1.1. THE AFRICAN DIGITAL SCHOOL OF DISTINCTION MODEL:

BASELINE STUDY ON ICT INTEGRATION IN TEACHING AND LEARNING OF STEM SUBJECTS IN TANZANIA SECONDARY SCHOOLS

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List of Abbreviation and Acronyms

ADSI	African Digital Schools Initiative
CFIT	China Funds-in-Trust
CoICT	College of Information and Communication Technologies
CSSC	Christian Social Services Commission
DUCE	Dar es Salaam University College of Education
GESCI	Global E-Schools and Communities Initiative
ICT	Information and Communication Technology
ICT-CFT	ICT-Competency Framework for Teachers
ICT-CST	ICT-Competency Standards for Teachers
LCD	Liquid Crystal Display
MoEST	Ministry of Education, Science and Technology
MoEVT	Ministry of Education and Vocational Training
MUCE	Mkwawa University College of Education
NMB	National Microfinance Bank
Sida	Swedish International Development Agency
SPSS	Statistical Package for the Social Sciences
STEM	Science, Technology, English and Mathematics
TCK	Technological Content Knowledge
TCRA	Tanzania Communication Regulatory Authority
TIE	Tanzania Institute of Education
TK	Technology Knowledge
TPACK	Technological Pedagogical Content Knowledge
TPCK	Technological Pedagogical Content Knowledge
TPK	Technological Pedagogical Knowledge
UNESCO	United Nations Educational, Scientific and Cultural Organization

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2. Executive Summary

This baseline survey forms a backdrop against which a benchmark for implementing ADSI digital school development and integrating Information and Communication Technology (ICT) in Science, Technology, English and Mathematics (STEM) teaching and learning. It is envisaged that the overall program will be implemented in the coming four years focusing on ICT integration in secondary education. This study is guided by objectives which focus on the following areas, namely institutionalization, digital schools development, teacher development, and students. The study employed both qualitative and quantitative approaches with interviews, questionnaires, and observations as the main instruments of data collection. Data was collected from school leaders, school ICT coordinators, subject teachers, and students. Observation was used to capture actual classroom application and integration of ICT in teaching.

The study found that a large number of teachers have access to computers, mobile phones, and the Internet at school environment and at home. Moreover, teachers have shown to have positive perceptions on the usefulness of ICT as a pedagogical tool in enhancing teaching and learning. However, the majority of teachers have moderate competence and skills to use ICT integration in the classroom as United Nations Educational, Scientific and Cultural Organization ICT-Competency Standards for Teachers (UNESCO ICT-CST) domain and Technological Pedagogical Content Knowledge (TPACK) elements were found to be moderate. This shows that despite teachers having access to computers and using them for various activities, their knowledge levels on ICT integration in the classroom is moderate. Therefore, there is an urgent need for stakeholders such as the African Digital Schools Initiative (ADSI) to develop a comprehensive framework for professional development that will assist teachers to develop knowledge and skills about ICT integration taking into account elements in TPACK and ICT-Competency Framework for Teachers (ICT-CFT) domains.

Similarly, this study found that students have low usage of computers in their schools. Nonetheless, students' perceptions of the usefulness of computers in supporting teaching and learning was high. Therefore, there is a high propensity amongst students to use ICT for learning, if and when they have the appropriate ICT skills and equipment. The government and parents should equip schools with computers and the Internet in order to increase accessibility of these facilities to students. The findings of this study provide valuable insights to the development of teacher preparation activities that would lead to more efficient use of technologies in preparing students who are cable of supporting the country's efforts towards industrial economy.

3. Background – International and Tanzania Context

With the ICT and changes in the 21st century, technology in education is no longer an option or a choice, but an inevitable reality. Consequently, enhancing technological integration in education is one of the pivotal issues in Tanzania today, as the country envisions leaping towards being a middle-level income earner and a semi-industrialized country by 2025 (MWTC, 2016). With this reality in mind, a large number of initiatives have been directed towards ICT integration in enhancing teaching and learning at all levels of education. For instance, the government and partners have been equipping schools with computers and ICT. A recent report by the Ministry of Education, Science and Technology (MoEST) indicates that approximately 31.4% of government secondary schools (out of 3,601) have been equipped with computers ranging from 1 to 68 computers (MoEST, 2017). The report further states that nearly 20% of these schools are connected to the Internet. Although the report focused on government schools, it is clear that the number of private schools with computers connected to the Internet is high.

Similarly, there are many initiatives in developing digital content and making them available for students to access via the Internet. For instance, the College of Information and Communication Technologies (CoICT) in collaboration with Halotel Tanzania developed the Halostudy system with digital content for all science and mathematics subjects for Form 1 to Form IV. The content was enhanced with multimedia elements to facilitate self-learning and was deployed in 426 secondary schools connected with Halotel Internet. Christian Social Services Commission (CSSC) developed an eLearning platform with content for secondary schools in Tanzania (CSSC, 2014). Other initiatives that have developed content for secondary schools in Tanzania include Shuledirect (Mtebe & Kissaka, 2015), and retooling project (Mtebe, Mbwilo, & Kissaka, 2016).

Nonetheless, the impact of ICT integration has not managed to enhance students learning in several secondary schools in Tanzania as the pedagogical integration of ICT in teaching and learning is still low (Kafyulilo, Fisser, Pieters, & Voogt, 2015; Kayombo & Mlyakado, 2016; Mwalongo, 2011; UNESCO, 2015). It should be noted that the success of ICT integration in the classroom depends on teachers' competence and skills to effectively integrate ICT facilities in the classroom (UNESCO, 2016). In other words, the teachers' competence with technology integration is the basis for effective change (Hooker, Mwiyeria, & Verma, 2011). However, many teachers graduate with insufficient skills to use ICT in the classroom (Kihoza, Zlotnikova, Bada, & Kalegele, 2016; Koehler, Mishra, & Cain, 2013; Ndibalema, 2014). As a result, despite government and partners continuing to equip schools with computers and the Internet the impact of these investments will not be realized as many in-service teachers do not have adequate competence and skills to properly utilize ICT in enhancing teaching and learning.

In recognizing the role of teachers in ICT integration, the government and partners have continued to improve ICT infrastructure in schools and colleges, increasing ICT awareness among teachers and learners, and increase in the use of ICT to facilitate administrative functions in schools. One of the notable efforts of the government was equipping thirty four (34) teacher training colleges with computers and Internet connection through the Swedish International Development Agency (Sida) (Hooker et al., 2011). The main aim was to ensure that pre-service teachers are trained in the use of ICT for teaching and learning so that they can use these skills in secondary schools once they graduate (Kafyulilo, Fisser, & Voogt, 2016).

Similarly, the Ministry of Education and Vocational Training (MoEVT) in collaboration with UNESCO under the support of UNESCO-China Funds-in-Trust (CFIT) developed ICT Competency Standards for Teachers in Tanzania which defines the competency outcomes and the supporting knowledge and skills that are needed in applying ICT in the educational setting (UNESCO, 2015). The framework is intended to equip teachers in Tanzania with competencies needed in the 21st century.

Moreover, the Global E-Schools and Communities Initiative (GESCI), in collaboration with The MasterCard Foundation and the government of Tanzania is embarking on a five year African Digital Schools Initiative (ADSI) initiative (2016-2020) to integrate use of technology in teaching and learning at the secondary education level. It is designed specifically to build secondary-level student 21st century skills and teachers' innovative practice in a way that is responsive to the needs of the market place and to the emerging knowledge economies and societies. The project targets ten (10) school support teams, forty (40) secondary schools, four hundred (400) teachers and approximately twenty thousand (20,000) students in Tanzania.

Therefore, this baseline study was designed to contribute towards a comprehensive program of implementing the ADSI project. The baseline study aimed to establish the baseline for school institutionalization, digital school development, development of teacher competencies and practices for ICT use in STEM, and measure learner experiences and attitudes towards the use of ICT. The study adopted UNESCO ICT-CST and TPACK to investigate teachers' competence and skills to use ICT in the classroom. This study was conducted in twenty (20) schools from two (2) regions (10 schools in each region) with a total of ninety-one (91) teachers, and one hundred thirty-three (133) students using qualitative and quantitative research methodologies.

4. The study

4.1. Purpose of the Baseline Study

The purpose of the baseline survey is to provide a benchmark for onward progression of ADSI digital school development and for ICT integration in STEM teaching and learning over the five-year period of program implementation. The ADSI program general research questions and the baseline strategic and specific objectives are outlined below.

4.2. The ADSI Program Research Questions

1. Institutionalization: What is the general context of the ADSI project in terms of the historical, education, policy and reform factors which can support or constrain the ADSI project implementation and expansion in Tanzania?
2. Digital Schools Development: What is the status of school readiness for the pedagogical integration of ICT in teaching and learning of STEM classroom practices?

- What types of policies both at school level (micro) and outside the school (macro) are in place to help inspire better and greater use of ICT in school and classroom practices?
- What have been the rollout characteristics in terms of goals, planning, supports and resources for ADSI expansion of project schools in Kenya, Tanzania and Cote d'Ivoire?

3. Teacher Development: What is the status of teacher readiness for the pedagogical integration of ICT in teaching and learning of STEM subjects?

- To what extent do teachers use ICT in STEM classroom practices?
- What is the level of teacher competency for ICT integration in professional and classroom practices?

4. Learners: What are students' attitudes toward the use of ICT in STEM lessons?

- To what extent do learners use ICT in STEM classroom activities, assignment and projects?
- To what extent do the learners improve achievement in STEM with the integration of ICT in classroom practice?

The baseline study will focus on the first questions in each domain related to the context and status of ICT use in the ADSI project schools prior to the roll-out of the intervention.

4.3. Objective of the Baseline Assignment

To establish the status and context of ICT use in STEM teaching and learning in the ADSI project schools in Tanzania.

4.4. Specific Objectives of the Baseline Study

i. Institutionalization: Establish school readiness in the use of ICT for teaching and learning

ii. Digital Schools Development: Establish the enabling conditions, needs, resources and priorities of the schools in relation to ICT in STEM teaching and learning; clarify school e- readiness; GESCI

iii. Teacher Development: Establish teacher competencies and practices for ICT use in STEM; Clarify teacher e-readiness.

iv. Student Learning: Measure learner experiences and attitudes towards the use of ICT in STEM learning inside and outside of schools'

4.5. Scope of the Work

The scope of the Baseline Study Assignment involves three main tasks:

a) Conceptualization of the research model and contextualization/development of the baseline instruments.
b) Data collection.
c) Presenting an inception report with a proposal for carrying out data baseline analysis integrating
    i. a review of literature and ADSI concept note documentation.
    ii. a review of the baseline data sets collected in the Tanzania project schools.
    iii. a proposal for mixed methods approach for the analysis of quantitative (survey) and qualitative data sets.
d) Carrying out the data analysis inclusive of
    i. Baseline data cleaning.
    ii. Baseline data analysis
e) Report write-up integrating
    i. a draft report outlines of baseline report write-up.
    ii. a final student report integrating revisions based on technical review.

5. Baseline Methodology and Research Design

The research design employed both qualitative and quantitative approaches. It involved the preparation, testing and information gathering. The qualitative approach included interview and observation as the main instruments of data collection. The data were collected from school leaders and school based coordinators through interviews. The quantitative approach involved data collection through three sets of survey questionnaires for STEM teachers and students. Finally, the baseline used observation rubric for collecting quantitative data through classroom observation from selected STEM teachers.

The baseline project conceptualization and planning was conducted in collaboration with the MoEST, Dar es Salaam University College of Education (DUCE), Tanzania Institute of Education (TIE), CoICT, and GESCI partners and involved the development of the study design and methodologies. The following sections outline the main features of the Baseline Design

5.1. Identification of Study Sites and Scope

The baseline study was carried out in two regions: Morogoro and Pwani where the ADSI project was to be implemented. The list of schools in each region is shown in Table 1.

Table 1:Name of Schools Contributing Respondents for the Study

Morogoro	Pwani
1. Bagamoyo Secondary School 2. Mandera Girls Secondary School 3. Miono High School 4. Ruvu Secondary School 5. Zogowale Secondary School 6. Kibaha Secondary School 7. Kibiti High School 8. Minaki Secondary School 9. Chole Secondary School 10. Mwinyi Secondary School	1. Nelson Mandela Secondary School 2. Mzumbe Secondary School 3. Kilakala Secondary School 4. Dakawa Secondary School 5. Uwanja wa Taifa 6. Tushikamane Secondary School 7. Sua Secondary School 8. Mgulasi Secondary School 9. Lupanga Secondary School 10. Sumaye Secondary School

5.2. Development of Study School Sample

Twenty (20) schools selected through purposeful sampling were to be studied. From 20 schools, the sample per each subject involved in the study is hereunder:

- 20 schools (10 schools in Morogoro, 10 in Pwani)
- 67 school heads in interviews
- 91 STEM teachers in teacher survey 1
- 83 STEM teachers in teacher survey 2
- 17 STEM lesson observations

- 143 Student Survey

5.3. Data Collection Tools Development

The Baseline employed five instruments covering interviews, surveys and class room observations as follows:

- Interview- 1: Head teachers and school based coordinators
- Survey- 2: STEM Teacher Questionnaire on ICT competencies
- Survey-3: Lesson Teacher Questionnaire on TPACK competencies
- Survey-4: Student questionnaire on ICT use in STEM classrooms
- Lesson Observation-5: Lesson teachers

5.4. Data Collection Training and Testing

Prior to data collection, two training sessions for all the enumerators were organized. Training of all enumerators and supervisors was held at TIE covering best practices, proper behavior, sampling protocols and the questionnaire instrument was held. A total of 16 enumerators and supervisors were involved in the training and enumerators were sent to the field in teams of four for each school. The enumerators were drawn from the CoICT and DUCE.

5.5. Data Analysis

Data cleaning and entry was a continuous process undertaken daily in the course of fieldwork. This was to ensure quality and reliability of the data. Quantitative data analysis from the questionnaires was entered into Statistical Package for the Social Sciences (SPSS) and Excel data editor. It was then cleaned to take care of inconsistencies and errors, which may have occurred during coding and entry. Analysis was undertaken by computing the necessary statistics such as means, frequencies and percentages and in some cases cross-tabulations. These were then presented in descriptive formats such as tables, graphs or narrations. Qualitative data was analyzed thematically through content analysis. This was presented through inferential narratives and anecdotal quotes.

5.6. Demographic information

5.6.1 Profile of the Schools

This baseline study was conducted in 20 schools selected for the study (10 schools in each region). The frequency of the different categories of the respondents varied across the sampled regions as shown in Table 2.

Table 2: Distribution of Survey Respondents by Region

Region	**STEM Teachers (%)**	**Lesson teachers**	**Students**
Morogoro	48%	47.60%	44.10%

Pwani	52%	52.40%	55.90%
Total	100%	100%	100%

All the schools which were involved in the study from both regions are government public schools. The study did not consider whether the schools were rural or urban, day or boarding as well as could not consider whether the schools were boys only, mixed or girls only. For the student survey, a sample of students was drawn from Form 1 to Form 6.

5.6.2 Gender

The demographic information shows that 68.4% of teachers were males while 31.6% of teachers were females. Moreover, more than half of students were females (59.9%) as shown in Table 3.

Table 3: Distribution of Respondents by Gender

STEM Teachers		Class Teachers		Students	
Male	Female	Males	Females	Males	Females
68.4%	31.6%	65.5%	34.5%	40.14%	59.86%

5.6.3 Teachers and their experience

Data shows that the teachers who participated in the study were English language teachers (26.4%) Mathematics teachers (19.8%), Chemistry teachers (19.8%) and Biology teachers (15.4%). Moreover, few teachers (1.1%) were teaching information and Computer Science subjects. Figure 1 shows the distribution of teachers per teaching subject.

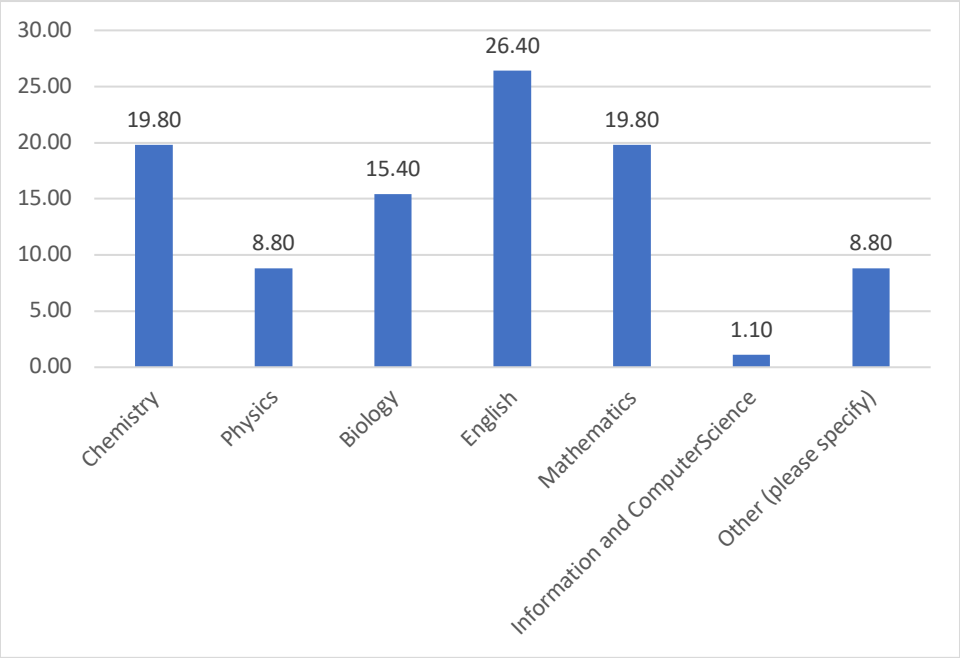

Figure 1: Distribution of Teachers per Teaching Subject (N=91).

In terms of in service duration of the teachers involved in the study, data from the study shows that the majority of teachers had teaching experience of 2-5 years (34.41%) followed by teachers with 6-10 years of teaching experience (24.73%), and finally there were teachers with 10-19 years of teaching experience (23.66%). A small number of teachers (5.38%) had a long teaching experience of over 20 years. Figure 2 shows the distribution of teachers per years of teaching experience.

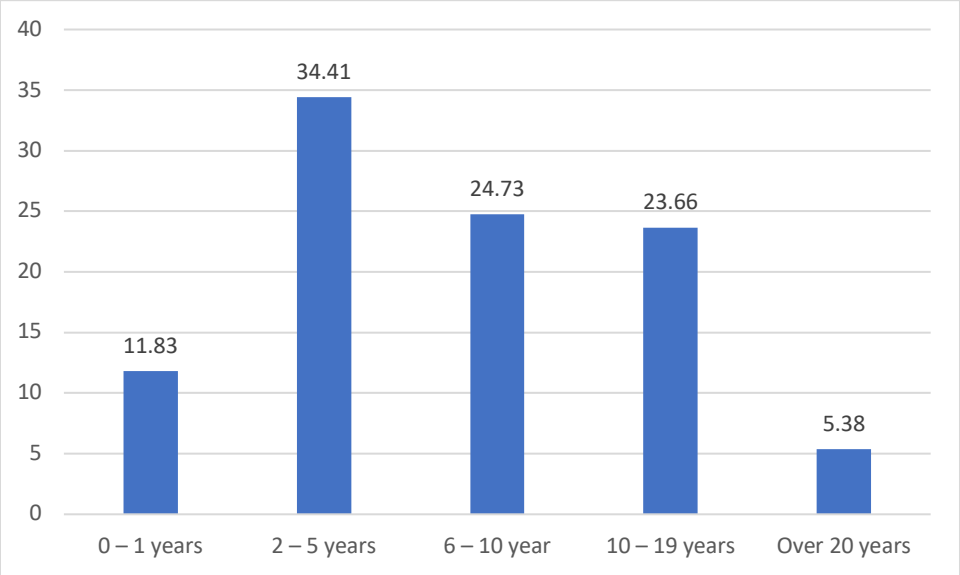

Figure 2: Distribution of teachers' teaching duration (N=91)

5.6.4 Education Level and Age Groups

The study found that the majority of teachers had bachelor degrees (78%) while a few of them had doctoral degrees and certificates of secondary education contributing to 1.1% each. It was also found that 11% of teachers had diplomas and 8.8% had master degrees from various institutions within and outside the country. In terms of age groups, the results showed that the majority of teachers who participated in the study were aged between 30 and 39 years amounting to 44.1% followed by those who were aged between 40 and 49 years amounting to 22.6%. Very few participants (1.1%) were aged below 24 years (See Figure 3).

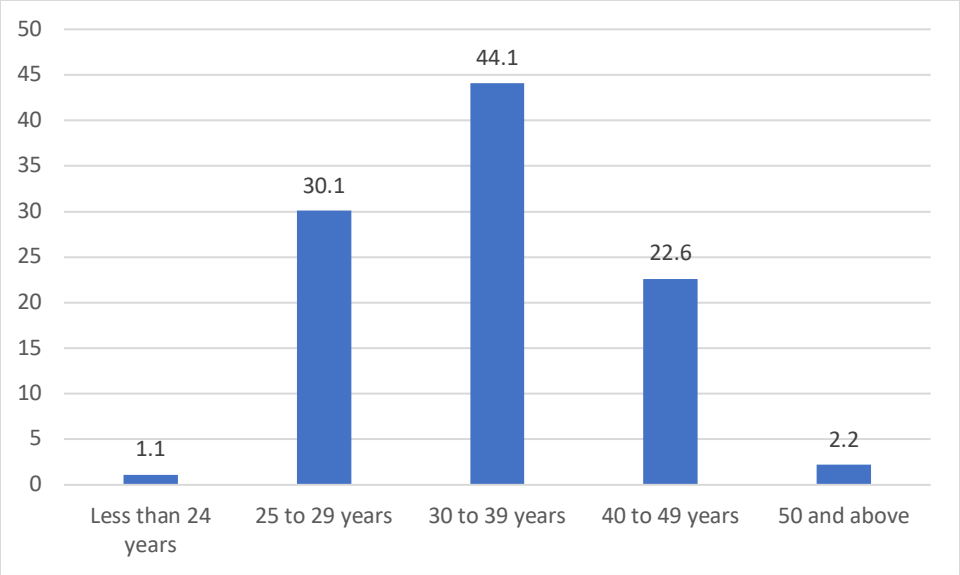

Figure 3: Distribution of Teachers per Age Group

6. Baseline Findings and Discussion

The key expected impact of the ADSI intervention is secondary schools turning into digital schools of distinction. This would encompass whole school ICT integration, innovative practice in STEM teaching and learning reflected in the acquisition of 21st Century skills, horizontal (inter and intra county and within and across schools and institutions) outreach and impact in quality teaching and learning experiences, and shared ownership.

The findings are presented in alignment with the four baseline research questions – on institutionalization, digital schools of distinction status development, teacher ICT use status and students' attitudes towards ICT in STEM.

- Findings 1 - Institutionalization
- Findings 2: Digital Schools of Distinction Development
- Findings 3: Teacher Professional Development
- Findings 4: Learners 21st Century Skills

6.1. Findings 1 - Institutionalization

Part 1 & II: Background information, Policy Goals and planning

School Vision: Leadership and Planning

The study found that the majority of school leaders had positive attitudes about their performance, discipline, and ICT use in their schools regardless of having no ICT policy to guide them. School heads, ICT coordinators, and teachers interviewed considered themselves as computer literate and aspired to improve performance and ICT use in their schools over the coming five years. In one of the schools in Morogoro Region, the head teacher had this to say:

> '*In five years, we expect to see all students and teachers being computer literate. More importantly, we plan to improve students' performance by integrating ICT in all teaching and learning activities. In addition, we aspire the school to become a centre for ICT training in Morogoro Region within five years from now.'*

The majority of heads of schools and school coordinators in the schools visited were aware of national projects (initiatives) designed to improve school performance. Some reported to have been involved in implementing some of the projects. 'Big Result Now', for instance, was mentioned by almost all heads of schools interviewed as one of such projects in their respective schools. Some schools were also involved in the iKnowledge project and with various cellular networks (Halotel, Vodacom, Tigo, etc.).

The baseline study also found that heads of schools were aware of their ICT needs and some had strategies in place to achieve their ICT goals. Meetings with parents and providing in-house training among staff members were some of the change strategies heads of schools mentioned. Some of the needs identified by the school heads included:

- More computers with reliable internet connection, projectors and other technologies
- Availability of teaching and learning materials
- Improvement of teaching methodologies using ICT
- Formal ICT trainings
- Electricity
- Computer labs

Technology Integration Solution

The baseline study sought to find out ICT projects currently present in schools and how they relate to school reforms and improvement goals. The study found that most of the teachers were using ICT for setting examinations and recording results. During interviews, school leaders revealed that there were several projects currently going on in schools regarding ICT integration. The projects mentioned include ADSI, Tanzania Communication Regulatory Authority (TCRA) program for girls schools (provide facilities such as desktop computers and printers to schools), iKnowledge (installed Internet for teachers to search online materials), ICT program 2012, CAMARA, and SME ICT. School leaders had the view that these projects fit very well in schools and are very useful in improving students' academic performance. School leaders were also aware of the advantages of ICT in their schools. They explained that technology is necessary as it simplifies search for teaching and learning material, motivates students to study and draws students' interests to the difficult subjects. One of the heads of schools in Morogoro had this to say.

> '*At the school level, we have mandatory ICT training to every teacher. Technology integration is in line with the school vision because we aim higher at ensuring that our graduates acquire requisite competencies and become good ambassadors in the community. As such, our focus in the long run is to ensure that formal ICT trainings are offered to the community around the school to make it a knowledgeable society'*

However, school leaders also aired their concern that materials (content) from the Internet are not according to the syllabus. They also had concerns with the teachers whom they said needed to be constantly encouraged to use ICT in lesson preparation and teaching.

Planning (School - Object of ICT integration)

The baseline study also sought to find out how schools planned for ICT implementation and how they communicated their implementation plans. The study found that heads of schools had various plans to facilitate ICT integration in their schools. According to the heads school support ranged from individual efforts to encourage teachers and students to use ICT in teaching and learning. Another form of support for ICT in schools included securing aid from other places to ensure that all subjects are taught using ICT technologies. The following are quotes from some of the heads of schools interviewed.

'*One of our strategies is that each teacher must buy his/her own computer and must be computer literate. Recently, Halotel has also shown interest to support our school with 10GB monthly.'* (Head of School, Morogoro Region)

'Some of our implementation plans are: first, we are planning two-hour training on ICT every week for our students. Second, teachers will no longer write examinations on the chalkboard; all tests will be processed using computers by 2019.' (Head of School, Pwani Region)

Interviews with most school heads, ICT coordinators, and teachers also revealed a range of additional ICT facilities needed in schools. The facilities needed included computers and computer rooms (labs), electricity, standby generators, projectors, scanners and whiteboards. Other needs mentioned were more pedagogical ICT training for teachers and School Websites.

'There is no special room for computers. The existing computer room was teachers' tea room. Teachers are now taking tea outside because the room is used as a computer room. Thus, a school needs a special room for keeping computers. The other challenge is that the school does not have electricity.' (Head of School, Morogoro Region)

'We have our own strategies that each teacher must buy their own computers. Every teacher must be computer literate. We also plan to have reliable electricity and construct a computer room in the school.' (Head of School, Pwani Region).

Communication (Subjects and outcomes)

The study found that many school leaders had their strategies for communicating ICT plans to teachers' management boards, parents and students. Common forms of communication channels mentioned included break (tea time) meetings, mobile phones, WhatsApp chats, e-mail, staff meetings, SMS, workshops, seminars and other forms of training. One of the heads of schools interviewed elaborated;

'We communicate through school management team - staff meetings, social networks and Emails and through general annual meetings, which are held once in every year. However, plans to students are communicated through school Baraza and students' government.' (Head of School, Morogoro Region)

Infrastructure & Resources

The study further sought to know the status of ICT infrastructure available and the kind of support that school leaders needed to effectively implement ICT projects in their schools. Findings revealed that despite the ICT support from the government and other development partners (Halotel, iKnowledge, SME ICT project, CAMARA Company, NMB, Sokoine University etc), none of the schools had computers in classrooms and the few that were available in offices were used mostly for administrative activities and for examination purposes. Very few schools had computer laboratories. All schools visited had internet problems and had no websites. Some of the interviewed school heads had this to say:

'I have received few computers from friends - Sokoine University. We had also support from Hallotel who provides us with 10GB bundle each month for wireless internet connection. Currently, our computer lab is having 20 computers; they are all working. Due to shortage of computers we have no computers in classrooms and in offices.' (Head of School, Morogoro Region)

'National Microfinance Bank (NMB) is supporting our school with computers. There is a computer lab at the school with 2 laptops and 20 desktop computers, but there are no computers in classes. We also have computers in the headmaster's office, accountant and academic office. So far, we have no internet connectivity but there are arrangements with Halotel mobile operator to connect internet at the school. The school does not have a website.' (Head of School, Pwani Region).

The baseline study also sought to find out other ICT devices available in schools. The study found out that the schools had devices such as projectors, photocopy machines, printers, phones, etc. Some of the anecdotal quotes from school heads are:

'Other ICT devices which the school own are a projector, smartboard, 4TV sets and music system. Yes, the school has a website that is used to publish information about the school. The site is updated frequently, especially when there are events. Our school received internet connection from TCRA.' (Morogoro Region)

'The school owns a projector, wireless router and a computer lab. Our school is connected with wireless but we have no school website.' (Head of School, Pwani Region)

'We have LCD projectors, LCD screens, printers and photocopier machines which are used for information management and administrative issues.' (Head of School, Pwani Region)

PART III: ICT School Supports (Curriculum, Pedagogy, Organization & Management, Community)

The baseline study needed to find out supports available to facilitate the implementation of ICT in the schools visited. The majority of school leaders revealed that schools had no ICT curriculum, nor were there any regulation for use of ICT in schools. In the majority of schools, heads of schools were responsible for setting standards for ICT use in their respective schools. In one of the schools the head teacher had this to say:

'There is syllabus in teaching ICT, some students are beginners. The computers are not loaded with content for ICT use in STEM subject. There is no portal, teachers search content online using search engine like the Google. There is a time table for ICT sessions. There are four periods per week which has to be followed. The

national examinations have no impact on the use of ICT in classes.' (Head Teacher, Morogoro Region)

We are using the National Curriculum on ICT. NO any curriculum changes the school undergone in the last few years. The school head and ICT coordinator are responsible with sets and standards for ICT use. Currently there are no formal or specified rules in the use of ICT. However, the rules and ethics on the use of ICT will be developed by 2018.' (Head Teacher, Pwani Region)

The findings further revealed that in some schools, computers were loaded with content for ICT use in STEM subject teaching while others were not. However, the baseline found out that in many schools there was no portal or a common pool where teachers and students could access resources. It was found difficult for school leaders and ICT coordinators to make a direct link regarding ICT and school academic achievement of students in the National Examinations. In one school in Pwani Region, the head of school had this to say:

'The computers at school are loaded with word, PowerPoint and other simple ICT contents. Moreover, we have received some contents from SHULE DIRECT contents-online components which enable students learn and download materials. The integration of ICT in teaching and learning is not implemented for the time being. Apparently, there is no direct connection between ICT and national examinations; and as such ICT has not direct impact on students' school progress.' (Head of School, Pwani Region)

Pedagogy Support (Tools and approaches)

The study also sought to find out if there were rules and beliefs about teaching and learning in the school, developing student knowledge using ICTs and about performance. Findings indicate that there are no specific regulations on ICT pedagogy support rather teachers are encouraged to support each other and students in the use of ICTs. The study also found that the majority of teachers are comfortable to use internet for their personal use while only a handful are comfortable to use it for teaching and learning purposes. One head of school responded that:

'Teachers are comfortable in using computers. Few teachers are using ICT in teaching and learning. Chemistry subject teacher is using ICT in classroom.' (Head of School, Pwani Region)

Heads of schools and ICT coordinators revealed that teachers use ICT to search for materials, presentation in classes using projectors, preparing and printing tests and examinations, photocopying, and in preparing lesson plans. It was also revealed during interviews that the majority of teachers and students had positive attitudes towards integrating technologies in teaching and learning despite the acute weak ICT base. One Head Teacher in Morogoro Region had the following to say:

'About 75% of teachers are positive on the use of ICT in teaching and learning and towards improving students' performance. On the other hand, 100% of students are positive and very interested in learning using technology. As I said earlier, the majority are very positive in using computers. Due to weak infrastructure, here at school very few teachers are using computers in teaching and learning.' (Head of School, Morogoro Region)

However, school leaders had mixed feelings on whether subject teachers were interested in teaching using ICT. Some teachers disclosed that they were more comfortable to use ICT to teach STEM subjects while others said they were more confident to use ICT in teaching such subjects as History, Geography, Kiswahili and other arts subjects. This may imply that actually ICT can freely be integrated across all the subjects taught in secondary schools without limitations. Nevertheless, preference to teach using technologies seems to depend on an individual teacher's ICT competence. Teachers who are well acclimatised with ICT skills are more likely to integrate ICT in their teaching than teachers who are not well exposed to technologies.

Organization and Management Support (Division of Labour)

The baseline study also sought to find out how schools were organised in terms of the division of labour on managing ICT related issues in schools. In the majority of visited schools, the Head teachers were responsible for overseeing everything regarding ICT integration in schools while ICT coordinators were responsible to ensure that ICT implementation was successful. The coordinators also reported to the heads of schools for administration, acquisition and budget allocation to run ICT units. The management of ICT and related budget to run ICT units were shared with the school boards while the subject teachers' role was limited to teaching and supervising all classroom works. Roles of ICT coordinators also included coordinating ICT projects in schools, keeping safe the ICT equipment in schools and training students on using ICTs as well as providing in-house training for other teachers. In some cases, a few schools had technical staffs who dealt with technical issues such as helping with minor repairs. They, however, expressed their concern that due to limited budget they received from the government, they focused more on providing traditional technologies such as textbooks, chalks which were less expensive compared to digital technologies**.** In some schools, academic teachers were sent for training and supported other teachers to solve minor technical problems. Here are what heads of schools said:

'There is a computer room; there is ICT coordinator who is controlling ICT facilities. Keeping all facilities and record use by teachers as well as doing minor repairs of the ICT facilities. Head of departments are responsible to supervise other teachers and make sure that all teachers teach using ICT.' (Head of School, Morogoro Region).

'The ICT coordinator is responsible for ensuring that all matters related to ICT integration in teaching and learning are accommodated. The coordinator is also responsible for internal training of teachers in ICT and maintaining the ICT infrastructure. Teachers are responsible to optimize use of digital and non-digital technologies into their teaching. They also have to ensure that students

are ICT competent. Head of departments coordinate the units ensuring that there is ICT integration in their respective departments.' (Head of School, Pwani Region)

Professional Learning Support (Community of Practice)

On the issue of whether or not teachers collaborated to support one another in implementing teaching with technology the study found that teachers supported each other. In addition, the study revealed that even ICT coordinators collaborated with subject or content teachers in implementing ICT in respective schools. The study revealed further that teachers get assistance from one another in connecting projectors, projector screens and materials for teaching and learning. The study found that the majority of teachers interviewed believe in collaborative teaching and are comfortable using computers especially in STEM subjects.

The study further showed that in some schools teacher do collaborate in creation of learning material. However, data from the baseline study revealed major barriers to full ICT integration in schools include poor physical infrastructure, lack of computer lab, lack of computers and projectors, lack of technical support and local area internet connection. Further, it was revealed that most teachers do not have training support with the exception of two schools. One head of School in Pwani Region had the following to say:

'Teachers help each other to make sure they know how to use ICT in teaching. Shortage of computers is the greatest challenge. There are many teachers amounting to 64 and 651 students. No training has been provided to teachers. But some teachers have taken self-initiatives to attend ICT course elsewhere'. (Head of School, Pwani Region)

'Teachers have been collaborating informally as they use technologies/ ICT in preparations of notes for their students. There is no formal collaboration between students and teachers in projects. The greatest barriers to ICT includes the following: infrastructures, limited fund and devices such as computers, projectors and ICT software's. Moreover, Interment connections remain another great challenge. Teachers had received training from Kamala-Swedish government and ADSI.' (Head of School, Pwani Region)

Part IV: ICT buy-in, Usage and Results

The baseline study sought to understand how school leaders visualize teachers and students' use of ADSI laptop and projector technology, school lab and what results were anticipated. Data show that there is a positive perception on the use of ICT in schools in a sense that many teachers are ready to adopt the new technologies. The majority of school heads and ICT coordinators indicate that both students and teachers will be very happy to use ADSI ICT facilities for teaching and learning. Heads of schools in the Morogoro Region said the following:

'Students have positive perception in using ICT in teaching. They are very happy. Teachers are also happy with ADSI project. Parents are not yet informed but they

will be willing to buy laptops to their kids once they are told. The income of most students' parents is good. They can manage to buy computers to their kids.' (Head of School, Morogoro Region)

'100% students are very positive about ICT, while teachers with positive perception on ICT are about 75%. The majority teachers are very positive and are keen on using ICT to teach. Students like to learn using ICT despite the fact that available technology is limited.' (Head of School, Morogoro Region)

ICT Usage (Outputs)

The baseline study also sought to find what school leaders had in mind when thinking of teaching and learning using ICT. Findings indicate that the majority of school leaders would like to see teachers and students use ICT in day to day activities. There were however varied opinions as illustrated below:

'*Students will be very quiet listening and watching the presentation so that they can see what is happening. Students will not be bored as live presentation is delivered. They will not be tired following the presentation using projector and laptop in classes.'* (Head of School, Morogoro Region)

'I would expect to see students' active participation in the lesson and completely engaged. I would also expect peer learning in place. As I said earlier, there are still some obstacles that need to be addressed to see STEM gols being realized. Drawing on the ADSI goal, my belief that the project will equip students with necessary competencies and skills in and beyond the classroom. However, to achieve this, all challenges as highlighted earlier need to be solved first.' (Head of School, Morogoro Region)

Findings further show that most heads expect change in performance, behavior of teachers and students. Heads of Schools also look forward to changing approaches to teaching and embracing teaching with technologies. Heads of schools in their general comments indicated their enthusiasm for the ADSI project and that they expected to see positive changes to be sustained via ICT integration.

'ADSI is coming with something new. We are expecting to get something new and sustainable. We are hoping to stop teaching by using chalkboard. (Hed of School, Morogoro Region). *We hope those who will be trained will teachers as well from Morogoro region'*

'I am very grateful to the ADSI team and I look forward to see how this endeavor/projects' goals unfold. Given the development of science and technology, making ICT part and parcel of teaching and learning is the call for all stakeholders in the education area. Thank you so much.' (Head of School, Morogoro Region)

6.2. Findings 2: Digital Schools of Development

Access to ICT Facilities

The effective adoption and use of ICT into classrooms depends upon the availability and accessibility of ICT facilities and the Internet. Hennessy, Harrison and Wamakote (2010) point out that if ICT cannot be accessed by teachers, it will not be used. Based on this argument, it was necessary to find out if teachers had access to various ICT facilities at their schools. Interestingly, the majority of teachers (88.8%) indicated that they had access to computers, 67.5% had access to Internet modems, and 65% had access to Liquid Crystal Display (LCD) projectors. However, a minority of teachers (19.5%) had access to radio while 11.7% had access to digital cameras (See Figure 4).

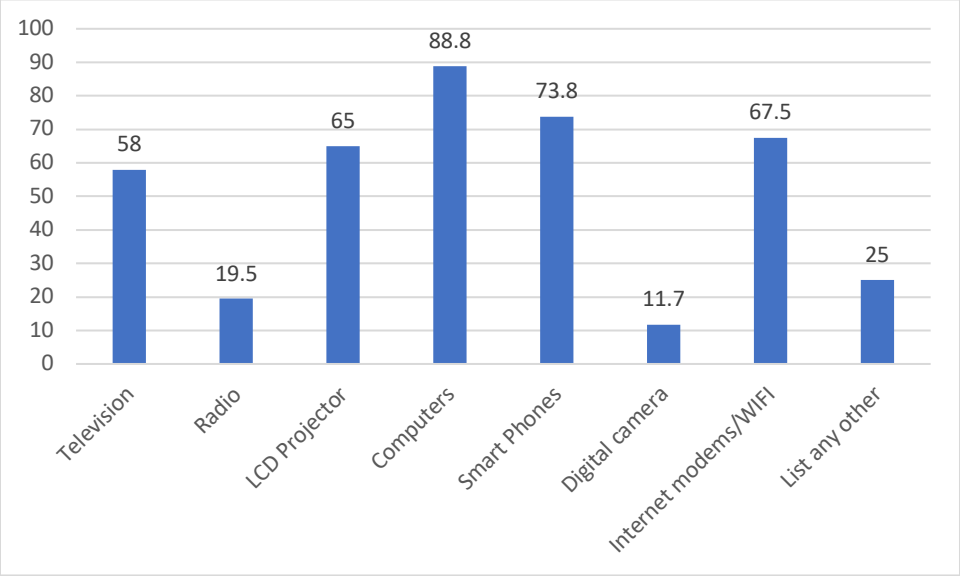

Figure 4: Teachers' Access to ICT Facilities at Schools (N=91)

These findings clearly indicate that many teachers have access to ICT facilities in their school environment. This result may be explained by the fact that the government and partners have been equipping schools with ICT facilities to improve the quality of education in secondary schools in Tanzania. A recent report by the MoEST indicates that approximately 31.4% of government secondary schools (out of 3,601) have computers ranging from 1 to 68 computers (MoEST, 2017). It is possible some of the schools participated in this study could have benefited from these initiatives. Access to ICT facilities provides a strong foundation for the introduction of ICT mediated teaching and learning in secondary schools as this is a prerequisite for ICT integration in teaching and learning.

Access to Mobile Phones

All teachers who took part in the study indicated that they had access to mobile phones. The majority of them (96.7%) indicated that they use mobile phones to access the Internet. When asked how often

did they use the Internet via their mobile phones, 44% said "always" while more than one-third (37.1%) indicated they often use it. Figure 5 shows the frequency of accessing the Internet via mobile phones.

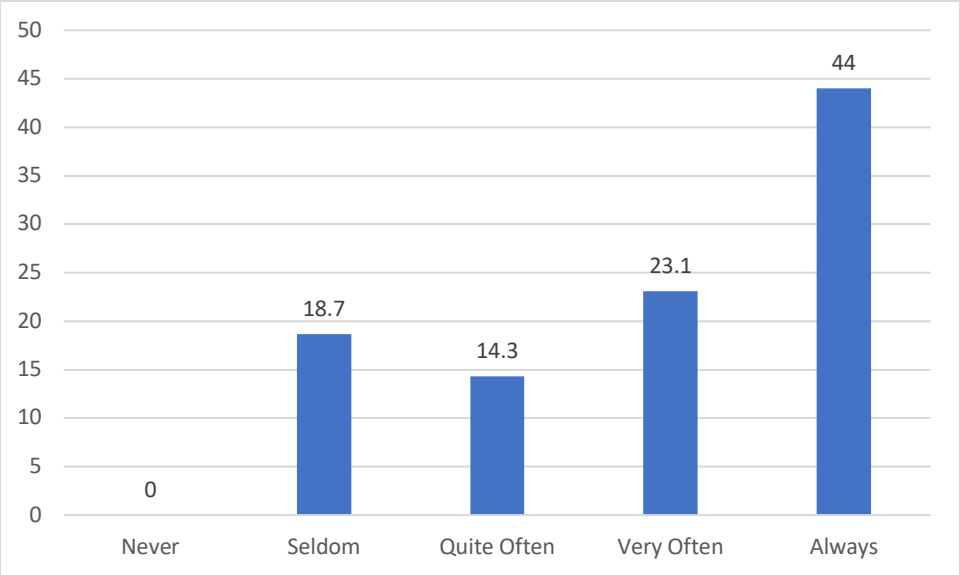

Figure 5: Frequency of Accessing the Internet via Mobile Phones. (N=91)

These results seem to be consistent with other studies conducted previously. For instance, a study research conducted to 1,137 teachers in 19 regions in Tanzania found that many teachers had smart phones of various kinds (Mtebe et al., 2016). These results are likely to be related to the fact that the cost of mobile devices such as smartphones and tablets has dropped to as low as US$ 30 and are affordable to the majority of Tanzanians (Mtebe & Kondoro, 2016). This finding calls for the government and partners to find a way in which teachers' professional development can be tailored towards using mobile devices which are already owned by teachers.

6.3. Findings 3: Teacher Development

6.3.1 ICT Usage

Use of Computers at School

Since the majority of teachers indicated that they had access to computers at school, we were further interested to find out how often teachers use these computers to facilitate teaching and learning. Out of those who indicated that they had access to computers, more than two thirds indicated that they use computers often. The distribution of the frequency of using computers is summarized in Figure 6. As indicated e previously, many schools are currently equipped with computers and therefore this finding was expected. This research extends our knowledge of teachers' access and use of computers in secondary schools in Tanzania.

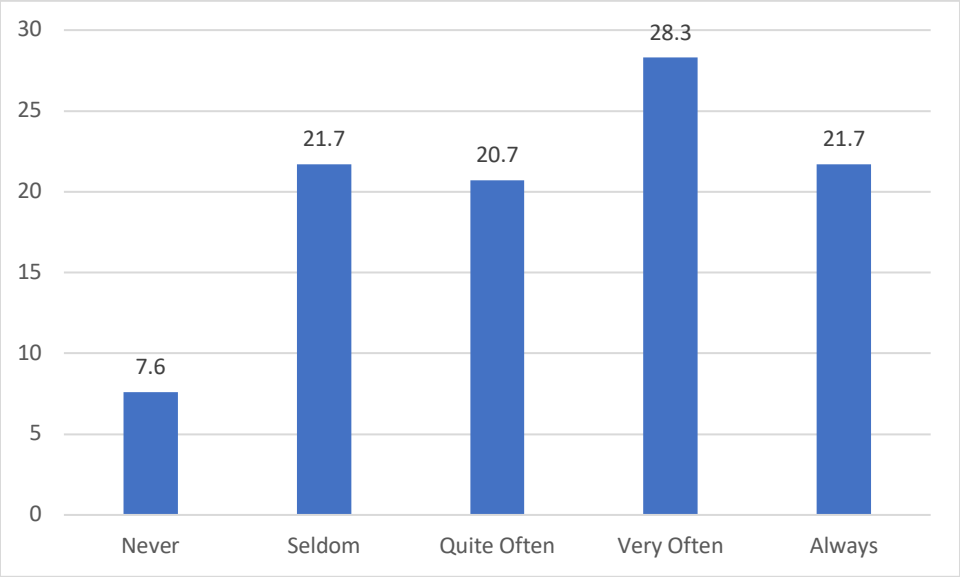

Figure 6: The Distribution of the Frequency of Using Computers (N=91).

Use of Computers and Internet at Home

The present study found that more than half of teachers (52.8%) had access to computers at home while 47.2% did not. Moreover, among the teachers who said they use computers at home, 44.6% pointed out that they use computers to access the Internet. The distribution of use of computers and Internet at home is summarized in Figure 7.

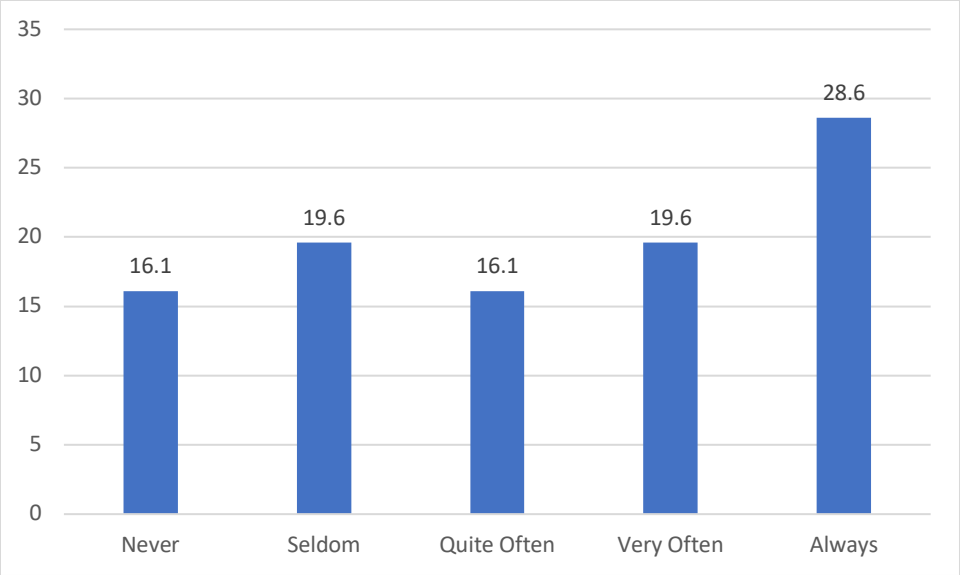

Figure 7: Distribution of Accessing Internet at Home (N=91)

This finding is in line with another study conducted at Mkwawa University College of Education (MUCE) and DUCE with a total of 386 teachers. This study found many teachers indicated that they use the Internet once per week (30.8%) or several times per week (36.5%) to access course material (Raphael & Mtebe, 2017). A possible explanation of this finding could be due to the fact the number of Internet users have increased significantly in Tanzania. For instance Internet users have increased from 29% in 2014 to 40% in 2016 (TCRA, 2017). Therefore, the findings enhance our understanding on teachers' accessibility and usage of computers and the Internet. Combining the findings from this study and others, it seems therefore that teachers have access to computers and the Internet. The main challenge that remains to be addressed is how these teachers can integrate ICT in enhancing their teaching activities and improve students' learning. The government and agencies such as GESCI should take advantage of these developments in planning for professional training in ensuring teachers have competences and skills to apply ICT in teaching and learning.

Teachers Perceived Usefulness of ICT

The perceived usefulness is the degree to which a person believes that using a particular technology would enhance his or her job performance (Davis, Bagozzi, & Warshaw, 1989). In fact, individuals would use technologies if they could see that there would be positive outcomes in their activities (Higgins & Compeau, 1995). In the context of this study, the perceived usefulness is the degree to which a teacher believes that using various ICT in the classroom will enhance teaching activities. Teacher beliefs have been identified as a 'second-order' barrier to the integration of ICT in the classroom with extrinsic barriers such as lack of resources, time, access and technical support being the first-order barriers (Ertmer, 1999). Therefore, teachers' beliefs have strong influence on teachers' attitude towards using ICT in classrooms. In this study, teachers' perceived usefulness of ICT integration in the classroom was investigated using a five Likert scale ranging from Strongly agree=5; Agree=4; Neither agree nor disagree=3; Disagree=2; Strongly disagree=1.

As indicated in Table 4, the overall level of teachers' perceptions towards using ICT in the classroom is moderate (M: 3.64 SD: 4.74). However, a detailed examination shows that mean score of one item 'ICT provide valuable resources and tools to support student learning.' is 3.82 (SD: 1.66) which is described as high. Table 4 gives the breakdown of the means for the various items under this dimension.

Table 4: Teachers Perceived Usefulness of ICT (N=91)

Response	Mean	Std. Deviation
Students' use of ICT can support student-centred learning.	3.79	1.64
ICT provide valuable resources and tools to support student learning.	3.82	1.66
ICTs can be mainly used for efficient presentations.	3.77	1.54
ICT has enormous capacity to provide benefits in the classroom (item rescaled)	3.19	1.66
Overall Perceptions	**3.64**	4.74

These results are in accord with a recent studies conducted in Kondoa District involving 80 teachers in 10 school (Ndibalema, 2014), and 29 teachers at Kisutu secondary school in Dar es Salaam (Kafyulilo et al., 2016). These two studies have found that teachers have positive attitudes towards using ICT as a pedagogical tool in enhancing teaching and learning. Generally, these results show that teachers have positive perceptions on the usefulness of ICT in supporting students' learning.

6.3.2 Evaluation of Teacher ICT Competencies 1- UNESCO ICT Competency Framework

There is a continuous debate on the competences and skills needed for teachers to integrate ICT in the classroom environment. Many frameworks and models do exist. As a result, UNESCO and China launched the UNESCO-China Funds-in-Trust (CFIT) project in 2012 to develop a framework that will be used to help African countries with teachers' competences to integrate ICT in the classroom more effectively. The 4-year initiative aimed to use ICT to boost the capacities of Ministries and key Teacher Colleges (TCs) in the area of pre- and continuous teacher training and development. Through this project, MoEVT and UNESCO reviewed the main ICT-Competency Standards for Teachers (ICT-CST) and developed ICT-Competency Standards for Teachers in Tanzania to serve as a comprehensive ICT training guide for teachers to enhance proficiency and pedagogical skills (UNESCO, 2008). It is envisaged that the ICT-Competency Standards would serve as milestones in improving quality in teaching and learning (UNESCO, 2015).

The ICT-CST was contextualized to suit country-specific needs of Tanzania and focused on the first two stages of the knowledge ladder: technology literacy and knowledge deepening (UNESCO, 2015). In this study, the UNESCO ICT-CST to evaluate teachers' ICT competences to integrate

ICT into their professional practice was adopted. More specifically, the framework emphasizes the role that ICT can play in supporting 6 major education focus areas:

- Education policy
- Curriculum and assessment
- Pedagogy
- ICT
- School organization and administration
- Teacher professional development

It should be noted that if mean scores of tests are between 1 and 2.33, the level of perception is considered as "low". If mean scores of tests are between 2.34 and 3.67, the level of perception is considered as "moderate". If mean scores of tests are between 3.68 and 5.00, the level of perception is considered as "high" (Kabakci Yurdakul et al., 2012).

Policy Awareness

The government of Tanzania has developed several policies that create a conducive environment for ICT integration in secondary education. One of the important policies is the ICT Policy for Basic Education which sets the guidelines desired to transform Tanzania to information and digital driven society (MoEVT, 2007). This was supposed to be achieved through the application of ICT at all levels of education. This policy was followed by the Education and Training Policy of 2014 that stresses the use and application of ICT in education and training at all levels of education in order to improve provision of quality education. This is evident through policy statement 3.3.5 which states that, 'The Government shall facilitate and emphasize the use of ICT in teaching and learning at all levels".

Recently, the government under the funding from the Finnish Government has formulated the National ICT Policy of 2016 replacing the ICT policy of 2003 (MWTC, 2016). The policy emphasizes on effective integration of ICT in education while calling for increased broadband access and ICT Infrastructure development. In the presence of these policies at national levels, some schools have established policies that guide ICT integration in teaching and learning. Therefore, it is important that teachers are aware of these policies and be able to specify how classroom practices correspond to and support these underlying aspirations.

In this study, teachers' awareness about the existence of ICT related policies which guide ICT integration in teaching in secondary schools and at the national levels was investigated. Out of 92 teachers who completed the questionnaires, nearly two thirds of (66.3%) indicated that they were aware of ICT policy in the schools for ICT introduction while 20.7% of teachers indicated they did not know (See Figure 8).

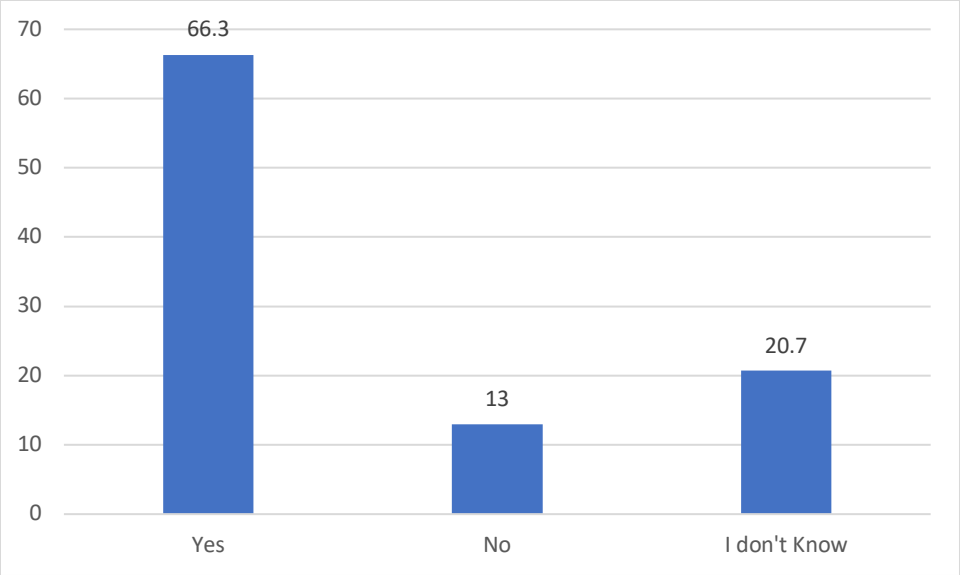

Figure 8: Teachers' awareness of existence of policies for ICT introduction (N=91)

Teachers who indicated that they are aware of policies for ICT introduction were further asked to specify the levels of policies adopted at their schools that enabled the integration of ICT in the classroom. Out of 78 teachers who responded to this question, 37.2% indicated that the policies were developed at school level while 25.6% indicated that they were aware that the policies adopted to enable ICT integration in their schools were those of the national level. However, a good number of teachers (25.6%) who were aware of existing policies at their school did not know whether the policies adopted at their school were national level polices or school level polices (See Figure 9).

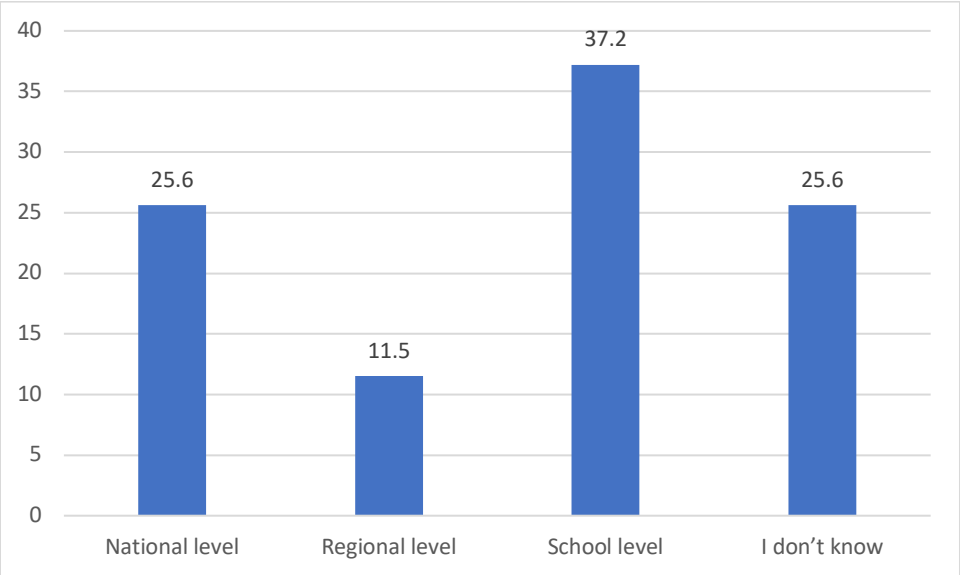

Figure 9: Teachers' Awareness of Levels of Adopted Policies for ICT Introduction (N=91)

Teachers were further asked whether they could describe how the adopted policies were implemented at their schools. Of the 83 teachers who responded to this question, more than half (57.8%) indicated that they could describe how the policies are implemented at their schools while 20.5% of respondents indicated that they were not certain whether or not they could describe the policies implemented at their schools. Moreover, a minority of teachers (21.7%) indicated that they could not describe how they policies were implemented at their schools.

Furthermore, we were interested to know if teachers were able to describe the strengths and weaknesses of any of the policies implemented at their respective schools. Of the 81 teachers who responded to this question, 54.3% indicated that they are able to describe the strengths and weaknesses of policies for ICT integration in teaching and learning at their respective schools. Moreover, 22.2% of teachers indicated that they could not describe the strengths and weaknesses of any of the policies being implemented while 23.5% of teachers indicated that they did not know if they could describe the strengths and weaknesses of any of the policy.

These results are consistent with those of Kayombo and Mlyakado (2016) conducted in 26 schools located in Tanga and Mwanza who found several gaps existing between the ICT policies and the real practice or implementation in facilitating teaching and learning. This combination of findings clearly indicates that despite the fact that some teachers are aware of existing policies, they are not aware how these policies do relate to school practices as well as to their application in the classroom environment. There is a need for the government and partners such as ADSI to assist schools in practically operationalizing of these policies in school management and teaching and learning practices.

Curriculum and Assessment

Teachers must have the knowledge of the curriculum for their subject, and the knowledge of standard assessment procedures. Moreover, teachers must be able to integrate the use of ICT into teaching, learning and assessment (UNESCO, 2015). It was important then to elicit teachers' competence in integrating ICT in the subjects they taught. To do so, teachers were asked to indicate whether they ever had used educational software related to their subject matter before.

The findings indicate that 57.1% of teachers had used educational software while 42.9% indicated that they had never used any educational software. These findings suggest that a good number of teachers do not have experience of using educational software for enhancing teaching and learning. This is further demonstrated in Table 5, where the overall mean score of teachers who use ICT in curriculum and assessment is low, i.e. 2.14 (SD 3.72). Overall, the findings indicate that many teachers' competence integrating ICT into curriculum and assessment is low. A more detailed analysis shows that many teachers had low usage of digital artifacts from student assignments as evidence of student achievement was the lowest mean score (1.76).

Table 5: Teachers' Use of ICT in Curriculum and Assessment (N=91)

Item	Mean	Std. Dev.
To what extent do you use ICTs with your students in the context of your teaching subject?	2.15	1.20
To what extent do you use educational software related to your subject matter with your students?	2.22	1.31
To what extent do you use digital artifacts from student assignments as evidence of student achievement?	1.76	1.06
To what extent do you use ICT applications to monitor, evaluate and report on student achievement?	2.41	1.33
Overall	**2.14**	***3.72***

Indicators: Large extent =5; Good extent=4; Some extent=3; Limited extent=2; Little or no extent =1

These findings indicate that although nearly half of teachers indicated they have used educational software before, the application of education software in a variety of learning situations in assessing learner'\s' understanding of key subject matter concepts, skills and processes is low. Therefore, teachers should be exposed to various education software and their application in curriculum and assessment.

Pedagogy

Teachers are required to have the knowledge of the subjects they teach and the knowledge of various ICT. However, in order to use ICT in enhancing teaching and learning, they must know where, when (as well as when not), and how to integrate ICT in classroom activities (UNESCO, 2015). Therefore, teachers were assessed on their levels of pedagogical use of ICT in the classroom. The results indicate that teachers have low levels of pedagogical use of ICT (M=2.60; SD= 2.64). Out of the three items in Table 6, the findings indicate that teachers have low levels of pedagogical use of presentation software as evidenced in the lowest mean score of 1.84. These findings are in agreement with Ndibalema (2014) who found that teachers had low familiarity of ICT use as a pedagogical tool. There is a need to help teachers with competences and skills that will enable them to design activities that engage learners with diverse needs to work collaboratively in solving real world problems.

Table 6: Teachers' Use of ICT in pedagogy (N=91)

Item	Mean	Std. Dev.
To what extent do you use presentation software in your lessons?	1.84	1.21
To what extent do you use digital resources in your lessons?	2.22	1.28

To what extent do you share your experience of ICT use with other teachers?	3.76	1.13
Overall	**2.60**	2.64

Indicators: Large extent =5; Good extent=4; Some extent=3; Limited extent=2; Little or no extent =1

ICT

The knowledge of ICT in general is very important for smooth adoption of ICT in teaching and learning. The ICT in question include multimedia software, office application, web browser and presentation software (UNESCO, 2015). Teachers were asked to indicate their knowledge in using basic software applications. Overall, teachers indicated that they had high knowledge and skills for using basic software applications (mean score 4.06 SD: 4.16).

Table 7: Teachers Use of ICT in general (N=91)

Item	Mean	Std. Dev.
To what extent do you use a word processor?	4.21	1.043
To what extent do you use presentation software?	4.12	1.172
To what extent do you use a web browser?	4.05	1.073
To what extent do you use a search engine?	4.15	1.024
To what extent do you use an email address?	3.97	1.173
To what extent do you use open educational resources?	3.86	1.134
Overall	**4.06**	**4.16**

Indicators: Large extent =5; Good extent=4; Some extent=3; Limited extent=2; Little or no extent =1

However, when they were asked to indicate specifically what they used computers for the majority of teachers (76.3%) reported to use computers to record grades and others (68.8%) use to keep students' records. A small number of teachers (21.1%) indicated that they used computers to take students' attendance. These findings match those observed earlier that many teachers have access to ICT facilities and the Internet.

Organization and Management

Teachers must be able to use basic ICT in various class situations including computer laboratory, small groups and individual activities and ensure equitable access is provided to all learners (UNESCO, 2015). Teachers were asked to indicate the extent to which they integrated ICT in the teaching activities in the classroom. The findings show that the teachers' use of ICT to facilitate teaching in the classroom is high (Mean: 4.08 SD: 4.23).

Table 8: Teachers' Responses on Organization and Management Domain (N=91)

Item	Mean	Std. Dev.
To what extent do you integrate the use of a computer lab in the teaching activities?	4.11	1.232
To what extent do you use ICT in the classroom?	3.91	1.251
To what extent do you use ICT with your students for presentations, without altering the classroom setting?	4.13	1.23
To what extent do you use ICT in the classroom for individual study?	4.16	1.124
To what extent do you use ICT in the classroom for small group activities?	4.08	1.247
Overall	**4.08**	**4.23**

Indicators: Large extent =5; Good extent=4; Some extent=3; Limited extent=2; Little or no extent =1

Professional Teacher Learning

Teachers must have the technological skills and knowledge necessary to acquire additional subject matter and pedagogical knowledge in support their own professional development (UNESCO, 2015). They must have the skills and knowledge to search various websites for teaching resources and professional development. Teachers were asked whether or not they ever used ICT to access various online resources for their individual capacity building. Interestingly, 47.78% of teachers indicated that they tend to access online courses to support their professional development while 52.22% of teachers said they did not. Moreover, teachers were asked to list at least three of the main Internet issues related to ethics. More than half of teachers (50%) indicated that they were able to list Internet issues related to ethics while 40% of teachers indicated they were unable.

The teachers also expressed their levels of competencies regarding the use of ICT in professional teacher learning. The findings indicate that teachers' levels of using ICT in professional teacher learning is high (Mean: 3.85; SD: 1.60). Table 9 shows teachers' views on their extent of use of various ICT in professional learning.

Table 9: Teachers Views on Their Professional Learning (N=91)

Item	Mean	Std. Dev.
To what extent do you use digital resources to enhance your school productivity?	3.78	1.107
To what extent do you use digital resources to learn about your subject matter?	3.92	0.991
Overall	**3.85**	1.60

Indicators: Large extent =5; Good extent=4; Some extent=3; Limited extent=2; Little or no extent =1

In conclusion, the evaluation on the competencies of teachers' use of ICT in schools and classroom practices using the ICT-CFT framework six domains as reported by the teachers were compared. Figure 10 gives an overview of how respondents reported low competencies demonstrating gaps in their perceived capacities under all the ICT-CFT domains.

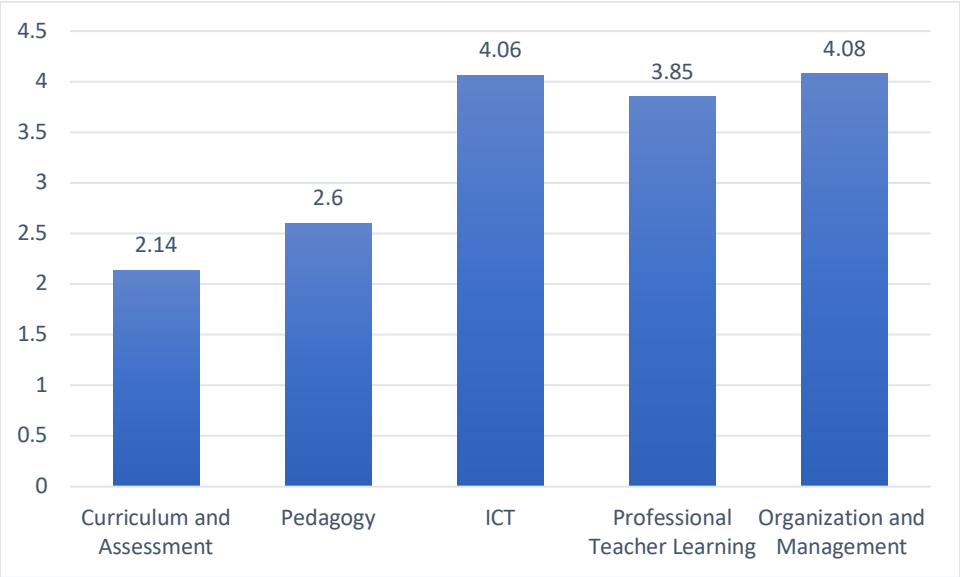

Figure 10: Competencies of Respondents Across the ICT-CFT domains (N=91)

Generally, the findings indicate that teachers in the surveyed schools have access to ICT facilities and the Internet as the mean score is high (Mean score: 4.06). Nonetheless, these teachers have low competence and skills in ICT integration in classroom environment. This is evident from the fact that curriculum and assessment, and pedagogy have low mean score compared to other elements in the ICT-CFT domains. It was interesting to note that teachers' ICT competence and skills on organization and management was higher than all other elements in the ICT-CFT domains (mean score: 4.08).

6.3.3 Evaluation of Teacher ICT Competencies 2–TPACK

Technologies have continued to be evolved and being accessible to educators in all levels of education. Teachers are now faced with a challenge on how to integrate them in the classroom in a bid to improve the quality of teaching and learning. Technologies have their own propensities, potentials, affordances, and constraints that make them more suitable for certain tasks than others (Koehler et al., 2013). Therefore, good teaching requires an understanding not only of the technology itself but also how that technology relates to the pedagogy and content. This study aimed to evaluate TPACK of the teachers in selected schools in Tanzania.

The study adopted TPACK as a conceptual framework for the knowledge base teachers need to effectively teach with technology (Voogt, Fisser, Roblin, Tondeur, & Braak, 2012). According to Koehler and Mishra (2009), this framework is the heart of good teaching with technology taking account of three core components: content, pedagogy, and technology, plus the relationships

among and between them. To understand why and how secondary school teachers use ICT to facilitate their use of diverse pedagogical strategies in the classroom, Technology Knowledge (TK), Technology Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and TPACK were investigated.

The survey was conducted among STEM teachers in the survey schools – in order to contrast the teacher self-perception of TPACK with observed TPACK in lesson practice. For all the items under the domains, a five-point Likert scale (1=strongly disagree to 5-strongly agree) was used. It should be noted that if mean scores of tests are between 1 and 2.33, the level of perception is considered as "low". If mean scores of tests are between 2.34 and 3.67, the level of perception is considered as "moderate". If mean scores of tests are between 3.68 and 5.00, the level of perception is considered as "high" (Kabakci Yurdakul et al., 2012). A total of 83 teachers participated in the study. The findings are explained next.

Technology Knowledge

In integrating ICT into the classroom, the first knowledge for any teacher is to understand how to use various technologies. This knowledge is referred to as the Technology Knowledge (TK). TK is teachers' understanding of the possibilities and constraints of a certain technology and the skills to utilize such technology efficiently in the classroom (Chai, Koh, & Tsai, 2011; Koehler et al., 2013). Based on Table 10, this study found that the overall teachers' competence levels on TK is moderate (M=3.04, SD=3.17). Generally, teachers have been found to have moderate knowledge and skills on how to use various technologies.

Table 10: Descriptive statistics of Teachers' Responses on TK (N=83)

Item	Mean	Std. Dev.
I know how to solve my own technical problems	3	0.681
I can learn technology easily	3.45	0.5
I keep up with important new technologies	3.23	0.65
I frequently play around the technology	3.05	0.714
I know a lot of different technologies	2.70	0.619
I have the technical skills I need to use technology	3.08	0.648
I have had sufficient opportunities to work with different technologies	2.75	0.602
Overall TK (M=3.04, SD=3.17)		

Technological Pedagogical Knowledge

Technological pedagogical knowledge is an understanding of the nature of teaching and learning with technology and of the benefits and disadvantages of various technologies for particular pedagogical practices (Koehler et al., 2013). This knowledge is important as it provides a platform for teachers to be able to use a suitable technology for a specified domain and nature of the students. The findings from this study show that the overall teachers perceived competence on TPK was moderate (M=3.17, SD=2.54). The finding indicates that teachers in the surveyed schools have moderate knowledge of how various ICT facilities can be used in teaching and understanding that using technology may change the way they teach various subjects despite having access to several various ICT facilities as indicated Figure 4.

Table 11:Descriptive Statistics of Teachers Responses on TPK (N=83)

Item	Mean	Std. Dev.
I can choose technologies that enhances the teaching approaches for a lesson	3.05	0.642
I can choose technologies that enhance student's learning for a lesson	2.99	0.653
My teacher education program has caused me to think deeply about how technology could influence teaching approaches I use in my classroom	3.08	0.752
I am thinking critically about how to use technology in my classroom	3.28	0.668
I can adapt the use of the technologies that I am learning about to different teaching activities	3.43	0.609
Overall TPK (M=3.17, SD= 2.54)		

Technology Content Knowledge

Technological Content knowledge (TCK) is teachers' knowledge about the technologies used within the content area (e.g. Biology, Mathematics etc.) (Koehler et al., 2013). Therefore, the knowledge about how to use technology to represent the content in different ways technologies is very important for teachers given the continued proliferation of various technologies (Chai et al., 2011). Teachers' perceived competence on TCK was found to be moderate (M= 3.03; SD= 2.22). This is to say, teachers' perceptions on their knowledge on how using a specific ICT facility can change the way learners understand and practice concepts in a specific content area is moderate (See Table 12). It should be noted that teachers need to know not just the subject matter they teach but also the manner in which the subject matter can be changed by the application a certain ICT facility (Mishra & Koehler, 2006). This knowledge is very important and is lacking amongst surveyed teachers in this study.

Table 12: Descriptive statistics of Teachers Responses on TCK (N=83)

Item	Mean	Std. Dev.
I know about the technologies I can use for understanding and doing Science	3.06	0.687
I know about the technology I can use for understanding and doing technology	2.83	0.794
I know about technologies I can use for student's understanding and doing English	3.12	0.688
I know about technologies I can use for students' understanding and doing Mathematics	3.11	0.625
Overall TCK (M= 3.03; SD= 2.22)		

Technological Pedagogical Content Knowledge (TPCK)

Teachers learned their subject matter is not necessarily the way their students will need to be taught in the 21st century. In fact, learning subject matter with technology is different from learning to teach that subject matter with technology (Niess, 2005). To effectively teach with technology, teachers the need an understanding of interactions among content, pedagogy, and technology knowledge (Koehler et al., 2013). According to Mishra and Koehler (2006),

> "TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones." (p. 1029)

Therefore, teachers' perceived knowledge on TPACK was studied. The findings revealed that teachers' perceptions on TPACK was moderate (M=2.99, SD=1.92). This is to say, teachers perceived 'know-how' to holistically integrate technology into pedagogy to support content knowledge construction is relatively moderate. Table 13 shows the descriptive statistics of the responses on TPACK.

Table 13: Descriptive statistics of Teachers Responses on TPACK (N=83)

Item	Mean	Std. Dev.
I can teach a lesson that appropriately combines science content, technologies and teaching approaches	3.05	0.77
I can teach a lesson that appropriately combines English content, technologies and teaching approaches	2.94	0.822
I can teach a lesson that appropriately combines technology content, technologies and teaching approaches	2.84	0.738
I can teach a lesson that appropriately combines Mathematics content, technologies and teaching approaches	3.13	0.651
Overall TPACK (M=2.99, SD=1.92)		

Overall Results

Overall, the teachers' self-reported confidence in their knowledge in all four components of TPACK was moderate with limited variance. The highest teachers self-reported confidence was in TPK (M=3.17, SD=2.54) and the lowest being TPACK (M=2.99, SD=1.92).

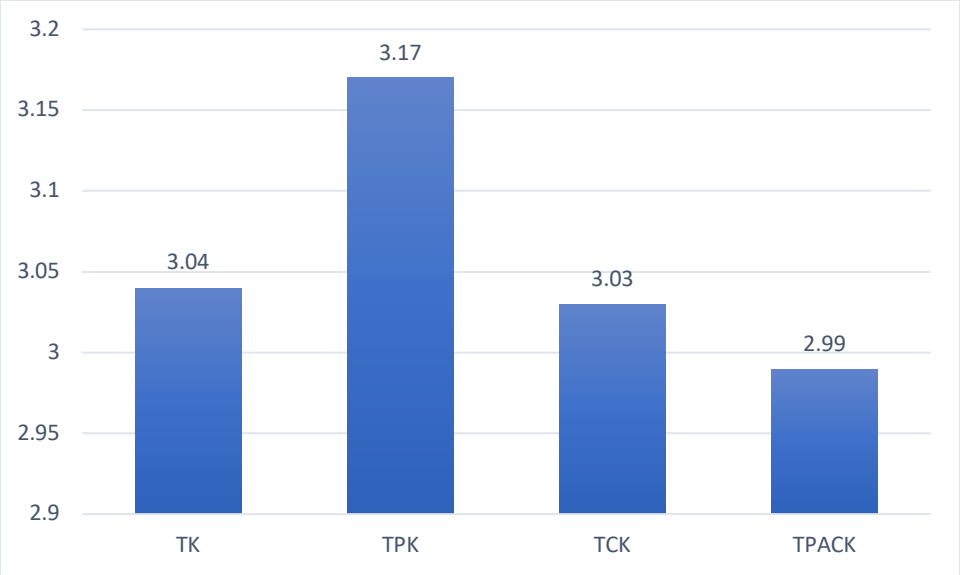

Figure 1: Descriptive Statistics of Teachers Responses on the TPACK Domains (N=83)

Generally, the findings show teachers' self-reported confidence on TPACK elements were moderate on TK, TPK, and TCK. Interestingly, TPK was found to be higher than other elements in the TPACK domain. This implies that teachers have knowledge of pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies. However, they have lowest mean score amongst TPACK elements. This shows that despite having access to ICT facilities and the Internet, as well as their affordances and constraints, teachers do not have the knowledge and skills needed for the integration of technology, content, pedagogy with their interactions in the classroom. Therefore, teachers must have a good understanding of the complex interplay between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies. This knowledge is lacking amongst teachers, stakeholders such as ADSI are argued to develop professional teachers' development programs taking this into account.

6.3.4 Teacher ICT Competencies 3- Lesson Teachers- Observation Data Analysis Model on TPACK

The study used observation to complement the quantitative data collected via self-administered questionnaire. Once teachers completed the questionnaire they proceeded to teach one of the topics in the classroom while the research team was observing. Using an observation rubric, TPACK evidence was assessed in observed instructions. The rubric instrument consisted of a four-point Likert scale: 1=Beginning, 2= Developing, 3= Approaching and 4-Ideal/Target.

Generally, the study found that teachers' observed confidence in their knowledge in all five components of TPACK was low. The Technology Logistics -Operating technologies effectively component had the lowest mean score on the TPACK domains during the lesson observations (M=1.35 SD=0.573). Interestingly, all other domains had mean score of 1.71 with various variances (See Figure 14).

Table 14: Distribution of Scores on TPACK Domains from Lessons Observed (N=17)

Item	Mean	Std. Dev.
TK (Matching technology to both curriculum and instructional strategies)	1.71	1.047
TCK (Matching technology to curriculum)	1.71	0.92
TPK (Matching technology to instructional strategies)	1.71	0.985
TPACK (considering curriculum, pedagogy and technology all together)	1.71	0.92
Technology Logistics -Operating technologies effectively	1.35	0.606

It is somewhat surprising that teachers' perceived levels of TPACK in each element was higher than the corresponding observed confidence in their knowledge. One possible source of uncertainty could be due to the small sample size used during classroom observation. Another possible explanation could be the timing of data collection as it was done in the last week of the teaching semester and many schools were doing exams. Teachers might have agreed to participate conduct observation in a rush with inadequate understanding and comprehension of what TPACK entails

Notwithstanding these limitations, this observational study adds our existing knowledge that the competences of teachers in integrating ICT into classroom is low as shown in both self-reported perceived levels and observed TPACK Domains. These findings are in line with those of previous findings that adopted the UNESCO competence framework which suggest that teachers in the surveyed schools have low competencies and skills in integrating ICT in teaching and learning. There is an urgent need for stakeholders such as ADSI to develop a comprehensive framework for professional development that will assist teachers to develop knowledge and skills about the use of ICT integration taking into account TPACK domains.

6.3.5 Teacher ICT Competences and 21st Century Competencies 4– Classroom Observation

Tanzania is striving towards an industrial economy in order to become a middle-income country by 2025. One of the pre-requisites to achieve industrialization is for educational systems to equip young people with new skills and competencies, which allow them to benefit from the emerging new forms of socialization and to contribute actively to economic development under a system where the main asset is knowledge. Our education system needs to prepare students with 21st century skills to be able to work in the agenda of the industrial economy. Nonetheless, the 21st century skills are different from 20th century skills primarily due to the emergence of ICT (Dede, 2010).

It is obvious that not only learners, but also teachers need to acquire 21st century competencies as well as become competent in supporting 21st century learning (Voogt, Erstad, Dede, & Mishra, 2013). Several conceptual frameworks for "21st Century Skills" have been developed such as Partnership for 21st Century Skills (2006), the Metiri Group and NCREL (2003), the American Association of Colleges and Universities (2007), and the Organization for Economic Cooperation

and Development (2005) (Dede, 2010). Across these frameworks it is generally agreed that collaboration, communication, digital literacy, problem solving, critical thinking, creativity and productivity are essential skills needed for 21st century students (Voogt et al., 2013).

However, this study investigated twenty-first century skills from the perspective of technological pedagogical content knowledge (TPACK) using pre-defined observation rubric tool. The observation rubric consisted of key elements of 21st century skills: critical thinking, communication, collaboration, creativity and innovation, and use of technology. The findings of the study show that teachers have low levels of ICT integration in the classroom of the 21st century skills in the lessons observed as the mean score of all elements in TPACK domain are below 2.0 (See Table 15). It should be noted that if mean scores of tests are between 1 and 2.33, the level of perception is considered as "low". If mean scores of tests are between 2.34 and 3.67, the level of perception is considered as "moderate". If mean scores of tests are between 3.68 and 5.00, the level of perception is considered as "high" (Kabakci Yurdakul et al., 2012).

Table 15: Distribution of Scores on 21st century skills from Lessons Observed (N=17)

Item	Mean	Std. Dev.
Critical Thinking	1.68	0.749
Collaboration	1.79	0.713
Communication	2	0.943
Creativity & Innovation	1.53	0.905
Technology use as learning tool	1.63	0.895

The finding from this study clearly show that teachers' competence for teaching in 21st skills environment is low. Teachers need to learn how to leverage ICT to help students learn 21st century competencies (Hennessy et al., 2010). The government and other partners such as ADSI should put emphasis on equipping teachers with competences and skills to be able to teach students in 21st century environment through various teachers' professional development trainings. While 21st century skills are emphasized in different countries' national educational goals, Tanzania is no exception. Efforts to equip teachers to be able to prepare students with necessary twenty-first century skills are important and ADSI project have a role to play.

6.4. Findings 4 – Students on ICT use in the STEM Classroom

The government of Tanzania and its partners have been making considerable efforts towards improving ICT infrastructure and the Internet in secondary schools in a bid to enhance the quality of teaching and learning. As pointed out earlier, the government through the MoEST has equipped approximately 31.4% of government secondary schools (out of 3,601) with computers ranging from 1 to 68 computers with 20.1% them being connected to the Internet (MoEST, 2017). Other notable efforts from partners include that of the Universal Communications Service Access Fund (UCSAF) which equipped 1,000 teachers with laptops in 10 districts in rural areas. British Council Tanzania donated more than 700 computers to secondary schools in various regions in Tanzania

(British Council Tanzania, 2013). Similarly, Halotel supported 400 schools and Tigo supported 700 with computers connected to the Internet in selected regions of the country (Kazoka, 2016; Tanzania TELECOMS, 2016).

Some partners have also developed various eLearning systems in order to facilitate sharing of digital content and provide interaction between teachers and students synchronously and asynchronously via the Internet. Some of these initiatives include Retooling, Shuledirect, Halostudy, and Brainshare. For instance, Halostudy has multimedia enhanced content of Science and Mathematics subjects from Form I to Form IV with more than 50,000 students accessing the content. Given these developments, this baseline study aims to find out how students in secondary school use the ICT facilities and the Internet for enhancing their learning activities. This part of the study is guided by the following research questions.

- To what extent do learners use ICT in STEM classroom activities, assignment and projects?
- To what extent do the learner improve achievement in STEM with the integration of ICT in classroom practice?

6.4.1 Student ICT Readiness

Students were asked to mention if they had used a computer before. More than half (57.45%) indicated that they have used computers with 42.55% indicated that have not used computers. Those who indicated they use computers were further asked to indicate how long they have been using these ICT facilities. The findings indicate that more than half of these students have been using computers in less than three years (See Table 16).

Table 16:: Period of Computer Use (in Years) against gender for students (N=143)

Gender	Years of Use					Total
	Less than 1 year	1-3 years	3-5 years	5-7 years	7 years or more	
Female	9	18	14	11	5	57
Male	27	26	11	13	9	86
Total	36	44	25	24	14	143

This finding was unexpected given the fact that many schools are currently equipped with computers and that many teachers indicated they have access to computers in their schools. A possible explanation of this finding could be that in the surveyed schools, some schools use computers for administrative purpose and not for teaching. Therefore, teachers have access to them and use them frequently to enhance their administrative activities but they do not use them for enhancing teaching and learning.

The findings of this investigation complement those of earlier findings that suggest the integration of ICT in the classroom is still low in many secondary schools in Tanzania. While the government

and other partners have continued to improve ICT infrastructure and equipping schools with ICT facilities, efforts are needed to ensure that teachers use ICT facilities in the classroom in order to bring the expected benefit. The starting point for ICT integration in teaching and learning should be to equip teachers with competences and skills for ICT integration in the classroom.

Since the study was conducted in two regions in Tanzania, we were also interested to compare the extent of usage between the two regions. As expected, Pwani fares more favourably in exposure to computers compared to Morogoro. A possible explanation for this might be that the proximity to Dar es Salaam could have played some part. This is summarised in Table 17.

Table 17: Period of Computer Use Against Region for Students (N=143)

Name of the region	Period of Computer Use (in Years)					Total
	Less than 1 year	1-3 years	3-5 years	5-7 years	7 years or more	
Morogoro	18	19	11	10	5	63
Pwani	18	25	14	14	9	80
Total	36	44	25	24	14	143

6.4.2 Students' Use of ICT

The increased ICT usage is an important indicator that they are improving students' learning (DeLone & McLean, 2003). If learners use ICT facilities for learning more frequently and efficiently, they are likely to improve their learning outcome. Davis, Bagozzi, and Warshaw (1989) insist that ICT cannot improve users' or organizational performance if they are not used. In this study, students were asked to indicate how often they use computers during lessons in subjects of Science, Computer Studies, English, Mathematics, Humanities and Practical subjects using five point Likert Scale (1=Never, 2-In some lessons, 3- In most lessons, 4-In every or almost every lesson I, 5-don't study this subject).

The results show that Science and Mathematics have lower mean score of computer usage (M=1.87, SD=0.87) and (M=2.03, SD=1.405) respectively. Generally, students' use of computers during lessons in subjects' ranges from low to moderate. These findings enhance understanding of our previous findings that ICT integration in the classroom is still low in the majority of secondary schools in Tanzania. In fact, teachers do not use ICT in enhancing teaching and learning in the classroom environment despite having access to ICT facilities and the Internet.

Table 18: Descriptive Statistics on the Student Responses frequency of Use of Computers during Lessons

Subject	N	Mean	Std. Dev.

Science	79	1.87	0.868
Computer studies	80	3.06	1.625
English	79	2.58	1.892
Mathematics	79	2.03	1.405
Humanities	78	2.67	1.601
Creative arts	79	2.78	1.759
Other subjects.	80	2.76	1.737

6.4.3 Student Responses on the Tasks They Have Learned to do at School

As pointed out earlier, ICT usage is a key indicator that the installed ICT facilities do bring about the intended benefits. Nonetheless, simply saying that more ICT usage will yield more benefits is insufficient (DeLone & McLean, 2003). Delone and Mclean (2003) further suggested that the nature, quality, and appropriateness of use are important outcomes, and measuring time learners have spent on the system is inadequate. Therefore, in order to bring about the intended benefit, we need to measure the intensity and quality of use of the ICT facilities by students. To this end, students were asked to identify the kind of tasks they have learnt to do at school using ICT.

Generally, the results were not encouraging as less than 40% of students indicated they have learnt to do tasks at school using ICT (See Table 19). Moreover, even those agreed to have learnt at school, only a minority of students were capable of doing some more extensive features of the ICT facilities such as using computers for presentation (11.5%), identifying trustworthy information in the Internet (16.2%), and organizing information obtained from internet sources (24.96%).

Table 19: Student Responses on Computer Task they have learnt (N=143)

Task	Yes (%)	No (%)
Identifying references to internet sources	33.6	58.56
Accessing information with a computer	38.4	53.76
Presenting information for a given audience or purpose with a computer	11.52	80.64
Working out whether to trust information from the internet	16.15	74.1
Deciding what information is relevant to include in school work	35.52	56.64
Organizing information obtained from internet sources	24.96	67.2
Deciding where to look for information about an unfamiliar topic	27.55	62.7
Looking for different types of digital information on a topic	32.64	59.52

6.4.4 Student Perceptions of Computer Usefulness

Perceived usefulness is one of the variables that may influence ICT use. People tend to use or not use the ICT when they believe it will help them perform their job better (Davis, 1989). In the context of this study, students' perceived usefulness represents the degree to which they believe

that using ICT will enable them to perform learning activities much better than before. Therefore, it was important to elicit students' perceived usefulness of ICT in facilitating learning activities. To this end, students were asked to indicate their perceived usefulness of computers in enhancing teaching and learning using five-point Likert scale (1-Strongly disagree to 5-Strongly agree). Based on findings in Table 20, overall students' perceptions of the usefulness of computers in supporting teaching and learning was high with the majority of the items having mean score above 3.0. Since many students perceive the use of ICT can enhance teaching and learning, this poses a very good opportunity for teachers and other stakeholders who plan to integrate ICT in supporting teaching and learning.

Table 20: Descriptive Statistics on the Student Perceptions of Computer Usefulness (N=143)

Item	N	Mean	Std. Dev.
It is very important for me to work with a computer	93	4.45	0.801
Learning how to us a new computer program is very easy for me	93	3.28	1.305
I think using a computer is fun	92	3.79	1.182
I have always been good at working with computers	94	2.76	1.342
It is more fun to do my work using a computer than without a computer	94	3.63	1.312
I use a computer because I am very interested in the technology	91	3.44	1.470
I know more about computers than most people my age	93	2.29	1.166
I like learning how to do new things using a computer	94	4.33	.822
I am able to give advice to others when they have problems with computers	94	3.27	1.369
I often look for new ways to do things using a computer	94	3.45	1.275
I enjoy using the internet to find out information	94	4.10	1.137

7. Limitations of the study

Timing of the study. The study was conducted in the last week of school term. This was due to the logistic delays. As a result, students were doing exams while some schools were already closed and therefore we could not get enough data for the study. Initially, we managed to get only 5 teachers in all 20 schools who completed the self-reported TPACK questionnaire. It was also difficult to conduct classroom observations as many schools were already closed or students were doing examinations. We had to wait until January when the new semester began to repeat the data collection exercise. The second data collection enabled us to get 83 respondents which was adequate for the study.

TPACK for 21 century skills. There was a miss match when teachers were evaluated on self-reported competence on TPACK elements and classroom observation for 21st century skills. The self-reported competence using TPACK was not integrated with 21st century skills. Future studies could use questionnaires that are already integrated with 21st century skills so that it can be easier to compare teachers' competence on self-reported skills and those observed in the classroom using similar instrument. Some TPACK questionnaires combined 21st century skills to be considered for future research include (e.g. Valtonen et al., 2017). Notwithstanding these limitations, the study provides a good baseline study for understanding teachers' competence and skills in adopting and using ICT to enhance teaching and learning in secondary schools in Tanzania. The conclusions and recommendations derived from this study are discussed next.

8. Conclusions and Recommendations

8.1. Status of Institutionalization of ICT in the Schools

The study found that the majority of school leaders had positive attitudes about their performance, discipline, and ICT use in their schools. School heads, ICT coordinators, and teachers considered themselves as computer literate and aspired to improve performance and ICT use in their schools over the coming five years. It was interesting to note that they are aware of national projects (initiatives) designed to improve school performance with some of them been involved in implementing some of these projects. However, some of the recommendations obtained from this study include:

- Many school heads, ICT coordinators, and teachers indicated a need to provide a range of additional ICT facilities such as computers, projectors, standby generators, scanners, and whiteboards.
- School heads and ICT coordinators should be equipped with skills to be able to develop and maintain school websites.
- Schools should select some teachers within their schools who will be trained in handling technical issues related to ICT facilities installed in their premises.

8.2. Status of Digital School Development

A large number of teachers have access to computers, mobile phones, and the Internet at school environments and at home. Moreover, teachers have shown to have positive perceptions on the usefulness of ICT as a pedagogical tool in enhancing teaching and learning. The findings of this study have a number of practical implications:

- The government and partners should continue to equip schools with computers and other ICT facilities in order to increase accessibility of these devices to teachers.
- With many teachers having access to mobile phones, there is a need to find means of utilizing the potential of mobile phones in equipping teachers with competence of ICT integration through mobile devices. Previous studies have already shown that mobile phones have the potential to be used to enhance teaching and learning in Tanzania (Mtebe, Kondoro, Kissaka, & Kibga, 2015).

The study also found that nearly half of the teachers are aware of existing national and school related policies for ICT integration in the teaching and learning. However, they are not aware how these policies relate to school practices as well as to their application in the classroom environment. It is therefore recommended that the government and partners assist schools in practically operationalizing ICT policies and relevant policies in school management and teaching and learning practices.

8.3. Status of Teacher Professional Development for ICT Integration

It is widely accepted that the success of ICT integration in the classroom depends on competence and skills of teachers to use ICT facilities as well as pedagogical skills that will enable them to

effectively integrate ICT in the classroom environment. One of the important conclusions obtained from this study based on UNESCO ICT-CST and TPACK is that the majority of teachers have moderate competence and skills to use ICT facilities in day to day activities. There is a need to continue equipping schools with ICT facilities such as computers, projectors etc. as well as training teachers on how to use these facilities.

The study also found that teachers have low competence and skills in ICT integration in classroom environments from both UNESCO ICT-CST and TPACK frameworks. The curriculum and assessment, and pedagogy elements in the ICT-CFT domains have low mean scores. Similarly, TPACK has the lowest mean score amongst all elements in the TPACK domain. Therefore, there is an urgent need for stakeholders such as ADSI to develop a comprehensive framework for professional development that will assist teachers to develop knowledge and skills about ICT integration taking into account elements in TPACK domains and ICT-CFT domains.

It is increasingly evident that the globalized economy requires employees with more that job related technical skills but also the abilities to communicate, collaborate, and demonstrate problem solving skills with people worldwide (Saavendra & Opfer, 2012). The study has found that these skills are lacking amongst teachers. Teachers need to be prepared for new pedagogical approaches that fit the 21st century, and they need to understand how ICT and pedagogy interact in order to be able to facilitate the development of 21st century competencies in their students (Voogt et al., 2013). The government and other partners such as ADSI should put emphasis on equipping teachers with competences and skills to be able to teach students in 21st century environments through various teachers' professional development trainings.

8.4. Status of Student Attitudes Towards and Use of ICT in STEM

This study found that students have low usage of computers. However, students' perceptions of the usefulness of computers in supporting teaching and learning was high. A practical implication of this finding is that is that there is a high propensity amongst students to use ICT for learning, if and when they have the appropriate ICT skills and equipment. This study recommends that:

- The government and parents should equip schools with computers and the Internet in order to increase accessibility of these facilities to students.
- Students should be trained on ICT and associated software applications that will enable them to use ICT for learning purposes.

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