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# Assessment of Vlan for the Implementation or Expansion of a Lan using Cisco Packet Tracer: the Case of Sefwi Bekwai Senior High School, Ghana

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#### ABSTRACT

In today's technological environment, the internet is the most resourceful repository of knowledge. Students at all stages of school may use the internet to obtain a wide range of information. That is, there is direct relationship between internet access and instructional resources. Using Cisco packet tracer, this research assesses Virtual Local Area Network (VLAN) for the establishment or extension of Local Area Network (LAN) at Sefwi Bekwai Senior High School (SEBESS). The study first established a link between internet and students' learning by examining network availability and accessibility at the Senior High School (SHS). The investigation was carried out utilising a cross-sectional design, a questionnaire, and interview methodologies on a sample of 263 people. The Pearson Correlation analysis approach was performed by the researcher to determine if pupils' learning was linearly connected with online resources. The study revealed that availability and accessibility to online resources are desired since the computer laboratory with internet access is timetabled and the majority of the Personal Computers are also malfunctioning. The VLAN was then investigated in order to expand the internet to reach the entire school. The study found out that internet availability and accessibility impact SEBESS students' learning.

#### **KEY WORDS**

Sefwi Bekwai Senior High School (SEBESS), Senior High School (SHS), Virtual Local Area Network (VLAN), Local Area Network (LAN), Internet Protocol (IP), Dynamic Host Configuration Protocol (DHCP), Information and Communication Technology (ICT)

#### 1. INTRODUCTION

Proper implementation of technology is faster and more accurate than the human mind. Technology has changed the way we do our things. Some of the areas technology has affected are: Agriculture, Health, Security, Education, Communication, Transportation, and Manufacturing. A school's computer network performs so many functions such as connecting students with the school, teachers, faculty, administrators or school management and the school library. As a result, computer networks play an important role in education by facilitating effective communication in the classroom setting. Installing networks in an educational institution depends on the budget of the institution, which differs from one institution to



another. Despite their limited resources, many schools strive to provide capacity comparable to the most famous educational institutions. As a result, this design will concentrate on improving the computer network for an educational institution with a limited budget so that it may compete well with another computer network for an educational institution with enough financial resources.

# 2. BACKGROUND OF THE STUDY

Technology has become an integral part and distinct feature of modern societies (Fraillon et al., 2014). There is no doubt that over the decade, information technology has been beneficial to the human race. Taking a critical look at the level of development at countries like; the US, UK, Canada, Germany and China, their economy is technology driven. The Covid-19 pandemic further emphasized the crucial role of technology in our daily lives especially for teaching and learning in schools at home (Seufert et al., 2021). That is, technology has change the ways of teaching and learning in this our modern societies. This means every academic institute in this modern societies needs to change the way teaching and learning is done from the basic traditional way of always face - to - face learning to the new modern ways of integrating technology most especial internet into the teaching and learning process. According to (Dimitrios et al., 2013) the traditional methods of teaching and learning are: Reading texts and problems, Formulate questions, Attending lectures, Monitor discussions, Writing and reply brief or extensive questions and objective type questions, Solving short or lengthy unstructured problems and cases and Oral presentation of topic and reply to short questions from the audience. And the modern technology integrated teaching and learning methods are: Downloading and watching on the internet, video watching, attendance and participation in lectures online and reading online materials. In Ghana, where there is an educational gap between the urban and rural dwellers. It is through the use of technology that will bridge that gap if not reduce it completely. Due to this, since the country begun its educational reforms the provision of Information Technology Infrastructure to schools in the country have become a challenge and this has advisedly affected the educational sector in the teaching and learning processes which inversely has an impact on the Ghanaian economy. The innovative policy of the Ghanaian government to provide a medium (WIFI) whereby students get access to educational and learning resources through the Ministry of Communication and Technology was to provide internet facilities in schools in order for these schools to set up computer networks to enhance teaching and learning. The sitting up of these computer networks in the various schools in the country is dependent on the school's budgetary allocation from the Ministry of Education. Sefwi Bekwai Senior High School (SBESS) is among the schools whose computer network is dependent on its budgetary allocation. Again an observation in SBESS reviewed that almost all of their teaching and learning activities were through the traditional means. Discussion with some of the students, teachers and administrator of SBESS reviewed that, teaching and learning in the school was mostly traditional because the school lacks the necessary tools and equipment to integrate technology into teaching and learning. Again internet facility was only available at the school library and the computer laboratory which only give students limited or no accessibility outside those geographical locations. The assistant head master of the SBESS said, the school cannot afford the cost of networking materials like routes and switches to network the entire campus because it comes with high cost. Especial with the number of departments and hostels in school like SBESS with small budget or financial status cannot buy networking materials for every department and hostel.



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## 3. STATEMENT OF THE PROBLEM

The study of several civilizations throughout history has revealed the importance of education as it applies to societal economic growth and recognizing the importance of learning, and the fact that continuing growth through knowledge is a powerful tool for maintaining elite status globally. There is a direct relationship between internet access and instructional resources accessed by a student through the school's computer network (Chanboualapha & Islam, 2012). Networking is a matter of imagination, and it's hard to track the movement of packages in a real-time environment. Therefore, different network concepts can be explained by creating a virtual environment that will display the momentum of packets exactly as they would in real time. Several methods of setting up a computer network have been discussed but SBESS, where the school administration (Headmaster and the Assistant Headmaster) said, computer network in the school is dependent on the school's limited budgetary allocation from the Ministry of Education. The concept of Virtual Local Area Network (VLAN) will be developed to provide computer network services to student at SBESS. A Virtual Local Area Network (VLAN) is a type of local network. In this type of network, a host group provides a set of general communication requirements. Virtual Local Area Networks (VLANs) have lately been a component of all major Local Area Network (LAN) equipment. With a VLAN, each port can be configured on a switch in a given VLAN. The switch will only allow devices configured in the same VLAN to communicate.

#### 4. LITERATURE REVIEW

Figure 1.1 depicts taxonomy of various research methodologies to the use of the Internet in continuous training and education ranging from the use of the network to supply organized learning content to collaborative learning methodologies (Trentin, 2001).



Figure 1.1 The possible uses of the Internet in continuous education and training (Trentin, 2001) According to (Trentin, 2001) there are numerous options, including:



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- 1. Free and open usage of the network to obtain unstructured content in order to pursue a specified educational route (similar to walking into a massive library to search up material on a certain topic);
- 2. Use of organized learning materials created specifically for remote self-study;
- 3. Use of content structured for remote education (mainly self-learning), but with some provider help (counseling);
- 4. Use of learning material that is not necessarily structured into a self-learning course, with assistance from the provider's tutors and teachers (who may also function as organizers of events such as brief online workshops/seminars on course themes);
- 5. Employing a hybrid strategy that includes complementing stages of face-to-face instruction and online learning activities;
- 6. Utilization of "pure" online techniques based on extensive, distant contact among all process players (learners, instructors, experts);
- 7. Use of communities of practice techniques, which result in the establishment of collaborative groups made up of, for example, course graduates or professionals who share their experiences, knowledge, and best practices for the aim of collective progress.

#### 5. RELATED LITERATURE

The availability of contemporary computers, peripherals, networking, and resources within an increasingly wide variety of technologies is a crucial aspect of learning and teaching in the twenty-first century for instructors and their students. Information and Communication Technology (ICT) is an input in the student learning process that should contribute to improved learning outcomes. The availability of ICT resources can improve learning by reducing reliance on varying instructor quality and making education possible at home throughout the day (ViralSangat, 2013). It is argued that the usage of ICT can help pupils learn more effectively (Chollampatt & Ng, 2018). Furthermore, the availability and usage of ICT can assist students in taking advantage of vast opportunities for gaining knowledge for educational purposes, as well as increasing learning through communication (Lynch et al., 2021). Students are more engaged and conceptual comprehension is reinforced when visual digital technology (such as animation, simulation, and moving visuals) is available. ICT use also promotes the transition from a teacher-focused or teacherled paradigm to a more student-focused model in which students collaborate, make their own decisions, and participate actively in learning (Prosser & Trigwell, 2014). According to Sampaio and Almeida, greater availability of ICT is especially beneficial for children with learning impairments since ICT use helps teachers to more efficiently develop appropriate assignments for specific requirements for each person (Sampaio & Almeida, 2016). Computers are a subset of the information and communication technology facilities required in schools, and even then, they must be equipped with quality accessories, installed with appropriate software, and linked to necessary networks to allow access to rich resources outside the school rather than serving as a resource for minor typesetting and other word processing activities. While the preceding research sought to explain how the availability of ICT impacts learning in general, they did not examine how computer networks or the internet obviously impacted students' learning. Effective ICT integration in schools would necessitate the networking of a whole institution to guarantee access to multimedia and learning-rich materials via the school's Intranet and the Internet wherever students and teachers are, in or out of school. The computer laboratories and classroom computers must be adequate in quantity to provide students and staff easy access to most disciplines across



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the school. A variety of peripheral and remote working equipment, including video-conferencing, are available and integrated into the curriculum. Both large and small group presentation facilities are available (Mutula, 2003). Despite the desired scenario, most African institutions confront challenges to successful ICT integration in the teaching and learning process, including poor infrastructure in terms of appropriate physical conditions of laboratories and subsequent access to resources (ICT) by learners. Many commercial and academic instructional multimedia providers have concentrated largely on information availability and presentation (Trelease, 2016). The accessibility and usage of ICT helps students to conduct more in-depth investigations into the actual world (Eneje, 2020). They have easier access to information sources outside of the classroom and can utilize tools to evaluate and comprehend it. Information can be accessed via internet platforms or data logging systems (Anshari et al., 2017). They may obtain feedback, develop their comprehension, gain new information, and transition from school to non-school situations thanks to the technology (Bransford et al., 2004). Accessibility and infrastructure are the main barriers to ICT adoption and integration into learning. Placing computers in centralized laboratories may offer students with equal and efficient technology exposure, but it greatly limits the accessibility of technology for education (Baş et al., 2016). Labs limit instructors' ability to decide when to introduce technology into education and may give the message to students that technology is not vital to learning or activities in their classrooms. The researcher agrees with the Ministry of Education in Ghana's assertion that, in general, governments and training institutions appear to grasp the need of using ICT in education and training. As much as students and employees require ongoing training in contemporary required skills to effectively exploit the ICT environment in their various roles, awareness skills alone may not be sufficient; rather, continual access to ICT resources would fare far better. Continuous access to ICT tools makes instructors feel safer in their ICT use during lessons, gives them the confidence to experiment more, and so allows them to successfully incorporate ICT into teaching. Many studies also show that the influence on learning will grow over time as teachers and students get more experience with computer use (Kim, 2020). Whereas the preceding research examined the accessibility of ICT resources in institutions of learning, critical information on how to extend access to internet or ICT resources within and outside the school campus for schools with low financial resources was never examined.

Cisco hierarchical (3-layer) networking model is generally used in developing a low cost, scalable and reliable internet work. It comprises of layers like core, distribution and access and their function in the network model (Onopreychuk, 2018). Network design is based on device numbers and specifications of the organisation. That is, the networking infrastructure requirements of a smaller organisation of a few devices will be less complex compared to the networking infrastructure needs of a large organisation with many devices (Cisco Press, 2014). According to Cisco Press (2014), irrespective of network devices or specifications, the correct execution of network architecture adheres to formal engineering standards. This contains the following:

- **Hierarchy**: Hierarchical networking architecture may be used to construct a dependable network system. It deconstructs the dynamic network architecture to make it simpler and easier to handle.
- **Modularity**: The existence of features that occur while dividing network into segments simplifies network architecture. Cisco divides networks into units. Enterprise campuses, data center, service block, in addition to internet edge are a few examples.
- **Resilience**: The network should be usable under both abnormal and normal situations. Hardware and program glitches, high traffic levels, unusual traffic, denial-of-service (DoS) incidents, and



other unpredictable events comprise abnormal circumstances. Normal environments consist of traffic movements and patterns as well as maintenance activities planned in windows.

• **Flexibility**: This refers to the potential to change parts of the network, add additional facilities, or expand capacity without requiring a significant forklift upgrade (i.e., replacing major hardware devices).

According to the fundamental design goals, a network should be designed on architecture that allows for both versatility and expansion.

#### 6. NETWORK HIERARCHICAL DESIGN

The connectivity, delivery, and center layers are the 3 major layers of the network hierarchical design. Figure 1.2 depicts the network hierarchical architecture. From Cisco Press (2014), the architecture of a network hierarchy involves layering the network. Each layer of the hierarchy performs unique roles that describe its position in the whole network. This enables the network builder to elevate and pick the appropriate network hardware, applications, and functions to fulfil various network layer tasks. Hierarchical models can be used in both Wide Area Network (WAN) and Local Area Network (LAN) architecture.

One of the benefits of splitting networks into smaller and more accessible blocks is that local traffic stays local. Two, only traffic intended for other networks is transferred to a higher tier. The network is split into three distinct broadcast realms in Figure 1.2.

A traditional enterprise hierarchical LAN campus network architecture involves the three layers stated below:

- Access layer: This provides network access to users and work groups.
- **Distribution layer**: It provides policy-based communication and manages the distinction between the core and access layers.
- **Core layer**: This also offers high transport via distribution switches on the business campus.



Figure 1.2 Hierarchical Networks (Cisco Press, 2014)



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## 7. METHODOLOGY

Research design is the way the study is planned and conducted (Akhtar, 2016). The procedure and techniques that are employed to answer the research problem, explain the pattern the study intends to follow so as to control variance due to independent variables, eliminate or reduce influence of extraneous variables, minimise error variance and also ensure the testing of findings for implication. The study employed a cross-sectional research design. Cross-sectional design permits the population checking at a particular time and the change between the groups in the population to be matched. Again, it provided for the scrutiny of the co-relationship between accessibility to network or internet and students learning in the context of Sefwi Bekwai Senior High School seeking the views of students, teachers and administrators. The selection of this design is dependent on the variables to be studied.

#### 8. SAMPLING STRATEGIES

The process of taking the sample from the population is crucial in a research. Ideally, a sample is taken randomly to avoid having a biased sample in the sense that no member of the population has more chances of being selected as the sample than any other member. A total of two hundred and sixty-three (263) respondents made up of students, teachers and administrators were randomly selected for the study. The study also relied on stratified, purposeful and convenient sampling strategies. (Taherdoost, 2018) opines that stratified sampling is where the population is separated into strata and a sample is randomly taken from each sub group. Convenience sampling is selecting participants because they are often readily and easily available. Maxwell (1996) posits that purposive sampling is a technique in which particular settings, persons or events are selected deliberately in order to provide important information that cannot be obtained from other choices. Stratified sampling will help identify the stratum in the population. The study recognises students, teachers and administrators as the relevant stratum and their actual representation in the population. Sufficient number of subject from each stratum was been selected. Stratified sampling ensures equal representation in an event where particular strata or many strata within the population will have a small incidence relation to other strata. Simple random sampling is used to attain the appropriate number of student's representation in the study. Simple random sampling that was for picking students for the study gives every student equal chance of taking part in the study and also helps to prevent partiality. The students represent the widest variety of perspective in respect of network or internet and learning in Sefwi Bekwai Senior High School. Convenient sampling would help identify the teachers and administrators that form part of the study. That is, convenient sampling was suitable for the teachers because they are mostly unavailable on campus and are only available in the school only when they have lessons. There, convenient sampling was used to collect information from the teachers who were available on school campus at the time of collecting the data.

## 9. DATA COLLECTION INSTRUMENT

Data gathering is crucial in research, as it is meant to contribute to a better understanding of a theoretical framework (Tongco, 2007). According to (Saleh & Sohn, 2001) the term instrument means equipment for collecting the data. Based on this statement, instrument plays a vital role in conducting a research that is for gathering the data accurately. An instrument is a tool designed to measure knowledge, attitude and skills. (Parahoo & Mccaughan, 2001) argues that a research instrument is a systematically prepared form or document purposely designed through compilation of questions to elicit responses from respondents with the aim of collecting data. Data collection instruments refer to devices used to collect data such as



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questionnaires, tests, structured interview schedules, via telephone and checklists (Seaman, 2008). Data collection procedures vary in time cost of money or many resources at the disposal of the researcher (Megel & Heermann, 1994). In line with these explanations, the data collection in this study was done through the assessment of a secondary data gathered by the method of analysis of documents. Such documents included official records, newspaper accounts, reports, and published items. Primary data was also obtained directly from the field and collected via observation and self-administered questionnaires.

#### 10. NETWORK ARCHITECTURE

This network design is a framework for the requirement of a network's physical components and their functional organisation and configuration. And its operational principles, procedures and data formats are used. The simulated network architecture approach was divided into these departments. The departments are:

- i. Administration
- ii. Teaching Staff
- iii. Students

The administration or administrative section comprises of Headmasters (School Head and the Assistants), Finance, Chaplain and Senior Housemaster. Administration was put in VLAN **10** (Administration). Teaching staff comprises of the heads of department and the teachers. All teachers were put in VLANs (VLAN **20**, VLAN **30**, VLAN **40** and VLAN **50**) Students comprise learners from the following departments; General Science, Business, General Arts, Agricultural Science, Visual Arts, Technical and Home Economics. All students were put in VLAN **200** (Students). The systems comprises of a Web Server and a Mail Server. Each device receives an Internet Protocol (IP) address from a Dynamic Host Configuration Protocol (DHCP) server.



Figure 1.3 The Architectural View of the Network Design



#### **NETWORK CONNECTION**

Computer network devices interchange data with one another using data links among nodes. The data connections are established through wireless media like WiFi or cable media like wires and optic cables. As the packet tracer layer three switches (the multi-layer switch) cannot provide fiber optic connectivity, generic devices were used. The reason was that fiber optic covers longer distances. At core and distribution level, standard routers were used since they have interfaces for fiber optic and serial connections. Generic switches were used in access level.

#### NETWORK PROTOCOL

Routing Information Protocol (RIP) version 2 was used as the routing protocol for inter VLAN, with RIP. A router sends its full routing information to other connected routers every thirty seconds. Triggered updates also occur when a router drives down beforehand **30** second timer expires. RIP executes "routing by rumor" and it is very loops prone than other routing. That is because RIP router transmits its full routing information to all other routers.

#### VLAN CONFIGURATION

Cisco Systems (2006) opine that when creating and modifying VLANs in network, the following guidelines should be followed:

- Switch module accepts **1005** VLANs.
- Normal-range Ethernet VLANs are numbered from 1 to 1001 and LAN 1002 to 1005 is set aside for FDDI VLANs plus Token Ring.
- Switch module does not accept FDDI media plus Token Ring. Switch module does not forward FDDI-Net, FDDI, TrBRF, or TrCRF traffic.
- VLANs 1 to 1005 remain saved within VLAN database and switch module using configuration file.
- Configuration alternatives intended for VLANs 1006 to 4094 are inadequate to private VLAN, MTU, UNI-ENI VLAN, and RSPAN VLAN. VLAN database does not save extended VLANs.
- STP (Spanning Tree Protocol) by default is activated for NNIs on VLANs. STP can be configured on ENIs. Same VLAN for NNIs and ENIs use the same spanning-tree instance. When switch module takes many active VLANs accepting spanning-tree instances, spanning-tree may be activated in 128 VLANs and deactivated on other VLANs.

At the access layer, devices are many and there is the possibility it may expand. Due to this, DHCP automatically gave IP addresses by the use of routers performing as gateways to all switches. In order to secure and control unauthorised access to some sections of the network, network ACL was configured.

# DISCUSSION OF FINDINGS ON THE IMPACT OF NETWORK RESOURCES AVAILABILITY ON STUDENTS' LEARNING

The study established that the availability of the different network or internet resources in the SHS is still very much wanted. About (74.3%) of the respondents said computers were not available in the classroom. (68.6%) of the respondents stated that internet connection in the SHS is not available and also (56%) consented to computer laboratory being fairly available. Technology gadgets and their accessories should be made available for usage to produce the desired benefits for proper and full integration of internet or networking into the teaching and learning process.



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According to (Siddiquah & Salim, 2017), computer and internet affect the educational process more than the previous educational technologies. ICT integration in higher education benefits both instructional and learning processes. In addition to aural and visual senses, computers and the internet engage the user's sense of touch and give the possibility for more interaction for the development of the user's unique, creative, and intellectual talents. Furthermore, Ben Youssef & Dahmani (2008) state that students who receive ICT-based teaching perform more than those who do not get ICT-based instruction. When computers and related technology are made available in schools and institutions, students are forced to use databases, spreadsheets, multimedia, e-mail, and network search engines to complete their projects, and such processes have a greater potential to promote cognitive development. Computers have the ability to provide students with higher-order skills such as enquiry, reasoning, problem solving and decision-making abilities, critical and creative thinking and learning how to learn. According to study, using computers have a beneficial influence on students' success when compared to conventional ways. The study also indicates that the SHS's internet resources are insufficient. About (65.1%) percent of the respondents thought computers in classrooms were inadequate while (60%) percent agreed that the internet was inadequate and (57.1%) percent said computer labs were inadequate. (Baluku & Kasujja, 2020) indicate that the inadequacy of ICT facilities translates into lack of skills in the use of ICT equipment and software which results in a lack of confidence in using ICT tools among the students. Learning using internet or network is hindered by accessibility different ICT to resources. (BarriersofICTIntegrationinTeachingLearning2016jje, n.d.) and (Ghavifekr et al., 2016) emphasised the issue of accessibility as a feature of ICT integration into teaching and learning process. In the same vain, (Ben Youssef & Dahmani, 2008) stressed that inaccessibility of internal school network outside the institution may limit teachers and students from accessing and using ICTs. The study reveals that because of the limitation in the numbers of functional computers and laboratories, the computer laboratories are timetabled and the time for accessibility is limited. Teachers and students from the different faculties are supposed to adhere to time schedules which do not promote accessibility at convenience. Nonetheless, timetabling is aimed at better organisation and management of the few resources and most respondents agreed that there is access though insufficient in the SHS. The study indicates that easy access to internet facilities was a problem in the SHS. According to the findings, majority of the students hardly access network facilities from their dormitories. No time was allocated for students' practice in the computer lab. Besides, the teachers also compete for facilities in the computer lab with students. However, the survey also reveals that the computer lab and the SHS library continue to be the two most popular locations for accessing network resources. It is worth mentioning that access to the internet which is one of the most important indicators of ICT in learning in an institution is not fully implemented in all sectors, particularly dormitories and classrooms. Furthermore, Chukwunonso et. al. (2013) emphasise that the internet and the World Wide Web have altered the face of technology particularly in the way people communicate and interact. Learning on internet conforms to constructivist instructional approach (Gold, 2001). Therefore, the limit to places is not an ideal practice. (UNESCO, 2002) points out that the success of ICT in the teaching and learning process in education shall base on the degree with which students and teaching staff access ICT facilities. Findings from respondents echoed limited network resources as the biggest challenge affecting students' network devices (61%). This was closely followed by financial constraints cited by (13%) of the respondents. The researcher's discussion with the administrators reveals the need for increment in ICT facilitation so as to increase on the number of technology accessories in the SHS. Limited



time access to the computer lab (10%), unreliable network (7%) and power fluctuation (3%) were some of the other reasons cited as affecting students' access to ICT or network resources.

### **11. SUMMARY OF FINDINGS**

The findings from the study revealed that:

- The study established that the availability of the different network or internet resources such as computers, internet, computer laboratory and video conference like zoom in the SHS is still very much wanted. That is, these network resources were fairly available in the SHS but they were not adequate to support teaching and learning
- Learning using internet or network is hindered by accessibility to different ICT resources in the various location of the school like classrooms and dormitories. Accessibility to internet or network was possible at the SHS library and computer laboratory but the computer laboratory was mostly occupied by the IT students and the library was not always accessible especially weekend. There is the accessibility to internet at the internet kiosk but it is very expensive for students to afford. The major challenge affecting students' accessibility of network or internet resources were few network devices, financial constraints and limited access the SHS computer laboratory.
- With limited capital the Local Area Network at Sefwi Bekwai SHS can easily be implemented or expanded to cover the entire campus using VLAN technology since it makes use of few routers and switches

### 12. CONCLUSION

From the findings, the following conclusions were drawn:

- The ICT infrastructure of the SHS is poorly developed, unevenly distributed and inadequate. However, some ICT resources like computer lab, projectors and computers were considered to be fairly available. Though not fully adequate, the SHS recognises the essential need for good network and other ICT resources in its academic endeavours and as such there is already something to build on.
- Network access in different sectors of the SHS for both teachers and students was not well attended to. The biggest challenge still affecting easy access to network facilities in the SHS remains the limited number of ICT resources which do not match with the ever-increasing student population. But there was at least something in place to build on though there were still limited computers.
- ➤ To a large extent, students training in ICT in the SHS were mainly theoretical but not skill acquisition that led to ICT skill transfer to use ICT both for learning and in other settings.
- The objective of this project is to build simulated LAN for implementation or expansion at Sefwi Bekwai SHS which will ensure that no ICT device stays on its own, that connectivity is fast, and that the addition of devices must not hinder packet transmission. It can be said that these objectives have been achieved and that the network and troubleshooting standards have been fully met.

#### RECOMMENDATIONS

Based on the findings of this study to improve on the internet or network availability and accessibility, the following recommendations may be considered:



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- There is a need for the SHS to spend more on computers and associated technologies in order to not only solve the accessibility problem but also to improve the presence of facilities particularly computers in the classroom and computer lab.
- Proper internet connection installation in the SHS is required. That is, the connection of more computers to the internet. The school should then liberalise internet access. Overall, the school will take time and effort to achieve a 1:1 ratio of student-to-ICT access to amenities. Thus, students should also endeavor to acquire themselves what they can afford or visit commercial internet providers like internet café to access internet facilities.
- Training in ICT skills should not be limited to Microsoft Office suits or too theoretical. The SHS should go ahead to integrate the other internet or network programmes in the curriculum for schools. Clearly, a basic level ICT skill must be achieved but this should be followed by an integrated approach to ICT and learning. The aim should be for embedding ICT firmly into the teaching and learning process. Such changes may offer the potential to improve on teaching and learning using modern technology.

#### **RECOMMENDATIONS FOR FUTURE WORK**

- 1. Additional Access Control Lists (ACLs) must be implemented throughout the network to provide robust end-to-end security.
- 2. IPv6 addressing can be implemented to overcome restrictions on the number of hosts that can be used due to the available address space.
- 3. In addition to the existing VoIP functionality, further network setup can be done to enable video conferencing.
- 4. Investigate the relationship between technology and genuine learning in Senior High Schools.
- 5. Research on students' perception and use of the internet as a hub for learning.
- 6. Research on the effects of modern technology on students' performance.

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