	Qualitative and Quantitative `	Checklist, Photographs
2.	Students	200	Qualitative & Quantitative	Questionnaires/Discussions,
3.	Teachers/ Technicians	80	Qualitative & Quantitative	Questionnaires
4.	Centre Managers	10	Qualitative	Interviews
5.	National Coordinators	3	Qualitative	Interviews,
6.	Former Head of SEU	1	Qualitative	Interviews
7.	Heads of Schools	10	Qualitative	Interviews
8.	Management Committee Members	10	Qualitative	Focus group Discussions
9.	Resource Persons	10	Qualitative	Interviews
10.	Consultant	1	Qualitative	Interviews
11.	Ministers of Education	2	Qualitative	Interviews
12.	Director-Generals of GES	3	Qualitative	Interviews
13.	Heads of Science Education. Department	4	Qualitative	Interviews
14.	Service Providers	2	Qualitative	Interviews

Scoring the Instrument

Interviews, discussions, Photographs, audio-recordings, transcripts and footnotes provided descriptive information. The responses from questionnaires and checklists were converted to percentages for easy interpretation and analysis of data.

Validity of Instruments

The questionnaires, discussion and interview guides were given to lecturers of the Science Education Department of the University of Education, Winneba and other research experts to analyse in relation to policy guidelines, used in setting up the centres so as to ensure the maximum validity of the research instrument.

This researcher sought to establish the content and face validity of the research instruments. According to Waltz, Strickland and Lenz (1991), content validity is the extent to which an instrument adequately samples the research domain of interest when attempting to measure phenomena. After analysing the questionnaire, the experts effected the deletion of incorrect items and replacement of such deleted items with alternative ones.

Secondly, the face validity of the questionnaire was also established with the help of science education experts. These experts helped to correct all typographical errors in the form of wrong spellings, omissions etc. and elements of ambiguity in the final version of the instruments. The experts deemed the instruments to be suitable to be used in gathering data for the present study.

Reliability of Research Instruments

To ensure the reliability of the various respondent questionnaires, it was administered through a pilot test of selected Centre and satellite schools in the Western and Upper East Regions of the country. All other instruments, including the checklists, discussion and interview guides were subjected to review by expert supervisors.

The reliability of the questionnaire was then determined using Cronbach's Alpha. According to Borg, Gall and Gall (1993), coefficient of reliability values above 0.75 are considered reliable.

The Cronbach's Alpha reliability value obtained for teacher/technician questionnaires was 0.784 and that of students were 0.806. The corrected item correlation ranged from 0.32 to 0.61. De Vaus (2004) suggests anything less than 0.30 is a weak correlation for item-analysis purposes. Thus the values obtained for the present instrument were acceptable.

The interview protocol was also piloted with the same sample used in piloting the questionnaire. The reliability of the interview was then assessed using inter-rater reliability. The transcriptions of the audio recordings of the interviews were given to different experts to determine the inter-rater reliability of the data. According to Mays and Pope (1995) "The analysis of qualitative data can be enhanced by organizing an independent assessment of transcripts by additional skilled qualitative researchers and comparing agreement between the raters" (p. 110).The experts used, agreed that the interview protocol could be used to undertake the substantive study. The reliability of the interview protocol was also enhanced by the fact that the interviewer held one-to-one interview sessions with the various respondents using almost the same questions.

According to Conway, Jako and Goodman (1995), one-to-one interviews with standardized questions appear to have the highest reliability.

Procedure for Data Analysis

The SPSS version 16 was used to undertake analysis of quantitative data gathered through the use of questionnaires. In keeping with recent trends in the research on classroom learning environments, this study utilized both quantitative and qualitative methods (Fisher & Fraser, 1990; Fraser & Tobin, 1991; Fisher, Rickards, & Fraser, 1996). The researcher tallied item responses and the means for each class were determined. Qualitative data were gathered from stakeholders and the data obtained from interviews were transcribed, analysed and summarized thematically.

Policy documents and education sector reviews as well as other project documents, were subjected to the Document Analysis Guide (DAG) to give indications of the overall national goals with respect to education in science. According to Bryman (2001), as a social research method, document analysis is an important research tool in its own right and is an invaluable part of most schemes of triangulation. Most of these documents were collected from archives, mainly MOE/GES library and cupboards of Curriculum Research Development Division (CRDD) of the Ghana Education Service (GES), internet and individuals. Several of SRC project documents, monitoring reports, impact assessment studies, updates and write-ups were obtained from the Science Education Unit of the GES and the International Training and Education Consultants (Itec) Company Limited, the service provider of the SRC Project. During the data collection period, the Researcher obtained various science curriculum materials from school heads, science

teachers and also from the officials of the CRDD and the National Information and Communication Technology (ICT) and Science Resource Centre.

CHAPTER FOUR

RESULTS

Overview

In this chapter, the results obtained from the study are presented along research questions asked to establish the status of the SRC project. The chapter is, however, divided into two main areas, representing background of student and teacher respondents; and responses to the four research questions asked.

Background Information on Students

A total of 200 students were sampled from various Senior High Schools across the country to partake in the study. The country was zoned into three, namely the northern zone (Northern, Upper East and Upper West Regions), the central zone (Eastern, Ashanti and Brong Ahafo Regions), and the southern zone (Volta, Greater Accra, Central and Western Regions). The students were chosen from two categories of schools; the centre or host schools and the satellite schools.

Table 3 presents the number of student respondents from the different type of schools distributed along zonal level.

Table 3: Number of Students in Centre and Satellite Schools sampled for the Study

	Host School	Satellite School	Total
Northern	30	22	52
Central	30	38	68
Southern	40	40	80
Total	**100**	**100**	**200**

A total of 200 students were involved in the study as respondents. There were 100 students each from all the host and all the satellite schools. However the number of respondents was not equally distributed across the zones. The main reason for unequal distribution was that the southern zone had four regions whilst the two other zones were made up three regions each. Additionally, there were fewer schools in the northern regions than the Southern Regions.

Table 4 presents number f student respondents at the various schools forms.

Table 4: Number of Students at Various Forms

Level	Frequency	Percentage
Form one	8	4
Form two	23	11.5
Form three	85	42.5
Form four	84	42

In all 8, 23, 85 and 84 students were from SHS forms 1, 2, 3 and 4 respectively. Skewing the participation of students towards higher forms ensured that student respondents, who had stayed in the various types of school long enough, responded to the questionnaires and participated in discussions, based on their real life experiences with respect to their involvement or non-involvement in the SRC project.

Table 5, presents the gender distribution of student respondents across the zones.

Table 5: Gender Distribution of Student Respondents

Gender	Frequency	Percentage
Males	106	53
Females	94	47

Fewer females compared to male respondents participated in the study, even though they were randomly selected. This occurrence is in conformity with gender difference generally served in students' participation in science.

Table 6 presents ages of the student respondents in years.

Table 6: Age Distribution of Student Respondents

Age	Frequency	Percentage
16 years	10	5
17 years	71	35.5
18 years	57	28.5
19 years	42	21
20 years and above	20	10

Majority of the student respondents were between ages 17 and 18 as respondents within this age range made up a total of 64% of the total student sample. Those above 20 years made up only 10% of the total sample size.

Background Information about Teachers

Table 7 shows the distribution of the 56 teachers involved in the study according to zones.

Table 7: Distribution of Respondent Teachers from the Zones

Zone	Frequency	Percentage
Northern	13	24
Central	18	31
Southern	25	45
Total	**56**	**100**

As evident in the table, the northern zone contributed the least percentage of teacher respondents. The zone which had the greatest percentage of teacher respondents was the southern zone, which contributed 25 out of the total of 56 teachers, representing 45% of the total sample.

Table 8 presents the distribution of male and female teacher respondents involved in the study.

Table 8: Gender Distribution of Teachers

Gender	Frequency	Percentage
Male	48	86
Female	8	14

The number of male teachers who participated in the study was greater than that of females. Only 8 out of the 56 teachers were females. Thus, male teachers constituted a whopping 86% of the teachers involved in the study.

Table 9 presents the age distribution of the teacher respondents.

Table 9: Distribution of Ages of Teacher Respondents from the Various Zones

Age	Frequency	Percentage
20-30 years	4	7.1
31- 40 years	14	25
41 – 50 years	27	48.2
Above 50 years	11	19.2

Those above the age of 40 made up 38 out of the total number of 56 teachers. Only 4 teachers were less than 31 years of age as seen in Table 9.

Table 10 presents Academic Qualifications of Teachers.

Table 10: Academic Qualifications of Teachers

Qualification	Frequency	Percentage
Diploma	1	1.8
First Degree	46	82
Second Degree	9	16.2
Total	**56**	**100**

As shown by the data provided in Table 10, most of the teacher respondents had Bachelor's degrees rather than Diploma or Masters Degree. Only one teacher had a diploma and the remaining 9 indicated that they were second degree holders.

Table 11 presents Subject Specialization of Respondent Teachers.

Table 11: Subject Specialization of Respondent Teachers

Subject	Frequency	Percentage
Agric	13	22.4
Biology	16	27.5
Chemistry	14	24.1
Physics	12	20.7
Integrated Science	3	5.3
Total	**58**	**100**

It is seen from Table 11 that the distribution of teachers was evenly spread among the various science subjects areas. Apart from integrated science which contributed only 3 out of the 56 respondent teachers, the number of respondent teachers from the other science subjects ranged between12 and 16.

Main Results of the Study

The results of the study are presented in line with research questions.

Overview

Research Question 1: To what extent have the policy objectives for establishing the SRC Project been carried out and achieved?

This research question examined the impetus for establishing the SRC Project, the implementation processes and the extent to which the objectives for setting up the SRCs project have been achieved, focusing on two main issues:

1. The education policy guidelines which provided the impetus for establishing the SRC Project
2. The main objectives for establishing the SRC project and SRC project implementation issues.

Several instruments were used to guide responses to this research question. The instruments were mainly the DAG, the SDGI and SPQ. The DAG was used to carry out desk reviews in analysing documents and materials on policies on education in Ghana as well as documents which provided directives from the Ministry of Education on the establishment of the SRC project. DAG was equally used to gather information on project implementation issues, from the documents on logistics supplied, project evaluations, monitoring and assessment reports.

The SDGI and SPQ were used to gain insight into project implementation difficulties from stakeholders and their current perspectives on SRC project relevance.

The data obtained through analysis of documents are presented in Table 12.

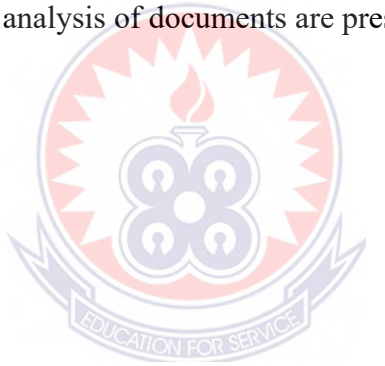

Table 12: Documents Analysed based on the Place of Science in Ghana's Development, the Role of the SRC Project and SRC Project Implementation Issues

Documents Reviewed	Statements, clues, policies on importance of science education and the directives and guidelines for establishing the SRC project; logistic documents and reports on SRC implementation issues			
	Importance of education in science	**Development of human capital**	**Responsibility for school infrastructure development and equipment supplement**	**The role of the SRC and implementation issues**
Education Acts	√		√	
Government White paper on Education	√		√	
Education reform documents	√	√		
Education sector reviews	√	√		√
Education Sector Strategic Plans	√	√		√
Education Sector Performance Reports,	√	√		√
Science and technology (S & T) policy documents	√	√		√
S & T implementation plan	√	√		√
Science Education policy documents	√	√		√
Syllabuses , curriculum	√	√		
Students' Text books, teachers' manuals	√	√		
SRC Project documents	√	√		√
SRC manual and source books	√	√		√
SRC project Monitoring & Assessment reports				√

From, Table 12, it can be seen that with the exception of the SRC project Monitoring and Assessment reports, all the documents analysed have some statement indicating the importance of science education for national development. Various Education Acts and the Government White paper on Education did not specifically state the importance of development of human capacity for the achievement of national goals and aspirations. However, these two classes of documents were the only ones which were found to have some statements referring to the responsibility of local government for resource

mobilization. The role of the SRC project in national development agenda is found in Ministry of Education and Ministry of Science and Technology policy documents, Education Strategic Plans, Education Sector Reviews as well as SRC Project documents, manuals, monitoring and assessment reports.

1. The Education Policies which provided the Impetus for Establishing the SRC Project

Generally, some of the documents analysed indicated the place of science in Ghana's developmental agenda. As a prelude to the newly developed Science, Technology and Innovation Policy (STIP) document of the Ministry of Environment, Science and Technology (MEST), reference is made to the high priority agenda statement by the first President of Ghana. According to McWilliam and Kwamena-Poh (1975), Dr. Kwame Nkrumah spelt out his vision for development of human capital for Ghana's development by emphatically stating that:

> "Our whole educational system must be geared towards producing a scientifically-technically minded people. Because of the limitations placed on us, we have to produce of necessity, a higher standard of technical education than is necessary in many of the most advanced countries of the western world. I believe that one of the most important services which Ghana can perform for Africa is to devise a system of education based at its university level on concrete studies of the problems of the tropical world. The University will be the coordinating body for education research, and we hope that it will eventually be associated with Research Institutes dealing with agriculture, biology, and the physical and chemical sciences which we hope to establish" (p. 94).

From the documents analysed, it can be noted that several education sector plans allude to achieving a 60 to 40 ratio of science to the humanities at the tertiary education level of education, giving credence to the nations' agenda to apply science and technology to accelerate her economic development (Addae-Mensah, 2000).

The Accelerated Development Plan for Education of 1951 and the Education Act of 1961(Act 87) Section 7, established the responsibility of government to provide educational infrastructure development including facilities for the study of science and education right for all children, including education in science, respectively.

Several of the documents on the SRC project reviewed, indicated the state of science education at the onset of the SRC project. The initial SRC proposal documents and information gathered from SEU outlined some of the problems in the field of science and technology which informed the establishment of the SRC as:

- Insufficient number of qualified science teachers in schools
- non-availability of good science laboratories in some senior secondary schools offering the science programme
- Generally insufficient quantities and types of equipment, chemicals and materials in the science laboratories in our schools.
- inadequacy of science reference books in school libraries
- insufficient number of bio-charts and models in school science laboratories

From some the documents reviewed, several information gathered, provided the major thrust for the establishment of the SRC.

2. The Main Objectives that Influenced the Establishment of the SRC Project

As clearly stated in the SRC project implementation documents (MOE, undated) the main policy objectives for establishing these centres were:

1. The SRCs are to serve as teaching centres to supplement existing facilities in Secondary Schools and give ample opportunity for practical work using facilities and techniques including the use of computers.
2. They will provide tuition for students in schools without well-equipped laboratories.
3. They are to be used as centres for running in-service training programme for teachers of science at both JSS and SSS Levels.
4. They will serve as venues for students to engage in project development.

The Ministers, Directors of Education, coordinators of SRC project and the staff of SEU, in their interviews and discussions were univocal that the SRC project was intended to provide learning centres, well equipped with modern science equipment which teachers and students could use for practical work to supplement teaching and learning in the classroom. The intended beneficiaries of the SRC were chiefly the students, teachers and ultimately all citizens of Ghana on the whole.

Interview and Focus Group Discussions

The views of some stakeholders on the objectives for setting up the SRC project were solicited using the Stakeholders' Interview and Discussion Guides (SIDG). The Ministers and Directors of Education, the coordinators of SRC project and the staff of SEU, in their interviews and discussions, were univocal that the SRC project was intended to provide learning centres, well equipped with modern science equipment which teachers and students could use for practical work to supplement teaching and learning. According to them, the intended beneficiaries of the SRC were chiefly the students, teachers and

ultimately all citizens of Ghana. However, in an exclusive interview with a National Coordinator of the SRC project, he shared his perspective as transcribed in Appendix N.

A focus group discussion with the second NSRC Coordinator and his assistant gave another side of the picture. They pointed to the lack of adequate resources for teaching and learning science as the rationale for the establishment of the SRC Project. Thus they considered it cost saving for government to make resources central to benefit more schools. Both teachers and students were motivated through exposure to modern equipment.

Interviewer: In your opinion, what do you think was the motivation for setting up the SRC project in the first place?

Respondent 1: I think the SRCs were established to make up for inadequate laboratory materials and equipment in school. The centres were to be community lab with every district having one to supplement the teaching of science practicals and demonstrations. These really helped with teaching. In actual fact, these equipment are not just for practicals. However, because of lack of time, teachers fail to take students through activities. Nevertheless, teachers should view some of the modern equipment as for demonstration which needed no preparation i.e. requiring time for preparation. When the equipment is brought out for demonstration, it makes students become familiar with it, helps them to visualize some scientific processes in concrete terms and appreciate science better. This definitely led to improvements in their examination results which were clearly evident during the first 5 or 6 years of project implementation.

Respondent 2: The whole project was cost effective. Government saw that it was a cost-effective way of ensuring most schools have lessons in practical science. The project equally exposed science teachers who had the opportunity to be involved in the use of modern equipment. Both teachers and students were exposed to modern teaching and learning approaches in the use of science equipment e.g. data loggers, seismometers which provide excitement among students and motivated them to want to study science.

i. Perspectives of Stakeholders on SRC Project Achievements

From interviews with some of the stakeholders, including students, teachers, centre mangers, education officers and education officials as well as service providers, they were univocal that the SRC project was intended to provide learning centres, well equipped with modern science equipment which teachers and students could use for practical work to supplement teaching and learning. According to them, the intended beneficiaries of the SRC were chiefly the students, teachers and ultimately all citizens of Ghana.

The perspectives of other stakeholders, whose views were recorded, (Appendix V), were in accordance with information found in several documents within the SEU and those provided by the service provider. Deducing from their views and responses, it is apparent that the rationale for setting up the SCR project was to serve as an intervention to make up for the shortfall in the delivery of quality education in science and technology.

From interviews with teachers, it became evident that in their perspectives, the establishment of the SRC project was clearly a major boost and a shot in the arm of

education in science in Ghana. The envisaged benefits from the above objectives were varied and numerous. The prospects were that the SRC project would impact positively on the attitude of students and teachers and in the wider context, accelerate the rate of technological advancement of the nation. Information obtained from some assessment and monitoring reports revealed that some of the intended benefits which were deemed to have been achieved in the first few years of the project were:

- improved teaching and learning methods
- Increased enthusiasm of students in the learning of science
- Increased enrolment of science students at the secondary and tertiary levels of education.
- Better preparation of both teachers and students to fit into the modern information technology age
- Strengthening of the science and technology base of the country as pre-requisite for national development (SEU, 2006).

Research Question 2: What is the current state of resources available at the SRCs?

To assess the current state of available resources, different approaches were used. The researcher based the assessment of the current state of the SRC on four main criteria namely: a) the state of financial resources, b) the state of physical structures, c) the state of material and d) the state of human resources for the SRC project.

a. An Assessment of Financial Resources provision for the SRC Project

Information on the financial resources invested into the project was obtained mainly from the study of policy documents, using DAG. In the local context, the Ministry of Education has contributed immensely towards improvements in education at all levels

through the disbursement of various sums of money. The Draft Education Performance Plan 2009 (MOE, 2010) states that "government's expenditure from 2007 to 2009 on Science Laboratory Workbenches & Stools was $ 10, 204,620.00 (ten million, two hundred and four thousand, six hundred and twenty USA Dollars)". According to MOE (1996), the government's expenditure on the SRC project at its inception in 1995 was £20 million (twenty million pounds sterling). After 12 years of project implementation in 2008/2009, all the SRCs were re-equipped at a cost of £10 million and some centres are currently (20011/2012) being rehabilitated at a total cost of GHC16.5 million. The 2012 proposal on the phase II of the SRC was estimated to cost £8 million.

Information gathered through documents analysed pointed to several directives issued during the period of intense project implementation. Several monitoring reports indicated satellite schools were required to pay a levy of 0.40GHp (forty Ghana pesewas) per student at the onset of the project. This was to provide the centres with much needed capital crucial to their maintenance. However, this policy was not adhered to and collapsed several years after its inception.

In effect, it was evident from documents reviewed that, the finances of the SRCs leaves much to be desired and there is the dire need for financial capital to be injected into the project regularly to ensure its continual sustenance and existence.

b. Assessment of Physical State of Facilities, Materials and Equipment for Science Practical Lessons

The assessment of resources for SRC project implementation was done using the Resources Analysis Portfolio (RAP).

Conditions of Physical Structures

Part 1 of the Resources Assessment portfolio (Appendix I) was used to gather information on the conditions of the physical structures of 20 science resource centres and 20 science blocks/laboratories of the satellite schools. The type of building being used and the type of materials used for constructing the building are presented in Figs. 1, 2, 3, and 4.

1. Type of building used by schools as SRCs and science blocks/laboratories

Heads of schools were made to indicate type of building used as resource centres, science blocks and laboratories. Proportions of facilities found refurbished, newly constructed or converted in the different types of schools are indicated below in fig 1 and 2.

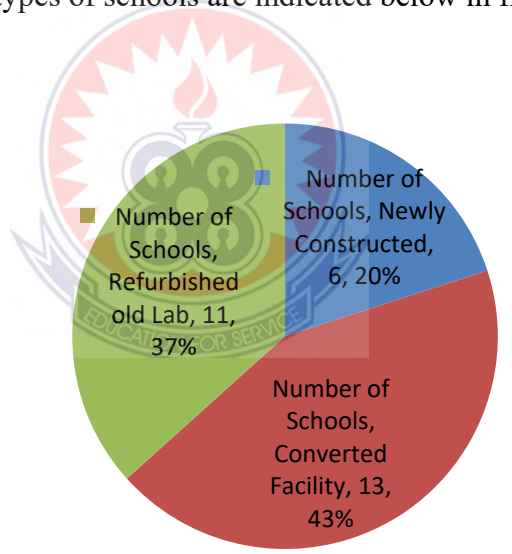

Fig. 1: Type of building used by host schools as SRC

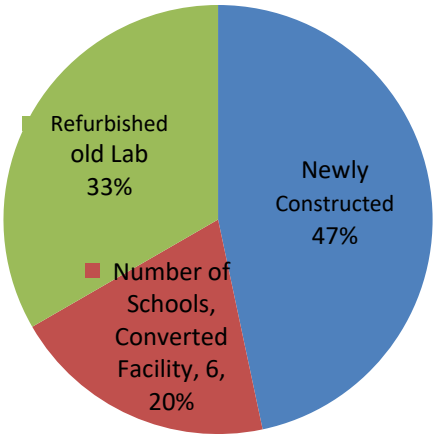

Fig. 2: Type of building used by satellite schools as science blocks/laboratories

Respondents listed three main building types 1) newly constructed buildings, 2) refurbished buildings and 3) converted facilities used for practical science activities. Comparatively, more host schools (43%) have converted facilities used for science practicals than satellite schools (20%), whereas more satellite schools (47%) have newly constructed buildings as science blocks than host schools (20%). However, both types of schools appear to have about the same number of refurbished buildings used for science practical activities.

2. **Type of building materials used by schools for SRCs and science laboratories**

   Materials used for building the various school facilities for studying science are indicated in fig 2 and 4.

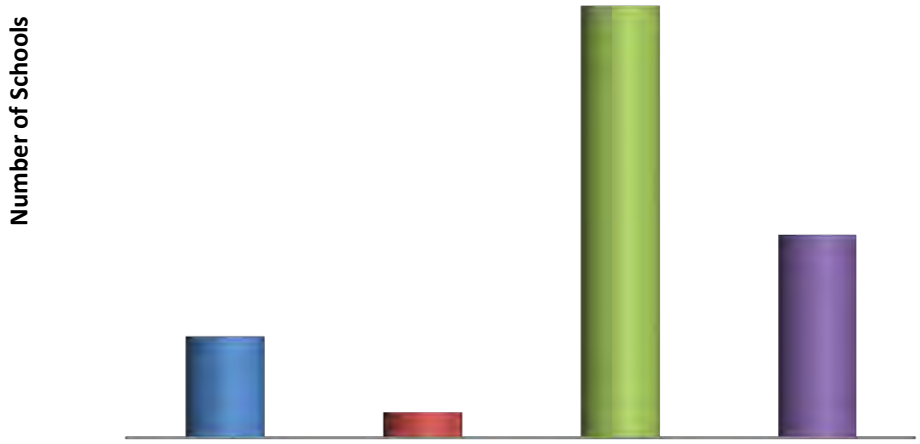

Fig 3: Building materials used by host schools

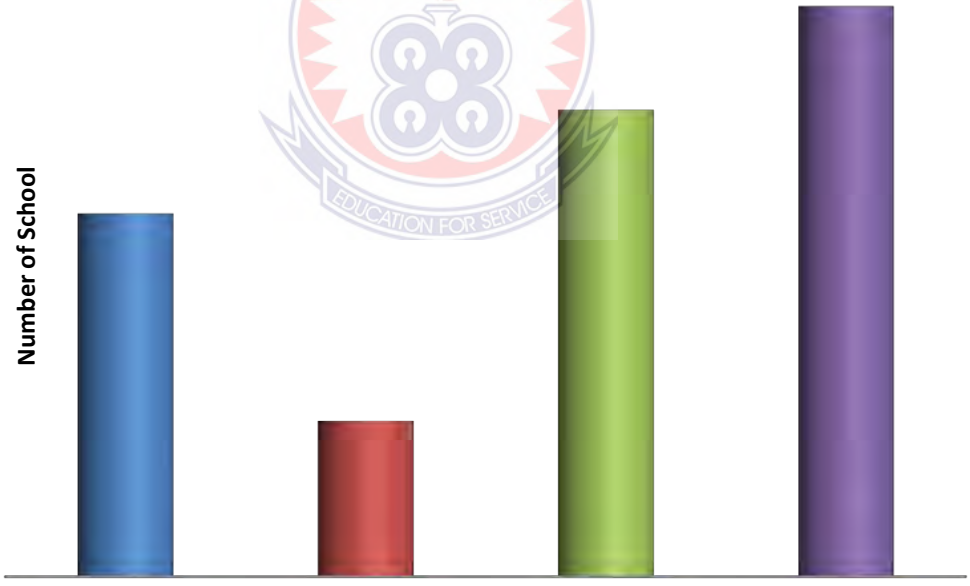

Fig. 4: Materials used by satellite schools

Most schools used cement blocks or bricks for science blocks. Wood and metallic materials were found in only few schools. Some schools had used iron containers as laboratories or for storage of items.

Ages of Buildings used for Practical Science Activities in the Various Schools

School heads were asked to complete the RAP by indicating the approximate age in years of buildings used as SRC/science blocks/laboratories. The results are represented in figs. 5 and 6.

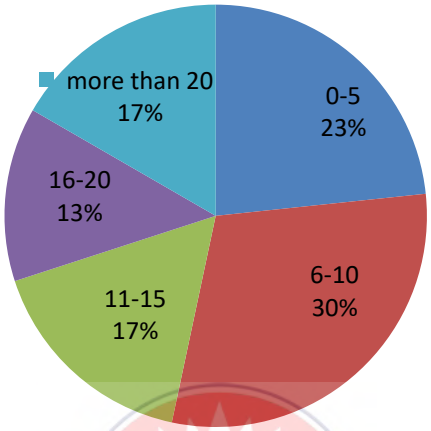

Fig. 5: Age of facilities used as SRCs by host schools

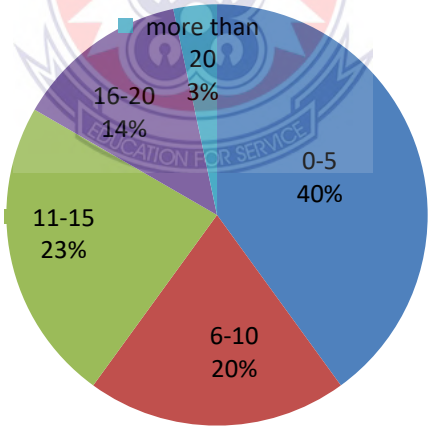

Fig. 6: Age of facilities used by satellite schools as science blocks/laboratories

On the average, more satellite schools (40%) have relatively new buildings (age 0-5 years) than host schools (23%). In over 50% of the cases, buildings being used for science practicals in both host and satellite schools are between ages 5 to 10 years. Very few satellite schools have very old buildings.

Rating of Conditions of Facilities, Materials and Equipment for the study of science

1. Conditions of Facilities and Material Resources

The Part 1 of the Resources Assessment Portfolio (RAP) was used by teachers' or centre coordinators to rate selected facilities, materials and equipment as good, satisfactory or poor and the results are presented in Table 13.

Table 13: Teachers' and Centre Coordinators' Rating of States of Facilities and Material Resources in SRCs

Items	Proportion of Schools (%)		
	Good	Satisfactory	Poor
Laboratories	19.2	23.1	57.7
Physical state of SRC	6.5	27.3	66.2
Chemical reagents	10.3	19.2	70.5
Equipment	18.2	16.9	64.9
Usage of tally cards	15.4	20.5	64.1
SRC Manuals	21.1	43.4	35.5

From Table 13, it is evident that with the exception of SRC manuals, most schools rated the current status of facilities and materials as being poor.

Host school teachers and Coordinators' Rated structures of the SRC and the results are presented in Table 14.

Table 14: Percentage of Teachers and Centre Coordinators Rating of Condition of Structures of the SRC in Various States in Host Schools

	Roofs	Floors	Walls	Windows	Doors	Pipes	Drainage
Very bad	13	17	17	15	20	23	20
Bad	23	17	27	25	23	30	23
Satisfactory	27	33	26	30	27	33	33
Good	20	13	7	17	17	13	11
Very good	17	20	23	13	13	11	13
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Based on the data provided in Table 14, it can be seen that only a few of the facilities in the host schools were in very good shape. On the average, 27% to 33% of all the schools

indicated that the selected items were in good conditions. However, between10% to 30% of the centres had their facilities in very bad conditions and 17% to 30% listed facilities as being in bad states.

Only 3% of doors in the schools were considered to be very good and 10% of the schools also could be considered as having very good pipes. As many as 43% of the schools had broken pipelines and about the same number had bad drainage system. Finally 36% of the schools had roofs in found to be in bad condition.

Satellite school teachers Rated structures of their laboratories and the results are presented in Table 15.

Table 15: Percentage of Teachers Rating of Condition of Structures of Facilities in Various States of Some Satellite Schools

	Percentage of Schools Physical Structures in Various Stages						
Stages of Facilities	**Roof**	**Floor**	**Wall**	**Windows**	**Doors**	**Pipes**	**Drainage**
Very bad	15	16	10	7	17	13	10
Bad	27	27	30	30	23	23	20
Satisfactory	30	27	23	40	20	30	33
Good	13	16	13	3	13	21	24
Very good	15	20	21	20	27	13	13
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

The situation in satellite schools was not too different from those found in host schools with regards to the state of the physical structures as evident on Table 15. On the average, 20% to 40% of the schools were considered to have good structures in the satellite schools. Those satellite schools with very poor structures made up only 7% to 15% as against 10% to 30% of the host schools. Also, 30% of doors found in satellite schools

were in very good conditions, in contrast to the conditions in the host schools whereby only 3% of the schools had very good doors. Similarly, a greater percentage of the satellite schools (between 13% to 23%) had better pipes and drainage systems compared to the host schools (10% to 13%). However, the conditions of the walls, windows, ceilings and floors found in both host and satellite schools were similar.

Extent of Usage of 30 Selected Items in Laboratories

An analysis of the extent of usage of 30 selected items in the SRCs was conducted with the aid of a checklist designed for that purpose. The item was in use, spoilt or finished in boxes or other meaning lost, borrowed or cannot account for the item for one reason or the other. The percentage mean of items found in various stages are presented in Table16.

Table 16: Extent of Usage of 30 selected Items in Laboratories

Item	In Use (%)	Spoilt/Finished (%)	Still in Boxes (%)	Other (%)
Glass Gas syringe	5	20	60	7
Red Pipette filler	25	2	45	17
Hand held thermometer	15	9	11	33
Boiling flask socket	70	0	18	12
Filter papers	87	5	5	3
Chromatography papers	23	14	29	34
Chemical balance	41	5	31	33
Litmus papers	36	37	24	3
Sulphuric acid	65	29	2	4
Glass blocks	34	0	40	26
Potentiometer	18	11	64	7
Pendulum bulbs	54	0	34	12
Convex mirror	13	8	46	33
Plane mirrors	23	37	25	15
Resonance tube	12	4	63	21
Electricity kits basic	18	31	38	13
Magnets	15	0	82	3
Alcohol fermentation kit	28	2	65	5
Stop watch	47	16	25	12
Gene kit	7	1	74	18
Pulse and BP monitor	10	8	63	19
Lung volume bag kit	0	4	91	5
Petri Dishes Disposable	31	41	18	10
Centrifuge	4	17	78	1
DNA Helix	12	24	58	6
Cover glasses	39	13	32	16

It is seen on Table 16 that many of the items supplied to the centres were in their package boxes and thus still unused. These items included lung volume bag kits (91% of the schools), magnets (82% of the schools), centrifuges (78% of the schools), gene kits (74% of the schools), alcohol fermentation kits (65% of the schools), potentiometers (64% of the schools) and Pulse and B.P monitors (63% of the schools). The data shows that sulphuric acid (2%) and litmus paper (5 %) were still in their boxes. On the average, 41% of schools had items still in their original boxes which apparently had not been used previously.

Observation on State of Facilities at the SRCs

As part of data gathering on the current state of physical resources at the SRCs, the researcher visited all of the 20 centres selected for the present study. Some pictures taken to capture the state of some of the facilities are presented in plate 1, 2, 3 and 4.

Plate 1: A decaying drawer

Plate 2: A ramshackle students' work table

Plates 1 and 2 reveal some of the dilapidated tables, cupboards and tables in some of the SRCS.

Plate 3: Students' chop boxes found in an SRC laboratory

Plate 4: Students' trunks found in a satellite school laboratory

Plate 3 and Plate 4 depict the manner in which some schools are wrongly using the centres. As seen in the plates, in several schools the science laboratories are serving as store rooms for both non-laboratory items such and old and broken down science equipment.

Plate 5: Washing machines found stored in a laboratory of a satellite school.

Plate 6: Variety of old or broken equipment in SRC laboratory

Plate 7: Broken sinks found store in SRC laboratory

Plate 8: Newly supplied items stored in SRC laboratory

Newly purchased washing machines were stored in a laboratory (Plate 5) and a variety of broken down loboratory items found included broken sinks (Plate 7). In one school, it

was found that a physics laboratory was being used to store science items newly supplied in 2007/2009 (Plate 8).

It was also dicovered that some of the laboratory items supplied had not been use for several years. Some science items were found still in their packing boxes and some appeared not have been used before.

Up to 25% of supplies were found still in their packing boxes in 12 out of 40 schools laboratories visited and some converted facilitites such as classrooms. Some SRCs have both old science items supplied between 2000 and 2007 together with new ones supplied in 2008/2009. In 45% of the schools visited, old and very dirty laboratory items were found in laboratory store rooms (Plate 9). Large quanties of unused chemicals in boxes were found in one satellite school (Plate 10).

Plate 9: Poorly stored laboratory item on shelves in an SRC store room.

Plate 10: Chemicals still in their boxes and stored away in a satellite school laboratory

Thirty percent of schools which took part in the study had well-manned laboratories as evident on Plate 11. However 40% of schools had laboratories in various poor conditions. Some satellite schools(5%), mostly Model Schools have maintained good standards and 2 Model schools visited have newly built laboratories.

Plate 11: A well-manned laboratory in a model satellite school

Plate 12: A dilapidated work table in a laboratory in a SRC

In some schools, it was found that some broken down laboratory items were found still in the laboratories or packed away in corridors of SRCs (Plates 13 and 14).

Plate 13: A broken cupboard still in the laboratory at SRC

Plate 14: Obsolete computers and roofing sheets packed in the corridor of an SRC block

Plate 13 shows a broken and rotten cupboard still in the laboratory. In one school, unused obsolete computers were found packed together within the premises of an SRC.

c. The Current State of Human Resources of the SRC Project

The Resource Assessment Portfolio (RAP) questionnaire was used to gather data on the current status of human resources at the SRCs. Information was provided by stakeholders such as heads of schools, heads of science departments, and science teachers. The data collected with the RAP, supplemented with SPQ and SIDG, provided information on the available human resource for supervision, teaching and learning of science. Heads of schools, science teachers and technicians provided their bio-data, areas of specialization and subjects taught. The design of the SPQ was such that it captured data on the type of in-service training teachers received from GES and its impact on their professional

development. The data collected with the SPQ also gave an indication of available SRC trained teachers and technicians for the SRC project continuation.

Teacher Qualification, Areas of specialization and subjects Taught

The data in Tables 10 revealed that majority (82%) of the science teachers in both the satellite and centre schools held at least a bachelor's degree. Only one teacher held a diploma and 9 had a second degree. This gives an impression that the teachers were qualified enough to handle teaching and other forms of instructional activities at the centres. The data collected (Table 11) showed that even though few teachers (5%) may have specialized in integrated science, the subject is being taught in all schools throughout the country.

Professional Teacher Development

Table 17 gives information on the number of respondent teachers who had received specialized training on the SRC.

Table 17: Number of Teachers who have received In-service training on the SRC

Response	Frequency	Percentage
Yes	26	46.4%
No	17	30.3%
No response	13	23.3%
	56	100%

Out of the total of 43 respondent teachers, 17 of them, representing a sizable 39.5% indicated that they had not received any in-service training on the SRC.

Table 18 presents the number of respondent teachers who had received other forms in-service training teachers organised by GES.

Table 18: Number of Teachers who have undergone other forms of In-service training

Response	Frequency	Percentage
Yes	25	44.6%
No	18	32.1%
No response	13	23.3%
	56	100%

From Table 18, it is evident that whereas majority of the science teachers had undergone one form of in-service training or the other, a significant 42% of them hadn't received any form of in-service training at all.

Research Question 3: What is the current level of schools' involvement in the activities of the SRC?

This research question sought to find out the current level of relevance and usage of the SRC from students and science teachers in both satellite and centre schools. Thus their responses to some items on the questionnaire were used to answer the research question.

Students' Perception about the Use of the SRCs by Students

Item 1 of the students' perspective questionnaire, (SPQ) required students to indicate venues used for practical science activities.

Results of proportion of students indicating usage of the venues for practical science lessons are presented in Table 19.

Table 19: Percentage of Students indicating Venues used for Conducting Practical science Lessons

Type of School	SRC	Classroom	SRC/Classroom	Total
Host	48	19	33	100
Satellite	21	62	17	100
Total	69	81	50	200

Information available in Table 19 shows that 48% and 21% of the students from the host schools and satellite schools respectively indicated that the SRCs were used for practical science activities whilst host schools (19%) and satellite schools (62%) said classrooms were used. The remaining 33% of students from host schools and 17% from satellite schools revealed that both venues were used to undertake science practical lessons.

In Table 20, the frequency of usage of the science resource centres as indicated by the students is presented.

Table 20: Frequency of Usage of the SRC to Conduct Science Practical Lessons, as Indicated by Students

Responses	Type of School		
	Host School	Satellite School	Total
All the time	10	10	20
Quite often	30	22	52
Several times in a term	7	9	16
Never used	53	59	112

Majority of the students in both the host (53%) and satellite (59%) schools indicated that they never used the SRCs. Only 10% of students from both host and satellite schools indicated that the SRC was used at all times. Generally, it was revealed that students from the host schools used the SRCs more often than their colleagues from the satellite schools.

Comparing the results from Table 19 and Table 20, it can be deducted that even though quite a number of students (48% and 21%) from centre and satellite, respectively used the centre for science practical activities, not many of them used the centres too often. However, an indication of host (53%) and satellite (59%) schools student never using the SRCs is consistent with earlier information given in Table 19.

Students' Perception about the Usage of Science Resource Centres by Teachers

Table 21 presents subject teacher patronage of the SRCs as perceived by students

Table 21: Students' Responses on subject Teacher patronage of the SRCs

Teachers	Frequency	Percentage
All subjects	43	21.5
Only Biology	25	12.5
Only Chemistry	16	8
Only Physics	40	20
None	76	38
Total	**200**	**100**

It can be seen from Table 21 that 38% of student respondents were of the view that none of the teachers from the various subject areas liked using the SRCs. Only 21.5% of the students said that teachers from all the various science subject areas used the SRCs. Twenty percent said Physics teachers mostly used the centres and a further 8% said Chemistry teachers rather used the centres.

The linkage in the three tables, 19, 20 and 21 is obvious and consistent with reported poor patronage f the SRCs

Proportion of Teachers Using the SRCs for practical science lessons in a school term

In order to establish the extent of usage of the SRCs in recent times, the teachers, responding to item on their questionnaire, stating their use of SRCs, were further asked to state how often they used the SRCs for science practical work in a term and the results presented tables 22.

Table 22: Teachers' Usage of SRC for Practical Activities in a term

Responses	Frequency	Percentage
All the time	2	3.6
Quite often	10	17.9
Once a while	5	8.9
Never	39	69.6
Total	**56**	**100**

It was revealed that as many as 39 (69.6%) of the teachers never used the SRCs. Only 2 (3.6%) respondent teachers indicated they used the SRCs all the time. A further 10 (17.9%) out of the 56 teachers said they used the centres quite often. The entire breakdown of teachers' responses is as displayed in Table 22.

It was of interest in this research to investigate whether any activities take place at the SRCs and by whom.

Teachers' responses to current patronage of the centres are presented in table 23

Table 23: Teachers' Responses on Level of Patronage of SRC by Various Schools

Type of School	Host	Old Satellite	New Satellite	JHS
Responses				
All the time	16.1	1.8	1.8	3.6
Quite often	8.9	3.6	1.8	3.6
Once in a while	3.6	8.1	5.4	14.3
Never	71.4	85.7	90.2	78.4
Total	**100**	**100**	**100**	**100**

From the results presented in Table 23, it was evident that generally, not many schools patronize the SRCs. It is revealed that as much as 85.7% and 90.2% of the old and new satellite schools respectively had stopped using the centres. A paltry 1.8% of these same categories of schools still visited the centre frequently. Teachers also indicated that only 16.1% of the host schools still used the SRCs on a regular basis.

Table 24 provides a breakdown of the reasons provided by science teachers as to their purpose for visiting the centres individually or with their students.

Table 24: Reasons for which various Schools visit the SRC

Reasons given	Frequency	Percentage
Borrow materials	8	14.3
Borrow equipment	1	1.8
Only for examinations	7	12.5
All of the above	4	7.1
Just visit	33	59.0
Not indicated	3	5.4

This question was posed to both host school and satellite school teachers. Thirty-three of the 56 teachers just visit the centres as displayed by their responses presented in Table 24. For those who used the centres, 14.6% of them mainly visited the centre to borrow materials or equipment and 12.5% used the centre for examination purposes. Three respondents failed to indicate the purpose for which they visited the centre.

Research Question 4: What present perspectives do stakeholders have regarding the relevance of the SRC project in the current school system?

This research question sought to find out the views of teachers and students on the relevance of the SRC so far as academic work is concerned. It sought to establish the impact the centre has on the study of science by students and also how it helps teachers in effective lesson delivery in science.

Students Perspectives on Practical Work at the Science Resource Centre

An aspect of the questionnaire designed for students examined the students' perspectives on the use of SRC for practical science activities. The means of the responses of 200 students who took part in the study are presented in Table 25.

From the results presented in Table 25, it can be deduced that whereas most students agreed with the statement that they loved going to the SRC for science lessons, several of them did not appreciate the usage of SRC in gaining knowledge and understanding. Some of the students agreed that SRC assisted them in computer appreciation, yet not too many of them accepted the suggestion that they were happy having lessons at the SRC. Students were quite divided in their opinions regarding the sufficiency of materials in the SRCs for practical work. Most students neither accepted that all science lessons are done at the SRC nor that only practical lessons are done at the SRC nor that only science students used the SRC.

Though some students disagreed with the statement that all students must use the SRC and that SRC played important role in students' achievement in science, many of them supported the notion that they can never progress in science lessons without the usage of SRC.

Table 25: Perceptions of Students on the Use of the SRCs for Practical Work

Item	Mean	SD
I gain more knowledge when using the SRC for practical science lessons than the classroom	2.49	1.604
Practical science lessons at SRC provide me with better understanding of science concepts than practical science lessons in the classroom.	2.60	1.851
Lessons at SRC help me to like using the computer.	3.55	0.545
I am always happy when we go to SRC for practical lessons.	2.90	1.860
I love going to SRC for practical science activities.	4.14	0.728
All science lessons must be held at the SRC.	2.66	1.468
Only practical lessons must be held at the SRC.	2.70	1.295
Only science students must use the SRC.	2.88	1.373
All students should use the SRC.	2.86	1.353
We can never progress in our science lessons without SRC.	3.21	0.659
SRC plays important role in students' achievement in science.	2.10	1.577
Our science teachers are confident in handling lessons at the SRC.	2.72	1.641
We always have enough materials for practical science activities at the SRC.	3.73	1.082
We always have too much materials for practical science activities at the SRC	3.95	0.917
Total	**Mean = 3.35**	**1.28**

Teachers' Views on the Percentage of the SRC Practical Lessons in WASSSCE

Parts of the questionnaire for teachers was used to explore teachers' views regarding the importance of SRC Programme in the SHS curriculum.

Table 26 presents the perspectives of 56 teachers on the percentage of practical activities of the SRC programme which are found to be the same as or were similar to practical questions found in the WASSCE in the previous two years examinations.

Table 26: Teachers' Responses on Percentage of SRC Practicals Present in WASSCE

Percentage of SRC Practical Questions In WASSCE	Frequency	Percentage
less than 50	12	21.4
50 to 60	9	16.1
61 to 70	4	7.2
71 to 80	3	5.4
81 to 90	4	7.1
91 and above	6	10.7
Not indicated	18	32.1
Total	**56**	**100.0**

Some of the teachers (32.1%) did not give any response to the item bothering on the percentage representation of SRC type activities in WASSCE. However, for those who responded to this item, 21.4% of the teachers indicated that SRC type activities constituted less than 50% of the WASSCE questions and a total percentage of 46.5 indicated that the SRC activities made up more than 50% of the WASSCE questions of the two most recent editions of the examinations.

Teachers' Perception on the Benefits of the SRC Project to Students

To find teachers' views on the usefulness of the SRC to their students, teachers were asked to respond yes or no to whether the activities at SRC helped students to appreciate science better. Teachers' views are presented in Table 27.

Table 27: Teachers Views on Benefit of SRC to Students

Item	Frequency	Percentage
Yes	55	98
No	1	2
Total	**56**	**100.0**

The data presented in Table 27 shows that the teachers overwhelmingly agreed to the fact that the SRC project is beneficial to their students so far as their academic achievements are concerned. Only one out of the 56 teachers who answered this item disagreed with the perception that the SRCs were beneficial to students, as can be seen in Table 27.

The teachers who responded in the affirmative with regards to the question on the benefits of the SRC to students' academic achievement were required to further explain the rationale behind their response. Table 28 shows a summary of the reasons that informed teachers' answer to the statement.

Whereas some of the teachers (28.6%) did not respond to this item, others (19.6%) indicated that the opportunity afforded students to handle equipment at the SRC was the most important reason why the project was good for students. A further 16.1% perceived that the SRC programme makes the study of science more practical and relevant to students. Some teachers (3.6%) stressed that the SRCs helped to generate the interest of students in science as a subject of study whilst 7.1% also claimed that lessons at the SRC enhanced the rate of interaction among individual students in the class. The entire breakdown of responses provided by the 55 teachers is as presented in Table 28.

Table 28: Reasons why Teachers Believe the SRC is Beneficial to Students

Reasons why the SRC is beneficial to students	Frequency	Percentage
Makes science more practical and relevant to the students	9	16.1
Students get opportunity to handle equipment	11	19.6
Improves students' understanding of topics	3	5.4
Makes students attend classes regularly	1	1.8
Makes students participate actively	4	7.1
Not indicated	15	28.6
Improves learning style	4	7.1
Improves classroom interactions	4	7.1
Improves students' confidence	2	3.6
Generates interest among students	2	3.6
Total	**55**	**100.0**

Teachers' Perception on the Benefits of the SRC Project to Themselves

In order to help answer the question on the relevance of the SRC to academic work in current terms, the respondent teachers were required to indicate whether they deemed the SRC as being valuable to themselves or not. Table 29 gives a summary of the answers given by the 56 teachers to the above question.

The data provided on Table 29 reveals that teachers held the opinion that the SRC project was beneficial to them. The above assertion is backed by the fact that as many as 46 out of the 56 teachers, representing 82.1% of the total number of respondents perceived that the SRC project has been beneficial to them. However, a sizable 17.1% of the respondents held contrary views as displayed in Table 29.

Table 29: Teachers Views on Benefit of SRC to Themselves

Item	Frequency	Percentage
Yes	46	82.1
No	10	17.9
Total	**56**	**100.0**

The 46 teachers who deemed the SRC project as being beneficial were required to state the reason for their response. The responses they gave are as summarized in Table 30. Whilst some of the teachers (23.9%) indicated that the project helped improve their teaching methodology, others (10.9%) said their involvement in the programme made them like practical activities and made them more efficient as teachers. Several others (8.7%) revealed that they gained more understanding through the project. Further details on the reasons given by the teachers are presented in Table 30.

Table 30: Teachers reasons for saying the SRC is beneficial to themselves

Reasons why the SRC is beneficial to teachers	Frequency	Percentage
Gained more understanding	4	8.7
Improved my teaching methodologies	11	23.9
Makes me like practical activities	5	10.9
Got acquainted with equipment and their usage	3	6.5
Not indicated	14	30.4
More efficient	5	10.9
Change attitude to teaching	2	4.3
Time wasting	2	4.3
Total	**46**	**100.0**

Discussion of Results

From several documents within the SEU including those provided by the service providers, the rationale for setting up the SRCs was to serve as an intervention to make up for the shortfall in the delivery of quality education in science and technology. The equipment supplied to the centres, though intended to supplement resources for teaching practical science, from the findings, several schools have not demonstrated value for money in the way the resources are being used.

This observation tends to support views of researchers who continue to challenge the role of laboratory-based-science practical teaching. In his extensive review of the various positions researchers have taken, Ghartey-Ampiah (2004) explained that "those with positive views are still divided over issues such as aims, the organization of activities and the skills to be acquired by students" (p. 36).

Perhaps there is the need to carefully examine Tobin (1990) position and assess the Ghanaian School environment as well as ensuring that students are supported by trained teachers, to make use of the opportunity being offered by the SRC programme to construct their own knowledge and develop understanding of scientific concepts. Nevertheless ensuring adequate resources for practical science lessons has always remained a challenge, yet Hofstein & Lunetta, (1982) reported that information is available to help researchers understand how science laboratory resources can be used, how students' work in the laboratory can be assessed, and how science laboratory activities can be used by teachers to enhance intended learning outcomes. In spite of this, Ghartey Ampiah (2004) citing Knott and Mutanga (1995) explained that two main issues were: 1) the high cost of laboratory work not allowing continuous provision of resources and standards and 2) the time constraints from overloaded time tables, affecting the requirements of quality and quantity as well as the effectiveness of conventional laboratory work.

By analyzing the effect of the availability and the use of science laboratories on academic achievement of students in Punjab (Pakistan), Dahar and Faize (2011) also concluded that important issues to consider would include quality, standard quantity, equity and efficient

use of resources. As outlined in the original project document, though the SRC project was established for concerted and sustained efforts at supporting the rapid and quality improvements through the provision of adequate and sufficient science equipment and logistics, the other key objectives which the SRC programme was meant to attain, included the following:

- to serve as teaching centres to supplement existing facilities in secondary schools, with emphasis on practical work.
- to provide tuition for students in schools without well-equipped laboratories
- to offer facilities for running in-service training programmes for teachers of science at both JSS and SSS levels.
- to expose students and teachers to the use of computers and other electronic equipments in the teaching of science.
- to provide facilities for running science and mathematics education clinics for girls.
- to serve as venues for students to engage in the development of their science projects.

It is obvious that the SRC project was a major boost and a shot in the arm of science education in Ghana. The envisaged benefits from the above assessments were varied and numerous. The prospects were that the SRC project will impact positively on the attitude of students and teachers and in the wider context, accelerate the rate of technological advancement of the nation. Some of the intended benefits which were deemed to have been achieved were:

- Improvements in the teaching/learning methodology
- increased enthusiasm of students in the learning of science
- increased enrolment of science students at the secondary and tertiary levels of education.
- teachers and students being computer-literate and therefore better prepared to fit into the modern information technology age.
- Strengthening of the science and technology base of the country as pre-requisite for national development. etc.

The project document and other directives of the MOE were explicit on how the project should be implemented. With the establishment of 108 centres, all the then existing 464 senior high schools were to have access to a centre for science practicals. Ideally, one centre was to be established in one school in each district of the nation. Schools using the centre were expected to be within a range of 30 km. However, the MOE directed that "in instances where a particular school was closer to the centre in another district, such a school may access the resource centre in the nearest district. At the regional level, the number of secondary schools as well as the population of science students in the region was to be taken into account before the centres were established" (MOE, 1995;14). The selected schools were also expected to have some basic infrastructure such as three laboratories with storage facilities and an office for the centre co-ordinator. Such a school must also be connected to the national grid.

Many of the earlier monitoring reports studied advised that for prolonged and sustained use of the centres, much would depend on how well the centres were manned and maintained as much as it would also depend on the regular allocation of resources. In

these monitoring reports, it was clearly established that material, financial and human resources were considered key pre-requisites to ensuring the smooth running of the centres. These regular updates gave specific situational reports and also made specific recommendations on several centres.

Based on data collected on different aspects of the physical facilities for science practical work in both centre and satellite schools, a picture of the current state of physical structures is formed. Good physical facilities, including proper infrastructure and building, computer and science laboratory are cited among facilities which enhance achievements of institutions (Ghazi, Azam, and Khan). In his write-up titled "Do School Facilities Really Impact a Child's Education?', Lyons (2001), gave five (5) physical factors which had an impact on the performance of institutions. These five factors were identified as: 1) perpetuating crowded classrooms, 2) outmoded designs, 3) poor communications systems, 4) limited technology, and 5) inadequate security. These factors in literature are issues that can be used to evaluate the standard of teaching and learning facilities.

An important observation was that some relatively old schools which were considered endowed and were not made to host the SRC project, continue to use their old science laboratories which were sometimes found to be neater and better maintained than several of the SRCs. Another important observation was that some new schools and even satellite schools had mobilized resources and put up excellent buildings as SRC. In most cases, these schools whether new or old and do not have 'modern equipment' still come to the national SRC to beg for equipment. Some also continue to wait to be equipped before they put the facilities to use.

Having been set up among other reasons to serve as learning centres, the SRCs were established at a time when the level of technological advancement of Ghana was relatively low. Not too many schools had their own science laboratories. However, most schools now have science laboratories and some are better maintained and in some cases better equipped than some SRCs. Thus the SRCs seem to have lost that projected importance to the Ghanaian society. These research findings suggest that majority of stakeholders do acknowledge the need to move to the next generation of science resource centres where students and other people would use science and can contribute to the meaning of the enabled society. There is the need to place the whole SRC concept into a societal perspective, and consider how best the science centre may contribute to the society in the near future. Globalization is another key factor that has contributed to the diminishing role of the SRC in serving as a source of reference to the community in the area of scientific and technological advancement. With an increase in the use of internet, new ways of organizing social communities have emerged, with the information and knowledge society replacing the industrial society. It should be noted that since the era that produced the SRCs is about to end, the next generation of SRCs has to relate to the conditions of the new era. This perspective allows the integration of two key concepts of knowledge acquisition as provided in the school syllabus and the equipment of individual schools' laboratories. There is also the need for a shift from knowledge to meaning which require new metaphors for the role of the SRC, e.g. the 'market place'; 'The centres should be equipped and designed in such a way as to hold the possibility for people to gather, to experiment, and to learn about current trends in science and technology, which

might aid discussion about practical work such as exercises, experiences and investigations'.

This research contributes to understanding the importance of retooling the SRCs in order to make participation in activities of the centre more engaging and interesting to all users. Furthermore, it emphasizes the need to redesign and restructure the whole concept so as to increase its social relevance and also make it meaningful. This connects to the idea of the ideal Ghanaian society, where people apply scientific principles and technology to enhance learning and ultimately improve upon the standard of life. This research work also emphasized the crucial role played by competent teachers in the learning process. Sustaining qualified teachers in schools is a prerequisite in ensuring that students obtain maximum benefits from the centres. Furthermore well-trained teachers will provide the conducive working conditions that will whip up the interest of students in the activities of the SRC whilst at the same time protecting them from all forms of danger and hazards which they may be exposed to. This will also go a long way to ensure the adequate maintenance of equipment at the facility. Suffice to say, the success of the entire SRC project relies heavily on the comprehensive training and retraining of personnel to man the various centres and the role of teachers in the whole learning process.

Judging from the fact that no income is generated by the SRCs and with the little support from government, it was hard to see how the SRC project could be sustained. Complaints made by most schools which host the centres cited financial problem as a major barrier in sustaining the SRC project. The students levy was the major source of income. However,

the problem of satellite schools failing to pay the levy to the centres was a major setback in project sustainability.

The discussion about how to make the SRC contribute immensely to the growth of science and technology in Ghana is obviously not only about specific physical features of these equipment, there is the need to be keenly aware of ideological, societal, and historical aspects of how and what to communicate and what forms of participation and activities should be enabled, to fit into a changing society. This is probably a good starting point in future studies of what the future curricula on science practical work will consist of.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter focuses on the summary of the research findings, identifies implications, states the major conclusions of the study and finally gives recommendations on how to improve equitable use of resources for achievement of national goals and aspirations for the study of science. The chapter also makes suggestions for future research.

Summary of the Research Findings

In investigating the current state of the SRC project, official documents were explored to examine the extent to which the objectives for establishing the SRC project have been carried out and achieved. Information gathered also indicated the resources available for project implementation, the level of involvement of various schools in the activities of the SRC and finally the views of various stakeholders on the impact of the SRCs in academic work and the relevance of the project in the current school system. Summary of findings and some implications include the following:

1. Several official documents analysed and information gathered from a wide range of respondents on the SRC project, made obvious Ghana Government's agenda on application of advancements in science and technology for Ghana's development, making the SRC project high profile political activity.
2. From documents analysed (using statements, clues, SRC implementation guidelines, directives and issues), 86% were on importance of science, 71% on development of human resources, 14% on responsibility for infrastructural

development and 51% on directives for SRC project and project implementation issues. Stakeholders outlined their impressions, views and perceptions of extent of project implementation, challenges and relevance.

3. It was indicative that the Ministry of Education contributed immensely towards improvements in education at all levels through the disbursement of various sums of money. Initial input into the SRC project in 1995 was £20 million; after 12 years of project implementation (in 2008/2009), all the SRCs were re-equipped at a cost of £10 million. On-going rehabilitation of some centres, at the time of this research was stated as GHC16.5m. (SEU, 2011); planned SRC Phase II was estimated to cost £8 million.(SEU, 2010). A levy of 0.40GHp per student in each academic term, was sustained for only the first few years of the project's existence, making it difficult to sustain the project at the school level. Apart from the national SRC, no school centres generate income. Complaints made by most centre schools cited financial constraints as a major barrier in sustaining the SRC project. The students levy was the major source of income. However, the problem of satellite schools failing to pay the levy to the centres was a major setback in project sustainability.
4. Positive impact of the SRC project in the early years (1997-2002), were well documented (SEU, 2003). However, monitoring and assessment reports reviewed during this study pointed to implementation difficulties. As observed in one of the reports (Anamuah-Mensah & Eminnah, 2005), not much effort was made to put in place initial mechanisms that would deal with the complex mix of difficulties, involved in shortages in human, material and financial resources. This, according

to the report, accounted largely for the performance of the SRC project in the ensuing years. These reports provided early warning signs on project implementation difficulties and recommendations for the sustainability, were well articulated but yet to be rolled out. A key recommendation which was to equip 200 more schools and train about 1000 more teachers and technicians did not come into fruition for a period of over three years ranging from 2008 to 2011 (SEU, 2012).

5. About 90% of original centre/satellite schools relationship was no longer working. This was largely due to growth in student population, lack of maintenance, lack of replenishment and replacement of materials and obsolete equipments. Majority of the students in both the centre schools (53%) and satellite schools (59%) indicated that they never used the SRCs. Only 10% of them from both centre and satellite schools indicating that the SRC was used at all times. Whereas 21% of teachers indicated that SRC activities in WASSCE were less than 50%, as many as 32% of the teachers could not indicate the percentage of SRC practical activities in WASSCE, pointing to poor teacher perception of the SRC project, in terms of its relevance to the current SHS programme.
6. Forty-four percent of teacher respondents have had opportunity in other types of in-service training (INST) and 46% teachers have had SRC specific training. In spite of availability of sufficient numbers of SRC trained teachers, they were unequally distributed, making some schools lacking teachers with knowledge and skills for laboratory science practical work. It was conclusive of this research that some teacher-respondents in the host schools had never made use of the SRC in

the school term. A considerable percentage of teachers (45%) indicated that they never made use of the SRC to conduct lessons in a term.

7. From the findings, even though there were unequal distribution of science teachers across the country (45% f teachers were covered in the southern zone, 31% were in the central zone and 24% participated in the northern zone), 82% of them had first degrees, 9 teachers had second degree and only one of them a diploma. Yet considering the subject areas taught, there was considerable number of teachers in all areas:- Agriculture (22), Biology(28), Chemistry(24), Physics(20) and Integrated Science(5) .
8. In this study, 75% of the SRC laboratories were found in poor conditions. Whereas the two Model Schools, included in this study were newly built with well-manned laboratories and, 30% of the SRCs were between the ages 16years and 20years and above and over 25% of them were found in very deplorable conditions. Assessment report reviewed, revealed that 56 SRC were under- going refurbishment at the time of this research and were at various stages of completion.
9. Most laboratory items found in schools and were in regular use included boiling flask sockets (70%) and stop clocks (47%) and others which were consumable or disposable, such as filter papers (85%), sulphuric acid (65%). Items found in this category were those which teachers were more familiar with. Some of these items were often associated with practical activities found in teaching and examination syllabus.

10. There existed the key problem of poor documentation of movements of equipment and materials. There were practically no records on some items which had been borrowed or were being shared with other schools, or items which were missing, stolen or could not be accounted for in one way or the other.
11. Majority (67%) of the personnel teaching science and or managing the centres were between age 41years and 50 years of age and beyond, suggesting the need to quickly develop succession plans for continuity.
12. Several teachers did not think that the SRC has important bearing on the school curriculum or on the WASSCE syllabus. In spite of this, majority of the teachers (98%) were of the view that the SRC project was beneficial to students since students were eager to handle equipment. Some teachers considered that the SRC project made science more relevant to the students. While some teachers (18%) could not attest to the positive influence of the SRC on themselves, and one person, stating it was a time wasting. However, teachers (23.9%) indicated that the project helped improved their teaching methodology, others (10.9%) said their involvement in the programme made them like practical activities and made them more efficient as teachers. Several others (8.7%) revealed that they gained more understanding through the project, despite project implementation difficulties.

Conclusions

The persistent nature of some of the problems associated with the SRC project, suggests that perhaps not much was taking into consideration during pre-project assessment to minimise wastage due to misallocation of laboratory resources, leading to ineffectiveness of science laboratory work and less academic achievement.

Barriers, whether physical, economical, or cultural, need to be removed to make science accessible to all. Teachers must actively engage students in practical science work. In this way, the youth will acquire an unrivalled interest in science and technology education which will in turn, enable them play various roles expected of them in the society. Through such sustained opportunities of involvement in the SRC, they would be able to develop not only a deeper understanding of the science embedded in the exhibits and equipment, but also come to realize their potential as learners in a general sense. Accordingly, sustained involvement as supported by evidence in previous studies has local as well as broad implications for science literacy development, and may serve as a ladder for the enrolment of a greater percentage of students in science-related disciplines at the tertiary level of education. Ghana will equally have value for money, regarding the substantial investment made in acquiring items for practical science activities through the SRC project.

Initial appraisal work established that the SRC contributed tremendously to enable students to undertake practical lessons in the theoretical concepts they were taught in the classroom. Majority of the teachers (98%) were of the view that the SRC project was beneficial to students since students were eager to handle equipment. Teachers considered that the SRC project made science more relevant to the students. Though several teachers had no real experience in SRC project, those who had, indicated good benefits to them. Only a few did not either find the project beneficial to them or found it a waste of time.

Some stakeholders were of the view that the SRC project supplemented facilities , resources and helped improved science instructions in underserved SHS, in spite of the

implementation challenges. The current state of the SRCs was largely blamed on centralising SRC activities in a centre school, without involving the centre school administration. Failure of the central government to maintain, replenish, resource and provide funds was a major step back in the project implementation processes.

For equitable access to resources for science practical work, it is expected that findings from this study would guide policy makers in reconsidering the centre/satellite system so that schools have ownership of their SRCs or laboratories and maintain them as other school facilities.

Recommendations

This study reveals clearly that the main intended objectives of setting up the SRC project was the projected crucial role of science and technology in Ghana's socio-economic development. Some modifications of the SRC project must be considered as workable measures in upholding these objectives. Three main modifications being suggested are placed under three main headings namely:

1. Making the SRC project relevant to the current formal school system.
2. Using science centres to serves the needs of both formal and informal forms of learning
3. Taking advantage of e-learning and virtual laboratories to reduce high cost of laboratory supplies

1. Making SRC project relevant to the current formal school system

   In making the SRC project meet the needs of the current school system, two issues to consider will be:

a. To ensure equitable distribution of science resource to the schools, in view of increase in school population.
b. Synchronizing the SRC programme with demands of the SHS curriculum and examination.

a. Equitable distribution of science resource to the schools.
   i. Poor maintenance of the SRCs seems to stem from ownership and patronage issues. To address these, most centre schools should be made to own the SRCs and maintain them as other school facilities. Where satellites schools can continue to patronise the SRCs, the schools must be rezoned to reflect their geographic locations to make the facility more accessible to students.
   ii. To minimise the degree of wastage in the system due to poor patronage and documentation, there should be the re-distribution of existing materials, equipment and chemicals for all schools to have equitable amounts, and supplement these where necessary.
   iii. Due to on-going refurbishment work in schools, several laboratories are not in use and chemicals, equipment and other materials are poorly stored. To avoid any future catastrophe, completion of civil works should be considered urgent. Meanwhile, to make resource for science teaching accessible to all students, schools should be encouraged to use whatever space / accommodation or room available for science practical activities, whilst all parties responsible should ensure that on-going civil works in the schools are completed. Schools which are suffering from constraints should be encouraged to perform practical lessons in classrooms as much as possible until the situation improves.

iv. Where it is not possible to have all science materials for practical lessons for all schools, some mobile system should be put in place and borrowing arrangements should continue.

v. In a class lesson, where there are not enough sets of equipment, the teacher should plan ahead to group practical lessons to be done on a rotational basis.

vi. GES should make arrangements so that occasionally, students from less endowed schools spend an appreciable amount of time in endowed schools undertaking more practical lessons, especially during the holidays.

vii. Some teachers can equally give of their time to help strengthen science teaching in less endowed schools.

viii. GES should consider the concept of Science Colleges once more

b. Synchronizing the SRC programme with demands of the SHS curriculum and examination.

i. Since most teachers continue to use time constraints, non-syllabi nature of the SRC programme and no linkage with WASSCE as excuse for not using the SRC programme, the SRC source book and manual should be revised to reflect the school curriculum. Science teachers should have more education on the objectives of the programme and training and retraining of science teachers should include models from the SRC programme.

ii. The teaching universities which have been linked to the SRC project, should ensure that science resources supplied them are put to use in training of teachers.

iii. The aspect of the SRC programme which is for general acquisition of scientific knowledge and building of scientific attitudes as well as role-modelling of scientists should be recognised for teachers to make effective use of the programme.

iv. The stakeholders should make the proposed SRC network function by ensuring that there is regular interaction among all interested parties such as the policy, makers, decision takers, service providers and users of products of science and technology. These should include officials of MOE, GES, teaching and research institutions, industries, curriculum developers, examination officials, teachers, and students working together to ensure that the SRC project is regularly reviewed to meet current needs in using science and technology to address the developmental needs of the country.

v. The regular monitoring and evaluation of the SRC is important timely intervention so that any shortfalls can be relayed to the national centre and other appropriate authorities for action to be taken. It has also been suggested that the regional SRC oversight committee members must embark on periodic visits to the centres in order to keep the centre staff on their toes.

vi. There will be the need to recruit and train more laboratory technicians to assist teachers for effective management of laboratories.

vii. GES will have to allocate more resources for training and retraining of science teachers, especially the new ones in the system.

viii. Regular inspection and monitoring of school laboratories must be mainstreamed within the Inspectorate Division.

2. Using the Science Centre Concept to address both formal and informal learning needs

    i. From the literature reviewed, science centres can be used as are powerful facilities for especially informal learning at community level for people of all ages and at all levels. Apart from complementing the formal school curriculum, they are powerful in developing scientific attitudes, literacy, a knowledgeable society and also improving on the economic level of the society. Subsequently, consideration should be given to the following recommendations:

    ii. Starting with the few regions that are ready, science centres should be created in all regions to enhance knowledge building and skills development in science and technology. Several regions already have parks and centres which can easily incorporate Science Centres.

    iii. As much as possible, there should be dependence on readily available materials, whether local or foreign, which are cheaper, recyclable and pose limited dangers to health.

    iv. Creating opportunities for innovations in solving problems of the country should inform the curriculum and activities of these centres. Partnership with countries such as America, Britain, Japan, Singapore, China and Korea, among others, should be beneficial in developing the programmes of the centres. Requests for foreign volunteers should include the relevant competencies that are needed.

v. Special capacities should be built for data collection, research and documentation on science centres. Several centres may have some peculiarities pertaining to the regions. These could be built into already existing programmes, to foster inter-regional tourism.

vi. Seasoned curators and science educators should manage these centres and must have assistants they mentor to grow to succeed them.

vii. Several activities of these informal learning centres should be made to complement formal learning of science.

viii. The SACOST concept could feature prominently; however, it should be taken into account that the relevant experience of today's Ghanaian child is more with electronics and e-learning than merely focusing on indigenous activities only.

3. Taking advantage of e-learning and virtual laboratory environments

There are now available a whole range of e-learning facilities that make use of simulations and animations for virtual laboratories. These could be taken advantage of to supplement, integrate or even totally replace physical laboratories.

Suggestions for Further Research

There is an overwhelming evidence of informal learning in science centres on people's attitudes, knowledge, understanding, concept formation, career choices, the social change, the community, job creation and other economic benefits, including money. If Ghana would pursue the agenda for science and technology literacy.

From the policy point of view, that is developing scientific literacy of the populace, scientists and technologists for socio-economic advancement, it is suggested that further research into operations of SRC would be necessary to develop and strengthen informal learning to supplement the overall learning experiences of students, teachers and the general public.

Stakeholders' notions on restructuring of the SRC project tend to be at variance with literature reviewed on meeting the current needs of the SHS programme. There is the need for more research into the influence of the SRC project on the Ghanaian society in general and possibly the communities within which the centres were located. This is against the backdrop of the fact that although SRC were initially intended to be accessed by a wide range of persons in a given society, there have been few attempts to assess the societal impact of the programme.

Further study on the economic impact of these centres could contribute to a stronger public awareness of the positive effects that the SRC has on employment generation and income creation in the local area.

Finally studies are recommended into a mix of science rooms and science laboratories, that could come out with strategies to lower costs, increase use and achieve reasonable outcomes.

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APPENDIX A

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Interview Guide for Heads of Centre Schools

Part 1

Age …… Sex: Female [ ] Male [ ]

Name of School……..... District……....

Part 2

1. What is your highest qualification?.....

2. What is your major area of specialization?.....

3. What is your minor area of specialization?.....

4. Do you think there are enough materials at SRC for practical activities for all students in school? Yes….No..…

If No, suggest two ways of getting all students engaged in a practical activity in school

a) ……..……..

b) .....……....

5. Do you agree that the SRC contributes to students' performances at WASSCE ?

i) Yes .....… ii) No…...…… Give two reasons for your answer

a) ……..……..

b)…….....……..

6. Do you think the SRC helps students to appreciate science and technology better?

i) Yes…….. No…….... Give two reasons for your answer

a)…….....…….

b). …….....…….

7. Provide any three suggestions you think is needed in order to improve the status of the SRC

a)…….....……

b) …….....……..

c) …….....……

8. Give three suggestions to improve practical science teaching in Ghana

a) …….....……

b)……...…….....…… ……..

c)…….....

9. Suggest three ways of equipping and maintaining laboratories in schools

a) …….....

b)……...…… …….....

c)…… …….....

10. Give three practical steps MOE/GES needs to take to sustain efforts at improving teaching and learning of science.

a) …….....……..

b)…….....……...……

c)…….....…… …….

12. Give three suggestions for guideline development for effective functioning of the SRC.

a) …….....……

b)…….....……...……

c)…….....……

13. Suggest three cost effective ways of keeping the SRCs running all year round.

a) …….....……..

b)…….....……...……

c)…….....……

14. How many laboratory technicians do you have in schools?.....

Suggest three ways of keeping laboratory technicians in schools.

i)……

ii)……

15. Are you satisfied with the way resources for the Centre are being used?

Yes… No..… Please explain

……

……

……

16. Please state any other suggestions you have vis-à-vis the SRC.

……

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APPENDIX B

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Questionnaire to Students studying Elective Science in Schools with the Centres

Part 1

Age……**Sex**: Female [ ] Male [ ] SHS Level……

(Please Tick one)

Centre School Name ……

District ……Region……

List all science subjects you study in school……..

Part 2

1. a. Indicate where you normally go for your practical science lessons,

   i. SRC…..... .ii. Classroom…..... iii. SRC/Classroom.....……

   (Tick whichever is applicable)

   b. Do you use the SRC or the classroom for your practical science lessons? ***(Tick whichever is applicable)***

Venue	Frequency				
	All the time	Very often	Twice A Term	Once a Term	Never use
SRC					
Classroom					
SRC/Classroom					

2. In your opinion, which of your teachers like using the SRC? ***(Tick as many as applicable)***

   i) All science subjects…… ii) Only Biology……..iii) Only Chemistry……iv) Only Physics

3. What roles do Laboratory technicians play at the Centre?

i) Do nothing… ii) Clean only…. iii) Clean and prepare materials…

iv) Sometimes teach us……

4. When you visit the Centre, do you have enough materials for practical activities? Yes…No

5. Name 3 practical activities you have carried out at the Centre?

a) ……

b)……..……..……

c)……

6. Name some of the items you need for practical activities at the Centre……

……

Read each sentence below and indicate your response by a tick as follows: SA-Strongly Agree; A-Agree; D-Disagree; SD-Strongly Disagree

S/N	Sentences	SA	A	D	SD
7.	I gain more knowledge when we have practical science lessons in the SRC than the classroom.				
8.	Practical science lessons at SRC provide me with better understanding of science concepts than practical science lessons in the classroom				
9.	Lessons at SRC help me to like using the computer				
10	I am always happy when we go to SRC for practical lessons				
11.	I hate going to SRC for practical science activities				
12.	All science lessons must be done at the SRC				
13.	Only practical lessons must be done at the SRC				
14.	Only science students must use the SRC				
15.	All students should use the SRC				
16.	We can never progress in our science lessons without SRC				
17.	SRC plays important role in students' achievement in science				
18.	Our science teachers are confident in handling lessons at the SRC				
19.	We always have enough materials for practical science activities at the SRC				
20.	We always have too much materials for practical science activities at the SRC				

APPENDIX C

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Questionnaire for Teachers of Centre Schools

Part 1

Age …… Sex: Female…...….. Male……..…

(Surname first) ***(Please Tick one)***

Centre School Name……...……...……

District ……...……Region……..…….…….....

Part 2

1. What is your highest qualification?.....
2. What is your major area of specialization?.....
3. What is your minor area of specialization?.....
4. In your current school, mention all science subjects you teach and the forms in which you teach them. …….
5. What other science subjects have you taught, before?.....
6. Have you had any in-service training in science since you graduated? Yes……No…….
   If yes, state the periods …….....
7. Have you had any training organized for SRC before? Yes……No…… If yes, state the periods. …….....
8. How many schools come to the SRC in a term?……...…….

9. On the Average, indicate usage of the SRC as follows:

		Number of Schools attending per term	Patronage			
S/N	**School Type**		**All the Time**	**Very Often**	**Once a while**	**Never**
1.	My own school					
2.	Original Satellite Schools					
3.	New Satellite Schools					
4.	Junior High Schools					

10. On the average, how often do you have practical lessons in the SRC in a term? ***(Tick one)***

i) All the time ……....ii) Very often……iii) Once a while……iv) Never..……

11. In your opinion, which teachers in your school like using the SRC.

(Tick as many as applicable)

i) All science subjects…… ii) Only Biology……..iii) Only Chemistry……iv) Only Physics

12. What roles do Laboratory technicians in your school play?

i) Do nothing… ii) Clean only…. iii) Clean and prepare materials… iv) Sometimes teach…***(tick one)***

13. Do you think there are enough materials at the SRC for all students for practical activities?

Yes… No…..

If no, what types of materials do you need for practical activities at the Centre?

……

……

14. State five practical activities you carried out at the Centre last academic year.

a) ……

b)…….....……

c)…….....……

d)……...…….……

e)…….....……

15. Indicate in the list below whether you have used these equipment before and the purpose

S/N	Equipment	Used before	Which type /Activities used in	Class
1.	Software			
2.	Data logging			
3.	Sensors			
4.	Computer			

16. (a) In your opinion what percentage of practical activities in SRC is the same or similar to practical activities set by WAEC during WASSCE?.....

(b) State three practical examination topics from WAEC conducted at the SRC.

i)……

ii)……..……

iii)……

17. Do you think activities at the SRC help students to appreciate science better? Yes….. No…...

Give your reasons …..……...

…….

18. How has your involvement in SRC contributed to your own understanding and methodology of science teaching? ……..

……

19. Provide any suggestions to help improve the operations of the SRC

……

……

……

20. Do you think satellite schools interfere with normal school activities? Yes [ ] No [ ] if yes to what extent do you think satellite schools interfere with normal school activities?

i) ……..……..

ii)……...……...

iii)…….....

21. Give three suggestions for developing guidelines for effective functioning of the SRCs.

i)…….....……

ii)……...……

iii)…….....……

22. Suggest three cost effective ways of keeping the SRCs running all year round.

i)…….....……

ii)…….....……

iii)…….....……

23. Are you satisfied with the way resources for the Centre are being used? Yes… No….Please explain

……...……

……...……

……...……

24. Please state any other suggestions you have vis-à-vis the SRC.

.....……...……

……...……

……...……

APPENDIX D

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Questionnaire for Technician of Centre Schools

Part 1

Age …….Sex: Female [ ] Male [ ]

School…….District……..……Region……...…….…....

Part 2

1. What is your highest qualification? .....

2. What is your major area of specialization? .....

3. What is your minor area of specialization? .....

4. In your current school, mention all science subjects you teach and the forms in which you teach them ……

5. What other science subjects have you taught before?.....

6. (a) Have you had any in-service training in science since you graduated? Yes [ ] No [ ]

   (b) If yes, state the number of times……..

7. (a) Have you received any in-service training on the activities of the SRC? Yes [ ] No [ ]

   (b) If yes, state the number of times ……

8. How many schools come to the Centre in a term? ……

9. On the Average, indicate usage of the SRC as follows:

		Number of Schools attending per term	Patronage			
S/N	**School Type**		**All the Time**	**Very Often**	**Once a while**	**Never**
1.	My own school					
2.	Original Satellite Schools					
3.	New Satellite Schools					
4.	Junior High Schools					

10. On the average, how often do you have practical lessons in the SRC in term? ***(Tick one)***

i) All the time ……....ii) Very often……iii) Once a while……iv) Never..……

11. In your opinion, which teachers in your school like using the SRC. ***(Tick as many as applicable)***

i) All science subjects…… ii) Only Biology……..iii) Only Chemistry……iv) Only Physics

12. What roles do Laboratory technicians in your school play?

i) Do nothing… ii) Clean only…. iii) Clean and prepare materials… iv) Sometimes teach

13.(a) Do you think there are enough materials at the SRC for all students for practical activities?

Yes…. No….

(b) If no, what types of materials do you need for practical activities at the Centre?

……

……

14. State five practical activities you have assisted in carrying out at the Centre last academic year.

a) ……..……

b)……...…….....……

c)…….....……

d)…….....……

e)…….....……

15. Indicate in the list below whether you have used these equipments before and for purpose

S/N	Equipment	Used before	Which type /Activities used in	Class
1.	Software			
2.	Data logging			
3.	Sensors			
4.	Computer			

16. (a) In your opinion what percentage of practical activities in SRC is the same or similar to practical activities set by WAEC during WASSCE?.....

(b) State three practical examination items from WAEC done at SRC.

a)……

b)……..……..……

c)……

17. Do you think activities at SRC help students to appreciate science better? Yes [ ] No [ ]

Give your reasons…..…….....…….

…….....……

18. How has your involvement in SRC contributed to your own understanding and methodology of science teaching? …….

……

……

19. Provide any information you think we need to have to help improve the operations at the SRC

…….....……

……..……

……

……

20. To what extent do you think satellite schools interfere with normal school activities?

i) ……

ii)……

iii)……

21 Give three suggestions for developing guidelines for effective functioning of the SRCs.

i)……

ii)……

iii)……

22. Suggest three cost effective ways of keeping the SRCs running all year round.

i)……

ii)……

iii)……

23. Are you happy about the way resources for the Centre are being used? Yes… No….

Please explain……

……

……

24. Please state any other suggestions you have vis-à-vis the SRC.

……

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APPENDIX E

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Questionnaire for Centre Managers

Part 1

Age …… Gender: Female……..Male……

Centre School Name ……District ……..Region……..…..

Part 2

1. What is your highest qualification?.....

2. What is your major area of specialization?.....

3. What is your minor area of specialization?.....

4. a. How long have you been a Centre Manager? State the period……

4. b. Do you have a job description as a Centre Manager? Yes….No……

List all your responsibilities as a Centre Manager ……

……

……

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……

……

5. Do you teach in your current school? Yes……No….. If yes, mention all science subjects you teach and the forms in which you teach them …….....…….....……

……

……

6. What other science subjects have you taught before?.....

7. Have you had any in-service training in science since you graduated? Yes……No…….

If yes, state the periods…….....……

8. Have you had any training organized for SRC before? Yes……No…… If yes, state the periods…….....……

9. a) How many schools come to the Centre in a term? ……..

(b)Do you have timetable to regulate activities of the centre? Yes……No…….

(c) If yes, do the schools adhere strictly to the timetable? Yes [ ] No [ ]

10. On the Average, indicate usage of the SRC as follows:

		Number of Schools attending per term	**Patronage**			
S/N	**School Type**		**All the time**	**Very often**	**Once a while**	**Never**
1.	My own school					
2.	Original Satellite Schools					
3.	New Satellite Schools					
4.	Junior High Schools					

11. On the average, how often do you have practical lessons in the SRC in term? ***(Tick one)***

i) All the time ……....ii) Very often……iii) Once a while……iv) Never..……

12. In your opinion, which teachers in your school like using the SRC. ***(Tick as many as applicable)***

i) All science subjects…… ii) Only Biology……..iii) Only Chemistry……iv) Only Physics

13. What roles do Laboratory technicians in your school play?

i) Do nothing… ii) Clean only…. iii) Clean and prepare materials… iv) Sometimes teach

14. Do you think there are enough materials at the SRC for all students for practical activities?

Yes… No.....

If no, what types of materials do you need for practical activities at the Centre?.....

……

……

15. State five practical activities you carried out at the Centre last academic year.

a) ……..……

b)…….....……...……

c)…….....……

d)…….....……

e)…….....……

16. Indicate in the list below whether you have used these equipments before and for what activities.

S/N	Equipment	Used before	Which type /Activities used in	Class
1.	Software			
2.	Data logging			
3.	Sensors			
4.	Computer			

17. In your opinion what percentage of practical activities in SRC is the same or similar to practical activities set by WAEC during WASSCE?.....

State 3 practical examination items from WAEC done at SRC.

a)……

b)……..……..……

c)……

18. Do you think activities at SRC help students to appreciate science better?

i) Yes ….. ii)No…….....

Give your reasons…….

……

19. How has your involvement in SRC contributed to your own understanding and methodology of science teaching?

……

……

……..

20. Provide any information you think we need to have to help improve the operations at the SRC

……

……

……

……

21. To what extent do you think satellite schools interfere with normal school activities?

i) ……

ii)……...……

iii)……....……

22. Give three suggestions for developing guidelines for effective functioning of the SRCs.

i)……....……

ii)……...……

iii)……....……

23. Suggest three cost effective ways of keeping the SRCs running all year round.

i)……....……

ii)……....……

iii) ……...

24. In your opinion, are resources for the Centre properly being used? Yes… No….Please explain

……....……

……....……

……....……

25. Are you happy about the way resources for the Centre are being used? Yes… No….Please explain

……

……

……

26. From your records, estimate the initial number of students attending practical lessons at the Centre?.....What is the current number?.....

What do you think account for the change if any?.....

……

……

……

28. Please state any other suggestions you have vis-à-vis the SRC.

……

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APPENDIX F

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Questionnaire to Students studying Elective Science in satellite Schools

In an effort to solicit information on the current status of the Science Resource Centre Project, we request you to kindly provide responses to items below. The answers you give should be basically based on your perspective as a student studying science in a satellite school and they are for research purposes only. Please provide any other opinions which will help provide helpful information.

Thank you.

Georgina Quaisie

Part 1

Respondent No.……**Age**…….**Sex**…..... SHS Level……

Name of school ……..……..……..

District ……..……..……..…Region……..……..…….....

List all science subjects you study in school ……..……..

……

Part 2

1. a. Indicate where you normally go for your practical science lessons, i. SRC….ii Classroom…..iii.SRC/Classroom…… ***(Tick whichever is applicable)***
1. b. Indicate where you use for your practical science lessons, using the table below. ***(Tick whichever is applicable)***

Venue	Frequency				
	All the time	**Very often**	**Twice a term**	**Once a term**	**Never use**
SRC					
Classroom					
SRC/Classroom					

2. In your opinion, which of your teachers like using the SRC? ***(Tick as many as applicable)***

   i) All science subjects…… ii) Only Biology……..iii) Only Chemistry……iv) Only Physics

3. What roles do Laboratory technicians play at the Centre? ***(Tick as many as applicable)***

   i)Do nothing… ii) Clean only…. iii) Clean and prepare materials… iv) Sometimes teach us…

4. When you attend the Centre, do you have enough materials for practical activities? Yes…No..

5. Name three practical activities you carried out at the Centre, first term.

   a) ……..……...

   b)…..……...……

   c)……..……

6. Name some of the items you need for practical activities at the Centre……..

   ……

   ……

7. *Read each sentence below and indicate your response by a tick as follows: Strongly Agree; Agree; Disagree; Strongly Disagree. If you never been to a SRC before, indicate not applicable wherever necessary.*

S/N	Sentences	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Applicable
7.a.	I gain more knowledge when we have practical science lessons in the SRC than the classroom.					
7.b.	Practical science lessons at SRC provide me with better understanding of science concepts than practical science lessons in the classroom					
7.c.	Lessons at SRC help me to like using the computer					
7.d.	I am always happy when we go to SRC for practical lessons					
7.e.	I hate going to SRC for practical science activities					
7.f.	All science lessons must be done at the SRC					
7.g.	Only practical lessons must be done at the SRC					
7.h.	Only science students must use the SRC					
7.i.	All students should use the SRC					
7.j.	We can never progress in our science lessons without SRC					
7.k.	SRC plays important role in students' achievement in science					
7.l.	Our science teachers are confident in handling lessons at the SRC					
7.m.	We always have enough materials for practical science activities at the SRC					
7.n.	We always have too much materials for practical science activities at the SRC					

APPENDIX G

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Questionnaire for Teachers of Satellite Schools

In an effort to solicit information on the current status of the Science Resource Centre Project to support a thesis write up, we request you to kindly provide responses to items below. The answers you give should be basically based on your perspective as a teacher teaching science in a school with an SRC. Please provide any other opinions which will help provide helpful information.

Thank you.

Georgina Quaisie

Part 1

Name …… Age …… Sex: Female……..Male……

(Surname first) ***(Please Tick one)***

Centre School Name……..

District ……...…… Region……..…….……..

Part 1

1. What is your highest qualification?.....
2. What is your major area of specialization?.....
3. What is your minor area of specialization?.....
4. In your current school, mention all science subjects you teach and the forms in which you teach them. .....……
5. What other science subjects have you taught before?.....
6. Have you had any in-service training in science since you graduated? Yes……No…….

   If yes, state the periods …….....

7. Have you had any training organized for SRC before ? Yes……No…… If yes, state the periods. ……..

8. How many schools come to the Centre in a term? …….

9. On the Average, indicate usage of the SRC as follows:

		# of Schools attending per term	**Patronage**			
S/N	**School Type**		**All the time**	**Very often**	**Once a while**	**Never**
1.	My own school					
2.	Original Satellite Schools					
3.	New Satellite Schools					
4.	Junior High Schools					

10. On the average, how often do you have practical lessons in the SRC in term? ***(Tick one)***

i) All the time ……....ii) Very often……iii) Once a while……iv) Never..……

11. In your opinion, which teachers in your school like using the SRC. ***(Tick as many as applicable)***

i) All science subjects…… ii) Only Biology……..iii) Only Chemistry……iv) Only Physics

12. What roles do Laboratory technicians in your school play?

i) Do nothing… ii) Clean only…. iii) Clean and prepare materials…

iv) Sometimes teach…***(tick one)***

13. Do you think there are enough materials at the SRC for all students for practical activities?

Yes… No .....

If no, what types of materials do you need for practical activities at the Centre?

……

……

14. State five practical activities you carried out at the Centre last academic year.

a) ……

b)……

c)……

d)……

e)……

15. Indicate in the list below whether you have used these equipments before and for what activities.

S/N	Equipment	Used before	Which type /Activities used in	Class
1.	Software			
2.	Data logging			
3.	Sensors			
4.	Computer			

16. In your opinion what percentage of practical activities in SRC is the same or similar to practical activities set by WAEC during WASSCE?.....

State three practical examination items from WAEC done at SRC.

a)……

b)……

c)……

17. Do you think activities at SRC help students to appreciate science better?

i) Yes ….. i) No……...

Give your reasons …..……

……

18. How has your involvement in SRC contributed to your own understanding and methodology of science teaching?

……

……

19. Provide any information you think we need to have to help improve the operations at the SRC

……

……

……

20. To what extent do you think satellite schools interfere with normal school activities?

i) ……

ii)……

iii)……

21. Give 3 suggestions for developing guidelines for effective functioning of the SRCs.

i)……

ii)……

iii)……

22. Suggest three cost effective ways of keeping the SRCs running all year round.

i)……

ii)……

iii)……

23. Are you happy about the way resources for the Centre are being used? Yes… No….Please explain……

……

……

24. Please state any other suggestions you have vis-à-vis the SRC.

……

……

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APPENDIX H

DOCUMENT ANALYSIS GUIDE (DAG)

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE

PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Checklist for The documents the researcher accessed and analysed

Documents Reviewed	Statements, clues, directives and guidelines for implementation of the SRC project			
	Importance of education in science for Ghana's development	Development of human capital for Ghana's development	Responsibility for school infrastructure development and equipment supply	The role of the SRC Project in science education and implementation issues
Various Education Acts				
Government White paper on Education				
Education reform documents				
Education sector reviews				
Education Sector Strategic Plans				
Education Sector Performance Reports,				
Science and technology (S & T) policy documents				
S & T implementation plan				
Science Education policy documents				
Syllabuses , curriculum				
Students' Text books, teachers' manuals				
SRC Project documents				
SRC manual and source books				
SRC project Monitoring & Assessment reports				

APPENDIX I

RESOURCES ASSESSMENT PORTFOLIO (RAP)

Part 1

Checklist for gathering information on the facility, equipment, materials, chemicals and other supplies for practical science activities in the schools

Name of School…….

District……..…….……Region…..…….....

State of Laboratories			
Type of Building being Used	**Conditions of the Building**	**Facilities Available**	**Approximate Age of Building(Yrs)**
Constructed new	Roof	Store	0 -1
converted facility	Floor	Prep room	2-5
refurbished old laboratory	Wall	Manager's room	6-10
Wooden	Windows	Cupboards	11-15
Iron	Doors	Shelves	16-20
Bricks	Pipes	Drawers	21-25
Cement	Drainage system	Students' working benches	More than 25

APPENDIX J

RESOURCES ASSESSMENT PORTFOLIO (RAP)

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE

PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Checklist for gathering information on the conditions of facilities, equipment, materials, chemicals and other supplies for practical science activities in the schools

Name of School…….

District……..……..……Region…..…….....

S/N						
	Cat. No.	**Item**	**In Use**	**Finished/Spoilt**	**Still in Boxes**	**Other**
1						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10. **-30**						

APPENDIX K

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Interview with the Service Provider

Age …… Sex: ……

1. What is your highest qualification?.....

2. What is your major area of specialization? .....

3. What is your minor area of specialization? .....

4. In your opinion, what do you think was the motivation for setting up the project in the first please?

.....

.....

5. In your opinion, the original objective for setting up the SRC Project was:

i) Fully achieved ……. Partially achieved……. Not achieved……..

(Please tick one)

Give reason for your answer .....

……

7. In your opinion is the SRC project relevant to schools today?: Yes…….. No…….

(Please explain your choice of response)

……

……

8. If you think the project is still relevant, would you keep in its original state or modify some aspects of it. Suggest any modification you have in mind.....

.....……

……

9. Do you think activities at SRC help students to appreciate science better? i) Yes ..ii) No.....

Give your reasons …….

……

10. How has your involvement in SRC contributed to your own understanding and methodology of science teaching? ……...

……

11. To what extent do you think satellite schools interfere with normal school activities?

12. Were you happy about the way resources for the Centre were being used? Yes… No….

Please explain ……

……

13. Give three suggestions for developing guidelines for effective functioning of the SRCs.

14. Suggest three cost effective ways of keeping the SRCs running all year round.

15. Please state any other suggestions you have vis-à-vis the SRC.

16. Provide any information you think we need to have to help improve the operations at the SRC

APPENDIX L

THE STATE AND STATUS OF THE SCIENCE RESOURCE CENTRE PROJECT IN GHANAIAN SENIOR HIGH SCHOOLS

Perspective of Stakeholders

Interview with the First National Coordinator

1. What is your highest qualification?

2. What is your major area of specialization?

3. What is your minor area of specialization?

4. a. How long were you the first National Coordinator?

4. b. Did you have a job description as a National Coordinator?

What were your responsibilities as a National Coordinator?

4, c. Did you receive any training in that respect?

If yes, please state the periods

5. Did you have any training organized for SRC before? If yes, state the periods

5. In your opinion, what do you think was the motivation for setting up the project in the first please?

6. In your opinion, do you think the original objective for setting up the SRC Project has been achieved.

Give reason for your answer

7. In your opinion how relevant is the project to schools today?:

8. If you think the project is still relevant, would you keep in its original state or modify some aspects of it.

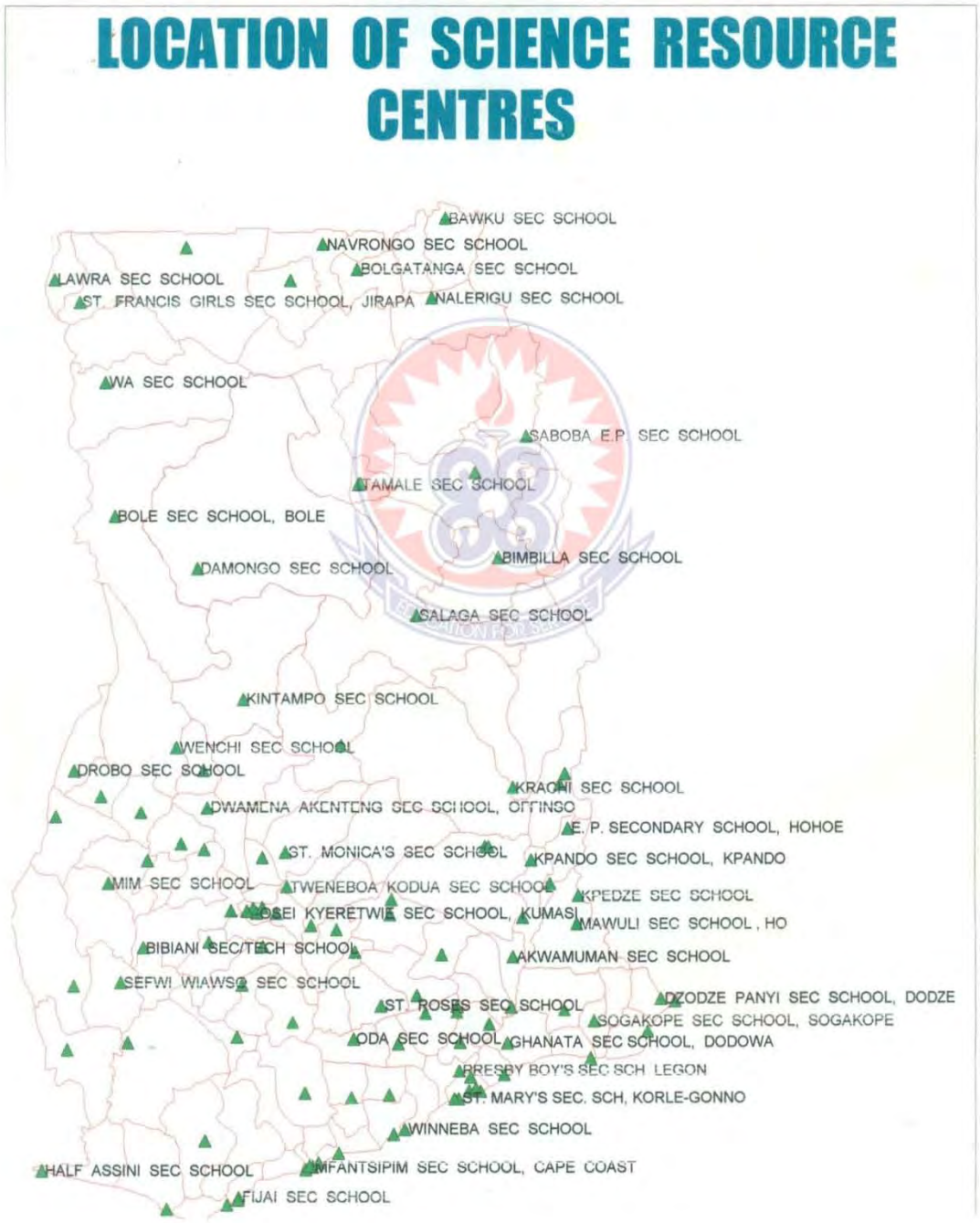
Suggest any modification you have in mind

9. Do you think activities at SRC help students to appreciate science better?

10. Provide any information you think we need to have to help improve the operations at the SRC
11. To what extent do you think satellite schools interfere with normal school activities?
13. Give 3 suggestions for developing guidelines for effective functioning of the SRCs.
14. Suggest 3 cost effective ways of keeping the SRCs running all year round.
15. Were you happy about the way resources for the Centre were being used? Yes… No…. Please explain
16. Please state any other suggestions you have vis-à-vis the SRC.

APPENDIX M

MAP OF GHANA SHOWING LOCATION SCIENCE RESOURCE CENTRE



APPENDIX N

RECORDS OF INTERVIEWS AND FOCUS GROUP DISCUSSIONS WITH STAKEHOLDERS

Interviewer: In your opinion, what do you think was the motivation for setting up the SRC project in the first place?

Respondent: They were saying schools needed science equipment so the idea was to take a school from a district, make it a centre and have other schools use the facilities and the resources.

Interviewer: How well do you think this worked out?

Respondent: This is a good idea but I do not think it is okay with some of the equipments which were brought in at that time.

Interviewer: Why do you say so?

Respondent: Take for example equipment for an activity like 'graphing with computers'. Many of the students were not computer literate to understand what was going on. Several of the equipment were too sophisticated.

Interviewer: But students must be familiar with them. This is because some of the complaint at that time was that students did not handle equipment in school till later in life. Don't you think it is a good idea to get students exposed to the equipment whilst in school?

Respondent: If the exposure to these very sophisticated equipment was only to make students familiar with what they would use in the industry one day, then I do not think the huge sums of monies spent on the SRC project was justifiable. After all in their work life, they can be trained on the job.

Interview: Why do you say the equipments were too sophisticated? What was your role as a National coordinator in the selection of equipment?

Respondent: The idea was to let the students have access to modern equipment. I did not have a part to play in the selection of equipment. As far as I am concerned, it was someone trying to sell the equipment to Ghana.

Interviewer: In your opinion, what do you think was the motivation for setting up the SRC project in the first place?

Respondent 1: I think the SRC was established to make up for inadequate science laboratory materials and equipment in school.

Interviewer: How well do you think this worked?

Respondent 1: This worked well especially in the first few years of the project life. The centres were to be community laboratories with every district having one SRC to supplement the teaching of science practical lessons and demonstrations. These really helped with teaching and learning. In actual fact these equipment are not just for practical activities but also for class demonstrations. However due to lack of time, teachers failed to take students through the activities of the SRC programme.

Interviewer: Why do you think time was such a big issue, which has contributed to the current state of the project?

Respondent 1: Several teachers used work load and insufficient time as excuses for not having practical lessons. Nevertheless teachers were to view some of the modern equipment as provided for demonstration purposes which needed no preparation. In this way, teachers did not require too much time for practical lesson preparation.

Interviewer: What do you mean by saying that some of the equipment were for demonstration lessons and need no preparation for practical activities?

Respondent 1: This is what I mean. A teacher can bring out some science equipment for display to students; explaining either the parts or how the equipment functions and what is used for without necessarily using it in a practical science activity. When science equipment is brought out this way, it is for demonstration purposes only. Students however become familiar with it and they are thus helped to visualize some scientific process in concrete terms and students tend to appreciate science better. This can be viewed as also supplementing teaching and learning, which definitely led to improvements in their examination results as were clearly evident during the first 5 or 6 years of project implementation.

Interviewer: How cost effective was the SRC project?

Respondent 2: The whole project was cost effective- Government saw that it was a cost-effect way of getting most schools to undertake effective practical science lessons.

Interviewer: In what ways do you think students and teachers benefited from the SRC project?

Respondent 2: The project equally exposed science both teachers and students to equipment as well as modern teaching and learning methods. Both teachers and students had the opportunity to be involved in the use of modern equipment. Both teachers and students were exposed to modern teaching and learning approaches in the use of science equipment e.g. data loggers and sensometors. These provided excitement among students and motivated them to want to study science.

Interviewer: How are the SRCs financed?

Respondent: After the centres were established, there was no further funding from government sources for project implementation. The schools were however allowed to levy students. Each student was levied 0.40p in a term but this was not enough. Besides, this amount was woefully inadequate.

Interviewer: If this levy was not enough, how has the SRC project been financed over the years?

Respondent 1: We no longer depended on the students' levy of 0.40p to run the programme. In actual fact, the levy was initially meant to be used as contribution from each school in maintaining the SRC buses. However, since the satellite schools no longer patronize activities at the centres, the levies were not paid to the centre schools any longer.

Respondent 2: Some satellite schools from the onset did not pay the levies to the centre schools.

Interviewer: Why do you think this was the case?

Respondent 1: Several of the satellite schools had problems with conflict in school time table. There were lots of complaint that too much time was spent travelling to the centre. They considered it more efficient to spend the financial resource on improving their own facilities for the study of science.

Interviewer: Records show that it is hard to find the full complement of SRC trained teachers at the centres. Whilst some of them have gone on retirement, others have left teaching for greener pastures. How do we sustain the SRC project if this trend continues?

Phil Godding: Your observation is right. It will interest you to know that, whilst training teachers and technicians, we made conscious effort to train them as trainers and we

expect them to transfer the skills and experience gained to others. This way, at all times we can expect to have a pool of teaching force available for SRC project continuation. It is in the interest of GES to ensure that in-service training is regular. GES must make resources available to enable the trainers to pass on the information and skill to others. During the last set of training, the resounding message was training of trainers. It will be good for if GES would ensure that such resources are well utilised and building of capacities becomes regular feature of the project implementation.