Using GIS in Mapping and Evaluating the High School Infrastructure in Readiness for the Implementation of the New Curriculum. Case Study: Ugunja Sub-County, Siaya County.

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I dedicate this project to all my family members for the encouragement, support and love throughout the long period that it has taken for the completion of this task.
ACKNOWLEDGEMENT

I wish to thank all who contributed in any way towards the completion of this project. My sincere gratitude goes to my supervisor Dr. Siriba for walking with me throughout this journey and the confidence he has shown in me. All my friends who supported offered support both materially and emotionally will always be part of this success. Sincere gratitude to my friend Kimeli Noah for all the encouragement I received. Above all, I thank the ALMIGHTY for His grace and health throughout the study.
ABSTRACT

The Ministry of Education has intended to introduce a competency-based curriculum from the onset of 2018. This will be gradually carried out from the primary school level to senior school. However, the studies that have been carried out have been on application of GIS in education planning but there has been no much study to evaluate the infrastructural readiness for the schools in Ugunja sub-county to assess their readiness to implement the new competency based curriculum. The research has considered prerequisite infrastructure such as class size, computer laboratories and quality indicators like student teacher ratio and teachers ICT skill set for implementation of the new curriculum in this area. Some of the methods employed included desktop study, questionnaire surveys, and the application of Geographical Information System (GIS) to collect the spatial and attribute data. The results have shown that none of the schools is ready to implement the new curriculum but those with the ratings of 2 and 3 can be improved for successful rolling out of the STEM pathway of this curriculum, while those with the ratings of 1 designed for the remaining Social sciences, Art and Sports.
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CHAPTER 1: INTRODUCTION

1.1 Background Information

Every organization needs to comprehensively and transparently plan and resolve the decision-making process in their businesses. Fundamentally, they require a knowledge management strategy to make critical decisions efficiently. Timely and well-thought decisions are requisite for the success of any organization. Educational institutions, like any other organization, are pressed with the laborious task of ensuring they conform to the high standards of quality education system and management. The decision-making process in these institutions forms such vital aspects of the efficient management process and must be considered in high regard.

A universal definition of education is a process through which knowledge and skills are imparted to individuals with the aim of integrating such persons within the society or radically changing their cultural ways within the society UNESCO (1997). However, educational institutions in Ugunja sub-county and the country at large have found it challenging to provide educational services that meets the societal needs and demands of the job market. The sector is therefore faced with recurring challenges that hinder the provision of quality and efficient education system. Coupled with a decision to introduce the new curriculum in both primary and secondary schools in the country, educators could not face the challenge in a worse way than it is already. This situation has necessitated the establishment of a Decision Support System to help in the mapping of secondary schools in this area to provide the requisite information in form of the available infrastructure to aid in the transformation of the education system.

A decision support system refers to computerized information systems that aid organizations and businesses in decision-making. GIS technology can be viewed in this prism as it involves collection, organization, processing and explicitly showing solutions based on the
data. GIS has been used as a knowledge driven DSS to provide management advice or service to education sector in optimal location of education facilities and routing of school transport.

1.2 Problem Statement

The Government of the Republic of Kenya (GoK) through the Ministry of Education has designed a new curriculum (2-6-3-3-3) to replace the soon-to-be phased out 8-4-4 system. Subsequently, the Ministry of Education has been tasked with a systematic introduction and roll out of this new curriculum in both primary and secondary schools within the republic. Given the competency based nature of this curriculum, it would be prudent carryout an inventory of the infrastructure in secondary schools to assess their readiness for implementation of the new curriculum.

Additionally, this research provides the statistical analysis of data to give descriptive information on both the exact location of these schools in terms of their real coordinates and non-spatial information in terms of the number of teachers, students, overall enrollment, and examination results among others. However, the challenge that comes with handling comprehensive data is that such an exercise needs the expertise on data processing beyond average or ordinary skills in order to integrate the different sets of data and map the same a platform where ministry officials can tap such critical information. Doing so will help in determining the areas with the shortage of necessary facilities, resources, and personnel such as teachers. Studies have been done on the application on GIS in education planning in Kenya. Key among them was by Mulaku and Nyadimo (2011), mapped all learning institutions across all levels. However, the education sector in Kenya changes rapidly in terms of establishment of new schools and the new constitution has created new administrative units. The proposed competency
based curriculum presents a new challenge in terms of the new infrastructural requirement, hitherto, never existed. To this end, a solution that offers advanced data visualization and management focusing on specific area of interest is required, and this exactly what this particular research aims to achieve.

1.3 Objectives

1.3.1 Main Objective

To establish and map the infrastructural requirements for high schools in Ugunja district and evaluate their readiness in support of the new curriculum using Geographic Information System (GIS).

1.3.2 Specific Objectives

1) To find out infrastructural requirements for schools in support of the new curriculum.

2) To map the infrastructure of high schools in support of the new curriculum.

3) To evaluate the readiness of these schools in support of the new curriculum.

1.4 Justification for the Study

First and foremost, the study proposed in this paper is necessary since it is timely. Specifically, the major research that exists in the country on the application of GIS in education sector have not tackled the issue on infrastructural assessment of schools to evaluate their readiness for the implementation competency based curriculum. No research has also been tailor made to cover the high schools in Ugunja sub-county in light of the proposed new changes in curriculum and the administrative units. Secondly, GIS will be used as a knowledge driven DSS as this would target a broad range of consumers of this information within the education sector. This will essentially provide management advice on the best way to implement the new curriculum. Finally, this study is universal. Both the methodologies and conclusions of this study
can be applied to other areas of the country, and the overall effect will be an improvement in the educational system in Kenya. Further studies will also be recommended on the same line of research which would further boost the field of education.

1.5 Scope of the Work

The scope of this study will be to evaluate the infrastructural readiness of schools in the Ugunja sub-county to roll out a competency-based curriculum. This shall include the study of human capital to determine whether they have the set of skills to implement the curriculum. The study will only consider the public high schools. Analysis of the data obtained will help in determining whether the educational facilities and resources available make them ready for implementation of the new curriculum.
CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter dwells on some of the previous studies on the topic of GIS and its application as a decision support system for mapping a given location. The literature studied will be on the evolution of GIS and the general principles of its usage, especially when it comes to the mapping of schools, school-related facilities, and resources in an enclosed geographical area.

2.2 Definitions

Many definitions exist for the Geographical Information System. Maguire (1991) defines GIS as a computerized system that allows for storage, retrieval, analysis, manipulation and display of geographically referenced data. This understanding implies that GIS is a combination of a database system with unique capabilities for spatially referenced data, as well as a procedural instruction for working with those data.

2.2.1 History of GIS

GIS has existed from as early as the 1960s, at least according to Boonstra (2013), with its roots in Canada. It was initially used in data structuring, scanning, developing layers and performing overlay calculations on land resources. During the same period, the United States Census department developed a digital enumeration platform which was used in the census process. The Census department also produced a geo-coding which was used for address matching in commercial areas. Currently, GIS has evolved to find its applications in government, business, and educational issues.

2.2.2 Components of GIS

Five components make up a GIS. Each of these is integral parts of the system and are discussed hereafter.
2.2.2.1 Hardware

The GIS hardware is made up of the technical equipment and the devices required to aid in the various activities of GIS such as data collection, data analysis, and so on. A computer system is part of this hardware and is responsible for providing such things as enough power to run the associated software, a storage system for the vast amount of data involved and the input-output devices like digitizers, media disks, scanners, GPS data loggers and printers (Sui & Chen, 2009).

2.2.2.2 Software

Different software packages exist for GIS. They include ArcCadastre, MapInfo and most commonly, ArcGIS. Regardless of the type, the packages must be capable of all the data processing procedures such as data input, storage, management, transformation, analysis and ultimately output (Steiniger & Weibel, 2009). There are also extensions or add-ons for extending how the software can be used.

2.2.2.3 Data

Chang (2015) explains that data is an integral part of any GIS application. The data quality must be highly considered because any erroneous data can lead to multiple unpleasant and costly hours in the implementation of the GIS application and the results and analysis may be wrong. There are three categories of geographical data used in the GIS analysis. The first data category is the map data which contains the shape and location of the geographical features. Points, lines, and areas are used as the shapes to represent real-world features. The other data category is the Tabular or Attribute data. GIS uses these descriptive data to link to map features. These tabular data are collected and compiled to be used in specific places like states and cities. After compilation, the attributes are obtained and then added to the map. The last category is
called image data, and it includes aerial photographs and satellite images. Image data are efficient in obtaining spatial data when the area of consideration is large. It is more efficient and cost-effective than collecting data layers like roads, buildings, lakes, and so on, ones at a time.

In a GIS, there is an abstract representation of the geographic data used. Three data types are used to represent the spatial components of these geographical data. The data types are points, lines, and areas. The spatial data can be represented in a GIS in the following two ways:

i) **Raster data model**

This model is an abstract of the real world whereby the basic data unit, which can be points, lines or areas, is represented by using a grid cell identifiable by rows and columns (Chang, 2015).

![Raster Data Model](image)

*Figure 1: Raster Data Model*

As illustrated in figure 1 above, the simplest form of a raster data model is a cell which holds a value for the element. A cell which does not have a feature is assigned a value of zero. In more elaborate systems, the cell value contains a link to the records as an attribute.
ii) **Vector data model**

In the vector data model, the features are represented in coordinate form. The data units, which can be points, lines, or areas, are composed of one or more coordinate points. A line, for instance, can be a collection of related points and an area can be a collection of related lines. Figure 2 below illustrates the difference the two data models.

![Vector and Raster Data Model](image)

*Figure 2: Raster and Vector Data Model*

### 2.2.2.4 Web Mapping

Web mapping is a recent technology introduced in the GIS field to ensure maps and geo-information are availed to remote users through a web page. Two types of web mapping applications exist. They are called static and interactive maps.

i) **Static Maps** are displayed in form of an image in a web page. They are common because any scanned map document can be added to a web page and be referred to as a static map (Krygier & Wood, 2016).
ii) **Interactive Maps** are uncommon because they require skilled personnel to keep the web sites running. A user of an interactive map can use the different map layers to view or zoom.

### 2.3 The Use of GIS as an Educational Decision Support System

#### 2.3.1 Overview

As stated before under the introduction section, the process of making decisions in any business or organization needs planning as well as being resolved in a comprehensive yet transparent, reliable, and predictable manner. In fact, quality and timely decision-making have proven to be one of the most regarded fundamental aspects any successful organization. Interestingly, to sufficiently inform and dictate the decision process, one would need the relevant decision support tools to be implemented appropriately. Educational institutions and the associated governing bodies, just like organizations and other businesses, have been lately faced with the increasing desire to improve both the management and quality of the education system and learning process. As a result, the management of both primary and secondary schools, especially at the national level tend to do the following. Firstly, they use more sophisticated information and data. Secondly, they invest more financial and human resources in some of the tools and systems that enable data collection direct management of information. Finally, they involve all other stakeholders such as students, teaching staff, and the respective local communities in the process of decision-making.

#### 2.3.2 The proposed new curriculum

Curriculum has been defined as the sum total of learning experiences presented to a learner that is planned, organized and constructed for that end (Education Act, Cap. 211) (MoE, 2012b). Vision 2030 is a national long-term economic development plan for propelling the republic into middle-income nation. Education was seen as means of achieving this goal by
producing learners capable of raising Kenya’s international competitiveness (Kivati, 2015). The Ministry of Education appointed a task force in 2011 to review and align education and training in accordance with the Constitution 2010 and Kenya Vision 2030 (Kivati, 2015). The recommended education structure is 2-6-6-3; a departure from 8.4.4. The structure consists of 2 years in pre-primary, 6 years of primary, 6 years secondary and a minimum of three years in university (MoE 2012a, b9 (MoE, 2012).

2.3.3 The Secondary structure

Secondary education as proposed will take a duration of 6 years; 3 years of junior secondary and a further 3 in senior school.

(a) Junior Secondary Education
This will be the middle school education for the age brackets of 12 and 14 years. The transferable skills developed at primary school level are enhanced here. The four main learning streams are general education, talent, technical and vocational. The learner will be at liberty to make any choice depending on interest and advice from other stakeholders. Education at this level will emphasize technology, talent identification, moral and attitudinal skills beside academics (GOK, 2015).

(b) Senior Secondary
The schools in this category will be specialized institutions for learners to focus on areas of their interest and work with the streams similar to the ones in the previous stage. The focus of Technical stream will be technical subjects leading to technological degree courses. However, all streams will have same core skills of communication, moral and attitudinal, language, science and technological skills.

2.3.4 GIS and School Mapping

Employment of GIS as a school mapping technique serves as one of the significant sources of Educational Decision Support System (EDSS). The digital mapping techniques in the form of spatial and social coverage will be an essential method of solving some of the challenges brought
by the introduction of the new curriculum. In particular, GIS technology offers vital tools that assist institutions, learners, educators, and even the society in general to give answers to questions that have been designed spatially. The overall trend in the present field of geography is that more institutions continue to include GIS in their lessons to enable both their students and staff to acquire technical skills necessary to handle geographical challenges that are both local and global. Additionally, the application of GIS as a school mapping technique is helpful in planning because it covers a wide range of educational management and planning issues. The mapping technique is used efficiently in revealing the distribution of schools in a given area, information which can be utilized for organizing and planning purposes. Therefore, while rolling out this new curriculum in Kenya, administrators at the ministry of education will inevitably turn to GIS to help them with the management of educational facilities, routing of vehicles, mapping of boundaries, facilitation of safety and preparedness among others.

GIS is a database where most of the data involved are spatially indexed, and specific procedures are invoked to generate the relevant queries about the said database. In other words, it is a decision support system that integrates spatially referenced data to be used in solving real-life problems. The school mapping procedure that this project particularly intends to carry out involves the physical location of the secondary schools. The information received from the spatial analyses allows for easy decision-making processes to be achieved. The distribution of schools is an essential aspect of school planning because it will help determine the areas that are overpopulated with students or regions short of enough teachers. This information will be used to help in the full realization of the objectives of the new curriculum as proposed by the Ministry of Education.
The mapping of schools entails analyses of their physical locations. For this exercise to be possible, one would require an understanding of both the population and settlement patterns within the area under consideration. Fundamentally, analysis of the region’s accessibility is based on the environmental attributes such as houses, roads as well as other infrastructural layers. Hite (2008) asserts that both spatial and accessibility analyses facilitate the making of quick and easy decisions.

The use of GIS in the mapping of schools is a common term in the context of educational planning. It primarily entails a wider aspect of planning and management concerns in the education sector. Essentially, it relates to various functions ranging from resource allocation, efficient service delivery, and efficient improvement of the overall learning. The exercise of mapping is always used for purposes of revealing the existing relationships between school distributions and school-age population distributions in a particular area. GIS database offers a comprehensive model that organizes both spatial and non-spatial data making it a fundamental tool for planning and making decisions. School mapping besides capturing administrative boundary data as well as biophysical layers, including significant settlements and road networks give realistic appearance on the ground with regards to geographical coverage and presentation.

In most field applications, GIS is usually used as the advanced, elegant and technology-oriented tool. In fact, Hite (2008) records the benefits arising from presentation, flexibility, and preparation as the critical aspects that make GIS a highly significant tool for micro-planning as well as mini management. Moreover, according to Pellikka and Johnson (2005), GIS mapping enables field survey results to be appropriately visualized, assist in the provision of fundamental information as well as helping in economizing resources that are both human and financial in nature.
Interestingly, Tobler’s “first law of geography” states that “everything is related to everything else, but near things are more related than distant things” (Tobler, 1979). The example by Aliyu et al. (2013) perfectly demonstrates how “spatial distribution reveals patterns of underlying processes” by relying on Tobler’s first law to understand some of the existing “relationships between the distance phenomenon and the nearest which are in clustered use to bear same relationships,” especially when considering how a specific phenomenon like distance is distributed. By the same arguments, incidents that are exposed to the effects of similar underlying processes will tend to obey same locating patterns. As a result, studies on the spatial cluster may indicate information and data about those underlying geographical processes responsible for the creation of spatial patterns. For example, hot spots for crime in a given area arise when spatially clustered environmental backdrop has facilitated the occurrences of such crimes.

2.3.5 Previous Successful Cases of GIS and School Mapping

In general, the advancements in the GIS field have significantly contributed to various studies that deal with the measures relating to spatial access to both facilities and resources that are key to the education sector. In developing countries, for example, Hite (2008) claims that GIS and school mapping frameworks are commonly applied in creating necessary conditions to realize universal education both at the primary and secondary levels besides improving access to educational infrastructure for populations that are socially disadvantaged.

The study on “the use of GIS as educational decision support system (EDSS) for primary schools in Fagge Local Government area of Kano state, Nigeria” by Olubadewo, Abdulkarim and Ahmed (2013) demonstrated how GIS is a user-friendly method for mapping of schools. Specifically, the researchers showed that GIS is both a practical and feasible method applicable
for both educational monitoring teams and field researchers who engaged in the analysis of how educational facilities were geographically distributed in a diverse region.

Also, Makino and Watanabe (2002) conducted a study on “the application of GIS to the school mapping in Bangkok.” In this particular study, the authors used referred to “School Mapping” technique as “the location planning of educational institutions” and used it to identify those sites where educational facilities and the related resources should be located. Through GIS, the researchers managed to establish the distributions of both primary and secondary schools in Bangkok using detailed characteristics such as school size and the number of students and the relationship between their population densities and other infrastructural facilities such as transportation networks among others. Interestingly, the authors noted that it is necessary to integrate all school data and convert them into digital formats so as to make it easy and efficient to conduct simulations or analyses on future educational planning. Moreover, the authors also stressed that it is essential to create a database that can be easily linked to GIS features as features without specific attributes hinder further analyses.

Additionally, the study on “school mapping and geospatial analysis of the schools in JASRA development block of India” by Agrawal and Gupta (2016) provided the framework on how GIS can be applied in the education sector, particularly in school mapping and analyses of their geospatial data needed to ensure the Indian government’s policy on the right to education. This framework proposed the key parameters to be considered when mapping schools for implementation of new policies. The products considered included literacy maps, school catchment, student teacher ratio, school gender ratio, and basic facilities such as toilets. The findings of this study indicate that GIS is creating an innovative way for decision makers and analysts to critically examine some of the existing diverse range of both economic and social
challenges within our midst. In particular, the researchers clearly illustrated how GIS is applicable in both accessing the prevailing state of education in the focus area and locating some of the likely regions which may require particular attention from national stakeholders.

2.3.6 Infrastructural Requirements and Mapping for Competency-based Curriculum Implementation in High Schools

The infrastructural planning and mapping for the development and subsequent implementation of a competency-based curriculum is driven by a clear vision for learning and teaching. Consequently, as the government, through its various school district stakeholders, focus their attention on availing necessary resources that aide the implementation of the new curriculum; they need to also consider the educational and learning infrastructural requirements in schools. A study conducted by Kahera (2010) on “Factors affecting curriculum implementation in secondary schools in Kenya: a case of Kakamega South district,” revealed that competency-based curriculum implementation is mainly influenced by three factors: ‘standards and quality assurance resources, TSC policy, and other educational policies enforced directly by the government.’ Kahera (2010) arrived at this conclusion having established that staffing in secondary schools, especially teacher-student ratio was seen a major factor when it comes to the implementation of a newly aligned curriculum. Moreover, she noticed that transport and communication infrastructure in most districts within the country was inadequate, something that may significantly hinder both the implementation and evaluation of the readiness of secondary schools to the new curriculum.

Additionally, the study by Njoroge, Ngugi and Kinzi (2017) on the “Influence of selected factors on the implementation of information and communication technology policy in public secondary schools in Naivasha Sub-county, Kenya” found out that ICT is an integral
infrastructural requirement for implementing new curriculum in the country. Specifically, the study indicated that the use of ICT changes schools as well as classrooms by bringing in a new competency-based curriculum on real world issues and challenges.

An extensive study by Muthami (2013) on the “Development of a web based geo-visualization tool for secondary schools in Nairobi County” listed more infrastructural requirements for implementing a competency-based curriculum. In particular, Muthami (2013) argued that infrastructural mapping in secondary schools for purposes of rolling out a newly designed curriculum needs to cover all the “educational, demographic, and socioeconomic data” that can aid educational planning as well as decision making. These include; ‘school capacities, their facilities and their respective physical conditions, school enrolment and the number of teachers.’

Related studies that have been conducted locally, Makino and Watanabe (2002) conducted a study on “the application of GIS to the school mapping in Bangkok” and showed the same infrastructural requirements for ensuring competency-based as well as equal education to both primary and secondary students in Bangkok. The authors indicated detailed characteristics such as school size and the number of students and the relationship between their population densities and other infrastructural facilities such as transportation networks as some of the educational facilities and the related resources that should be located.

In summary, several studies on this subject have revealed that mapping the distribution of educational infrastructure, resources and analyzing their patterns whether clustered, random, or dispersed enables individuals to establish their capabilities to serve those residing in such areas. Key infrastructural requirements for implementing a competency-based curriculum include adequate basic physical facilities and amenities which are also in good conditions, sufficient
learning and teaching materials, functional ICT, as well as key variables such as school enrollment, number of teachers, teacher-student ration, and the number of students per classroom. It has also been demonstrated that GIS is a robust tool that can be used to inform decisions that influence the quality of the education services provided in a country. ICT has been fronted to be the main instructional instrument in the proposed curriculum and this facility will be required in all the three pathways of Art and Sports, Social Sciences, and Science Technology engineering and Mathematics (STEM).
CHAPTER 3: MATERIALS AND METHODS

3.1 The Study Area

The area of study is Ugunja-sub county located in in Siaya county in the western part of the republic. Formerly, this was known as Ugunja district in the old constitution having been promoted from a division. The sub-county is one of the six which forms the greater Siaya conty, others being Gem, Alego-Usonga, Ugenya, Rarieda and Bondo. The sub county is divided into two administrative divisions of Ugunja and Sigomre. It is further sub divided into four locations and twenty one sub-locations. The new constitution 2010 created three county wards of Ugunja, Sidindi and Sigomre. The total area of the Sub-county is approximately 198.8 km$^2$. The figure 3 below shows the study area.

![Figure 3: The map of the study area](image-url)
3.2.1 Methodology

The main objective that this project aims to achieve is to establish and map the infrastructural requirements for the successful implementation of the proposed competency based curriculum in Kenya. An in depth study of this curriculum has been carried out in the literature review section to address the first specific objective of the study to reveal the infrastructural requirements for the implementation of the competency based curriculum. The key requirements for its successful implementation have been identified in the section to include the external support infrastructure and the internal school infrastructure.

The external infrastructures deals with among issues such as accessibility and support services such as healthcare. The internal infrastructure have been identified to be the most important requirement if the curriculum is to implemented successfully. These included the availability of ICT support infrastructure such as sources of power, computers, computer literate teachers, and the labs. Other requirements include an optimal student-teacher ratio, class size and adequate physical facilities.

Data Collection

The three objectives were achieved by carrying out in-depth desktop study, picking of coordinates using the mobile topographer, interviews and filling the questionnaires. The desk top study was done at the literature review level where the first objective on finding out the necessary infrastructure for the implementation of the new curriculum was done. Several scholarly articles were studied that revealed the various infrastructural requirements needed for the implementation of a new curriculum in a number of countries.

Spatial data was collected using a GPS device, specifically the application known as the Mobile Topographer®. This involved visiting the 23 schools out of the 24. One school could not be visited as the study was done during a rainy season and it became difficult to access the school.
Once in a school, the coordinates were picked at the flag pole as this represented the most central place for the purposes of mapping the schools. Questionnaires were distributed to teachers with
the aim of capturing their skill sets in so far as ICT in concerned. This is key information as the backbone of the proposed curriculum is predicated on ICT.

Data analysis was done in a software environment using Arcgis. The spatial and attribute data were uploaded on to Arcgis and various maps generated as demonstrated in figures 7, 8, 9, and 10 in the sections that follow. The remaining sections of the flow chart of discussions of the findings and conclusions are herein covered on separate chapters.

3.2.2 Materials

The materials used to carry out this research work were divided in to two categories. These were the hardware and software components.

1) Hardware
   i. Computer Laptop (specification: 500GB hard disk, 2GB RAM, Dual Core processor)
   ii. Hand held Global Positioning System (GPS)
   iii. Printer (HP Printer Desk jet 710c)

2) Software
   i. Arc view GIS, version 10.1
   ii. Mobile Topographer

3.3 Data Acquisition

Two types of data were required for the purposes of this study. These were the spatial data and the attribute data.

3.3.1 Spatial Data

The coordinates of the existing schools within Ugunja district were obtained from field survey using a hand held GPS gadget. There are 24 secondary schools in the sub county and 23
were visited. By the time of data collection, it was impossible to reach Ogeda mixed school as it was during a rainy season and this presented an accessibility challenge.

Mobile Topographer is a leading survey tool for both professionals and any other individual willing to pick points of interest. Its level of accuracy is suited for this type of study as demonstrated by its graphical interface in the figure 5 below.

![Mobile Topographer interface](image)

**Figure 5: Mobile topographer interface**

This application has extensive functionality that most survey software lack. The GPS accuracy in this application has been increased using weighted averaging on each axis. In it, you can display and convert GPS geodetic to Cartesian EN coordinates and back. The auto stop capabilities for accurate positioning made it ideal for this project with the ability to show the signal strength and the number of satellites for each individual GNSS constellation.
3.3.2 Attribute Data

The attribute and spatial data were necessary for mapping the schools in the sub county and be brought in a software environment to reveal patterns with regards to readiness levels of schools to implement the competency based curriculum. These would ultimately aid in the achievement of the last two objectives of the study. Among the attribute data required included the total of students in schools both male and female, number of teachers, number of classrooms, power connection, and presence of computer laboratory in the schools visited. The data collected can be observed from the table 1 below

Table 1: Spatial and attribute data

<table>
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<tr>
<th>SN</th>
<th>Name</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
<th>Teachers</th>
<th>STR</th>
<th>Classes</th>
<th>Class Size</th>
<th>No of CL</th>
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<th>Longitude</th>
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</tr>
</tbody>
</table>
The location of schools studied can be observed on the figure 6 below.

**Figure 6: Map of schools studied**
CHAPTER 4: RESULTS

4.1 Questionnaire survey

A questionnaire survey was also used on this study to collect additional data on the side of the skill sets possessed by the teachers in their readiness to implement the competency based curriculum. A total of 46 questionnaires were distributed to the 23 schools as the 24th one could not be accessed at the time. The main teachers targeted were for Geography and any of the sciences. 31 teachers filled out the questionnaires in time and this represented a reply rate of 67%. 17 replies were made by the teachers of geography, therefore, constituting 55% of the respondents. These teachers were targeted since there will be introduction of GIS concepts in the proposed competency based curriculum at the senior school level.

All the geography teachers who responded admitted to have an idea on GIS from their university days but lacks the practical aspects. For those teachers who were unfamiliar with GIS technology, information was provided in the introductory letter of the questionnaires.

The general picture was that most teachers were optimistic of the proposed competency based curriculum and particularly incorporation of GIS in the new curriculum.

4.2 Student teacher ratio

The student teacher ratio is a very important quality indicator in education. The practise in the world is to reduce this ratio to increase the contact a teacher have with the student. It determines the availability of the teachers’ service to the learner. It is desired that this ratio be as small as possible, a fete that has been achieved in the developed nations of the world. The global average is a ratio of one teacher to eighteen students.

In the 23 schools included in the study, only one school met this global average representing a paltry 0.004%. The same percentage was also observed in the schools with the closest rating of
3. Majority of the schools are doing poorly with 14 (60.9%) having a student teacher ratio above 40. The map below shows the various levels at which schools are concerning this parameter.

![Map of student-teacher ratio](image)

**Figure 7: Map of student-teacher ratio**

4.3 Class size

Class size refers to the number of students handled by one teacher during an instructional process. The class size avails valuable information on the student’s learning environment. Class size is a significant indicator of the education quality as increases the chances of a learner receiving personalized attention from the tutor. This is highly applicable in a competency-based curriculum. A small class also reduces the load on the teacher due to a large number of students.
Globally, the class size vary between countries with countries like USA having an average of 23.

For this project, the average class size of M-PESA Foundation Academy was used as this has provided optimum use of the available resources and increased the teacher-student contact time. This ranges between 30 to 40.

The results show that only one school meets this criterion. Compared to the student teacher ratio, there is a marked improvement on the next category with four schools (17.4%) having a rating of 3. 30% of schools have a rating of 2 in this category. However, almost half of schools in this sub-county (47.8%) have class sizes above 60. The class size and the student teacher ratio are different but are very important indicators for measuring the quality of education students receive. This is informed by how the two measures relate on determining the teacher’s workload in terms of the students the teacher is in charge of and the number of lessons taken by the students. The two measures are crucial in the implementation of a competency-based curriculum since learners are expected to develop certain skill sets requiring increased contact with the teachers.
The figure 8 below shows the distribution of the schools based on class size in the area of study.

**Figure 8: Map of class size**

4.4 Computer laboratories

The proposed curriculum seeks to introduce GIS at senior school level, especially for the Science, Technology, Engineering and Mathematics pathway. Moreover, ICT will be a core area of study in the STEM pathway. The significance of computers in secondary schools can never be over emphasized. An inventory carried on the availability of these facilities in the schools revealed the following results.

Only three schools were found to have computer laboratories with computers that can be used to pilot the curriculum. This represents 13% of all the schools that were visited. The three schools
were also found in two wards with Sigomere ward lacking a school with computers need for the implementation of the curriculum. Below is figure 9 that shows the location of schools that meet the criterion in discussion.

![Map of schools with computers]

*Figure 9: Map of schools with computers*

### 4.5 Readiness levels

Weighted averages of the three main parameters (Student-teacher ratio, class size and schools with computers and computer laboratories) was obtained. The map revealed that there is no school with a rating of 4. Such a school would be ready for the roll out of the new
competency based curriculum. Only two schools had a rating of 3 representing 8.7% of the schools studied. Secondary schools had a fair rating of 2 which represents 39.1%. The rest of the schools, 12, had a poor readiness index of 1 meaning that they were found lacking in the three main parameters under investigations. The figure 10 shows the readiness levels of the various schools concerning the implementation of the new curriculum.

Figure 10: Map showing the readiness levels of Schools

It is important to note that all the schools visited had power connection. The schools with a rating of three need little improvements to be ready for the new curriculum. Ambira for instance scored an average of 3 in all the three parameters in this category but requires an improvement in teacher student ratio and construction of further 8 classrooms to bring the class
size to the recommended range of between 30-40. Bar Atheng is a new school and has ideal
student teacher ratio and class size consistent with the adopted standards (18 and 30-40
respectively). However, the school lacks computer laboratory and computers that are the basic
minimum requirements for successful implementation of the proposed curriculum. The schools
with the rating of 2 were found to be lacking in two indicators of quality education while the
poorly ranked schools (ranking of 1) lacked in the three mapped parameters.
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

The key infrastructural requirements for the successful implementation of the curriculum have emerged to be optimal class sizes, student teacher ratio, availability of well-trained teachers and adequate computers in the schools. The envisaged curriculum has three pathways of STEM, Social Sciences, Art and Sport Sciences. In all the pathways, ICT has emerged as a main instructional tool in the delivery of the curriculum. The skill sets of teachers on matters ICT will be a very important consideration future training and recruitment of teachers. Fortunately, most teachers have basic knowledge of basic computer packages since most of them own personal computers. The research has also demonstrated that the number of computers in the study area may not support the successful implementation of the new curriculum. This can be partly attributed to the fact that Computer Studies as discipline is optional in the current system and a preserve to the long established schools as observed in the study area. Most schools lack adequate teachers employed by the government and have attempted to bridge this gap by employing teachers using the school boards. As a result, the student teacher ratio has remained high and this is undesirable if the implementation is to succeed. Class size is also too large in most of the schools and this would greatly lower the student-teacher contact hours. This in the end would make it difficult to give the individualized attention needed when learning a skill set. All the three pathways will be negatively affected if the program is to be rolled out in the current state in which most schools in the sub-county are. These are skill-based undertakings and optimal levels of quality indicators in academics must be achieved.

Given that most teachers have a basic knowledge of ICT, this would be a good place to start the in-service training of the teachers to equip them with the advanced ICT skills demanded by this curriculum. This should be done in collaboration with the universities that train teachers for secondary schools. Such training would make the teachers feel more confident that they can
employ open-ended, computerized tools in a classroom environment. Majority of schools have a rating of 2 and above and such schools are midway to achieving the target readiness index of 4. There is a need to improve these schools and be specially designed to handle the STEM pathway of the proposed new curriculum. Schools proposed for this pathway must have additional modern computers; smaller classes with ICT competent teachers. The rest should be prepared to hand the remaining pathways of Social sciences, Art and Sports Sciences. The supporting infrastructure such as power connection has been achieved in all the schools and this makes it less complicated to prepare these schools for the proposed curriculum.
REFERENCES


Njoroge., N. F., Ngugi., M., & Kinzi., J. (2017). Influence of selected factors on the implementation of information and communication technology policy in public


APENDIX
1. Questionnaire

The University of Nairobi
Department of Geospatial and Space Technology
Msc. GIS project questionnaire

I, John Collins Otieno is carrying out a project research as part of the requirements in the course leading to a Master of Science in Geographic Information Systems. To this end, a questionnaire has been designed to aid in collection of part of the data for the project by the title “Using GIS in Mapping and Evaluating the High School Infrastructure in Readiness for the Implementation of the New Curriculum. Case Study: Ugunja Sub-County, Siaya County.” The objective is to obtain data on the current state infrastructure and the level of preparedness of the teachers to rollout the curriculum. Your participation in filling in and returning the questionnaire will be highly appreciated.

Instructions
Please circle a response for each question with multi-choices. You are urged to choose only one response for each question while the open-ended questions the answered in the spaces provided. When you are done, kindly deposit the questionnaire in the principal’s office for collection.

1. (a) Which college/University did you attend?

(b) What is your major/s? or minor if any?

(c) How many years have you been teaching?
2. (a) How many teachers employed by the government are in this school?

(b) What is the total number of students in the school? (give the number of boys and girls separately)

(c) What is the total number of classrooms in the school?

(d) Does the school have computer laboratories? If yes how many and what is the total of computers?

3. (a) I am proficient with most common software such as Excel, browser, word and power point.

   I. Strongly agree
   II. Agree
   III. I do not know
   IV. Disagree
   V. Strongly disagree

(b) Our school has modern computers and invests in new technology in the field of education.

   I. Strongly agree
   II. Agree
   III. I do not know
(c) I know the various digital sources of suitable content for the current curriculum that are available online.

I. Strongly agree  
II. Agree  
III. I do not know  
IV. Disagree  
V. Strongly disagree  

(d) I spare some time to learn new technologies that affects my teaching.

I. Strongly agree  
II. Agree  
III. I do not know  
IV. Disagree  
V. Strongly disagree  

(e) I tend to encourage my learners generate their own ideas and incorporate inquiry based learning in lessons.

I. Strongly agree  
II. Agree  
III. I do not know  
IV. Disagree  
V. Strongly disagree
(f) Teacher centered approach to teaching and learning is the best method for delivering any curriculum.

I. Strongly agree
II. Agree
III. I do not know
IV. Disagree
V. Strongly disagree

(g) I often use additional curriculum materials in addition to the recommended text books.

I. Strongly agree
II. Agree
III. I do not know
IV. Disagree
V. Strongly disagree

(h) I often use varied teaching methodologies to enrich the content and open to sophisticated educational methods.

I. Strongly agree
II. Agree
III. I do not know
IV. Disagree
V. Strongly disagree

4. Any other relevant information you would like to add on your instructional process?

Thank you for participating in this exercise.