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ICT Integration in Ethiopian High Schools

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Abstract

The purpose of this research is to describe the status of ICT integration in Ethiopian high schools. Ethiopian government invested millions of dollars every year to purchase of ICT devices and provide short term ICT training for teachers. However, the impact of this initiative was not systematically assessed whether it brings the expected impact on the quality of education. In other words, if teachers integrate ICT with pedagogy (use ICT to deliver instructions in the classroom), it is assumed that ICT is used to improve the quality of education.

The research was undertaken using descriptive research method. For data collection, questionnaire, one to one interview, focused group discussion and classroom observation was used. The participants of the study include teachers, students, vice directors for teachers' professional development, ICT technicians, and ICT4E and teachers professional development experts. During the study, 600 teachers, 120 students, 30 directors, 30 ICT technicians and 12 regional ICT4E and teachers professional development experts and four ICT4E expert at the federal level were involved The data was analyzed using descriptive statistical methods. There are two basic type of ICT devices used in the school, namely Plasma TV and computers. Plasma TV was introduced as instructional delivery tools. The main finding of the research is that ICT is still at a lower stage of integration. Although the Plasma was intended to enrich the classroom instruction with technology, almost in 50% of the schools, it is not used because of timely maintenance and power interruption. Computers are mainly used for teaching basic computer skills. Very few teachers try to use computers to enrich their instruction in the classroom. This is done by the individual teacher's initiative. There is no school level vision how ICT is used for pedagogical application. The study concludes that ICT integration in the schools require careful planning that considers contextual factors such as availability of electricity, availability of ICT technicians, availability of adequate budget to maintain existing devices and buy new devices, good ICT pedagogical knowledge and overall ICT strategy plan to integrate in the schools. In the Ethiopian case, there is no well articulated and detailed plan how ICT is integrated and specific expected benefits to be achieved rather than stating general benefits adopted from the literature.

Keyword: ICT, ICT integration, pedagogy, education, Ethiopian education

Introduction

Educational technology has evolved and become more central to teaching and learning nowadays(Pozo *et al.*, 2021). Even before the invention of computers, teachers tried to enrich classroom instruction with a variety of audio and visual aids including film, radio, slides, recordings, and the overhead projector (Farenga and Ness, 2005). With the development of computer technology after WWII, computers bring new opportunities to enhance learning in the classroom (Arkorful and Abaidoo, 2015). Computers integration with telecommunication network and web technologies brings additional capabilities for learning such as collaborative learning, blended learning and online learning. Web technologies create flexibility for learning. Students can access teaching resources not only from their school but also from other schools and content developers across the world. Web helps to implement fully student centered learning environment.

Although there are plenty of evidences about the benefit of information technology for learning, all schools are not equally beneficiary from e-learning implementation. The western societies made significant progress in the integration of technology in their schools. Cognizant of the potential of instructional technologies to improve educational effectiveness and access, developing countries have also begun to use technologies in their schools. The government of Ethiopia made different interventions to modernize its school system with technologies. Implementation of Plasma TV at national level in 2004 was a large scale initiative to transform the traditional method of teaching through ICT (Kim and Bogale, 2015).

The use of ICTs has become more important when schools were closed due to COVID-pandemic (König, Jäger-Biela and Glutsch, 2020). As it happened in all countries of the world, schools were closed in Ethiopia on March 2020. Although there was no formal school instruction through ICT during school closure in Ethiopia, there was an effort to support students at home through different technological devices including Plasma TV and radio (Barasa, 2021; Mengistie, 2021). Private primary and secondary schools intensively used messaging applications (such as WhatsApp and Telegram) to send lesson materials and receive assignments from students while radio and television learning programmes were primarily used by public schools to reach secondary and primary school students (Barasa, 2021). However, the efforts were not coordinated and planned in advance. It was also difficult to assess the achievements in student learning.

Despite government efforts, different research indicated that ICTs are not properly utilized in Ethiopian schools to improve the quality of education (Latchanna and Basha, 2012; Alemu, 2015; Kim and Bogale, 2015). Empirical research on use of ICTs for education in other countries did not bring significant improvement in student performance (Pozo *et al.*, 2021). In Ethiopia, there are some fragmented research that reported ICTs are used to develop basic computer skills rather than on pedagogical applications to improve student performance (Tezci, 2009; Aslan & Zhu, 2018). Therefore, it is necessary to undertake a systematic study on ICTs integration with a larger population covering schools in different regions of the country. It is also necessary to explore the underlying factors for low level of ICTs integration in Ethiopian high schools. Other researchers also recommended empirical research to gauge the status of ICT integration and inform decision makers and policy developers to make wise use of resources for ICT integration (Latchanna and Basha, 2012; Kim and Bogale, 2015; Jogezai, Ismail and Baloch, 2018). This study attempts to address the following research objectives:

- To assess the level of ICT infrastructure availability in Ethiopian high schools
- To rate the level of technology integration in Ethiopian high schools;
- To assess use of ICTs during COVID-19 school closure

The paper is organized as follows: Section two discusses previous literature on ICT integration. Section three deals with methodologies employed to undertake the research. Section four presents empirical research results. Then it is followed by discussion of the research findings in light of the extant literature findings. Finally the paper is winded up by providing concluding remarks and future research direction.

Literature Review

Educational technology is the use of ICT devices in the classroom to enhance learning. It is also defined as "the study and ethical practice of facilitating learning and improving performance by creating, using, and managing, appropriate technological processes and resources" (AECT. 2004. p.3). ICT is a technological innovation that augments the capability of teachers to make learning more effective in the classroom.

Current literature listed down many benefits of ICT for students (Pozo *et al.*, 2021). ICTs have the potential to motivate and engage students, help relate school experience to work practices, improve students' digital skills for tomorrow's workers as well as transforming the learning environment in the schools (Yusuf, 2005; Aslan & Zhu, 2018). It is also used to implement a rich learning environment with multimedia information content, student centered instruction and collaborative learning environment (Gellerstedt, Babaheidari, & Svensson, 2018). Through ICT, the whole instruction events are controlled by the learners so that students have the freedom to decide when to learn, how to learn and what materials to read in order to achieve the lesson objectives (König, Jäger-Biela and Glutsch, 2020). The use of computers and Internet generally increases students' independent learning (Mahdum, Hadriana, & Safriyanti, 2019).

ICT has also multimedia information representation capability. The same information can be represented in the form of text, image and animation. For example, the abstract concept of fertilization can be animated and visualized for learners. This concretization of abstract concept helps learners to easily assimilate new concepts. It also motivates learners to be engaged in the learning activities. Teaching using ICT is generally increased students motivation for learning (Kisirkoi, 2015; Yusuf, 2005; Ghavifekr, Razak, Ghani, YanRan, Meixi, & Tengyue, 2013).

ICT has also the potential to improve teachers' knowledge and skills. It allows teachers to access a variety of teaching resources and update their learning materials so as to better support their students in the classroom (Ghavifekr, Razak, Ghani, YanRan, Meixi, & Tengyue, 2013). Teachers should be role models for their students in using ICT in the classroom. Unless teachers develop confidence to use technology, they cannot support their students in the classroom (Hew and Brush, 2007).

Implementation of ICT in schools is not only buying computers and providing computers to teachers and students to work with (Umara & Hassanb, 2015). It is a complex process that must be guided through explicit vision and policy. As a result countries have formulated and developed ICT policy for education to fully exploit the benefit of ICT and prepare their students for the 21st century skill requirement. For example, the Malaysian government developed an explicit ICT policy how innovative ICT solutions are integrated in the classroom to enhance student learning and develop students' attitude for life-long learning (Ghavifekr, Razak, Ghani, YanRan, Meixi, & Tengyue, 2013)

ICT use during COVID-19

Schools started to use ICTs for education before the outbreak of COVID-19 pandemic. Schools were totally closed during the pandemic outbreak. Schools were not prepared in terms of ICT infrastructure and pedagogical skills to shift for online learning (Pozo *et al.*, 2021). However, most countries have established ways of continuing to provide education services through various distance learning modalities during face to face school closure (Wayne, Green and Neilson, 2020).

ICTs use in schools has two forms. The first use is aimed at teacher centered that mainly focuses on the transmission and access to information while the second one is student-centered which promotes diverse competencies (autonomy, collaboration, critical thinking, argumentation, and problem-solving) (Pozo *et al.*, 2021). Use of ICTs in Ethiopian schools mainly focused on transmission and assess of information to students because of lack advance preparation for COVID pandemic. Generally, the outbreak of the COVID-19 pandemic dramatically increased ICTs use for pedagogical applications in schools (König, Jäger-Biela and Glutsch, 2020; Pozo *et al.*, 2021) both in developed and developing countries.

ICT Integration

Technology integration is viewed as the use of computing devices such as desktop computers and Internet in schools for instructional purposes (Hew & Brush, 2007). Technology can be used for other school management activities such as managing school information and communicating with students and parents. In this research, we will focus on ICT integration for pedagogical applications. When we say pedagogical application, we specifically refer to the use of ICT as medium of instructional delivery by replacing traditional media such as blackboards and chalks. It is a change in pedagogical approach in student teaching (Lloyd, 2005).

ICT Integration must pass through different stages of development to get the maximum benefit of ICT in learning. There are different models of ICT integration developed by researchers. These are Model of instructional transform with five stages (familiarization, utilization, integration, reorientation, evolution) (Marcinkiewicz & Welliver, 1993), stages of concern with seven stages of ICT integration (awareness, informational, personal, management, consequence, collaboration and refocusing) (Anderson, 1997) and ICT Development model with four stages (emerging, applying, infusing and transforming) (UNESCO, 2002).

Jogezai et al., (2018) investigated the status of teachers with regard to ICT integration in Pakistani secondary school using stages of concern model. They argued that teachers are at the heart of ICT integration in the schools. Their level of knowledge in ICT has a direct impact on the use of ICT in the classroom. The researcher used stages of concern to assess the level of ICT integration. The research finding indicated that majority of the teachers are at the unconcerned, informational or personal stages on use of ICT in their instructions. Teachers at this stage are concerned to improve their personal knowledge on use of ICT rather than applying ICT in the classroom to improve instructions. The researchers further indicated why teachers are at lower stage of concern. Teachers are busy with their routine class lecture, shortage of time to experiment new technologies and inadequate knowledge to use ICT for pedagogical application. However, this research is not generalizable to other schools especially to schools which have different cultural and ICT infrastructure development. Ethiopian context is significantly different from Turkish school context.

Hew and Tan (2017) developed a model that predicts ICT integration in secondary school mathematics lessons. The researchers showed that students achieved higher academic performance in schools with better computer access, more IT resources, higher levels of IT curricular expectations, an explicit policy on the use of IT and positive attitude for ICTs.

Umara & Hassanb investigated ICT integration by gathering data from all school teachers in Malaysia. The study used Pedagogy * Technology Model which was developed by Lin, Wang and Lin in 2010 (Umara & Hassanb, 2015). This model has two levels of ICT integration which is labeled as pre-integratoin and integration phases. The model was developoed based on the frequency and type of ICT use. In the pre integration phase, the teachers are mainly used ICT for personal use such as searching materials from Internet, preparing lesson plan and producture of power point lecture slides. In the integraton phase, teachers use ICT for pedagogical applications.

The study reveals that teachers are not at the same level of ICT integration in their classroom. However, most of the teachers are at the preintegraton phase. The main reasons for level of interation were teachers do not have time to use ICT in schools, more time is requred to arrange ICT tools in the classroom especially if the ICT tools are stored in a place away from the classroom and teachers have also a fear not cover syllabus if they frequently use ICT in their classroom. In addition, in-house-trainings conducted in their schools do not meet the needs of their career development. This study as it is conducted in one country, it cannot be generalizable to other countries. In addition, the model used by the researcher simplifies ICT integration process as two levels activity.

Investigation of existing empirical research on ICT integration in schools showed that there is no one standard ICT integration model. This implies that the phenomena of ICT integration are not a matured concept which needs further investigation to acquire more evidences to develop a theory of ICT integration. The other limitation of the existing research is that it is very difficult to compare the level of ICT integration among different schools because of the different levels of integration models.

UNESCO's ICT development model is a comprehensive model that includes infrastructure development, teacher and student ICT skill and curriculum development. This research used the UNESCO's model as a lens to investigate ICT integration in Ethiopian high schools. The model has emerging, applying, infusion and transformation stages.

In the emerging stage, schools start to acquire some computers and software. Teachers are interested to get more information about the computer and its impacts on their personal career. They do not show any concern about the technology in relation to their personal life (Jogezai, Ismail and Baloch, 2018). They acquire general knowledge about ICT but do not know how to use it for personal use as well as for their students. They are more concerned to acquire basic computer skills. They show efforts to take training and hands on exercise either through the school or by taking their personal initiative. The teaching method is dominated by traditional methods. Teachers show strong anxiety about their ability to implement the change, the appropriateness of the change, and the personal costs of getting involved (Anderson, 1997).

In the applying stage, teachers start to understand the benefit of ICT for learning (UNESCO, 2002). They try to improve their instruction by including computer based instructional materials such as by downloading additional resources from Internet and preparing their lecture notes using power point slides. They show more interest to use the technology and ask school administrators to fulfill the necessary ICT resources to enrich their classroom practice. The teaching method is still teacher led. Students' access to technology is through one or two classroom computer labs. This access focuses to expose students to technology to get some basic computer skills.

In the infusion stage, schools have a range of computer-based technologies in laboratories, classrooms, and administrative areas (UNESCO, 2002). Teachers start to modify existing readymade ICT resources provided by the school in a way to improve its impacts on their students. They also show interest to work with other teachers in the school to improve classroom instruction through ICT (Anderson, 1997). Teachers start to play the role of the facilitator rather than being the center of knowledge source for their students.

Students have more choice to choose their learning style and learning activities. In other words, students take more responsibility for their own learning and assessment. The teacher organizes activities to develop problem-solving and critical thinking skills (UNESCO, 2002). ICT is taught to selected students as a subject area at the professional level.

In the transformation stage, schools have used ICT creatively to support learning in the classroom. ICT becomes fully integrated though invisible part of the daily personal productivity and professional practice (UNESCO, 2002). All instructional delivery is carried out through ICT. The schools have matured ICT infrastructure to support such seamless integration of ICT in the school. The focus of the curriculum is now much more learner-centred and integrates subject areas in real-world applications. Students can work with the community to solve community problems by accessing and interpreting information from different sources. Students have unlimited access to variety of technologies. ICT is taught as a subject area at an applied level. For example, students may work with community leaders to solve local problems by accessing, analyzing, reporting, and presenting information with ICT tools.

Research Method

This study used mixed method research design. It uses both quantitative and qualitative data collection and analysis methods. This method provides unique advantages to triangulate results that are derived from different research methods. Complementarity "seeks elaboration, enhancement, illustration, clarification of the results from one method with the results from another" (Greene et al cited in Almalki et al., 2016, p. 291). As ICT integration is a complex phenomenon, the use of mixed method research help to have deeper understanding on the process and outcome of the phenomenon under investigation.

Research Setting and Participants

Before selection of research areas for the major study, the researchers had conducted a pilot study in four geographically scattered regional states (Amhara, SNNPR, Benishangul Gumuze and Harari) at eight secondary schools. One hundred questionnaires were distributed for the pilot study to check the reliability and validity of data collection instruments. The reliability of teachers' questionnaires was checked with Cronbach Alpha. The reliability results of most of the items in the questionnaire were calculated to be between Cronbach Alpha .70 and .95 which is above the minimum acceptance value (Tabachnick and Fidell, 2013).

After modifying data collection instruments, the main study was conducted in 30 secondary schools which are found in five regional states and one city administration (Addis Ababa). The regions and schools were selected on the base of stratified random sampling. That is, there were about 120 secondary schools with digitized plasma lesson and e-learning centers (CEICT, 2017). From each stratum, six schools were selected on the base of random sampling technique.

The participants of the study were selected using simple random sampling method. The selected samples include 600 teachers, 120 students, 30 directors, 30 ICT technicians and 12 regional ICT4D experts and teachers' professional development experts and four ICT4D experts from Center for Educational ICT (CEICT). While teachers and students were randomly selected, experts and vice directors were selected purposefully.

Data Collection and Instruments

To gather data for the study, four different instruments were employed. These were questionnaire, observations, interviews and documents. Participant observations were conducted in the sample schools to observe teachers' application of ICT in the classroom. The observations were backed up with videos and photographs. Furthermore, in-depth interviews were made with school directors, ICT technicians, and ICT for education experts at regional and national level. Focus group discussions were also made with students

in each selected schools. Moreover, documents, such as ICT4E policies, teacher education preparation syllabi, implementation manuals, training materials, etc. were assessed.

The questionnaires were prepared from different articles reviewed during the literature review (see Annex 1). The questionnaire basically covered demographic data of respondents, availability of ICT infrastructure in the schools, ICT use by teachers and application of ICT for pedagogical application. All of the respondents were teachers who are proficient in English as English is the medium of instructional delivery in the schools. We selected one teacher in consultation with the school director to assist in the data collection. The teacher was briefed about the questionnaire and then he/she was given to fill one questionnaire to check if they have adequate ability to assist other teachers while they fill their questionnaire.

The other data collection instruments (observation, interview, FGD and documents) were employed to triangulate teachers' self-report data through the questionnaire. The observation checklist comprised issues like availability of ICTs, utilization of ICTs, and teachers' application of ICT in the classroom. About 45 observational surveys were conducted and the observations were mainly focused on the physical setting of schools where ICTs were used as an instructional tool, and teachers' application of ICT in the classrooms. The classroom observations lasted for 40 minutes each and some of them were backed up with video recording and photograph.

The interview guides and focus group discussions had the dominant themes, such as state of ICTs implementation and respondents' recommendations to improve secondary school teachers' use of instructional technologies in the teaching-learning process. The researchers together with field assistance made the interviews and focus group discussions. Interview was conducted with school director, school ICT technicians, regional ICT expert and teachers professional development expert. Focused group discussion was conducted with five students which are randomly selected by the school director. Students were selected from different grades and gender groups. Each interview and FGD lasted for 20 to 30 minutes, and the conversations were recorded. Documents were also used to collect data about ICT implementation during COVID-19 pandemic. Ministry of Education website, Concept Note for Education Sector COVID 19-Preparedness and Response Plan, performance reports of UNICEF and other partner organizations were the main documentary data sources.

Data Analysis

Both quantitative and qualitative data analysis techniques were carried out in the study. The results were interpreted and discussed in relation to the research objectives and relevant literature. Descriptive statistics including frequencies, percentages, means and standard deviations have been employed to analyze the quantitative data. Qualitative data was analyzed using open coding methods. List of themes were generated from the questionnaire which later used as a starting point to reduce the qualitative data into abstract concepts. Newly emerged themes were also added to the theme list. During data interpretation, both quantitative and qualitative results were integrated to address the research questions. Finally, based on the findings of the study, discussions were made, conclusions were drawn and recommendations were forwarded.

Research Results

Demographic Background of Respondents

This section describes the demographic characteristics of the respondents. Of the total 580 respondents, 78.4 percent were male while the remaining were female teachers. This indicates that teaching profession

in Ethiopian high schools is dominated by male teachers. This is generally a reflection of the overall employment composition. Because of cultural and social influences, females do not continue their education at higher levels. As a result, males are more educated than females and this also reflected in the employment composition.

When we look at the educational qualification, most of the teachers are first degree (74.3%) and second degree (19.0%) holders. Ethiopian government took aggressive action to improve the qualification of teachers through free in service continuing education program. The quality of education is a very serious problem in the country as it deteriorates from time to time. That is why the government introduces this massive continuing education program to improve teachers' qualification.

Different technologies are available to support teaching and learning in Ethiopian high schools. Plasma TV is used now as main instruction delivery in all Ethiopian high schools. At beginning, teachers were given only 15 minutes from 45 minutes period to provide lesson introduction and summery at the end of the Plasma TV instruction. Because of different criticism for poor value of Plasma as instructional delivery, Instructional coverage was reduced from 30 minutes to 20 minutes. The teachers were given more time to teach students in the classroom.

ICT Infrastructure

The Ethiopian government tried many efforts to create technology access in Ethiopian high schools. It introduced Plasma based instruction in 2004 through Schoolnet Project to support classroom instruction through ICT. During this time, one computer lab was established in all high schools where there is an electricity connection. Since then, the government allocated annual budget for acquisition of ICT resources for high schools.

The government also tried to create an Internet access for schools with reduced fee. Through the same project, Internet with 1MB capacity was installed in all high schools. Even where there is no telecommunication and electricity access in the remote high schools, the Ministry of Education provided VSAT dish and generator to make the schools accessible to technologies. Some schools have good ICT facilities.

However, the availability of ICT infrastructure is not adequate in Ethiopian high school. The available ICT facilities and the number of teacher and student population is not proportional. The following interview discussion also confirmed.

> *"There is shortage of computers and Plasma TV. There is also administration problem to manage the ICT facilities. For example, there is no budget for the school to use for purchase of new computers or maintain existing computers. The attention given for ICT by educational officers is low."*

Response from the school director from Amhara Region also reflected similar view

> *"There is shortage of computers in the schools. The school has no its own budget. There is also shortage of qualified ICT technicians that provide maintenance for ICT equipment and training for teachers. We had Internet connection but it is interrupted due to budget problem."*

The ICT technician from Addis Ababa City Administration also reported that

> *"There is shortage of ICTs tools, lack of knowledge and skills to operate computers, lack of Internet. There is Wi-Fi connection but it is weak to access resources from Internet."*

Generally, there is inadequate ICT infrastructure in Ethiopian high schools. In addition, schools do not have their budget to acquire new ICT resources as well as to maintain the existing resources. There is also manpower problem to maintain ICT resources and provide support for teachers. The salary of ICT teachers and technicians is not attractive as compared to the market. As a result, schools suffer from high manpower turnover.

Level of ICT Integration in Ethiopian High Schools

This section discusses level of ICT integration for pedagogical application in Ethiopian high schools. We have used Unesco's model of teacher's professional development in ICT. Teachers' competency in level of ICT integration for pedagogical application shows that they are mainly at emerging and applying stage. The number of teachers in these phases accounted for 39.7% at emerging stage and 40.2.5% at applying stage (see Table 1). Teachers at emerging stage are mainly focusing on developing their personal skills to operate computers. Unless teachers develop skills to operate computers, they may be considered as incompetent professionals by their colleagues as well as by the school administrators. As a result, every teacher is struggling to develop his/her personal knowledge and skills to operate the computers and other technological devices available in the schools. In order to develop the personal skills, availability of technological devices is very critical. As long as the technologies are available, teachers can acquire the necessary skills through their personal efforts.

Levels of integration	Weighted response/ Multi-response frequency	Percentage
Emerging/ Discovering ICT tools	3288	39.7
Applying/ Learning to use ICT for pedagogy	3330	40.2
Infusing/ Learning on innovative use of ICT tools	1664	20.1
Total of Multi-response	8,282	100
Table 1. Level of ICT Integration in Ethiopian High Schools		

Data collected from interview and focused group discussion also supports similar pattern to the survey data. A School V/Director from Addis Ababa City Administration reveals that

> *"Training was given to teachers on how to use the technology particularly school net program. In addition, a daily support is provided by ICT technician when teachers face problems during the use of the technology".*

The same view also forwarded by School Director from Amhara Region

> *"Teachers do not come with adequate ICT knowledge from the university. They improve it through experience by trial and error at school".*

Faculties of Education in Ethiopian universities are not well equipped with ICT infrastructure and ICT teachers. They provide them one course for basic computer skills. The course is also theoretical because of shortage of computer labs to provide hands on practical training. As a result, when teachers graduate from the university, they do not have adequate knowledge and skills to utilize computers even to prepare their lesson materials leave alone using computers for pedagogical application.

Some of the teachers, who have good skills to operate computers, use computers for pedagogical application. Teachers at applying stages start to use some technologies to support teaching and learning in the classroom. In Ethiopian high school curriculum, classroom instruction is provided in blended learning modality by teachers and Plasma TV. First the teachers provide introduction about the day's lesson for 5 minutes and then the Plasma TV provides the instruction for 20 minutes. Finally, the teachers provide 15 minutes revision and summary about the instruction provided by the Plasma TV. Using Plasma in the classroom is mandatory in Ethiopian high schools unless the Plasma TV is out of order or there is electricity blackout.

Plasma TV has positive effects to improve classroom instruction. It allows teachers to visually demonstrate abstract concepts such as fertilization in biology and environmental conservation in geography. It is also used to show science experiments for schools which do not have science laboratory and shortage of chemicals for experiments. It also improves students' language skills. This is also supported by empirical evidences. Students mentioned the benefits of Plasma TV during the focused group discussion in the selected schools. For example, quotation from focused group discussion in Amhara region showed that:

> *"Plasma TV helps to effectively utilize our class time. If the class is conducted by teachers, teachers may not come class on time. It provides good explanation on some abstract concepts. It also presents the same concept in different ways which is not possible by the teacher".*

In some schools, teachers try to use computers for pedagogical application by their own initiative. They download materials from Internet and develop power point slides and other supported materials to provide ICT supported instructions for their students.

The quantitative research finding is also supported by data gathered from interview and focused group discussion. As Teachers Professional Development Director from Amhara Region reported:

> *"In some schools, teachers provide ICT supported teaching. They use power point in Fasildes school in Gonder City, W/o Sihin school in Dessie City and Tana hyke school Bahir Dar city. This is not provided in other schools especially in small and rural villages".*

IT technician from Amhara region

> *"Science teachers download materials from internet and try assist students in the classroom. However, most of the teachers do not have such kind of effort".*

As some teachers show effort, there are also teachers who do not make any effort to improve their ICT skills. In some regions, universities organize some short term training for high schools teachers on basic computer skills and pedagogical applications. The Regional ICT Bureau also organizes similar training. However,

there is no integrated teachers' development program to improve teachers ICT skills for pedagogical application.

The quantitative result showed that teachers accounted for 20.1% of respondents are at infusing stage. Teachers at this stage show efforts to collaborate with other teachers to share their success and failure experiences. They also collaborate to work on a projects using ICT as a communication platform. This collaboration is not limited to a single school but include other schools inside and outside the country. As we observed the schools during data collection field visit, there is no school reach to this stage. All schools do not have adequate ICT resources even for pedagogical application in the classroom. Teachers do not have also advanced training in pedagogical application of ICTs except basic computer training. In fact, there are some very limited initiatives by some teachers. A quotation from IT technician from one school in Amhara region supports this claim.

> *"One teacher has laptop. He prepares his material by simulation and teaches in the classroom by connecting his laptop with the Plasma TV".*

Generally, the level of ICT integration in Ethiopian high schools is still at lower level mainly due to shortage of infrastructure access and lack of training on pedagogical application of ICT. In this 21st century, ICT skills have become an entry requirement for employment opportunities. Students must acquire ICT skills in the schools. In addition, students must develop higher order thinking through student centered learning approach. This is not possible without integrating ICT as pedagogical tools in the classroom. Teachers are not the only source of knowledge for students in the classroom. Opportunities must be created for students to access a variety of learning resources from different sources and develop their higher order thinking and problem solving capability. Unless this trend is changed, developing countries including Ethiopia will remain poor as they are now.

Ethiopian Educational delivery during COVID-19 Pandemic

Ethiopian schools were closed in March 2020 due to COVID-19 pandemic. The Ministry of Education developed a concept note for the Education Sector COVID-19 Preparedness and Response Plan on 3 April 2020. The objective of the plan "to pursue education disrupted by the incidence of COVID 19 pandemic for about more than 26 million students" (MOE, 2020).

MOE has its own TV channel and Plasma TV Education Programme was used to support high school teacher in selected subjects in the classroom since 2004 (Assefa, 2017).With the support of UNICEF, Save the Children and Société Européenne des Satellites (SES), the Ministry of Education and regional education bureaus managed to launch nine new educational TV channels on the Ethiosat TV platform (Khodr, 2020). Ethiosat is Ethiopia's first dedicated TV platform launched in October 2019 by agreement between the Association of Ethiopian Broadcasters (AEB), the Ethiopian Broadcasting Corporation (EBC), and SES (SES, 2020). The channels were broadcasted in eight languages (SES 2020). Addis Ababa Education Bureau was the first to initiate a programme called "Education at my home", which reached secondary school students at home through the Telegram application and the AfriHealth satellite TV channel (Sewunet, 2020).

The support of UNICEF and other partner organizations also includes content development and skill training (Sewunet, 2020). In Gambella, for instance, UNICEF has provided technical support in training of 37 radio script writers to develop radio learning materials (Khodr, 2020). In other regions, UNICEF has mapped out lessons and languages common across regions and facilitated cross-regional sharing of resources for broadcasting (Khodr, 2020).

The mode of instructional delivery during COVID-19 lock down was mainly focused on information dissemination from teacher to students. The TV programs were broadcasted for about 30 minutes with

some question answer activities to engage students. The original Plasma program was designed to be delivered with the support of teachers. Before the broadcast started, teachers introduce the lesson and then revising at the end of the lesson. They also manage the classroom to get students actively attend the Plasma TV instruction. However, during COVID-19 lockdown, students did not get support from their teachers. Only those students with educated family got support from their parents. Additional reading materials and assignments were also sent to students through Telegram accounts.

Although information was pushed to students from TV and Telegram channels during COVID-19 lock down, there was no monitoring system to track students' engagement. Students complete the assignments and answer keys were also sent as a feedback (See Fig. 1). However, this form of interaction is not sufficient to assist students to acquire the expected lesson objectives. More interaction between the teachers and students is required to make ICT based education as alternative mode of education to face to face education.
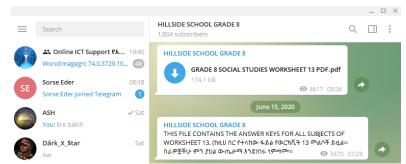

Fig. 1. Telegram Channel Created to support students during COVID-19 Lock down

Overall, TV broadcasting is the most reliable and cost-effective way to reach millions of students across a wide area in the country where other infrastructure access is a serious problem.

Use of ICTs during COVID-19 lock down in Ethiopia faced different challenges. The first challenge was the lack of infrastructure and devices for internet connection. Except students of the private schools, most of the students do not have access to computers at home. Main instruction delivery method was through TV and mobile devices. More than half of mobile devices in Ethiopia are not connected to the internet, with total connectivity being less than 20 per cent (Telecom, 2020). Access to mobile phones is mainly limited to students in urban areas. This created a digital divide between urban and rural students. Although the TV programs are the main educational delivery mechanism for public schools, most of the rural population, which accounts for 79 per cent of the total population, did not have access to television (Yigezu, 2021). Power interruption is also another challenge that hinders student access to TV educational programs both in urban and rural areas (Assefa, 2017).

Although MOE and schools tried to reach their students through TV and mobile devices, there was no adequate preparation on content development, instructional delivery modality and assessment methods during the COVID-pandemic (Khodr, 2020). Educational lessons provided via the Telegram application were not properly planned and lacked structure(Yigezu, 2021). Schools send summarized reading materials from textbooks and assignments in PDF and Word formats through Telegram application as well as 30 minute video lessons through TV. These programs have no clear lesson objectives and lesson completion time. There was no also clear assessment method on student achievement of the lesson objectives. All those programs were initiated to maintain students' connection with their schools. The TV lessons were better structured, as they had a defined schedule both in terms of subjects and time of broadcast.

Discussion

This research was undertaken to assess the level of ICT integration in Ethiopian high schools. There are different stages of ICT integration. We have used Unesco's model of teachers professional development ICT framework. Data was collected from different high schools in different part of the country using survey methods, face to face interview with school director, IT technicians and regional IT coordinator and regional teacher's professional development director and focused group discussion with students. Documents published by MOE and other donor organizations were also used as important source of information.

The result of the empirical data showed that some 50.4% of the teachers do not use ICT. Although the government is making efforts to provide computers and Internet access for schools, the current effort to integrate ICTs in schools is not adequate. There are about 40 or 50 computers in each high school. Even some of the computers are not working. The labs are used for teaching basic computer skills for students. Infrastructure access in Ethiopian high schools is a serious constraint and it may be the reason for low rate of ICT use. Other researchers also confirmed that infrastructure access and basic computer skills are first requirements to use ICTs for pedagogical application (Jogezai, Ismail, M., & Baloch, 2018; Avidov-Ungar & Iluz, 2014). In low income countries like Ethiopia, use of TV broad casting channels is most reliable and cost effective solution to integrate ICTs in schools (Sewunet, 2020; Yigezu, 2021).

Teacher training universities in Ethiopia do not provide adequate ICT training for newly graduating high school teachers. Almost all teachers acquire skills to operate and use computers after they join the schools. Ethiopian government also organizes short term training on basic computer operation for teachers during school break time. This training is not adequate only few teachers have the opportunity to get the training. Some schools try to arrange training through their IT technicians during weekends. Although this is a good initiative, it is not practiced regularly and done in all high schools. Some schools are successful while other schools are not as it is organized spontaneously. School level training would be more feasible than other initiatives and schools should allocate budget for internal trainer if they want to develop their teacher's computers skills.

Lack of support from school administrators indicate that school administers do not fully recognize the benefit of ICT to support learning and improve the quality of learning (Moses *et al.*, 2012). Other studies also indicated the role of support from schools to improve teachers ICT skills and knowledge (Kisirkoi, 2015). Shortage of ICT resources in the schools, inadequate training and professional development for teachers (Ghavifekr and Rosdy, 2015); lack of technical supports and poor condition computer lab are a common problem for pedagogical application of ICT in schools (Moses *et al.*, 2012). Schools should not expect everything from the government. They can take their own initiative to generate income for acquisition of the necessary ICT resources such as from alumina and parents (Kisirkoi, 2015). For example, Tana Hyke School was successful to mobilize and got computers from its alumni.

When we look at the level of ICT integration in Ethiopian high schools, some 39.7% of the teachers are at emerging and the other 40.2% are at applying stage. Teachers are at emerging stage spend more time to explore what ICT can do and how to use it. They are more concerned about themselves. They struggle to acquire basic ICT skills before they think how computer is used for pedagogical application. When ICT is introduced to schools, its main purpose is to improve student learning which the main goal of every school is. The analysis of qualitative and quantitative data indicated that most teachers in Ethiopia are at emerging stage. Use of technology for pedagogical application is a main challenge for all high schools world wide (Umara & Hassanb, 2015; Jogezai, Ismail, M., & Baloch, 2018). This is mainly due to the problems mentioned above.

The government of Ethiopia introduced Plasma TV to deliver instruction in all Ethiopian high schools since 2004 (Assefa, 2017). The Plasma TV has positive effects to improve classroom instruction. It allows teachers

to visually demonstrate abstract concepts such as fertilization in biology and environmental conservation as in geography. It is also used to show science experiments for schools which do not have science laboratory and shortage of chemicals for experiments. It also improves students' language skills. However, its effectiveness was hampered by different technical and pedagogical constraints (Assefa, 2017). Regarding technical challenges, it was not readily available for instructional delivery because of electricity blackout, lack of timely maintenance and scheduling problem between the school academic calendar and the central broad casting agency (i.e. Ethiopian information and Communication Technology Agency). With regard to pedagogical limitation, Plasma TV delivery is fast to follow up, language problem to attend lesson instructions and content coverage. Most of the contents delivered through Plasma TV are not considered in the national exam as a result students do not appreciate relevance of Plasma instruction. The government tried to solve these problems by modifying the instructional content design. The government has established an e-learning center in some selected high schools. The Plasma content will be loaded to the school data server so that teachers can decide use of Plasma instruction content in their daily lesson. This gives more control for teachers and overcome scheduling problem with central broadcasting station.

Teachers and students attitude is very critical for success of any ICT based intervention in the schools(Babu and Reddy, 2015). Both teachers and students have a positive attitude about the benefit of ICT to enhance student learning. In developing countries like Ethiopia, provision of ICT services at schools is critical to achieve the benefits of ICT for education (Moses *et al.*, 2012). Ethiopia may not provide qualified teachers in all high schools especially in remote area schools. Technology can be used to supplement teachers and provide better quality education for students.

During COVID-19 lock down, use of ICTs in schools increased throughout the world (Sewunet, 2020; Pozo *et al.*, 2021). Ethiopian schools also used different technologies to reach students at home. They used TV and Telegram channels as main educational delivery. Infrastructure access constraint and lack of pedagogical skills to design and implement e-learning content were the main bottleneck to utilize ICTs to its maximum potential during COVID-19 lockdown. The lockdown encouraged educational officials, school administrators, teachers and students to try and use different technological tools for educational application. This finding is also similar to researches done in other country (König, Jäger-Biela and Glutsch, 2020; Pozo *et al.*, 2021). The use of ICTs was mainly focused on dissemination of information from schools and teachers to students with little student engagement in active learning activities (Pozo *et al.*, 2021). For ICTs to be an effective pedagogical tools, it should be used to implement student centered learning rather than as tools for information dissemination.

Conclusion

The main purpose of this research was to assess ICT infrastructure access and levels of ICT integration by teachers in Ethiopian high schools. Teachers are the main agents for the success of any innovation introduced in the schools. Use of technology in the school is a new innovation which brings different challenges by teachers as well as students. The empirical result of the research shows that more than 50% of the teachers do not use technologies. Their level of ICT integration is at lower level. Most of the teachers are emerging and applying stages. Teachers at emerging stage are primarily concerned with developing their personal skills. This is because when teachers graduate from the university, they did not have adequate knowledge and skills to operate computers even for basic activities like preparing lesson plans. They develop their skills after they join the schools through trial and error methods. In fact, there are some short term trainings by Ministry of Education and by their schools; it was not adequate to develop teachers ICT skills.

The goal of introducing ICT in school is to improve student learning through technology. However, Ethiopian's initiative to enhance learning through ICT is challenged by many technical and administrative

problems. Installing technology does not bring the expected benefits. After implementation of the technology, what is working and what is not properly working must be identified and the necessary actions must be taken on time. Plasma TV was introduced as a solutions to enhance learning in the classroom. It brings some benefits for students. It allows teachers to demonstrate abstract concept through visual aids, improve students' language skills, better content coverage and supporting teachers to develop their subject knowledge.

In the visited schools, almost fifty percent of the schools did not use Plasma mainly for electricity blackout, maintenance problem and lack of follow up from schools directors. Installation of technology is the beginning of ICT integration. Schools administrators and Ministry of Education officials must follow up regularly utilization of ICTs in the classroom. They have to also identify problems and fix those technical and pedagogical problems immediately to effectively utilize ICTs for improving student learning performance. Although Ethiopian government allocate millions of dollar every year for broadcasting Plasma program and device maintenance, ICTs are not fully utilized to improve the qualities of education in Ethiopian high schools.

ICT integration requires new management style for schools administrators. School managers should regularly monitor if the ICT devices are working properly or not. If there is any failed device, it has to be maintained immediately to use ICT as reliable instructional delivery media. Teachers are key role players in the success of ICT application for education. They have to have adequate knowledge and skills to operate the available ICT resources. Continuous training should be organized for teachers both on technical and pedagogical contents. Schools should have also clear vision how ICT is integrated in the school. Strategy document gives clear direction what is expected from teachers and students to fully utilize ICT to improve the quality of education in the school. Schools should have also ear marked budget for ICT. Most of the respondents mentioned lack of ICT budget as one of the bottlenecks for ICT integration in their schools.

Recommendation for practitioners

- Schools should develop an ICT strategy plan that clearly guide for successful implementation of ICTs for pedagogical applications
- School administrators should appreciate the value of ICTs for improving student performance. They have to regularly follow up use of ICT in the classroom as they follow up other educational activities.
- The government should explore to acquire cheaper and durable technologies for schools so as to increase infrastructure access in schools. It is very expensive to buy and distribute computers for schools for developing countries like Ethiopia
- Schools with low income source should be given free Internet access. Many of those schools interrupt their Internet services due to lack of Internet subscription fee.
- Continuous on the job training should be provided for teachers at school level. The training should also include pedagogical application of ICTs. The government should also consider the on the job training to be e-learning based as we have matured technologies such as Google Classroom
- Implementation of ICT based education must be evaluated for its relevance to improve student performance.

Future research

The benefits of ICT are well documented in the literature. However, most the schools fail to apply ICT for pedagogical application. In countries like Ethiopia where schools have serious shortage of ICT infrastructure, budget constraint and qualified ICT technicians, ICT implementation is not successful to

achieve its targets. Future researchers should investigate what kind of technology should be introduced in schools where there is shortage of budget to acquire the required ICT resources. In addition, there are different models of ICT integration in the literature. It is also required to develop ICT integration model that fits to developing countries. In addition, the role of school directors for ICT integration is not well researched. Future researchers can undertake research what roles and responsibilities should have to successfully implement ICT in their schools.

Acknowledgements

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Annex I

Data collection instrument for ICT integration

ICT Integration Phase	Questionnaire items
Emerging	I do not have experience of using instructional technologies (ICTs).
	I use predominately textbooks, workbooks and black/white board.
	I use computers to prepare notes, access email and retrieve information.
	I encourage my students to know how to use computers.
Applying	I explore the possibilities of using ICT to the curriculum.
	I have an awareness of the use of ICT in my lessons.
	I still deliver my lesson in the conventional instruction though there are ICT-based instructions in my school.
	I use instructional technologies to support the text-based (textbook; workbook; black/white board) instruction.

	I use ICTs to develop supplementary activities.
	I get my students to do home works/assignments using ICTs.
Infusion	I explore new ways in which ICTs change my teaching practices.
	I employ ICTs to stimulate students' learning and demonstrate their knowledge.
	I utilize technology-based tools, such as databases, spreadsheet and graphing packages, multimedia, desktop publishing applications, and Internet, etc. in my teaching.
	I use technologies to help students identify and solve authentic problems relating to an overall theme/concept.
	I use technologies to promote collaboration among students for planning, implementing, and evaluating their work.
Transformation stages	I use ICTs beyond classrooms to expand students' experiences and collaborations within community.
	I employ technology-based tools for self-directed students' learning
	I have access to and a complete understanding of a vast array of technology-based tools to accomplish any particular task at school.
	I use entirely ICTs for students' learning.
	I utilize innovative ways to incorporate technology into students' learning experiences.