IMPACT OF THE AVAILABILITY OF EDUCATION INPUTS ON EFFECTIVENESS IN TEACHING OF SCIENCE SUBJECTS IN PUBLIC SECONDARY SCHOOLS IN NYANDARUA DISTRICT, KENYA

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DECLARATION

This project report is my original work and has not been presented for a degree in any other University.

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DEDICATION

This work is dedicated to my wife Esther and our children Elijah and Rahab.Their prayers and unstinted support gave me the drive and determination to complete the course.

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ABSRACT

Secondary schools in Nyandarua District perform poorly in national examinations and especially the sciences and mathematics. While many factors may account for this scenario; this study focused on the availability of education inputs and their effect on effectiveness of schools in the teaching of science subjects. The ultimate goal of the study was to assess the impact of the availability of education inputs on school effectiveness in the teaching of science subjects in public secondary schools in Nyandarua District. To realize this ultimate goal, the study had the following objectives: -

- The availability of the education inputs in the secondary schools, in the realms of the physical, human and material.
- The effect of the physical education inputs on school effectiveness in the teaching of science subjects.
- The effect of the human education inputs on school effectiveness in the teaching of science subjects and
- The effect of the material inputs on the school effectiveness in the teaching of science subjects.

Literature review was organized under the sub themes: - An overview of science education, methods of science teaching, empirical research on education inputs and school effectiveness.

The study used a questionnaire to gather the data needed to answer the objectives. An observation schedule for the physical facilities was also completed to complement data on the questionnaire. The study was an ex-post facto in design. The subjects of the analysis were 32 heads of science departments in the public secondary schools in Nyandarua District. The respondents were from all categories of secondary schools in the district viz: - The boarding boys only, boarding girls only, mixed boarding and day schools for boys and girls and the mixed day schools for boys and girls. The pilot study was conducted in five secondary schools of the various categories drawn randomly from Ndaragwa division, which had all the categories of

schools in the district. The pilot study guided the modifications and revision of the research instruments.

The data collected was coded and tabulated and then analyzed by the use of descriptive statistics such as averages and percentages. The data was analyzed in terms of the research questions and discussions made on results of the analyzed data.. The Pearson correlation coefficient was used to determine the nature of relationship between a given set of inputs and school effectiveness in the teaching of science subjects.

The study established that the availability of education inputs namely: the physical, human and material were not uniformly distributed among schools. The study also found out that availability of education inputs impacts on school effectiveness in the teaching of science subjects. The variables in the physical schooling inputs that were found to be of great consequence on school effectiveness were the boarding facility and the laboratories. The study further established that school effectiveness in the teaching of science subjects increases with increasing availability of the physical schooling inputs.

The human characteristics that were found to impact on effectiveness were the cumulative teachers experience and the workload of teachers in lessons taught per week. The study found that in general the availability of the human inputs does impact on school effectiveness.

The general finding of the study was effectiveness of a school in the teaching of science subjects increases with increasing intensity of the available resources. The study also found that majority of the schools were not effective in the teaching of science subjects was shown by the average number of candidates attaining a pass in the science subjects and mathematics. The study also found that most schools were not adequately prepared in the teaching of science subjects. The study concluded that, school effectiveness increases with increasing availability of education inputs, however no single set of the education inputs could be delineated to causing

greater effectiveness than the others but all work in an interwoven network of interaction.

Recommendations emanating from the study were that: -

- There is need for the ministry of education to develop and adopt a policy on the provision of education inputs to secondary schools to ensure that schools are at an equal footing not only on the availability but also on quality of the education inputs.
- The various stakeholders in the education sector should be sensitized on the need to provide the schools with the facilities that help increase the effectiveness of schools in the teaching of science subjects.
- The Kenya National examination council should liaise with the secondary schools management boards on the procurement of the equipments that are central to the secondary schools science practical examinations.

The following suggestions have been made for further research: -

- Research be carried out on school environment factors that lead to school effectiveness in the teaching of science subjects.
- A research be conducted on the impact of the availability of education inputs on the effective teaching of science subjects in the day public secondary schools.
- A research be conducted on the impact of the availability of education inputs on students attainment in the social sciences.
- A research be conducted on school effectiveness in the teaching of science subject on either the girl child or the boy child.
- A research be carried out on school effectiveness in the teaching of science subjects using a larger sample.

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List of Abbreviation

A.S.E: I	-	Activity, Student, Experiment, Improvise
D.E.B:	-	District Education Board
D.E.O:	-	District Education Officer
E.P.F:	-	Education Production Function
G.O.K:	-	Government of Kenya
H.O.D:	-	Head of Department
I.E.A:	-	International association for the Evaluation of Educational Achievement
INSET:	-	In- Service Teacher Education and Training
K.C. E:	-	Kenya Certificate Education
K.C.S.E:	-	Kenya Certificate of Secondary Education.
K.I.E:	-	Kenya Institute of Education.
K.N.E.C:	-	Kenya National Examinations Council
K.S. T. C:	-	Kenya Science Teachers' College.
P.D. S.I:	-	Plan, Do, See, Improve
SMASSE:	-	Strengthening of Mathematics and Science in Secondary Education.
UNESCO:	-	United Nations Educational, Scientific and Cultural Organization

CHAPTER ONE

INTRODUCTION

Background to the Study

The basic aim of science teaching is the same in all forward looking societies, the only difference being on the special needs of the particular country (Jallow, 1982).

Since different countries have witnessed uneven level of development: - technological, economic and other forms of development, their education systems are oriented to diversified priorities. The developing countries have the primary aim of modernizing and developing their economies through technological industrialization and they recognize that the pre-requisites for achieving these objectives are to be found in a system of education which stresses on the development of appropriate scientific and technological knowledge, competencies and skills (Common Wealth Secretariat, 1986).

Kenya's broad national development goals and objectives are articulated in the sessional paper no. 10 of 1965 on African Socialism and its Application in Kenya. A major philosophy in the paper is a concerted national effort for full mobilization of resources – human, financial and others for rapid economic growth and social progress and balanced growth between agriculture and industry, and between rural and urban areas (Republic of Kenya, 1965; 1999). It thus projected a mood of optimism concerning the achievement of these

fundamental goals, through its education system. The outcome of this optimism has been the commitment by the Government to expand education facilities at all the three tiers of formal schooling – primary, secondary and tertiary. Secondary education however was seen as instrumental to the achievement of these goals and objectives and in particular the science component in secondary schools curriculum.

Bogonko (1992) observes that the shortage of skilled personnel in technology, commerce and science related fields threatened to delay and frustrate efforts to modernize and expand the economy as well as slow down the Africanisation of the social and economic life of the Nation. It is observed that Kenya planned to plunge in promoting science and technical education from the outset both at the technical secondary schools and the academic secondary schools (Bogonko, 1992). Rotich (2003) notes that science education has been seen as an important component in the Kenya Society, for it is attributed in helping to meet the needs of the expanding Kenyan economy in various ways. The importance of science education in the secondary schools in Kenya cannot be over emphasized but both the Report of the National Committee on Education Objectives and Policies (Gachathi report) and the Report of the Presidential Working Party on the Establishment of the Second University in Kenya (MacKay report) had as the gist of their recommendations as emphasizing science, technology and mathematics than the arts and social science subjects (Republic of Kenya, 1976; 1981; Bogonko, 1992.)

Eshiwani (1982) noted that more formal and intensive science and mathematics education at Secondary school level was necessary in order to prepare the future scientists and technicians. He further stated that a minimum level of science and technology is crucial in the present world of science and technological revolution. Koech report (1999) identified science and mathematics education as the vehicles to industrialization.

The teaching of science and mathematics conforms to the general teaching-learning process in that the supply of education inputs is a major consideration. It is through inputs that the teaching – learning process is facilitated.

Cohn (1979) argues that the process of education involves the production of education outputs from sets of inputs. In support of this view (Thomas and Martin, 1996) observe that resources matter. Those who work in schools as teachers and associate staff, school premises, books and equipments all provide some of the means by which we transform our hopes and aspirations for children's education into daily learning opportunities and experiences and beyond that into the longer term outcomes of schooling. According to Mbamba (1992), resources are essential inputs needed to sustain the life of any organization including educational institutions

The resources that go to the education system and to schools for that matter consist of human, material, physical, financial and time resources (Cohn,

1979; Mbamba, 1992; Reynolds, etal. 1997). A basic conceptualization of a school is to look at it as an input-throughput-output system (Reynolds, etal. 1997). According to this conceptualization, a given set of inputs should yield an equivalent set of outputs. Thus the underlying assumption is that if schools meet specified standards on various input measurers, then adequate levels of performance will necessarily follow (Willms, 1996).

A mathematical notation of this conceptualization can be stated as: If the vector of educational outputs are denoted by **Q:** $q_1, q_2, \ldots\ldots, q_n$, the vector of school related inputs be **X:** $x_1, x_2, \ldots\ldots\ldots\ldots, x_k$ and the vector of non school inputs be

S: $s_1, s_2, \ldots\ldots\ldots\ldots, s_m$.

Then a total of **n** outputs and **k + m** inputs exist, and thus in general, the educational production function is given by **f (Q, X/S) = 0**.

That is, once the levels of the non-school inputs are given, the determination of the expected levels of outputs will depend on both the levels of the school inputs and the functional operator **f** (which specifies the shape of the production function). (Cohn, 1979)

In the Kenya Secondary Schools, the provision of education inputs has been the responsibility of the government, parents and communities. Historically, this mode of providing education inputs was highly differentiated with

secondary schools being classified as the aided and unaided. The aided schools received

financial subvention from the government while unaided schools were maintained by the parents and communities (Republic of Kenya, 1977). This mode of providing education inputs to the secondary schools did not ensure a homogeneous availability of resources but some schools were disadvantaged.

(Kinyanjui, 1974) observed that the impact of Harambee Secondary Schools on students who attend them was considerable. He further added that the physical facilities provided and the curriculum taught affects both their education and their outlook on life and argued that these schools have no laboratories; lack well stocked libraries and science teaching is virtually impossible.

The education sector in Kenya has been dogged in the provision of education inputs to the schools. The government interventions and community initiative have not guaranteed sufficient supply of inputs to schools. The report of working party on financing of Higher Education pointed out that, the expansion of government maintained secondary schools had been so large that the gap between the rate of development and government's ability to finance the needed facilities had widened each year. (Republic of Kenya, 1982)

The re-organization of the curriculum under the 8-4-4 system of education required all schools to teach both biological and physical sciences (Makau, 1987). This has been a big challenge to many of the small schools.

Ideally, with a uniform curriculum, the provision of inputs for effective implementation should be guaranteed.

A determined move to provide schools an equal footing on provision of education inputs alongside the re-organized curriculum was the adopting of the cost sharing policy in 1988. According to this policy, the government was to pay teachers' salaries and subsidizing costs of special science equipments. The parents were called upon to put up physical facilities including classrooms and workshops (Republic of Kenya, 1988: Okello, etal. 1998)

Kamunge report (1988) observed that an important feature of the four (4) year secondary school education curriculum was the teaching of science subjects in all secondary schools. The report noted that the effective teaching of these subjects was being constrained by the shortage of time allocated especially at form 3 and 4, lack of adequate science facilities and equipments and enough qualified teachers. The report recommended that secondary schools be provided with adequate facilities and equipments for proper teaching of science subjects (Republic of Kenya, 1988).

Major efforts by the Government, parents and other stakeholders to provide education inputs in order to revamp secondary education and especially effective teaching of science and mathematics have not been adequate.

The National Development Plan (2002-2008) notes that with regard to quality and relevance, concern continues to be raised on the failure of the education

system to satisfactorily inculcate a modern scientific culture and imbue learners with desirable social skills and values. The plan notes that this was due to inadequacies in the provision and maintenance of essential facilities, instructional and research materials and human resource capacity (Republic of Kenya, 2002).

Statement of the Problem

Education stakeholders continue to invest heavily in the education of young Kenyans year in year out with the hope that the inputs would be equivalent to the outputs if not better. The immediate expected output from the education system is good performance in examinations (SMASSE, 2004a).

Many schools have performed poorly at the Kenya Certificate of Secondary Education (K.C.S.E). Particularly poorly performed subjects have been sciences and mathematics.

These poor results are an indicator of ineffective teaching of these subjects at the school level, which precipitates into the overall national poor performance.

The reasons for this state of affairs are many ranging from lack of well trained and motivated science teachers, to curriculum reforms that have not been implemented as planned, either because the necessary resources have not been available or because it takes time, in any case, for schools and teachers to change their habits and teaching methods (UNESCO, 1992)

According to the results the mean score for sciences was below 40% for both years. The national mean score in mathematics was 18.5% for the year 2001 and improved to 19.45% in year 2002. Mean score for physics and Chemistry was below 30%for the period under review.

The results also revealed that the performance was poor for both boys and girls, although boys performed better than the girls in the subjects as deduced from Table 1

Table 1:
National Students Performance in K.C.S.E Science and Mathematics Subjects, 2001 and 2002

	2001				2002			
	Female		Male		Female		Male	
SUBJECT	No. Sat	Mean %	No. Sat	Mean %	No. Sat	Mean %	No. Sat	Mean %
Mathematics	89,481	15.83	104,334	21.19	91,647	16.44	105,471	22.53
Biology	85,499	29.52	91,525	33.59	87,141	24.58	90,241	28.34
Physics	16,225	22.22	38,425	26.84	15,315	26.61	38,868	30.89
Chemistry	84,534	21.45	96,862	25.31	87,725	22.05	99,536	26.62

Source: Kenya National Examinations Council (2002)

Results for small schools especially of Harambee Origin are conspicuously poor in the sciences and mathematics. These schools are known to be without laboratories, qualified teachers and other essential facilities. Admittedly these are necessary inputs for effective teaching of Science and mathematics and by implication they predict the outcomes.

Nyandarua District is one of the six districts of Central province and lies between latitudes 0^{o} 08' North and 0^{o} 50' South and between longitudes 35^{o} 13' East and 36^{o} 42' West. Its total land area is 3,528 square Kilometers (Republic of Kenya, District Development plan 2002-2008)

Compared to other districts of Central Province, the District is relatively young and majority of its schools are young and under developed having been established by the local communities through the Harambee efforts (Republic of Kenya 1995)

The district led in the Kenya Certificate of primary Education for six consecutive years from 1985 to 1990 and these Kenya Certificate of Primary Education (K.C.P.E.) graduates have formed the bulk of the Kenya Certificate of Secondary Education (K.C.S.E.) candidates since 1989. Surprisingly, there has not been a corresponding good performance in the Kenya Certificate of Secondary Education examinations by the same students (Republic of Kenya 1995)

The dismal performance drew comment not only from the education professionals but also the press. The East Africa Standard, Saturday, November 9, 1996 observed that "...because the disadvantaged regions have underdeveloped schools, many students who do well in the Kenya Certificate of Primary Education K.C.P.E have to be admitted in the schools within the region because of the 85 % rule of the quota system. The shortcomings of the rule was demonstrated when Nyandarua District and Turkana District, though considerably under-developed performed well in K.C.P.E in the late 1980s and early 1990s. Because the districts have very few well-equipped secondary schools, the students would end up performing very poorly at K.C.S.E level. Nyandarua, though in the high potential central province has about only three well-equipped schools. In contrast, pupils in Nyeri, Kiambu and to a lower extent Murang'a do well in the KCSE although they may not have done well at the primary level".

The Kenya Certificate of Secondary Education results analysis for the Districts in the science subjects and mathematics subjects depicts the scenario that the schools in the district are inefficient to handle teaching of the subjects. The analysis for the years 1999, 2000, 2001 and 2002 revealed that:

- The mean score for mathematics in the four years was below 3 points equivalent to grade D,
- Physics had a mean score of 5.3 points in the year 2000 but dropped to 3.7 and 3.9 in the year 2001 and 2002 respectively,

3. Chemistry posted a mean score that has been on a dramatic decline from 4.4 points in 1999 to 4.3, 3.3 and 2.9 points for the years 2000,2001 and 2002 respectively.

These facts are as revealed in table 2.

Table 2:

Mean score in sciences and mathematics subjects, 1999,2000,2001 and 2002 for Nyandarua District schools

SUBJECTS	YEARS			
	1999	**2000**	**2001**	**2002**
Mathematics	2.15	2.61	2.87	2.47
Physics	4.76	5.28	3.73	3.94
Chemistry	4.42	4.37	3.39	2.90
Biology	5.35	4.82	4.94	3.65

Source: District Education Office (2002).

The causative factors for the poor performance in these key subjects have been a subject of concern to educationists and researchers. This research was undertaken to investigate the availability of education inputs in the public secondary schools in the district. The focus of the study was to uncover

the causal effect relationship existing between a set of available inputs and corresponding school effectiveness in the teaching of science subjects in Public Secondary Schools in Nyandarua District

A research of this kind has never been done before in the District.

Purpose of the Study

The purpose of this study was to find out education inputs that are significant in inducing science and or predicting the effectiveness of the teaching – learning process for science subjects. It sought to find out the availability of key schooling inputs in the realms of physical, material and human in a given timeframe. The subsequent utilization of the available inputs and the resulting output as shown by the number of students attaining a pass grade of D+(plus) and above was also a major purpose of the study. Ultimately an understanding of the variations in school effectiveness as a function of the variations in the level of available inputs was purposively pursued as it underlies the theme of the study

Objectives of the Study

The overall objective of this study was to establish the effect of education inputs on school effectiveness in the teaching of science subjects.

The specific objectives therefore were: -

(i) To determine the availability of schooling inputs in the public secondary schools in Nyandarua District.

(ii) To examine the effect of the human schooling inputs on school effectiveness in the teaching of science subjects and mathematics.

(iii) To explore the effect of physical facilities on school effectiveness in the teaching of science and mathematics.

(iv) To determine the effect of learning materials on school effectiveness in the teaching of science and mathematics.

Research Questions

To meet the stated objectives, the study had the following research questions: -

- How is the availability of education inputs in the secondary schools in Nyandarua district?
- What is the effect of the available physical education inputs on school effectiveness in the teaching of science subjects?
- What is the effect of the available human education inputs on school effectiveness in the teaching of science subjects?
- What is the effect of the available material education inputs on school effectiveness in the teaching of the science subjects?

Significance of the Study

This study may be significant to a host of stakeholders in education.

The research findings may lead to major improvements in the rates of learning that are desirable to Kenyan nation as the quality of graduates in science and mathematics may help steer the nation forward towards indusrialising by the year 2020.

The understanding of the influence of education inputs on school effectiveness both absolutely and in relation to other variables, may be of

primary importance in policy decisions especially on policy variables such as the allocation of resources. Thus education planners and policy makers may utilize the findings in formulating strategies and policies that would ensure optimum allocation of resources significant to induce school effectiveness.

The research findings may be valuable to the parents and education administrators to know the optimum conditions under which students must be exposed for better science and mathematics results.

Limitations of the Study

The study used the heads of science departments to provide information on school effectiveness on behalf of the other members of schools.

Research findings may not be generalized to primary schools and tertiary institutions.

Delimitations of the Study

The study was carried out in Nyandarua District in the public Secondary schools. The focus was on school related inputs and their influence on school effectiveness despite there being an inter- meshed matrix of other factors that influence school effectiveness.

Basic Assumptions of the Study

The gathering of information required responses to be elicited from heads of science department. The assumption was that these respondents would be objective and competent in responding to the items in the instruments.

The study also assumed that the District Education Office was in a position to give pertinent information regarding to the number of Secondary Schools in the district, and the number of science teachers in the district.

The study further assumed that effective teaching and thus academic achievement in science and student learning is a function of among other things, the availability of adequate and appropriate inputs in the education system.

Definition of Significant Terms of the Study.

The following terms are significant in this study

Education refers to: - The development process which takes place in an individual as a result of his exposure and interaction with people and other stimuli in his/her environment.

Science education refers to: - Developmental process which takes place in an individual as a result of intellectual search involving inquiry, rational thought and generalization due to exposure and interaction with people and other stimuli in his/her environment.

Science subjects refers to : - The cluster of natural science defined by mathematics, physics, chemistry and biology.

Education input refers to : - Everything that is planned to contribute to the education enterprise whether inanimate or animate.

School effectiveness refers to : - The extent to which a school attains the objectives of the formal curriculum.

Teaching refers to : - The art of assisting another to learn which includes the providing of information and of appropriate situations, conditions, or activities designed to facilitating learning.

Impact refers to: - Strong impression or effect on somebody or something.

Public Secondary school refers to: -A four-year post Primary School, which is developed and provided with staff through public funds.

Head of Science Department: - Any person charged with responsibility of coordinating the teaching of science subject in a given school.

Organization of the Study

This study is organized into five chapters; Chapter one covers background to the study, the statement of the problem, purpose, objectives, research questions, significance, limitations, delimitations and basic assumptions of the study. Chapter two consists of the literature review which covered an overview of science education, aims of science education, methods of teaching science, inputs in education and empirical literature on education inputs and school effectiveness. Chapter three was the research methodology, which covered research design, target population, sampling techniques and sample size, research instruments, validity and reliability of the instruments, data collection procedures and the data analysis techniques.

Chapter four deals with data analysis, interpretations and discussion. It consisted of bio-data of the sample, availability of education inputs, school effectiveness and effect of education inputs on school effectiveness. Chapter five deals with the summary, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

This section deals with the literature reviewed for the study. It was reviewed under the following sub themes: an overview of science education, aims of science education, methods of science teaching, empirical research on inputs and school effectiveness and a summary of the literature reviewed. The section ended with a theoretical framework.

An overview of Science Education

Science in the broadest sense of the term is the elaboration of models or theoretical constructs to explain the behaviour of nature. In this sense, there are many different "science" different collections of processes, rules and knowledge bases for gathering information and processing into verifiable knowledge (Albert, 1985).

Ogborn (1997), states that the subject matter of science is the material universe and the aim of the scientific enterprise is to obtain the sort of knowledge and understanding of the material universe, which can be relied upon for action.

Science education is taken to mean specifically the teaching of science subjects in schools (Albert, 1985).

Turner and Dimarco (1998) define science as a highly successful human activity, a defining feature of our culture, ranking alongside the achievement of art, music and literature and for this reason alone, science can

be justified as a key part of any school curriculum that claims to transmit the culture.

In support of this view Jallow (1982), stated that the science curriculum of any society cannot be considered without reference to the total curriculum. He observed that curriculum as a document when available enumerates in theory the aims and objectives of education in the society concerned.

Mbamba (1992) observed that the formal curriculum is made up of clusters that define specific subjects such as mathematics, Physics, Chemistry and Biology under the cluster of natural sciences.

Aims of Science Education

Politicians, science educators, scientists, industrialists, teachers and governors frequently make statements about the aims of education and sometimes about the aims of science teaching. Science education offers a means of fulfilling many of the general educational aims of the school, that is, it is an education through science as well as in science (Turner and Dimarco, 1998).

One set of aims for science education developed by the Association for Science Education (ASE) is linked to general educational aims. They suggest that, through science education learners should: -

- Acquire a set of personal and social values and abilities (intellectual and physical) to guide action through a variety of experiences.
- Increase personal autonomy without infringing on the rights of others.

- Establish and appreciate their personal identity and self-esteem within the context of positive social and ethical relationships.
- Discriminate between choices realizing the possible consequences of action;
- Recognize the relationship between the process of learning and the outcomes of learning. (ASE, 1992,pp.5)

Jallow (1982) noted that the centrality of science in the world of education today is beyond dispute. Besides the need to training the manpower technological requirements through science, it is intrinsic in the social relations that everyone becomes exposed to scientific methods of problem solving. Sand (1987) notes that three approaches concerned with the teaching of science explain its importance. These are: -

- Science has intrinsic value as a body of accumulated knowledge and as a way of finding out about the world.
- Learning science is a means for helping individuals to fulfill their own personal potentials.
- Learning science helps the individual to live in a society and both to contribute to it and benefit from it.

Njaggah, (2003) notes that characteristic of industrially developed countries is that a part from scholarly advancement; there has been a rapid rate of economic growth, brought about by the rapid development of science and technology. Shipman (1990) observed that it was clear by 1960 that scientific

and technical knowledge was going to be the key, not only to national economic and military strength but also to individual advancement in employment. He further asserted that the launch of SPUTNIK I by the Russians in 1957 is always given as the reason for the investment in planned curriculum in mathematics and science in the U.S.A.

As early as the 1960s, developing countries embarked on programmes to support the development of science education at secondary and higher education level (UNESCO, 1992). Jolly (1969) observed that there are two areas of education, which are regarded as being of fundamental importance in most African countries. These are training in communication – reading, writing, language learning and science education.

Radhakrishna in (UNESCO, 1992) noted "the development of human resources is as important as development of natural resources and thus requires a proper realistic education .....This leads logically to a consideration of the role of science and technology in education. Scientists and technologists are required in the economic infrastructure of an industrial society, no matter how unsophisticated it may be"

In Kenya, the commission of inquiry into the education system (Republic of Kenya, 1999) noted that science is a vital requirement for industrialization and recommended that: -

- An appropriate balance between science and arts subjects be established.

- Science teaching and examination be oriented to problem solving approaches.
- Children be exposed to science concepts from an early age.

Methods of Science Teaching

Education all over the world has been struggling to develop approaches and methods that enhance the learning of science and mathematics (SMASSE, 2004 b).

The common methods of teaching science include lectures, discussion, demonstration, class experiments and project work. Demonstrations, class experiments and project work fall into the category of practical science (Owitti, 2003).

Woolnough, (1991) defines practical science as that which involves doing of experiments or practical exercises with scientific apparatus usually in a science laboratory.

The practical exercises ideally fall into two major teaching strategies; guided discovery and inquiry teaching. In guided discovery students are provided with information and through the guidance by their teachers they discover the abstraction identified. Inquiry teaching involves providing students with contents related problems, which serve as the focus for the class research activities. Guided discovery takes longer time due to redirection and divergent questions, but is more students – centered than inquiry teaching that is more teacher centred. (Owitti, 2003). Barrows and woods (1989) have

the opinion that it is preferable that children should find things out for themselves rather than be told everything.

In support of the student centred learning SMASSE laments that the teaching/learning process has been predominantly teacher centred. Teaching is directed at students and not organized for students. The teacher teaches the syllabus instead of teaching the students. Teaching has been for examinations as opposed to the acquisition of important and meaningful mathematical and scientific skills and concepts, (SMASSE, 2004C)

Albert (1985), argues that practitioners of science rely heavily on controlled experiments so that particular observation can be made and hence give an explanation to what they observe as their conclusion. Therefore in science, high value is placed on the use of measurement and numerical analysis for verification and validation of information. Wellington (1998) argues that science is not a practical subject in itself but we do practical work in science so as to build a bridge between the realm of objects and observable properties on the one hand, and the realm of ideas on the other.

Whatever the approach and method of teaching employed in the transmission of knowledge, mastery learning essentially rests upon a philosophy which asserts that anyone can learn anything, provided that the material to be learned is suitably subdivided into manageable, sequentially developmental components, and that enough time is allowed for the learning process (Beare, 1994). Essentially, whatever kind of teaching – learning strategies adopted

there must be a set of inputs that are put in place for effective teaching and learning to occur and in particular the learner centred approaches.

Inputs in Education

An education system is defined by inputs, the process, the product and the broader context of education (Reynolds, et al, 1997). Willms (1996) notes that researchers have conducted a number of large studies to explore the relationship between school inputs, school resources and schooling outputs such as pupils' examination results and their overall examination attainment. The concern for researchers is the development and the testing of a theory about what induces effectiveness, about which factors, which characteristics of education lead to effectiveness or put it other way, what causes the differences in schools (scheerens, 1993). Simmons (1980) has argued that the theoretical objective of efficiency is to obtain the optimum combination of inputs such as teacher training, and expenditure per student to achieve at least- cost the desired outcome, such as a certain level of reading achievement.

According to Reynolds, et al. (1997), variables such as the number of students, the resources like funding and materials, books, computer, audio equipment, the teachers and their quality and the quality of the buildings constitute inputs in an education system. Mbamba (1992) underscores the importance of resources in the teaching learning process when he says that

the basic requirements for curriculum implementation are competent teachers, instructional resource materials, adequate learning facilities and instructional supervision.

Cohn (1979) articulates that school inputs impacts on school effectiveness.

Eshiwani (1983) has argued that the presence or absence of school facilities distinguish high achieving from low achieving schools. UNESCO (1983) notes that the teaching of science demands special facilities. This observation has the implication that the effectiveness of schools in the teaching of science subjects depends on the availability of the right facilities.

The teaching of science in the Kenya Secondary Schools has been in practice in the years immediately after independence. The sessional paper No.1 of 1963 titled the observations on the Report of an Economic Survey Mission from the International Bank for Reconstruction and Development recommended that regular secondary schools should add science –technical streams in their curricula (Republic of Kenya, 1963).

UNESCO (1983) observed that when Kenya became independent in 1963 an expansion in secondary schools in the first ten years placed enrolments at 185,000 in 1974 from 36,000 in 1964. UNESCO further adds that; the expansion created many problems in science teaching and summarized them as: a lack of qualified science teachers; lack of adequate science equipment and lack of adequate science teaching facilities.

The national development plan (1974- 1978) observed that the school system was not producing a sufficient number of students with science qualifications to fill existing and proposed places in the higher educational system (Republic of Kenya, 1974). The plan further identified the causes of this failure to be due to inferior quality of science instruction and the school science laboratories and classes being inadequately equipped.

Efforts to improve the effectiveness of schools in the teaching of science subjects in Kenya have been through major interventions including donor involvement. In 1965 an agreement between Kenyan and Swedish governments was signed to build a teacher training college, the Kenya Science Teachers' College (KSTC) in Nairobi (Republic of Kenya, 1966; UNESCO, 1983). The School Equipment Production Unit (SEPU) was an initiative to assist in the improvement of the teaching of science, both in content and in method and in adapting teaching aids to Kenya's needs and financial resources (UNESCO, 1983). The national development plan (1997-2001) outlined that facilities especially laboratories and workshops would be improved through the establishment of a fund and coordinated action with other stakeholders (Republic of Kenya, 1997). However these initiatives have not yielded the anticipated output

The ultimate criterion for effectiveness is formulated in terms of student's outcome; which ultimately determine the quality of schools and of education in general (Reynolds, et al. 1996). Lewin (1974, 1976) in Cohn (1979) has

argued that schools are not perfect, fulfilling their missions to the great satisfaction of pupils, parents, schools boards and politicians at local and national level.

Bogonko (1992) observes that the Ministry of Education was forced in many ways to resort to division 3 EACE/KCE candidates who had combination in three science subjects for admission into form five. He adds that this recourse plus poor science teaching facilities in most schools, especially those of Harambee origin, resulted in the perpetuation of poor performance in the EACE/ KACE mathematics and science subjects with the consequence that the production of high-level scientific manpower was threatened with stagnation.

The minister for education was quoted as sayings that performance in the science subjects and mathematics was lacklustre. (Daily Nation, 2004, March 3) Mwiria, was quoted by Siringi saying, "that the 2003 Kenya Certificate of Secondary Education (KCSE) examination results proved once more that performance in the key subjects of science and Mathematics was poor for most schools". (Daily Nation, 4th April 2004). Daily Nation reported that the decision by the ministry of Education to compel all K.C.S.E. candidates to pursue pure sciences course did not consider the schools ability to provide the laboratory equipment, and that this new change affected the candidates performance and threw into disarray their career prospects (Siringi, Daily

nation: 2004). The District Education Officer Nyandarua reporting on 2001 K.C.S.E. results for the district said that with the phasing out of physical sciences there was a drop in performance compared to previous years (DEO Office Nyandarua, 2001). Mwiria, in the Daily Nation (4th April 2004) commented that schools should pay more attention to resources that impact on performance more directly as opposed to spending on administration blocks, school buses and swimming pools at the expense of apparatus, chemicals and textbooks.

Empirical Literature on Schooling Inputs and School Effectiveness

Student cognitive achievement, as measured by examinations, has been the educational benefit most extensively studied in developing and developed countries (Simmons, 1980)

Education is a complex process that may be influenced by factors both inside and outside the walls of the classroom. A major concern of educational planners is to identify those factors that have stronger relationship with school achievement than others (UNESCO, 1997). Cohn (1979) observes that both schooling inputs and non-school inputs contribute substantially to a students' education output.

Studies by Coleman (1966) and Jenks (1972) had formed the conclusion that the socio- economic factors and characteristics of the entering children are more important than school variables such as the school budget and its

policies, the characteristics of the teachers among others (Psacharapolous and Woodhall, 1985). Simmons (1980) has argued that studies by Coleman and Jenks were conducted in the United States where schools exhibit minimal differences in terms of facilities available to students from different socio-economic classes. Moyniham and Mosteller (1972) suggested that, had there been large differences in the school facilities of the races in the United States of America studied, differences might have proved of great consequence.

Research carried out in Brazil, Colombia, Chile, Puerto Rico and Venezuela showed that school variables explain a large part of the total variance in educational achievement, but amount of resources available and facilities per student differ markedly from school to school (Simmons, 1980).

Fuller (1987) considered more than 50 empirical studies and his review suggested that the school institution exerts a greater influence on achievement within developing countries compared to industrialized nations, after accounting for the effect of pupil background. Based on the percentage of studies showing positive effects, he found that effectiveness parameters influencing school achievements to be length of the instructional programme, pupil feeding programmes, school library activity, years of teacher training, text books and instructional materials.

Ideally, the schooling process involves an interaction of the human, physical and material inputs within a time frame in the school environment for production of an education output.

Human Inputs and School Effectiveness

Mbamba (1992) defines human resources as people who are directly or indirectly involved in carrying out activities related to teaching and learning. He further observes that education is a labour intensive activity that requires the services of the teaching staff, professionals like librarians, professional managers and support personnel. The human inputs emphasized in studies include teachers, administrators, secretarial, clerical, and other auxiliary staff, counselors and paraprofessional teaching aides (Cohn, 1979). He further adds that another input that conceptually should be included in the model of study is the initial educational endowment of the students which would permit analysis of the gain in output over a given time period. For any system of education to achieve its objectives, the supply of adequate teachers is crucial. Enough and qualified teachers must be produced and re-distributed accordingly by regions and school levels (Republic of Kenya, 1997b). In support of this view (Cohn, 1979) argues that productive attributes of teachers that need be examined are educational preparation, experience, resourcefulness, talents, attitudes and classroom practices.

Heyneman and Loxley (1983) studied science achievement in 16 developing and 13 industrialized countries. Their findings were that children who attend primary school in countries with low capita incomes have learned substantially less after similar amounts of time in school than have pupils in

high-income countries. At the same time, the lower the income of the country, the weaker the influence of pupils' social status on achievement. Conversely in low-income countries the effect of school and teacher quality on academic achievement in primary school is comparatively greater. The review of thirty-two studies concluded that trained teachers do make a difference, and in particular that teacher qualifications, experience, and amount of education and knowledge are positively related to student achievement (Psacharapolous and Woodhall, 1985). Coomber and Keeves (1973) in their analysis of data on student achievement in Secondary Science found that the average contribution of home background was between 0 percent and 2 percent, while schooling policy variables explain over 4 percent of total variance.

Irumbi (1990) argues that teaching experience is a frequently included variable in educational research but no clear picture of its effects seems to emerge. Cohn (1979) has observed that studies using a quadratic specification for teaching experience variables indicate that the first few years of experience are negatively associated with achievement, but that as more experience is gained, the relation becomes positive. SMASSE (2004b) asserts that effective teaching is intricate and goes further than thorough planning, choice of approaches/ methods and preparation of teaching / learning materials.

Ultimately effectiveness in highly dependent on two teacher factors. The mastery of subject content and interpersonal skills.

Although the teacher has a pivotal role in the teaching process, Science teaching depends heavily on good support from various technical support services (Turner and Dimarco, 1998). Kelwon (1991) in Owitti (2003) notes that a laboratory assistant helps the science teachers to accomplish their laboratory lessons by assembling the necessary specimen or materials/ apparatus ready for the laboratory classes. SMASSE (2004b) indicates that recent studies on school Science/ Mathematics teaching have the opinion that learning should by large be learner centred.

The implication is that more time is required, for learner-centered strategies to take place and consequently the necessity of laboratory assistants. Comber and Keeves (1973) observed that the more hours allowed to institutions in a given subject, the higher the achievement of the learners. Aduda as reported in Daily nation, 30th April 2002, observed that laboratory assistants were found to be professionally wanting and hence, were unable to advise the teachers about the necessary apparatus and equipment.

The work of Simmons (1980), concluded that the influence of teacher characteristics on student performance is a central issue. He suggests that no general policy recommendations for the variables that can be made but that majority of studies suggested that: -

- Teacher certification and academic qualifications are not important at primary and lower secondary grades. But they do appear to be important at upper secondary grades in some subject areas such as science, given the consistency across developed and developing countries in the IEA Science study regarding the significance of post secondary schooling of teachers.
- The percentage of teachers on permanent contract (tenure) has no effect on student achievement in primary and lower Secondary grades. However, it may have a positive or negative influence on upper Secondary grades depending on the country being examined. Examples of this agnostic conclusion are seen in the IEA Science study and the Thias – Carnoy Kenya study.
- Teacher experience tends to have a positive influence on academic achievement in primary and lower secondary. For example, teacher salary is significant in the Thias- Carnoy Kenya study grades, and this reflects teacher seniority and experience.

Physical Facilities and School Effectiveness

It is generally agreed that a schools' physical facilities, such as classrooms, laboratories, desks, and books, have a direct bearing on performance among students (Ayoo, 2003). The quality of the physical environment of a school undoubtedly affects the quality of teaching and learning and that school effectiveness research suggests that for a school to be effective, minimum standards must be met in terms of physical facilities (Republic of Kenya, 2000). Cash (1993) has shown that there are cases in the U.S.A. where in comparable environments, students who attend well maintained schools which have a good appearance have higher achievements rates than do those who attend poorly maintained buildings.

An analysis applying multivariate statistical procedures conducted by international institute of Education Planning (IIEP) with the cooperation of the ministry of Education and culture in Zimbabwe revealed that all things being equal – pupils could not be expected to learn effectively; If the classroom did not have fundamental items such as a blackboard, sitting and writing places for all pupils and basic storage facilities for books and teaching aids (Unesco, 1997).

A major approach in the modern teaching of science and mathematics is based on the acronym ASEI standing for (Activity – Student - Experiment – improvisation) lesson. These lessons enable learners to relate and integrate practical activities with theoretical knowledge (SMASSE, 2004b).

This approach by implication underscores the necessity of the availability of facilities for effectiveness in the teaching learning process in terms of space for activity and materials for experimenting and improvisation. Janaidu and Urwick (1983) in their investigations in Nigeria on factors influencing learners achievement formed the conclusion that facilities like buildings, separate classrooms and students' desks determine the very organization of teaching / learning activities and these factors do influence learner achievement. Ashman (1989) argues that the optimum use of classroom space and time ensures that students have the chance to maximize learning skills. Through preparation of teaching activities and materials, together with organization of classroom space, the teacher can ensure that students are involved in the learning process throughout the lesson and that time is not wasted or used inappropriately.

This observation by Ashman implies that strategies that ensure availability of facilities needed and those optimizing utilization of time efficiently are much needed for effectiveness in the teaching of Science subjects.

Waweru (1978) observes that scanty apparatus is the biggest problem that hindered effective science teaching in Harambee schools and further says that whereas a resourceful teacher could improvise some apparatus that are unavailable, it is not possible to improvise in all instances for such things like sodium and microscopes.

Layton in Hazel (1990) stated that science education without laboratory experience is unthinkable and it ought be an integral part of the science curriculum and it ought to raise key curriculum questions to anyone developing or teaching in a science progamme.

Hazel (1990) commented that certainly the laboratory is not only unique in kind, but uniquely expensive of resources including time, space, equipment, personnel, expertise and money. Musoko (1983) notes that a significant 50% of schools in Nairobi Province buy laboratory equipment near examination time and these same schools prepare their candidates for practical examination at the end of form four. The implication by these observations is that with low supply of appropriate apparatus then time on activity by students is less and thus effective teaching is hampered. Time as a component in teaching can only be understood in the context of the availability of certain facilities.

A Handbook of Inspection for Institutions in Kenya underscores the importance of time and states that time should be seen as an inelastic resource. It observes that Time management is a crucial factor affecting the efficiency of teaching and learning and adds that if Kenya is to achieve the target of industrialization by the year 2020, time management will be a key factor to be addressed (Republic of Kenya, 2000). Time is important in that it determines the level of exposure to the learning environment.

Simmons (1980) has noted that a policy variable that intensifies the exposure to learning environment is the provision of boarding facilities at the secondary school. He states that boarding independent of home background, has a greater influence than any other policy controlled variable in the Carnoy- Thias studies for Kenya and Tunisia and in the Youdi study for the Congo. Simmons stresses that we should note that boarding may be a substitute for more study time, fewer distractions and increased financial motivation. Bunyi and Okkemo (2000) in Ayoo (2002) carried out a study for UNICEF, Eastern and Southern Africa Regional Office to find out the influence of distance on education of girls. The study established that distance had a strong influence on retention rates and regular attendance of school, ultimately affecting students' academic achievement. The implication on science teaching with respect to boarding facilities and distance covered (for not boarding) is that out of class assignments and homework are either boosted or hindered. Schielfelbein and Simmons (1981) have showed that a close relationship exists between the out of class academic assignment and achievements.

Material Inputs and School Effectiveness

A good deal of evidence now suggests that material factors in schools such as more textbooks or writing materials –exercise more influence on achievement in the Third world than in the industrialized countries (Fuller, 1987).

(Njeru and Orodho, 2003) observe that instructional materials especially textbooks, science equipment, reference materials are quite crucial to students' learning at secondary school level. They however observe that secondary schools in Kenya face a diversity of inequalities ranging from quality of buildings and instructional materials especially text books and reference books.

Heyneman (1984) evaluated a textbook programme in the Philippines. The programme was introduced in the Philippines to raise the national level of academic achievement among students in three subjects: Philippino, mathematics and science in two grades. The programme reduced the ratio of pupils per book per subject from an average of 10: 1 to 2: 1 and there was marked improvement in performance. The study concluded that there was a reasonable impact of textbooks availability and the achievement of the pupils. A study to establish the effects of material inputs on the performance of students in single sex and mixed secondary schools by the population council of Kenya and the ministry of Education (1997) revealed that the shortage of the necessary material inputs was one of the factors affecting performance of boys and girls in public secondary schools. The study further revealed that in some mixed schools textbooks were collected for safe keeping at the end of each day which undermined students' ability to do extra work out of class and as a consequence hindered their performance.

Schiefelbein and Simmons (1981) have found that availability of textbooks was associated with student achievements in 7 out of 10 studies and the setting of homework was related to higher student achievement in 6 out of 8 studies. Eshiwani (1983) in his study about factors that influenced academic performance of schools in Western Province observed that homework influenced academic performance of learners. He established that a large percentage of the school studied had no formal homework assignments given to students and concluded that this contributed to under achievement in national examinations.

Riddell and Nyagura (1991) conducted a study in Zimbabwe based on a secondary school survey and multi- level analysis. They found that student achievement is higher when schools have greater availability of textbooks and a larger proportion of trained teachers who have taught at that school for a longer period of time. Levin and Lockheed (1991) argue that material inputs are important on achievement in economically impoverished countries where resources sufficient to provide even the most rudimentary conditions for success are often lacking. They argue that creating effective schools in developing countries requires three elements: basic inputs, facilitating conditions and the will to change. They enumerate necessary inputs as: -

- A well – developed curriculum, in terms of both scope and content.
- Sufficient instructional materials for students.
- Adequate time for teaching and learning.
- Teaching practices that encourage active students learning.

The handbook for Inspection of Educational Institution in Kenya has outlined that a key factor in the effective delivery of the curriculum is the availability and quality of teaching and learning materials. Without such materials classes will always be teacher centered and didactic, and pupils will not learn how to work independently or in groups. The book reports that the government of Kenya (GOK) and its donor partners have all pledged to support to the provision of textbooks for those children who cannot afford them. The intention being to raise the quality of education and reduce cost (Republic of Kenya, 2000) Turner and Dimarco, (1998) observe that worksheets are much used by science teacher to give information, instruction, provide a written task or act as a learning guide.

Although material inputs are important, the Kenya's Master Plan on Education and Training (1997-2010) notes that "constraints in resources for instructional materials have been exacerbated by absence of a systematic approach to provide for the widened curriculum introduced in the mid-1980's and the 1989 adoption of former Harambee Schools as Public Institutions. In this regard, inadequacy of equipment and materials for teaching learning science is a major worry" (Republic of Kenya, 1998).

Summary of Literature Review

Although the aims of Science education are well articulated for most of the education systems; the effective teaching of the subjects under the cluster Science education has not been well done. Factors accounting to the lack of

schools achieving effectiveness in this area have been identified to include the poor attitude of both teachers and learners but of utmost importance has been the casual effect relationship between the availability of the education inputs and the subsequent effectiveness of schools as depicted in good performance at national examinations.

This study therefore, intends to contribute to the knowledge of how availability of education inputs (or lack of them) affects school effectiveness in the teaching of science subjects. A study of this kind has never been carried out in Nyandarua District of Central Kenya. Thus, the timeliness of this study.

Theoretical Framework

This study is based on the theory of education production function (EPF) The production function is used to determine the maximum product which can be derived from a given combination of inputs within the existing state of technical knowledge.

Used for education, it is generally expressed as:

$A_{it} = f[F_{i(t)}, S_{i(t)}, p_{i(t)}, I_{i(t)}]$

Where i refer to i^{th} student, t refers to time and (t) refers to an input cumulative to t.

A denotes education output, usually academic achievement, and the input categories F, S, P, and I represent family background characteristics, school inputs, peer group characteristics and pre school age abilities, respectively.

According to this study :- $A_t = f(P_t, M_t, H_t)$

Where A_t =Achievement at time (t). For the input categories.

P = Physical inputs at time (t).

M = Material inputs at time (t).

H = Human inputs at time (t).

Such that a liner relationship exists that:-

A = xP + yM + zH where x, y and z are the estimated coefficients to be optimized for effective teaching. The argument is that achievement of learners depends on available physical, material and human schooling inputs at the particular time. The study as guided by this framework established that schooling inputs are paramount in effectiveness of schools in the teaching of science subjects. Schools with more of the inputs performed better and especially those with boarding facility for making maximum use of available time and encouraging students' active involvement in the learning of science subjects.

CHAPTER THREE

RESEARCH METHODOLOGY

This section covered research methodology used in the study. It consisted of the following subsections: - research design, target population, sampling techniques and sample size, research instruments, validity and reliability of the instruments, data collection procedures and the data analysis.

Research Design

This was a descriptive survey study that relied on facts that had already occurred and hence an ex-post facto research design was used. Scott and Usher (1966) observe that in ex-post facto research design, the researcher searches for casual relationships among phenomena by retrospectively reconstructing what happened.

The researcher in this study focused on the independent variables of the schooling inputs; namely the human, physical and material in the context of the school environment. The availability and quality of these inputs in schools cannot be manipulated by the researcher in anyway since they already existed. Kerlinger (1973) states that an ex-post facto design is a system of empirical inquiry in which the scientist does not have direct control of independent variables, because their manifestations have already occurred or because they are not manipulable.

The researcher in the study investigated the impact of the availability of schooling inputs in retrospect for the possible relationship to and effect on the dependent variable the school effectiveness in the teaching of science subjects as depicted by K.C.S.E results. The K.C.S.E. results relied on, already existed in the various schools that were used in the study. Similarly inferences about relationship among variables were made without direct intervention from the independent and dependent variables.

Target Population

This study targeted the total number of all the science teachers in the public secondary schools in Nyandarua District.

Nyandarua District has five categories of public secondary schools. These are:

- Boys boarding schools
- Girls boarding schools
- Mixed boys and girls boarding schools
- Mixed boys day/girls boarding schools
- Mixed girls and boys day school.

In total there are 87 public Secondary schools in the district with at total student enrolment of 16,612.

These schools are distributed in six administrative divisions as shown in the table below.

Table 3:

Distribution of Public Schools within District Administrative Units

Division	Area (Km^2)	Locations	Public schools
Ndaragwa	683.6	6	23
OlJoro Orok	381	4	10
Ol Kalou	592.2	6	20
Kipipiri	543.8	5	11
South Kinangop	348.1	3	12
North Kinangop	475.3	2	11
Total	**3304.0**	**26**	**87**

Source: Ministry of Education, Nyandarua District Headquarters. (2002)

Sampling Techniques and Sample Size.

Sampling is the process of selecting a number of individuals or units for inclusion in a research study in such a way that estimates of the characteristics of the large group (population) from which they are chosen have no (or minimal) bias and have known confidence limits based on correctly calculated sampling errors (UNESCO, 2001),

In order to select the schools that participated in the study, a stratified random sampling approach was adopted based on the distribution of schools in the divisions. Ary, etal. (1979), Observes that the major advantage of stratified sampling is that it guarantees representation of defined groups in the population.

From the list of all the public secondary schools in Nyandarua District, 32 schools were selected in terms of the six divisions.

The heads of science departments of the 32 sampled schools were purposively selected for the study. The heads of science department were selected for the study because it was deemed that they had good background information pertaining to the availability and establishment of inputs in the schools for effective teaching of science subjects, owing to their years of experience and position of their responsibility.

Individual science subject teachers were deliberately avoided to overcome differentiated opinions on availability and effectiveness of schools in teaching of science subjects.

This sample was acceptable. Mulusa (1990) says that " for training purposes, it was agreed in Kenya programmes that a sample of 30 thirty to 50 fifty cases would be acceptable.....Sample of thirty or more cases is therefore recommended.

Research Instruments

The primary data on the impact of the availability of education inputs was gathered by the use of the questionnaire administered to the 32 public secondary schools heads of science department. The questionnaires that were used in the study were the structured undisguised. This type of questionnaire was chosen for being simple to administer, easy to tabulate and to analyse.

Each questionnaire was made up of two sections. Section 1which dealt with background information of the school Section II dealt with questions for answering the research questions of the study.

To gather information on availability of the physical facilities, an observation schedule was also used.

Validity of the Instruments

Validity is that quality of data gathering instrument or procedure that enables it to measure what is supposed to measure (Best, 1998).

Three types of validity that are distinguished are content validity, criterion-related validity and construct validity (Ary, etal.1979).

To ensure validity of the instruments, a pilot study was conducted in five schools of Ndaragwa division as a pre-test of the instruments. The five schools were selected on the basis of the categories of

schools in the district. The schools used in the piloting did not participate in the study. The heads of department involved in the pretest pointed out items that were confusing or ambiguous and potentially offensive to the respondents. The responses resulting from the pre-test were coded and tabulated to check on the conceptualization of the problem and method of analysis necessary to answer the objectives. The responses were further used in the modification of the instruments.

The items on the instruments were further discussed by a senior academic staff in the department of education administration and planning who was well versed in matters of research and especially education research.

Reliability of the Instrument

Reliability is considered to be the ability of the instrument used in research to consistently measure the characteristic of interest. "An instrument is considered reliable to the degree that it consistently measures the characteristic of interest, both over time and from subject to subject" (Gay and Airasian, 2001)

The pilot study was used to assess the consistency of the instrument. The questionnaires were administered to the same group of respondents and their responses were scrutinized to ascertain instruments reliability.

The split half procedure was used to get the measure of reliability of the instrument. Ary, etal (1979) observes that this method requires only one form

of a test, there is no time lag involved, and the same physical and mental influences will be operating on the subjects as they take the two sections.

The split –half correlation obtained was transformed into an appropriate reliability estimate of the entire test, using the spearman – brown prophecy formula:

$$r_{xx} = \frac{2r_{½½}}{1 + r_{½½}}$$

Where

r_{xx} = the estimated reliability of the entire test

$r_{½\ ½}$ = the person r correlation between the two halves.

Data Collection Procedure

Before undertaking the research, a research permit was obtained from the office of the president through the Ministry of Education, science and Technology (Appendix 1)

The copies of the permit were then given to the District Commissioner and the District Education Officer Nyandarua District.

Head-teachers of sampled schools were contacted prior to the research.

The research involved the researcher in the administration of the instruments both at pilot and the main study.

Schools participating in the pilot study were not used in the main study.

A rapport was created with respondents and confidentiality assured to them pertaining to information provided

Data Analysis Techniques

To achieve the objectives of the study, data was analyzed using frequency tables, percentages and measures of central tendency.

The responses in the questionnaire were tabulated and coded.

To establish the nature of relationship between the independent variables and the dependent variables the spearman correlation coefficient was used. This utilized the formula

$$r = \frac{\sum (x - x)(y-y)}{[(x - x)^2 (\sum (y-y)^2]^{1/2}}$$

Where x and y are the respective means of x and y variable.

A computer programme, SPSS/PC+ (statistical package for social science) was used to out put the data.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND DISCUSSION

Introduction

This chapter presents the analysis and interpretation of the data collected with the purpose of assessing the impact of the availability of education inputs on school effectiveness in Teaching of Science subjects in Public Secondary Schools in Nyandarua District. The research study being a descriptive case study sought to generate an accurate account of the relationship between available education inputs and schooling effectiveness in the teaching of science subjects. To effectively generate this information questionnaire was designed and administered to the heads of science department in the sampled public secondary schools. An observation schedule for the physical facilities was also completed for each of the sampled school. The items in the Instruments (questionnaire and observation schedule) were focused towards the objectives of the study namely the availability of education inputs, the effect of physical schooling inputs on the school effectiveness, the effect of the human schooling inputs on school effectiveness and material schooling inputs on school effectiveness in the teaching of science subjects.

Data presentation was done in tabular form using frequencies and percentages. Averages and Pearson correlation coefficient have been used to explain and interpret relationships exhibited by the different sets of education inputs and the schooling effectiveness in the teaching of science subjects.

Questionnaire Return Rate

The questionnaire for the heads of science department was administered to the 34 sampled schools. A total of 32 questionnaires were completed and returned thus achieving 89.9% return rate. A similar number of the observation schedule for physical facilities was also completed. From the questionnaires returned and the completed observation schedules the data was analyzed in the light of the objectives and the research questions of the study.

Data analysis

Data analysis was worked out from responses on the questionnaires returned. The responses were coded and tabulated in accordance to the availability of the physical, material and the human schooling inputs in the schools. Responses on schooling effectiveness in the teaching of the science subjects were also coded and tabulated. The analysis and interpretation of the findings followed the research questions: -

- How is the availability of education inputs in the secondary schools in Nyandarua district?
- What is the effect of the available physical education inputs on school effectiveness in the teaching of science subjects?
- What is the effect of the available human education inputs on school effectiveness in the teaching of science subjects?

- What is the effect of the available material education inputs on school effectiveness in the teaching of the science subjects?

Before the analysis of the responses related to these research questions of the study, the bio - data of the sample was presented.

Bio- Data of the Sample

The study covered 32 schools selected from 87 of the public secondary schools in Nyandarua District. Apart from collection and analysis of data related to the availability of education inputs and their effects on school effectiveness, the study also collected data on salient characteristics of the sample that were deemed would complement the findings of the study. One such characteristic was the category of schools involved in the study as found in the district as shown in table 4.

Table 4:
Category of schools involved in the study

Category	Frequency	Percentage
Provincial Boarding Boys	1	3.13
District Boarding Boys	2	6.25
District Boarding Girls	2	6.25
District Boarding Girls and Boys	6	18.75
District mixed Day and Boarding Boys and Girls	3	9.37
District mixed Day School Boys and Girls	18	56.25
Total	**32**	**100**

From table 4, all categories of schools were involved in the study. However, majority of the schools are the district mixed day for both boys and girls, which represented 56.25%. The district boarding for both boys and girls represented 18.75%. In general a representation of all the categories has the implication that the findings on the availability of school inputs, school effectiveness and the effect of educational inputs on school effectiveness shall be a true reflection of the schools in the district.

Another observation of the study was the variation in the number of streams in the schools. Table 5 summarizes the distribution of the schools according to the number of streams.

Table 5:
Distribution of schools according to number of streams

Number of streams	Frequency	Percentage
Single	17	53.12
Double	12	37.5
Triple	1	3.13
Quadruple	2	6.25
Total	**32**	**100**

Table 5 reveals that majority of the schools are single streamed represented by 53.12%. The double-streamed schools are represented by 37.5%. The

three and four streamed schools are represented by 3.13% and 6.25% respectively. This indicates that schools in the district are at different levels of development that may explain variations in the availability of schooling inputs.

The study also found out that variations existed in the gender composition of the students enrolled in the various schools categories. Table 6 summarizes enrolment in schools by gender and school category.

Table 6:
Enrolment in school according to gender and school category

Category	Male	Female	Total
Provincial Boarding Boys	700		700
District Boarding Boys	1,124		1,124
District Boarding Girls		197	197
District Boarding Girls and Boys	729	511	1,240
District Mixed Day and Boarding Boys and Girls	129	137	266
District Mixed Day School Boys and Girls	1,924	1,380	3,304
Total	**4,606**	**2,225**	**6,831**

From table 6, the percentage enrolment for the males is 67.4% and that of females is 22.6%. This suggests that transition from primary school level to secondary school level is not even for boys and girls in the district. Another observation is that majority of the schools are the mixed day for boys and girls which suggests that they are relatively young in comparison to the other categories.

Question 1: - How is the availability of education inputs in the secondary schools in Nyandarua district?

Availability of physical schooling inputs

The study considered both the essential and auxiliary infrastructure that facilitates the teaching learning process. Essential infrastructure was the classrooms and the laboratories.

Classrooms

The study noted that schools had adequate classrooms both in the dimensions and the layout. The 32 schools representing 100% registered having adequate classrooms. However on salient aspects that should be exhibited by classrooms to facilitate effective teaching – learning process, the study considered ventilation and lighting as well as the organization of desks and chairs in the classrooms.

Table 7 summarizes the aspects of classrooms, among schools.

Table 7:
Aspects of the classrooms

Aspect	Frequency	Percentage
Good ventilation and lighting	27	84.38
Good organization of desks and chairs	22	68.75

From table 7, Majority of the schools, 84.38% have classrooms with adequate ventilation and lighting. Demonstration approach that is widely used in the teaching of science subjects requires that classrooms be well lit so that the various features and procedures involved in the process (of demonstration) are visible to all groups in the classroom set up. Moreover, the use of various teaching aids such as flow charts, diagrams and the maximum use of the chalkboard also require maximum visibility to all in the teaching learning process. Invisibility reduces the efficient use of time allocated for lesson delivery either by slowing the pace at which learners' grasp the concepts being demonstrated. Invisibility may also require that either the teacher or the students make unplanned movements during the teaching- learning process.

The study also found out that 68.75% of the schools had well-organized classrooms. Effective teaching learning process requires that the teacher

guides and supervises the progress of individual learners during the lesson. As a result, the teacher is involved in movements from one learner to another and from one group to another. This is facilitated by good organization of desks and chairs in the classrooms.

Availability of the laboratories

The central core of the teaching of science subjects is the availability of the laboratories. The study found out that there was no uniformity in the distribution of laboratories among schools. In the study 23 out of 32 schools representing 71.88 percent had laboratories. One conspicuous feature of the secondary schools science curriculum is the requirement that students must pursue at least two science subjects at the end of the four-year course. The Ministry of Education Science and Technology further made it mandatory in the year 2000 that all schools offer pure science to all the students except for the disabled at K.C.S.E. By this requirement availability of the laboratory facility became paramount for all the schools. However the study indicates that quite a good number of schools 9 out of 32 representing 28.12% do without the facility. The implication is that students from the schools without laboratories are disadvantaged during the end of course in the science practical papers due to limited exposure and experience to practical procedures and may end up performing poorly. Moreover, placement at tertiary level in the education system is highly influenced by performance in the key subjects of science and mathematics and thus the graduates from

these schools are disadvantaged and to most of them their career aspirations are put into disarray.

Further analysis found out that although 23 out of 32 schools had laboratory facility, it was not adequate to induce effective science curriculum delivery. It was only 3 out of the 23 schools representing 13% had a laboratory for each subject. Another 5 schools representing 21.7% had two laboratories either for Physics and Chemistry or for chemistry and biology. The rest 15 schools representing 66.3% had a multi – purpose laboratory that catered for all the science subjects. Table 8 summarizes the findings on the distribution of laboratories according to the number available.

Table 8:
Distribution of laboratories according to number

Number of laboratories	Frequency	Percentage
Three (specific per subject)	3	9.37
Two (Chemistry and Physics or Biology and Chemistry)	5	15.6
Multi – purpose (for all science subjects)	15	46.9
None	9	28.13
Total	**23**	**100**

From table 8, a scenario is depicted that suggests that most of the teaching approaches are teacher centered with limited individual or group practical work that is vital for inquiry discovery. Moreover, the study found that

schools are forced to adopt a policy on science subjects that limits on choice of the science subjects to be pursued by the students at form three and four.

Availability of laboratory equipments and apparatus

The study found out that availability of laboratory equipments and apparatus was not uniform among schools as presented in Table 9.

Table 9:
Availability of laboratory equipments and apparatus

Apparatus Equipments	Frequency	Percentage
Beakers	21	65.5
Bunsen Burners	11	34.38
Test tubes	16	50
Boiling tubes	14	43.75
Litmus Papers	19	59.38
Universal indicator	14	43.75
Pipettes	16	50
Measuring Scales and devices	9	28.13
Common Laboratory reagents	4	18.75

Table 9 reveals that schools are without adequate laboratory equipments and apparatus. Apparatus are a basic ingredient for effective science teaching. The existence of equipments and apparatus guarantees laboratory experience that ought to be an integral part of any science curriculum. This lack of

apparatus among schools agrees with the observation by Waweru (1978) that scanty apparatus was the biggest problem that hindered effective science teaching in Harambee schools. The study noted that while science subjects are compulsory for all candidates at Kenya certificate of Secondary Education (K.C.S.E) a significant number of schools do without the apparatus. Musoko (1983) had observed that a significant 50%, of schools in Nairobi province bought laboratory equipment near examination time and these same schools prepared their candidates for practical examination at the end of form four.

Although there was this scanty of the apparatus and equipments, interestingly schools do maneuver in the practical sessions. The study found out that the teachers in schools without apparatus and equipments adapt to the demanding environments by being innovative and especially during the national examinations where borrowing of apparatus and equipments from neighboring schools is not possible. The teacher innovativeness ranged from improvisation of oil lamps for heating sources to substitute the bunsen burners to that of improvising the universal indicator by the use of brown cabbage foliage.

On the general availability of the physical facilities the study found out that most schools are largely without adequate physical facilities. Table 10 provides an overview of the availability of physical facilities.

Table 10:

An overview of availability of physical facilities

Physical facility	Frequency	Percentage
Classrooms	32	100
Laboratories	23	71.88
Library	6	18.75
Preparation room	2	6.25
Water sources	14	43.75
Boarding facility	11	34.38
Play grounds	20	62.5

From table 10, it is evident that there is lack of physical facilities. While classrooms and laboratories are a necessary infrastructure in the overall teaching learning process others such as the library, water sources, the boarding facility and the playgrounds (open fields) are auxiliary infrastructure. The library by its very nature allows for discovery inquiry by engaging the learners to in depth learning due to variety of reading literature made available. Boarding facility affords more time to the students for the out of class activities such as assignments and homework. Moreover, the environment in the boarding schools allows for efficient sharing of various instructional or reference materials no matter how meagre they may be due to proximity among users. The study also found out that group activity such as

clubs in mathematics and other subjects thrived among schools with a boarding facility. During these group activities consultations and discussions run along and across the profile from the lower forms to higher forms. Interestingly, the study found out that schools with boarding facilities outshone all the others in science subjects as discussed under school effectiveness later in the chapter. An interesting feature of the secondary schools science syllabus is the permeability of the boundary between in-class and out-of-class learning activities. Fieldwork and excursion activities are a characteristic of the science syllabus on such key topics such as ecology in biology and also in physics for such topics like work and force, mass and weight among others. The existence of open fields facilitates these out of class activities that help to enrich learning. However, as revealed in table 4.7 there is lack of physical facilities that would enhance out of class activities. The implication is that for the majority of the schools, teaching strategies remain largely teacher centered and thus learners' active participation is inhibited. The consequence is that learners do not concretize abstract conceptions inherent in the cognitive domain of learning. Furthermore the availability of physical facilities determines the organization of teaching-learning activities as observed by Janaidu and Urwick (19913) that facilities like buildings, separate classrooms and students desks determine the very organization of teaching/learning activities and these factors do influence learner achievement.

Availability of human inputs

The study revealed that all schools had a good establishment of the teaching personnel in the science disciplines. According to the study all the schools are staffed with trained diploma and degree certificate graduates. The study further noted that majority of the schools had experienced teachers as in table 11.

Table 11:

A summary of distribution of teaching experience of teachers among schools

Teaching experience in years	Frequency	Percentage
0-5	5	15.63
6-10	18	56.25
11-15	8	25.0
16-20	1	3.12
Total	**32**	**100**

From table 11, majority of teachers have an experience of six years and above. This accounted for 84.37% of all the schools. The modal class of experience for the schools is an experience of 6-10 years which had 56.25%. The implication is that mastery of content among teachers is a widespread attribute and thus effective teaching is facilitated. This agrees with the review of thirty-two studies by (psacharapolous and Woodhall 1985) that trained

teachers do make a difference, and in particular that teacher qualifications, experience, and amount of education and knowledge are positively related to student achievement.

On the workload of the teaching force, the study revealed that 59.38% of the teachers had a workload of 20-24 lessons per week while the rest 40.62% had a workload of 25-29 lessons per week. Table 12 below gives a summary of workload distribution among teachers.

Table 12:

Distribution of workload per week among teachers

Workload (Lessons per week)	**Frequency**	**Percentage**
20-24	19	59.38
25-29	13	40.62
Total	**32**	**100**

The implication is that teachers do have a manageable workload and as a result they engage in thorough planning, choice and preparation of materials and in the choice of approaches/methods of lessons delivery, that are intricate to effective teaching.

The study noted that schools lacked the technical staff such as the librarians and laboratory technicians. Only 3 out of 32 schools representing 9.38% of all the schools had laboratory technicians and none of the schools had a librarian. As a result of this lack of the technical staff most of the practical work and out-of class activities was left on the hands of the teachers. Kelwon (1991) in Owitti (2003) noted that a laboratory assistant helps the science teachers to accomplish their laboratory lessons.

This limits the teacher and the students to engage in practical science methods of teaching namely demonstration, class experiments and project work. As a result guided discovery and inquiry teaching strategies that help to build a bridge between the realm of objects and observable properties on one hand, and the realm of ideas on the other; thus facilitating effective teaching are not facilitated.

Availability of material inputs

The study found out that there was no homogenous distribution of material inputs. According to the study, availability of recommended course books was 78.13%; availability of teacher guides was 25% while availability of models, charts and reference materials was 18.75%, 43.75% and 34.38% respectively. Table 13 summarises the distribution of material inputs among school.

Table 13:
Summary of material inputs among schools

Material Input	Frequency	Percentage
Course books	25	78.13
Teachers guide	8	25.0
Models	6	18.75
Charts	14	43.75
Reference Material	11	34.38

From table 13, it is observed that inequalities exist in the availability of material inputs. This agrees with Njeru and Orodho (2003) who observed that instructional materials especially textbooks, science equipment and reference materials quite crucial to students learning at Secondary level are at diversity of inequalities among Secondary Schools in Kenya. The implication is that extensive and in depth reading among students is not boosted among students, which inhibits mastery learning.

On textbook – student ratio the study revealed that most schools 52% had their ratio at 1:3 while 19.3% had a ratio of 1:2 and a ratio of 28:7% for other lower ratios. Table 14 gives a summary of textbook – student ratio among schools.

Table 14:
Textbook-student ratio

Text student ratio	Frequency	Percentage
1:2	6	19.3
1:3	17	52.0
Any other	9	28.7
Total	**32**	**100**

The implication is that teaching approaches remain largely teacher centred since varied assignments to meet individual requirements are not enhanced. Moreover it is through textbooks that a set of common reading experiences and questions to be answered are best presented to learners. Textbooks also help to organize and unify class instruction essential for effective teaching-learning process.

School preparedness for science curriculum

A concern of the study was to find out the extent to which schools were prepared to deliver the revised secondary schools science curriculum with due regard to the fact that the Ministry of Education made it mandatory for all K.C.S.E candidates to pursue pure science courses since the year 2000. It was found out that majority of the schools were not fully prepared as revealed in table 15.

Table 15:
School preparedness

State of preparedness	Frequency	Percentage
Well prepared	1	3.12
Fairly prepared	20	62.5
Poorly prepared	11	34.38
Total	**32**	**100**

From table 15, Majority of the schools 20 out of 32 representing 62.5 % indicated that they were fairly prepared and this combines with the 34.38% of the schools that were poorly prepared to account for 31 out of 32 schools representing 96.88% as the schools with incapacity to effectively match the curriculum requirements. This was attributed to inadequacy of equipments, chemicals and other essential facilities/inputs that help create conducive environment for the teaching and learning of the science subjects. As a consequence of this lack of preparedness the teaching of science subject was generally ineffective in most schools.

School effectiveness

Performance of candidates at the Kenya Certificate of secondary Education (K.C.S.E) was used as the measure of school effectiveness. The concern of the study being effectiveness in science subjects of mathematics, physics, chemistry and biology reviewed performance in the years 2001, 2002, and

2003. The number of students who attained a grade of D+ (Plus) and above in each of these subjects were enumerated for the period under review, the overall average for the students in these subjects was utilized as the effectiveness index for the schools and used for the analysis in the study. According to the study the following scores were obtained for the 32 schools involved in the study as shown in list 1.

List 1:
Scores in percentage representing the schools' effectiveness in science subjects

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89.15, 79.7,67.8, 66.35, 50, 47.18, 43.18, 39.7, 39.6, 37.15, 36.6, 35.2, 34.78, 34.1, 33.8, 30.1, 29.35, 24.7, 24.5, 22.8, 20.9, 19.3, 17.2, 16.6, 16.2, 14.9, 9.5, 9.5, 6.25, 03, 0 and 0.

From the scores, the study noted that effectiveness in the science subjects varied greatly from school to school. Only 5 schools out of the 32 schools representing 15.6 percent had effectiveness of fifty (50) percent and above. This implies that more than half of the candidates in 27 out of 32 schools representing 84.4 percent do not manage a pass grade at K.C.S.E. Further analysis reveals that the average effectiveness score stands at 31.27% which implies that majority of the students 68.73% in the schools fail in science subjects. The point here is that something is wrong with curriculum implementation given that a big percentage of candidates flunk in mathematics and sciences, which are vital for placement in higher education,

training and employment. This leads to the consideration of the second research question.

Question 2: - What is the effect of the available physical education inputs on school effectiveness in the teaching of science subjects?

A concern of the study was the effect of the available physical schooling inputs on school effectiveness in the teaching of science subjects.

Laboratory and effectiveness

Laboratory as an essential infrastructure in the teaching of science subjects was considered alongside effectiveness. According to the study 23 schools had laboratories. The effectiveness score for these schools with a laboratory was found to be 38.69%, which was higher than the average effectiveness score of 31.27% for the schools involved in the study. Moreover, effectiveness was higher for the schools with laboratories (specific for each subject), which was 67.77% while for schools with two laboratories had an effectiveness score of 54.38%. This implies that schools with laboratories are more effective in the teaching of science subjects.

Boarding facility and effectiveness

The boarding facility than any other infrastructure was found to boost effectiveness in the teaching of science subjects. 12 out of 32 schools had a boarding facility and according to the study, the effectiveness score was

47.12%. The implication is that boarding facility facilitates the teaching of science subjects by either allowing for more time for the out-of-class activities such as group discussions and the completion of assignments and homework or by giving extra time to teachers for experimentation and practical work with students.

The overall effect of physical schooling inputs on effectiveness

The study investigated the effect of education inputs on school effectiveness in the science subjects. According to the study, all the items in the data collection instruments related to adequacy of the physical, material and human education inputs were considered and awarded marks on an interval scale in percentage, items that indicated adequacy scored one mark while those indicating inadequacy scored a zero. Three sets of data were obtained related to availability of the schooling inputs in the realms of the physical, human and the material inputs.

The scores on availability of the physical schooling inputs and effectiveness are shown in table 16.

Table 16:

Availability of physical facilities / inputs and percentage effectiveness of schools

Availability score in percentage	Frequency	percentage	Average percentage effectiveness
83.3	5	15.6	45.2
67.7	7	21.87	42.1
50	11	34.38	26.55
33.3	9	28.15	20.9
Total	**32**	**100**	

From table 16, the higher the availability of the physical schooling inputs the greater the effectiveness in the teaching of science subjects. Compared to the overall percentage effectiveness of 31.27%, schools with availability index of 83.3% and 67.7% of the physical facilities have got a percentage effectiveness of 45.2% and 42.1%, which are higher. Those schools with lower percentage availability have their average percentage effectiveness being less than the overall percentage effectiveness.

The Pearson correlation coefficient between availability of physical facilities and school effectiveness in science subjects is presented in table 17.

Table 17:

Pearson Correlation Coefficient for Physical Facilities and School Effectiveness in Science Subjects

Availability & effectiveness Scores / Statistical measure	Availability Scores X	Effectiveness Scores Y
Mean	54.1	31.27
$\sum X^2$	9453.19	
$\sum Y^2$		14944.05
$\sum XY$	5134.88	
Pearson Correlation Coefficient	0.43	

A Pearson correlation coefficient of 0.43 was found between the available physical schooling inputs and effectiveness in the teaching of science subjects. The implication is that a positive relationship is exhibited between physical facilities and school effectiveness. The third research question related to the human schooling inputs and was: -

Question 3: - What is the effect of the available human schooling inputs on school effectiveness in the teaching of science subjects?

The study focused on the effect of various characteristics of the human inputs that impacted on performance in the science subjects. One such characteristic

was the effect of teachers teaching experience in years. Table 18 shows the distribution of the teaching experience in years among schools and the corresponding percentage average effectiveness.

Table 18:

Teaching experience and effectiveness

Experience in years	Frequency	percentage	Average percentage effectiveness
0-5	5	15.63	33.08
6-10	19	59.38	31.91
11-15	8	24.99	27.38
Total	**32**	**100**	

From table 18, teaching experience has positive affect on schooling effectiveness. The schools whose majority of the teaching force had 0-5 years of experience in the study had the highest effectiveness index of 33.08%. the schools with 6-10 years and 11-15 years had effectiveness index at 31.91% and 27.38% respectively.

This suggests that more years of experience do not necessarily lead to more effectiveness. However, the findings are justified on grounds that a teaching force with an experience of 0-5 years are newly employed graduates who are enthusiastic in their duty performance due to the intrinsic motivation of getting employed. The study also noted that by the very nature of the bracket

of the years of teaching experience the 0-5 years and 6-10 years are products of the current system of education. This implies that having gone through the system, they enter the field of teaching fully equipped with skills that facilitate effective teaching- learning process.

The workload of the teaching force was also considered and how it affects effectiveness. The study found out that as workload decreases, effectiveness in science subjects increased as revealed in table 19.

Table 19:

Workload and effectiveness

Workload (Lessons Per Week)	**Frequency**	**percentage**	**percentage Average effectiveness**
20-24	19	59.38	30.1
25-29	13	40.62	29.33
Total	**32**	**100**	

Student – Teacher Ratio and Effectiveness

Table 20 shows the student- teacher ratio and effectiveness.

Table 20:

Student –Teacher Ratio and Effectiveness

Ratio	Frequency	Percentage	Percentage Average Effectiveness
30:1 and below	12	37.5	21.0
31:1- 40:1	13	40.63	32.64
41:1- 50:1	4	12.5	33.46
51:1 and above	3	9.37	71.28
Total	**32**	**100**	

From table 20, the implication is that lower student – teacher ratio does not necessary lead to more effectiveness. The study found out that school with higher ratios are the boarding type and thus the comparative advantages of the boarding facility offsets any adverse effects of large student- teacher ratio.

The overall effect of Human Inputs on Effectiveness

Data on availability of human inputs and corresponding average effectiveness is shown in table 21.

Table 21:
Availability of human inputs and effectiveness in science subjects

Availability Score	Frequency	Percentage	Average Percentage Effectiveness
83.3	7	21.87	45.37
66.7	7	21.87	37.06
50	7	21.87	30.2
33.3	11	31.25	22.72
Total	**32**	**100**	

From table 21, schools with more of the available human inputs have higher scores on effectiveness. The implication is that effectiveness in science subjects increases with increasing availability of human inputs.

The Pearson correlation coefficient between human inputs and school effectiveness is shown in table 22.

Table 22:
Pearson Correlation Coefficient between Human Inputs and Effectiveness

Availability & effectiveness Scores / Statistical measure	Availability Scores X	Effectiveness Scores Y
Mean	55.2	31.27
$\sum X^2$	11918.01	
$\sum Y^2$		14944.05
$\sum XY$	4726.48	
Pearson Correlation Coefficient	0.35	

From table 22, a Pearson Correlation Coefficient of 0.35 exists between the available schooling human inputs and effectiveness in science subjects. Therefore human inputs have a positive effect on school effectiveness in teaching of the science subjects.

Question 4: - what is the effect of the available material inputs on school effectiveness in the teaching of science subjects?

Table 23 represents the data on availability of material inputs and the corresponding percentage effectiveness of schools.

Table 23:
Availability of material inputs and percentage effectiveness in science subjects

Availability Score	Frequency	Percentage	Average Percentage effectiveness
83.3	4	12.5	60
66.7	5	15.6	50.57
50	7	21.88	25.7
33.3	16	50	20.47

From table 23, material inputs have a significant contribution to school effectiveness. In the teaching of science subjects. The implication is that as material inputs increase, there is a corresponding increase in school effectiveness in the teaching of science subjects.

The Pearson Correlation Coefficient between the material inputs and school effectiveness in the teaching of science subjects is shown in table 24

Table 24:
Pearson Correlation Coefficient between the material inputs and school effectiveness

Availability & effectiveness Scores / Statistical measure	Availability Scores X	Effectiveness Scores Y
Mean	48.4	31.27
$\sum X^2$	6826.58	
$\sum Y^2$		14944.05
$\sum XY$	6451.36	
Pearson Correlation Coefficient	0.64	

From table 24, a Pearson Correlation Coefficient of 0.64 links the available material inputs and school effectiveness in the teaching of science subjects. Therefore, material inputs have a positive effect on school effectiveness in the teaching of science subjects.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The study was set up to assess the impact of the availability of education inputs on the school effectiveness in the teaching of science subjects in the public secondary schools in Nyandarua District. Science education has been recognized as an important component in the Kenya society for being attributed in helping to meet the needs of the expanding Kenyan economy in various ways. Koech report (1999) identifies science and mathematics education as the vehicles to industrialization. Towards this end, education stakeholders continue to invest heavily in education of young Kenyans year in year out with hope that the inputs would be equivalent to the outputs if not better. However, the performance continues to be poor in general and of great concern has been the learners' performance in mathematics and science subjects. Concern therefore has been on factors that contribute to school effectiveness and thus the undertaking of this study.

To generate information that would facilitate the study, four objectives were formulated. The first objective was to determine the availability of education inputs in the public secondary schools. The second objective

was geared towards the effect of the physical facilities on the school effectiveness in the teaching of science subjects. The third objective sought to explore the effect of the human characteristics on school effectiveness while the fourth objective dealt with the effect of material schooling inputs on the school effectiveness in the teaching of science subjects. To meet these objectives the study was guided by four research questions; namely: -

- How is the availability of schooling inputs among the public secondary schools?
- What is the relationship between availability of physical facilities and school effectiveness in the teaching of science subjects?
- What is the relationship between availability of human schooling inputs and school effectiveness in the teaching of science subjects?
- What is the relationship between learning materials and school effectiveness in the teaching of science subjects?

Literature review focused on aims of science education, methods of science teaching, inputs in education and empirical literature on schooling inputs and school effectiveness. The purpose of the literature review was to guide the collection of data that was pertinent to the study being undertaken. The study was conducted in the public secondary schools in Nyandarua District. The target population was the heads of science and

mathematics department in the public secondary schools. The study involved 32 schools out of the 87 public secondary schools in the district. The 32 schools were randomly selected in terms of the six administrative divisions. Five schools randomly selected from Ndaragwa division were used in the pilot study.

Being a descriptive case study, data was collected by the use of questionnaire and an observation schedule for the physical facilities. The data collected was coded, tabulated and then analyzed in the light of the objectives and the research questions of the study. Interpretation and discussion was made following the analysis of the data for each of the objective.

According to the study availability of the schooling inputs was not uniform among the majority of the schools and most schools were not effective in the teaching of science subjects.

According to the analysis 15.6% of the schools had adequate physical facilities. These schools were rated to have an availability score of 83.3% another 21.87% of the schools were rated to have an availability score of 66.7%. Other schools 34.38% and 27.73% were rated to have an availability score of 50% and 33.3% respectively. Among the specific physical facilities that were found to be lacking among most of the schools were the laboratories where only 71.88% of the schools had laboratories and out of which only 13% had a laboratory for each subject

while 21.7% had laboratories for any two of the science subjects and the rest 65% had a multi purpose laboratory. The analysis also found out that most schools do not have laboratory equipments and apparatus. The study revealed that only 18.75% of the schools had a library while only 6.25% had a preparation room. However, the study found out that 100% of the school had classrooms although in the adequacy of ventilation and lighting it was only 84.38% of the schools that met this specification. Further more on good organization of desks and chairs only 68.75% of the schools had their classrooms meeting this specification.

A good establishment of the teaching personnel in the science disciplines was noted among the schools. According to the analysis 100% of the schools were staffed with Diploma and degree certificate graduates. The analysis also found out that the teaching experience for most of the schools was between 6-10years, which accounted for 59.38% while the 0-5 and 11-15years was represented by 15.63% and 25% respectively. The study also found out that the distribution of workload among the teachers was 20-24 and 25-29 lessons per week and represented by 59.38% and 40.62%.

Availability of material inputs was noted to vary among schools. The availability was as follows: - course books 78.13%, teacher guides in the 25%, models 18.65%, charts 43.75% and reference materials 34.38%. The most prevalent student textbook ratio of 1:3 represented by 52% of the

schools. The 1:2 ratio and other lower ratios were represented by 19.3% and 28.7%.

The study also found that most schools are not adequately prepared for the science curriculum. Only 3.12% were well prepared while 62.5% and 34.38% were fairly prepared and poorly prepared respectively. The study noted that the lack of preparedness was due to inadequate availability of equipments and chemicals and other facilities necessary for science teaching. The study also found that most schools 84.4% were not effective in the teaching of science subjects since majority of their students do not make a pass in the science subjects at the K.C.S.E.

The availability of school inputs was found to influence effectiveness of schools in the teaching of science subjects. The study found out that the higher the availability of education inputs is the greater the effectiveness in the teaching of science subjects. The schools with availability score of 83.3% of the physical, human and material inputs had an average effectiveness of 50.19% while those with an availability score of 66.7% had an average effectiveness of 43.24% and those with 50% and 33.3% availability score had an average effectiveness score of 27.48% and 21.36%. Facilities that were found to have a strong influence on effectiveness were the boarding facility and laboratories. Teaching experience and amount of workload were the key variables in the realm of

the human inputs that positively contributed to effectiveness in the teaching of science subjects.

The Pearson Correlation coefficient between availability of inputs and effectiveness in the science subjects indicated that a positive relationship exists between education inputs and schooling effectiveness in the teaching of science subjects. According to the study, the Pearson Correlation coefficient for the physical, human and material inputs with respect to the school effectiveness in the teaching of science subject was 0.43, 0.35 and 0.64 respectively.

Conclusions

Based on the findings of the study, it was concluded that school effectiveness in the teaching of science subjects increases with increasing availability of education inputs. However, no single set of education inputs could be attributed to causing great or less effectiveness in the teaching of the science subjects but is all an interwoven network of interaction of all the sets contributing to effectiveness.

The findings of the study have also led to the conclusion that there is inadequate availability of the education inputs in most of the schools and as a consequence, schools have not been effective in the teaching of the science subjects.

The findings further led to the conclusion that while education inputs are a necessity to school effectiveness in the teaching of science subjects they are not the sufficient condition to effectiveness but rather that school effectiveness in teaching science subjects goes further than availability of education inputs to involve other factors in dynamic interaction in the school environment to lead or predict school effectiveness.

Recommendations

Recommendations emanating from the study were that: -

- There is need for the ministry of education to develop and adopt a policy on the provision of education inputs to secondary schools to ensure that schools are at an equal footing not only on the availability but also on quality of the education inputs.
- The various stakeholders in the education sector should be sensitized on the need to provide the schools with the facilities that help increase the effectiveness of schools in the teaching of science subjects.
- The Kenya National examination council should liaise with the secondary schools management boards on the procurement of the equipments that are central to the secondary schools science practical examinations.

Suggestions for further Research

The following suggestions have been made for further research: -

- Research be carried out on school environment factors that lead to school effectiveness in the teaching of science subjects.
- A research be conducted on the impact of the availability of education inputs on the effective teaching of science subjects in the day public secondary schools.
- A research be conducted on the impact of the availability of education inputs on students attainment in the social sciences.
- A research be conducted on school effectiveness in the teaching of science subject on either the girl child or the boy child.
- A research be carried out on school effectiveness in the teaching of science subjects using a larger sample.

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APPENDIX A

LETTER TO THE RESPONDENTS

Mutitu I. Mwangi
University of Nairobi
Department of Educational
Administration and Planning
P.O. Box 92
Kikuyu.

Date .....

Dear Respondent,

RE: THE IMPACT OF THE AVAILABILITY OF EDUCATION INPUTS ON SCHOOL EFFECTIVENESS IN TEACHING SCIENCE SUBJECTS IN PUBLIC SECONDARY SCHOOLS IN NYANDARUA DISTRICT

I am a postgraduate of the University of Nairobi, pursuing masters of Education in Educational Administration and Planning. I am conducting a study on the above stated topic in Nyandarua District. I hereby request that you respond to the questionnaire items as honestly as possible and to the best of your knowledge.

The questionnaires are designed for this research proposal only and therefore the responses shall be absolutely confidential.

Thanks for your participation and cooperation.

Yours sincerely,-

MUTITU I. MWANGI.

APPENDIX B

THE HEAD OF SCIENCE DEPARTMENT QUESTIONNAIRE

This questionnaire is meant to collect information for the purpose of research only.

Please note that information given here in shall be treated with confidentiality.

Do not indicate your name or the name of your school.

Section 1

Demographic Information

1. Indicate your school type

   Provincial boarding boys ☐

   Provincial boarding girls ☐

   Provincial boarding mixed Boys and girls ☐

   District boarding mixed Boys & girls ☐

   District boarding boys/girls ☐

   Day

   Any other specify_____

2. Indicate the number of streams in your school

   1 [ ] 2 [ ] 3 [ ] 4 [ ]

3. Indicate the total enrollment of students in your school.

   Boys _____

   Girls _____

   Total _____

4 (a) In the table below show the number of students who sat for K.C.S.E. in physics, biology, chemistry and mathematics in the respective years.

Subject	Years		
	2001	2002	2003
Physics			
Biology			
Chemistry			
Mathematics			

4 (b) Complete the table below by filling in the number of students who scored grades D+ and above for the years 2001, 2002 and 2003 in the respective subjects.

Subject	2001	2002	2003
Physics			
Biology			
Chemistry			
Mathematics			

Section II

5. (a) How many Science and Mathematics teachers do you have in your school?_____

(b) How many are trained in Sciences and Mathematics (specify) Diploma holders _____ Graduates_____

(c) Please indicate the number of teachers with the following subject combination.

Subject combination	Number of teachers
Mathematics/physics	
Mathematics/Chemistry	
Physics/ Chemistry	
Biology/ chemistry	
Biology/ Agriculture	
Any other specify	

6. On average, what is the number of lessons per teacher per week in your department?

   (a) 30 and above [ ]

   (b) 25-29 [ ]

   (c) 20-24 [ ]

   (d) Less than 20 [ ]

7. On average, what is the teaching experience in years for majority of the teachers in your department.

   0-5 [ ] 6-10 [ ] 1-15 [ ] 16-20 [ ] over 20 [ ]

8. What is the student / teacher ratio in the school for the science and mathematics.

9. What is the total number of classrooms available _____

10. Indicate the average number of students per class?

    10-19 [ ] 20-25 [ ] 26-30 [ ] 31-35 [ ] 36-40 [ ] over 41 [ ]

11. How many laboratories are in your school? (specify number)

    (a) More than one for each subject _____

    (b) One for both Physics and chemistry /Biology _____

    (c) One for all subjects

    (d) None

12. How is the adequacy of the following provisions?

Item	Adequate	Not adequate	Not available
Water			
Electricity			
Preparation room/store			
Botanical garden			
Apparatus			
Stools			
Fish Ponds			
Benches			
Common Laboratory reagents.			

13. Indicate on average the size of groups during class experiments

    1-2

    2-3

    3-4

    4-6

    More than 6

14. (a) Is there a laboratory assistant or technician in your school?

    Yes ____ no ____

    (b) How many are they? And what is their level of training

    Number = _____

    Level of training:

    (i) Certificate

    (ii) Diploma

    (iii) Any other specify

15. For the science topics in 8-4-4 syllabus requiring the teaching of the concepts using the experiment method of teaching; how well equipped is your school?

(a) Well equipped [ ] (b) fairly equipped [ ] (c) poorly equipped [ ]

16. Does your school have enough textbooks and materials for the following subjects?

1) Mathematics	yes	[ ]	no	[ ]
2) Physics	yes	[ ]	no	[ ]
3) Chemistry	yes	[ ]	no	[ ]
4) Biology	yes	[ ]	no	[ ]

17. Indicate for the different forms the extent to which to issue of textbooks to pupils is adequate.

Form	adequate	inadequate
1.	[ ]	[ ]
2.	[ ]	[ ]
3.	[ ]	[ ]
4.	[ ]	[ ]

For all the forms what is the student –textbook ratio for each of the following subjects.

18.

Physics	1: 2	[ ]	1:3	[ ]	1:4	[ ]	Any other specify
Mathematics	1: 2	[ ]	1:3	[ ]	1:4	[ ]	Any other specify
Biology	1: 2	[ ]	1:3	[ ]	1:4	[ ]	Any other specify
Chemistry	1: 2	[ ]	1:3	[ ]	1:4	[ ]	Any other specify

19. (a) is there a library in the school?

Yes _____ No _____

(b) If your response in19 (a) is yes which of the following is true. Tick as many as appropriate as they apply to your school.

(i) A main library exists for all subjects and managed by a qualified Librarian. [ ]

(ii) Each form has a class library [ ]

(iii) Each subject has its own library [ ]

20. The table below shows some necessary items that facilitate the teaching of sciences and Mathematics. Tick as appropriate

Item	Available	Adequate	Inadequate	Not available
Teachers guide				
Models				
Charts				
Projector				
Bunsen burners				
Microscopes				
Beakers				
Test Tubes				
Boiling Tubes				
Litmus Papers				
Pipettes				
Measuring Scales				
Weighing Balances				
Measuring cylinders				
Common Laboratory reagents				

Appendix C

Observation schedule of the physics facilities and resources in public secondary schools in Nyandarua District, Central province, Kenya.

1. **Availability of physical facilities**

Facilities	Available	Adequate	Inadequate	Not available	Total
Laboratory					
Classroom					
Dormitories					
Water Sources					
Ablution					
Playgrounds					

2. How spacious are the science laboratories and classrooms?

   (a) Very spacious ( ) (b) Spacious ( ) (c) congested ( )

3. Are the dormitories and classes clean

   Yes ( ) No ( )

4. How is the ablution block?

   Standard ( ) average ( ) substandard ( )

5. Size of dining hall in relation to number of student enrolments

   (a) Spacious ( ) (b) small ( ) (c) to small ( )