A REPORT FOR

THE "AFRICAN DIGITAL SCHOOL OF DISTINCTION MODEL":

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

BY

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ABBREVIATIONS AND ACRONYMS

ADSI	African Digital Schools Initiative
BOM	Board of Management
CFT	Teachers Competency Framework
CS	Computer Studies
GESCI	Global E-School and Communities Initiative
ICT	Information and Communication Technology
ICT-CFT	ICT Competency Framework for Teachers
KCSE	Kenya Certificate of Secondary Education
KU	Kenyatta University
LCD	Liquid Crystal Display
M	Mean
N	Total count
MoE	Ministry of Education
MOEST	Ministry of Education Science and Technology
OER	Open Education Resources
PPP	Public Private Partnership
SD	Standard Deviation
STEM	Science, Technology, English and Mathematics
TCK	Technology Content Knowledge
TK	Technology Knowledge
TPACK	Technology Pedagogy and Content Knowledge
TPK	Transform Pedagogy Knowledge
UNESCO	United Nations Education Science and Cultural Organization
UoN	University of Nairobi

EXECUTIVE SUMMARY

Executive Summary

The baseline study aimed at providing a benchmark starting point for onward progression of ADSI digital school of distinction in ICT integration in STEM teaching and learning over the five-year period of programme implementation. The purpose of the study was to establish the status and context of ICT use in STEM teaching and learning in the ADSI project schools in Kenya prior to the ADSI project intervention. It focused on the following four objective areas of the ADSI project

- **Institutionalization:** The study provides information on context of the ADSI technology integration programme in terms of the institutional policy and reform factors which support or constrain the programme implementation
- **Digital Schools of Distinction:** What are the enabling conditions, needs, resources and priorities of the schools in relation to ICT in STEM teaching and learning? What is the schools' level of digital readiness?
- **Teacher Development:** What is the level of teacher competency for ICT integration in professional and classroom practices? To what extent do teachers use ICT in STEM classroom practices?
- **Student Learning:** What is the quality of student 21st century skills development and learning experiences in relation to STEM? What are student experiences and attitudes towards the use of ICT in STEM learning inside and outside of schools?

Baseline data was collected from School heads (67), School Based Coordinators (66), STEM teachers (64), STEM teachers (405) and students (638) by use of survey questionnaires, interview guides and observation schedules

Key Findings

Institutionalization: What is the general context of the ADSI technology integration programme in terms of the institutional (national, regional and school level) policy and reform factors which support or constrain the programme implementation? The head teachers and School Based Coordinators' goals and vision on the integration of ICT in the teaching of STEM subjects were summarized as:

- To be among the best performing schools
- To be a school of choice
- To improve school infrastructure
- To acquire more ICT facilities
- To ensure integration of ICT in all subjects
- To enhance ICT competency among teachers and students

- To identify ICT problems faced by teachers and students and report them to the principal.

Digital Schools Distinction: Findings of the Baseline Survey, revealed that prior to the Implementation of the ADSI Project the status of schools in terms of digital school distinction was at an initial stage. In general, schools lacked adequate resources for enabling integration of ICTs in teaching and learning STEM subjects. There was also restricted and inadequate use of existing formal resources (ICT laboratories for Computer Studies and informal resources (educational use of mobile phone, internet, and social media software). Lack of a clearly defined ICT strategy, planning and standards on the path from national to school levels meant that school heads, heads of departments or teachers themselves would independently decide what direction to take. ICT was used on peripheral areas of school productivity (student register, finances, admin) and teacher productivity (materials searches, exam paper / revision question downloads, data review trends). It was also used in an isolated space (ICT computer lab) and with specialist student target groups (CS students). School planning for ICT integration focused on computers, e-content, internet (infrastructure); teacher training (ICT skills); curriculum integration (computer studies); ICT school budget (equipment, construction); and access to ICT labs (ICT culture).

Teacher Development: Based on the findings of the Baseline Survey, it could be concluded that prior to the implementation of the ADSI Project, the status and level of teacher ICT competencies and use was at the basic level (initial level prior to technology literacy). There was general lack of skills for ICT use in lesson planning and application in the teaching of STEM subjects. Teachers' knowledge of ICT and practice was theoretically aligned to curriculum reform student centred practice, while interview narratives and observed practice identified traditional transmission modes that were influenced by examination and academic performance culture.

Student Learning: Learners level of ICT use was at the initial stage as they used the computers for basic tasks out of personal interest and did not purpose to use ICT for improvement of their performance in STEM subjects. Students expressed positive attitude towards ICT integration which gave a conducive environment for the implementation of the ADSI project whose focus in the next five years is the development of ICT skills for the 21st Century.

Conclusion

Based on the findings, the study concludes that there is no clear policy, strategy and direction to guide the integration of ICT in teaching of STEM subjects. Head Teachers and School- Based Coordinators' goals and vision were also not clear but generally focused on equipping the schools with ICT infrastructure, improving teachers' and students' skills in ICT and improving performance through integration of ICT use in all subjects.

Prior to the implementation of the ADSI project, the participating schools were at the E-initial stage in terms of Digital School of Distinction Development in all the parameters of ICT School Planning Priorities, ICT in the Curriculum, ICT School Culture, Infrastructure & Resources,

Professional Learning level of teacher ICT competencies and use. There was general inadequacy of skills for ICT use in lesson planning and application in the teaching of STEM subjects. Teachers' knowledge and practice was theoretically aligned to student centred practice. This was observed through Interview narratives and practice that identified traditional transmission modes which were largely influenced by examinations and the academic performance culture.

Recommendations

This baseline report highlights the need for a triangular approach of school leadership development, teacher professional development and development of 21st Century skills as key for effective ICT integration in secondary level schooling. Based on the findings of the study, the following recommendations are suggested for integration of ICT in learning:

Institutionalisation: The ADSI project should reinforce the dissemination of policies to create awareness among all teachers. The reason for this recommendation is that an effective ICT policy implementation strategy or framework at the school level is essential to enhance teachers' effective integration of ICT in the teaching and learning processes at classroom level. This will promote a rapid integration of ICT into the learning environment. Related to this is a recommendation that the ADSI programme at the **School level /Classroom Practice should integrate** leadership capacity for planning and vision. ADSI should leverage school affordances (opportunities and constraints) during training, workshops and continuous engagement in the ADSI project activities.

Status of Digital School Distinction: School planning for ICT integration should focus on computers, e-content, internet (infrastructure); teacher training (ICT skills); curriculum integration (computer studies); ICT school budget (equipment, construction); and access to labs (ICT culture). This is based on the fact that the overall score is very low on management and organisational structure in integrating ICT in schools. At the same time the ADSI project should promote technological infrastructure-building and human and resource development that will allow teachers to create ICT environments such as school's learning management system which will allow students to store, share and develop their work collaboratively. This should include areas for shared files, wikis and discussion forums.

Status of Teacher Professional Development for ICT Integration: The ADSI project should consider an intervention for systematically building participant capacity from a technology literacy to knowledge deepening and knowledge creation levels of ICT use along all the domains of the ICT-CFT Framework. Much attention should be given to the domain relating to organizational and management support, Pedagogy and Curriculum and assessment (the lowest report domains in teacher self-assessment). The training of teachers, including those from integrated schools, in the use of ICT for teaching and learning should be an on-going endeavor. All these efforts are in tandem with the objectives of the African Digital Schools Initiative (ADSI) project in terms of building digital school of distinction capacity for on-going teacher professional development as a life-long learning endeavour.

Student Attitudes Towards and Use of ICT: ADSI should embark on a teacher professional development scenario that will assist students acquire skills on ways to integrate ICT in their learning processes. This is one of the significant issues identified in this study. Furthermore, in **the ADSI programme implementation,** students should be encouraged to apply more ICT and refocus the use of ICT towards STEM activities inside and outside schools and use of results to improve learning and teaching and eventually impacting on their performance and development of 21st Century skills.

1. BACKGROUND – INTERNATIONAL AND KENYA CONTEXT

1.1 Introduction - International and Kenya Context

This overview presents a general context of ICT in Education in Kenya and internationally – with a specific focus on the historical, educational, policy and reform factors which could support or constrain the implementation of the African Digital Schools Initiative (ADSI) and expansion in Kenya.

The ADSI Science, Technology, English and Mathematics (STEM)[1] education focus can influence the quality of future products and services in Kenya and Africa whose creation depends on engineers, scientists, and technology experts. In the increasingly significant role of STEM education, technology is recognized as both a subject and as a tool to enhance teaching and learning so as to prepare students for their role in the knowledge and innovation-based economy (Hooker, 2017)

Countries all over the world have given a lot of attention to the STEM subjects with a view to producing students with the right skills for innovation. Such countries have also modified their curricula to accommodate the use of Technology in the STEM subjects. For example, Israel in 2010/2011 revised the science and technology curriculum of primary schools, with the goal of clearly defining the knowledge and skills every student should acquire by the time he/she finishes the final year of primary school. Moreover, the science and technology curriculum for lower secondary students was updated and schools were given more resources to deal with the requirements of this new curriculum and which was eventually applied fully to all schools (European Schools Net, 2011).

Sweden has four resource centres for teachers, funded by *Skolverket*, the Swedish National Agency for Education, each focusing on a different area in the STEM field (Physics, Chemistry, Biology and Technology). The resource centres provide in-service teacher training, various teaching materials, newsletters, conferences and other relevant pedagogical resources. (European School Net, 2011). The Dutch Freudenthal Institute for Science and Mathematics Education (FISME) aims to improve education in the fields of mathematics and the sciences, with a focus on primary, secondary and vocational education. The Institute contributes towards this aim through research, teaching, curriculum development and other services (Nihuka and Voogt, 2009).

A further good example of technology enhanced educational practices is the United States project school that introduced one-to-one laptops and trained teachers to organize teaching around students doing all their written assignments using the laptops. This system has been seen to change teachers and pupils' work with the purpose of improving the academic

[1] In the literature, the traditional STEM acronym relates to the subjects of Science, Technology, Engineering and Mathematics. However, in the ADSI intervention the STEM acronym refers to Science, Technology, English (not Engineering) and Mathematics subjects.

achievements of at-risk pupils. Research indicated that middle school students had greatly improved in their academic standards. Teachers in those schools were also able to communicate with the parents more effectively using the ICT equipment (Fisher, 2013).

Fisher (2013) indicates that ICT assists students in collaborating with peers and experts, designing products, collecting and analyzing performance data, and, in many cases, actually helping them build products. The use of ICT can enhance both the practical and theoretical aspects of STEM teaching and learning. In this aspect, Fisher (2013) identifies areas of significance for ICT use in STEM subjects such as to:

- Enhance work production through ICT tools that expedite lengthy or difficult manual processes, leaving more time for critical thinking, discussion, and data interpretation.
- Assist with collecting and analyzing data, particularly through the use of mobile fieldwork tools.
- Increase the prevalence and scope of relevant information by linking school STEM learning to contemporary knowledge and providing access to experiences not otherwise feasible.
- Improve educational outcomes through self-regulated and collaborative learning that increases student motivation and engagement.
- Increase global awareness through collaboration with field experts and international classrooms.
- Support exploration and experimentation by providing immediate, visual feedback.
- Focus attention on real-world applications of STEM concepts through relevant technologies.

ICT offers access to a wide variety of Internet resources and tools that facilitate and extend opportunities for STEM learning both inside and outside the classroom (Mulwa, 2012). ICT has contributed to networking among schools and Universities and among individuals. This has been especially true in the developed countries and is now spreading to developing countries such as Kenya. For example, the Chilean Government's educational ICT system has made a priority of connecting rural schools to the internet and thereby integrating them more tightly into the larger educational system and connecting them further to the outside world. Many schools and all universities now communicate externally largely through e- mail (European School Net, 2011).

In Kenya, a developing country which has recently achieved middle-income-country status (Brookings, 2014), promotion of ICT use in schools and other educational institutions has largely been articulated through sessional and policy papers (GOK, 2004; 2006; 2008; 2012).

- The National ICT policy (GOK, 2006) recognizes the need to strengthen and streamline training through promotion of ICT in Education at all levels especially by improving ICT curricular and ensuring that teachers and trainers at all levels acquire the necessary skills.
- The launch and focus of the country Vision 2030 (GOK, 2008), has given the Ministry of Education the responsibility for taking the lead in developing of well trained teachers at all

levels to fully participate in the knowledge economy and more so in enhancement of 21st century skills.

- Sessional paper No. 1 of 2012 (MOE and MOHEST, 2012), clearly puts into focus the role of ICT in Education as it brings many benefits to the classroom. However, it tends to put more focus on the need to have educational institutions equipped with ICT facilities for the promotion of modern tools in teaching and learning.
- The National Education Sector Support Programme 2013-2018 (MOEST, 2014) also recognizes the importance of teachers in Kenya to be provided with modern and relevant experiences in using modern methods, including ICTs in curriculum delivery and implementation.

1.2 Statement of the Problem

In Kenya ICT systems have mainly been used to collect enrolment data, student attendance, basic information on teachers and basic information on schools. In other words, ICT use mainly helps administrators get a better idea about the size of the educational system in terms of system efficiency as opposed to being used to make decisions on resource allocations and use. Good school administrations do need to use ICTs to improve school performance but there has been very little evidence that this is being done in Kenya and other developing countries at the moment (Gakuu et al., 2009). Due to these and other underlining gaps in the educational use of ICT, we can say that;

- There are many unanswered questions particularly on the fact that with much greater effort to provide computers to schools by the Government and Public Private Partnerships (PPP), the computers seem to play a minor role in the teaching / learning process in most schools. Not many of the schools in Kenya have computers central to their educational process. Not much research has been done locally in the country about this important issue. Where research has been carried out, the methodology used before may not have been appropriate, and in many cases the research may have been carried out through surveys with inconclusive results. (Gakuu et al., 2009; Keiyoro, 2010; Mulwa, 2012; Gacicio, 2013)
- Compared to international standards, the general performance of Kenyan students in Science, Technology, English and Mathematics has generally remained low (Akyeampong, 2016). In Kenya 2014 Kenya Certificate of Secondary Education (KCSE) results, students attained a mean score of 4.4019 in Chemistry, 3.666 in Maths and 5.445 in Physics out of a total aggregate of 12.000. Due to the low enrolment in Computer Studies and Aviation Technology, student attainment was better with mean scores of 7.2309 and 6.8369 respectively (KCSE Online, 2015). From these statistics, there would appear to be a notable learning crisis. This calls for a shift towards foundational and transfer skills attainment through adoption of 21st century skills (problem solving, critical thinking, collaboration, communication and creativity) and the transformative use of ICT in teaching and learning practices.

1.3 The African Digital Schools Initiative (ADSI) Context

From the literature it is clear that the biggest challenge in the 21st century will be to establish **a quality educational experience at secondary level** with competencies in Science, Technology,

English and Mathematics (STEM) subjects, (Burnett and Jayaram, 2012; Lagaarde, 2014). In Kenya the dilemma of quality provision is underlined in government strategies for the introduction of free primary education (FPE) (started in 2003) and free secondary education (FSE) (started in 2008). The strategies have resulted in major breakthroughs in expanding access and equity amidst growing concerns on the capacity of the education system to provide inclusive and quality education (Gakuu et al., 2009).

The Global E-Schools and Communities Initiative (GESCI) in partnership with the Mastercard Foundation[2] and the Ministries of Education in Kenya, Tanzania and Cote d'Ivoire is embarking on a five year **African Digital Schools Initiative (ADSI)** initiative (2016-2020) - a comprehensive multi-country multi-year programme to implement an effective, sustainable and replicable model of digital whole school development in secondary education that will lead to improved student 21st century skills development, learning outcomes and readiness for the knowledge economy workplace.

The ADSI model presents a portfolio of system- wide ICT innovation elements that can address policy coherence needs for ICT integration in teaching and learning - inclusive of: a blended learning teacher development approach, whole school involvement, school leadership capacity building, converging technologies of e-learning and m-learning, use and development of open education resources, an online repository of materials, digital school awards, accreditation and certification to incentivize ICT integration and progression, policy dialogues to raise awareness and influence new policy formulation and institutionalization of new/good practice.

The ADSI programme will involve a substantial horizontal and vertical upscale from its SIPSE[3] pilot – as in: on a geographic level across the three project countries, targeting up to 1,400 STEM teachers, 140 schools, 35 school support teams, 140 school based leads with an outreach to some 250,000 students; on an institutional level targeting government institutional co-participation from national levels (ICT, curriculum, teacher development and evaluation institutes, departments and ministries) to local levels (schools, communities, county and regional directorates) in the development and management of the project (inclusive of monitoring, evaluation and learning).

Figure 1 provides an overview of the model underpinning the ADSI intervention. The model integrates three frameworks with a basis for improving learner 21st century skills in STEM subject areas – that is building learner STEM skills in 'interpreting, analyzing and manipulating information or data to harness opportunities for sustainable development' (Akyeampong, 2016, p 7). The learner progression in acquiring ICT-STEM knowledge and skills is the main 'dependent' variable in the diagram on the premise that it is through building digital school intervention to create enabling conditions (from initial, to e-enabled to e-confident to e-mature) and teacher ICT competency capacity (from beginning to technology literacy, to

[2] Master Card Foundation at: http://www.mastercardfdn.org/fresh-ideas-to-improve-secondary-education/
[3] SIPSE – Strengthening Innovative Practice in Secondary Education – the pilot ran from 2013 to 2015

knowledge deepening to knowledge creation levels) that will ultimately lead to improve student outcomes in STEM subjects.

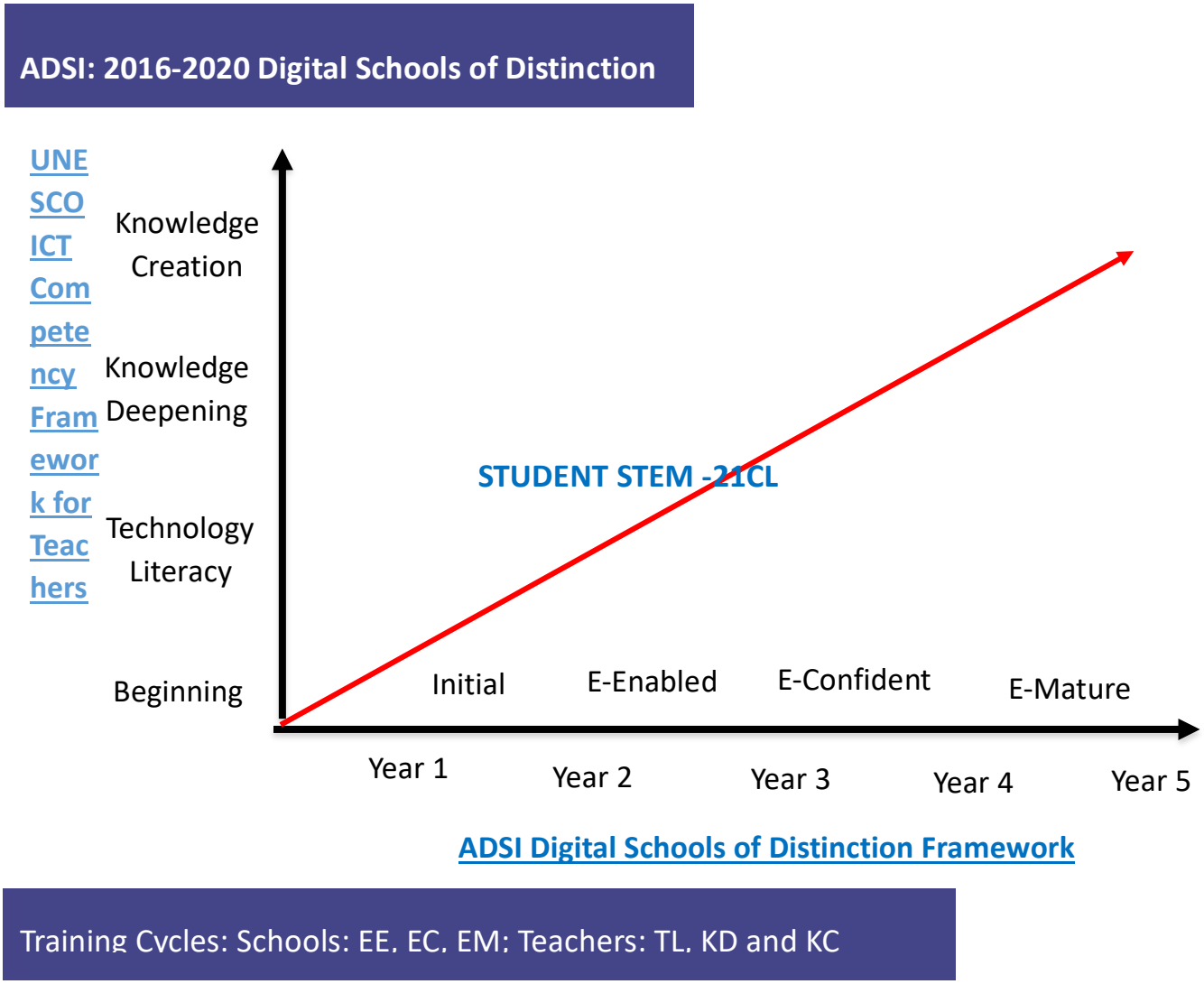

Figure 1: ADSI Model of Intervention

See appendix 1 for more information on ADSI.

1.4 Purpose of the Baseline

The purpose of the baseline survey is to provide a benchmark for onward progression in ICT use in STEM teaching and learning over the four year period in the ADSI schools.

1.5 Objectives of the Baseline Study:

Strategic Objective: To establish the status and context of ICT use in STEM teaching and learning in the ADSI project schools in Kenya

Specific Objectives:

1. **Institutionalization:** Investigate the level of institutionalisation of national strategies for the pedagogical integration of ICT use in STEM and other subject teaching and school management practices;
2. **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;
3. **Teacher Development:** Establish teacher competencies and practices for ICT use in STEM; Clarify teacher e-readiness
4. **Student Learning:** Assess learner knowledge, attitudes and experiences in the use of ICT in STEM learning inside and outside of schools

1.6 Research Questions

1. **Institutionalization:** What types of policies and school planning at school level are in place to integrate ICT use in school and classroom practices?

2. **Digital Schools of Development:** What types of school supports – curriculum, pedagogy, organization & management, teacher professional learning community are in place to support digital school of distinction development in the project schools?

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' knowledge and attitudes toward the use of ICT in STEM lessons?
    - To what extent do learners use ICT in STEM classroom activities, assignment and projects?

2. BASELINE METHODOLOGY AND RESEARCH DESIGN

The Baseline Project Conceptualization and Planning was conducted in collaboration with the Ministry of Education (MoE), the University of Nairobi (UON), Kenyatta University (KU) and Global E-Schools and Communities Initiative (GESCI) partners and involved the development of the study design and methodologies.

The research design employed a mixed qualitative and quantitative approach. The research methodology involved the following stages of preparation, testing and information gathering. Interview, survey and observation were the main instruments of data collection. There were interviews for school leaders and school based coordinators. There were three sets of survey questionnaires for STEM teachers, observed STEM lesson teachers and students. Finally, the baseline used observation tools for classroom application. These were augmented by secondary data reviews of published and unpublished resources which were relevant to the objectives of the baseline and would inform the project.

The following sections outline the main features of the Baseline Design

2.1 Identification of study sites and scope

The baseline study was carried out in the four counties in Kenya where the ADSI project was to be implemented. These were Kiambu, Nyamira, Narok and Taita Taveta counties.

The study targeted the secondary schools which had been selected to participate in the ADSI project by the ADSI technical team working with the MOEST officials. In all a total of 80 secondary schools were selected in Kenya, 20 from each of the 4 counties.

2.2 Development of study school sample

The sample size for the study was calculated based on Yamane's (1967) formula. Yamane's approach to the determination of sample size was used because the ADSI programme is engaged with a finite population of schools whose size is known. Yamane provides a simplified formula to calculate the sample size within finite populations with an assumption of 95% confidence level (P=0.5).

The formula is presented below:

$A = N/(1+Ne^2)$ where

N = sample size

E = the error of 5 percentage point

Thus, for the ADSI Baseline Study covering a finite population of 80 schools, the sample size was calculated as: $80/(1+80 \times 0.05^2) = 66.6$ schools

The baseline scope based on the sample above covered

- 17 schools in each of the four counties

- 67 school heads in interviews
- 66 School Based Coordinators
- 405 STEM teachers in teacher survey 1
- 64 STEM lesson teachers in teacher survey 2
- 56 STEM lesson observations
- 638 Student Survey

2.3 Background Characteristics of Schools and Respondents

The Baseline survey involved a total of 1296 respondents from 68 schools consisting of School Principals, School-Based Coordinators, STEM teachers, observed STEM lesson teachers and students from the project target schools whose profile is described below.

Profile of the Schools

As much as the baseline sampled roughly the same number of schools across the 4 counties, the frequency of the different categories of the respondents varied across the sampled counties. It is important to note that the sample sizes per category of respondents also differ significantly. This is presented in Table 1.

Table 1: Distribution of Survey Respondents by County

County 2.3	STEM Teachers (%)	Lesson teachers	Students
Kiambu	24%	26%	27%
Nyamira	28%	28%	26%
Taita-Taveta	23%	24%	23%
Narok	25%	22%	24%
Total	100%	100%	100%

The findings in Table 1 indicate that out of the 405 STEM teachers who participated in the Baseline survey, 24% were from Kiambu, 28% Nyamira, 23% Taita Taveta and 25% from Narok; out of 64 observed STEM lesson teachers, 26% were from Kiambu, 28% from Nyamira, 24% from Taita Taveta, 22% from Narok. Out of the 638 students, 27% were from Kiambu, 26% from Nyamira, 23% from Taita Taveta and 24% from Narok.

Gender of the Respondents

The quantitative data yielded findings on gender across the different categories. These were the STEM teachers, the observed STEM lesson teachers and the students. These findings are presented in Table 2.

Table 2: Gender of the Respondents

STEM Teachers		Class Teachers		Students	
Male	Female	Male	Female	Male	Female
67%	33%	80%	20%	45%	55%

As indicated in Table 2, there were more male (67%) than female (33%) STEM teachers, classroom teachers (80% male/20% female) while female students (55%) outnumbered their male counterparts (45%). The students were selected based on performance – an indicator perhaps of female students' progress in STEM that is not mirrored in female role model STEM teachers.

2.4 Data Collection tools development

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

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

2.5 Data Collection Training and Testing

The data collection training and testing involved the following processes:

- Development of data collectors' terms of reference and required skills
- Training of 12 data collectors from the UoN
- Piloting of the tools in the field where 2 schools from the SIPSE pilot were identified.
- Review, editing and adjustment of the piloted tools

2.6 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 the 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 analysed thematically through content analysis. This was presented through inferential narratives and anecdotal quotes.

3. BASELINE FINDINGS AND DISCUSSION

3.1 Introduction

The key impact expected from the ADSI intervention is secondary schools in project zones becoming Digital Schools of Distinction (DSD). This would encompass whole school ICT integration, innovation practice in STEM teaching and learning, horizontal (inter and intra county) and (within and across schools and institutions) outreach, impact in quality teaching and learning experiences, and shared ownership.

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

3.2 Findings 1 – Institutionalization

The baseline research questions on institutionalization referred to, *what types of policies and planning at school level (micro) are in place to integrate ICT use in school and classroom practices?*

The findings from interviews with school leaders pointed out their perceptions of ICT as an aid in the improvement of student performance in exams at the school and to enhance efficiency in not only teaching but also running the school. One of the anecdotal quotes from the head teacher interviews is below:

> *"Students are excited and motivated to learn. Teachers download content for their regular teaching, making teaching effective. Using ICT facilitates tracking of students' transition rate. Students can also access and download revision materials through ICT." (Head teacher quote)*

Head teacher vision for ICT integration included the following themes:

- To be among the best performing schools
- To be a school of choice
- To improve school infrastructure
- More ICT facilities acquisition

The school based coordinators concurred in their assessment of the importance of ICT in school practices. For them, they saw their role as that of ensuring technology integration in teaching of all subjects. For this to happen, they saw the need to enhance ICT competency among teachers and students and ensure digital equipment is available. They also saw their role in terms of facilitating frequent training of teachers on ICT use as well as supervision and monitoring use and handing of ICT tools. They believed frequent training of teachers would help change teachers' attitude towards ICT. Being the link between the school and other stakeholders, they believed they should be further mandated to ensure that schools have the necessary data bank for curriculum implementation.

"Make student and teachers ICT compliant…Using ICT in teaching and learning is in line with government policy on digitization… ICT is the pillar for industrialization, hence important for both teachers and students" (SBC quotes)

The school based coordinator goals for ICT integration included the following themes across the schools:

- Ensure ICT integration in teaching of all subjects
- Enhance ICT competency among teachers and students
- Identify ICT problems faced by teachers and students and report them to the principal

3.3 Findings 2 – Digital School of Distinction Development

The baseline research questions on the domain focused on, *what are the supports and resources – curriculum, pedagogy, organization & management, teacher professional learning community are in place to support digital school of distinction development in the ADSI project schools in Kenya?*

ICT should be among the needs, resources and priorities of the schools in relation to ICT in STEM teaching and learning. Apart from the resources, an important indicator is the extent to which the school is e-ready. One of the critical areas in the development of digital schools is the access to ICT resources in school for purposes of teaching STEM subjects. Table 3 presents a summary of the findings on access to different ICT resources in schools by STEM teachers.

Table 3: Access to types of ICT technologies in your school for teaching and learning purposes

ICT technology item	Count	% Responses	% Cases
Computers	341	19.2	86.8
LCD Projector	297	16.7	75.6
Smart Phones	293	16.5	74.6
Television	265	14.9	67.4
Internet modems/WIFI	209	11.8	53.2
Radio	199	11.2	50.6
Digital camera	150	8.5	38.2
List any other	20	1.1	5.1
Total	1,774	100	451.4

This was a multi-response item. Therefore, the analysis provides the proportion the response contributes to the overall picture. The findings indicate that computers occupy the highest position in ICT equipment for learning across all the schools that were sampled. Digital cameras are not available for the same purposes. Findings from interviews provide some inferential connection for this scenario. According to school based coordinators and school leaders, digital cameras are not considered part of the ICT infrastructure for teaching.

Findings from the interviews with the school leadership reveal that some of the schools have an enabling environment for the integration of ICTs in teaching and learning. For instance, the schools have purchased computers and constructed computer laboratories. Some of them have

also organised workshops for their STEM and class teachers. Electricity connection is important for ICT in schools. Most of the schools have electricity and a backup generator in case of power outage. Some have actually introduced computer literacy classes for students, though this is not an examinable subject.

> *"Work with the BOM to get more ICT resources, get support to train teachers on how to integrate ICT in the class, ask the ICT teacher to create an ICT plan / curriculum for the school" (School Principal quote).*

The following are some of the themes identified from head teacher and school based coordinator interviews on priorities for creating enabling conditions for ICT use:

- *Professional Learning*
    - Provision of training to teachers
    - Allowing teachers to attend workshops in ICT
- *Infrastructure & resources*
    - Upgrade facilities and equipment
    - Ensure repair and maintenance
- *ICT school culture*
    - Make computers accessible to teachers and students
    - Change attitude of staff, students & parents to ICT integration
- *ICT across the curriculum*
    - Introduce computer studies as a subject
    - Timetable adjustment to incorporate CS
- *Leadership & planning*
    - Include ICT in the school budget
    - Follow-up the implementation strategies laid out

3.4 Findings 3 – Teacher Professional Development

The baseline research questions in this domain focused on, *what is the status of teacher readiness for the pedagogical integration of ICT in teaching and learning of STEM subjects?*

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

3.4.1 Status of Teacher Readiness for ICT Use

Number of Years of Teaching

For STEM teachers, the number of years spent is a significant, though indirect pointer to the success in using ICT for teaching STEM. Figure 2 indicates the number of years of teaching for STEM teachers in the baseline schools.

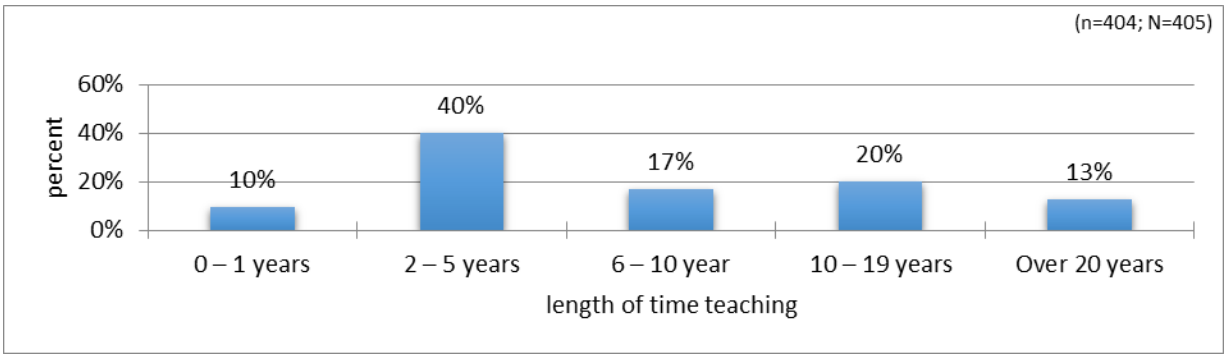

Figure 2: The number of years of Teaching for STEM Teachers

These findings do not present a normal distribution curve. The highest proportion of teachers (at 40%) have taught between 2 and 5 years. Those who have taught less than 1 year constitute the smallest proportion (10%). Some 67% of the teachers have up to 10 years teaching experience – a high population of young teachers. These findings become important when analysed against other variables such as exposure to ICT facilities or ability to use a computer.

Teacher Personal Access to ICT

Individual access to ICT infrastructure at home and school for both students and teachers is important in measuring their ability to utilize ICT in learning and teaching. As a starting point, ownership of mobile phones and personal computers provide the foundation of gaining such insights. The findings indicate that more than half (54%) of the teachers have personal computers compared to 45% who do not have. For those with personal computers, access to internet at home is tied at 50% for those with access and those without. Frequency of access to the internet is also important. The findings on this are presented in Figure 3.

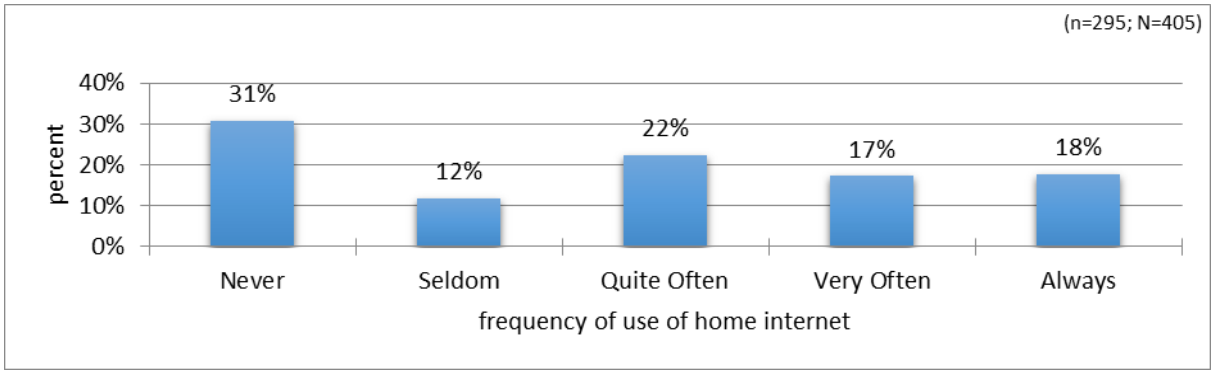

Figure 3: Frequency of teacher internet use on personal computer at home

On ownership of personal mobile phones, 99% of teachers indicated they owned one while 1% did not have any. Furthermore, access to the internet on personal mobile phones stood at 97%. As indicated in Figure 4, almost half (45%) of those who have mobile phones indicated that they always access internet on their handsets.

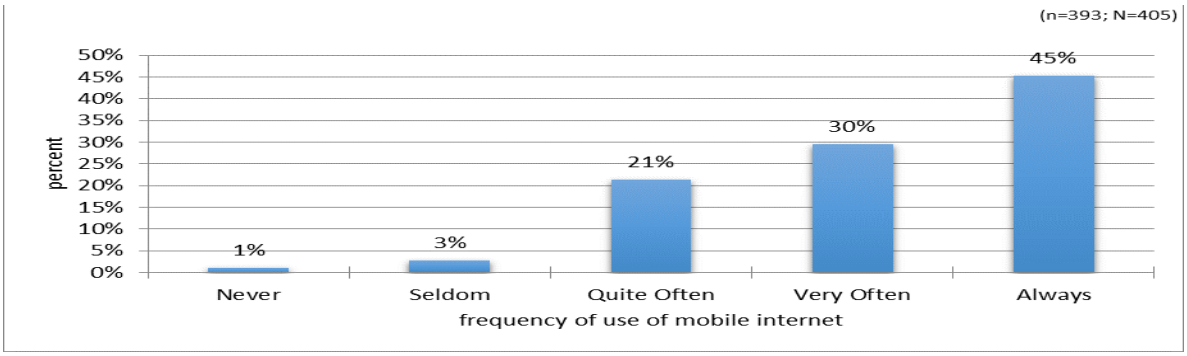

Figure 4: Frequency of the teacher use internet on personal mobile phone

3.4.2 Teacher Use of ICT

As indicated in Table 4, the baseline sought to find out if STEM teachers were able to perform certain tasks by themselves with the use of ICT for the purposes of professional practices.

Table 3: Ability to perform tasks on the computer

computer proficiency	1 =I do not know how (%)	2	3= I could work out how (%)	4	5=I know how (%)	Total (%)	Mean
Producing a letter using a word processing programme	7.90	6.30	13.90	8.70	63.30	100.00	4.13
Emailing a file as an attachment	12.10	8.90	15.80	9.20	53.90	100.00	3.84
Storing your digital photos on a computer	11.40	8.20	13.80	12.20	54.50	100.00	3.9
Filing digital documents in folders	11.40	6.10	18.40	10.10	54.00	100.00	3.89
Monitoring students' progress	9.50	10.90	28.10	15.60	35.80	100.00	3.57
Using a spreadsheet	20.10	11.80	26.20	11.50	30.50	100.00	3.21
Contributing to a discussion forum on the internet	18.80	12.40	23.00	13.00	32.80	100.00	3.29
Producing presentations	20.40	11.80	25.50	11.00	31.40	100.00	3.21
Using the internet/ mobile phone for online purchases and payments	11.90	7.40	18.50	11.10	51.10	100.00	3.82
Preparing lessons that involve the use of ICT by students	19.00	12.70	26.10	15.30	26.90	100.00	3.18
Finding useful teaching resources on the internet	6.10	7.40	18.50	15.30	52.60	100.00	4.01
Assessing student learning	14.60	16.40	29.60	12.40	27.00	100.00	3.21
Collaborating with others using shared resources such as Google docs	19.50	13.20	22.20	16.10	29.00	100.00	3.22
Installing software	36.50	10.10	15.90	6.90	30.70	100.00	2.85

Analysis of the findings as presented in Table 4 indicate that use of a word processing programme ranks highest among tasks which teachers could perform on their own. The lowest is installing software, yet this is the most technical of tasks. The implication is that more efforts should be put in training teachers on the more technical aspects of ICT use in schools. This will

not only enhance ICT knowledge and its application among teachers, it will also provide a proper foundation for the integration of ICT in teaching and learning in schools.

Apart from knowing how to perform certain computer tasks on their own, STEM teachers were also asked to indicate how well they could perform the same tasks by themselves. The findings are presented in Table 5.

Table 4: Application of Computer Tasks

computer proficiency	1 =I do not know how (%)	2	3= I could work out how (%)	4	5=I know how (%)	Total (%)	Mean
Producing a letter using a word processing programme	7.90	6.30	13.90	8.70	63.30	100.00	4.13
Emailing a file as an attachment	12.10	8.90	15.80	9.20	53.90	100.00	3.84
Storing your digital photos on a computer	11.40	8.20	13.80	12.20	54.50	100.00	3.9
Filing digital documents in folders	11.40	6.10	18.40	10.10	54.00	100.00	3.89
Monitoring students' progress	9.50	10.90	28.10	15.60	35.80	100.00	3.57
Using a spreadsheet	20.10	11.80	26.20	11.50	30.50	100.00	3.21
Contributing to a discussion forum on the internet	18.80	12.40	23.00	13.00	32.80	100.00	3.29
Producing presentations	20.40	11.80	25.50	11.00	31.40	100.00	3.21
Using the internet/ mobile phone for online purchases and payments	11.90	7.40	18.50	11.10	51.10	100.00	3.82
Preparing lessons that involve the use of ICT by students	19.00	12.70	26.10	15.30	26.90	100.00	3.18
Finding useful teaching resources on the internet	6.10	7.40	18.50	15.30	52.60	100.00	4.01
Assessing student learning	14.60	16.40	29.60	12.40	27.00	100.00	3.21
Collaborating with others using shared resources such as Google docs	19.50	13.20	22.20	16.10	29.00	100.00	3.22
Installing software	36.50	10.10	15.90	6.90	30.70	100.00	2.85

3.4.3 – On Teacher ICT Competencies 1

ICT Teacher Competency Framework (ICT-CFT) - Technology Literacy Level

The present study employed a situational assessment that integrated the UNESCO ICT-CFT framework to evaluate the general competencies of teachers' use of ICT in schools and classroom practices. The ICT-CFT framework illustrates the role ICT can play in supporting six major areas of a teacher's work: awareness of ICT policy in education, curriculum and assessment, pedagogy, ICT, organization and administration and teacher professional learning. The methodology employed in the study encompassed the collection and analysis of data along the six domains of the ICT-CFIT framework; the findings are presented in the following sections.

ICT Policy:

The first domain of evaluation focused on teachers' perceptions about the existence and implementation of ICT policy in the educational system and in their schools. The purpose was to explore whether there exists specific policies and clear strategies that support ICT implementation in the teaching and learning processes and to what extent teachers were aware of them. Out of 399 teachers who responded to the question, the majority of 303 representing about 75.9% indicated that there is a policy for introducing ICT in schools; 61 representing about 15.3% indicated that's such a policy was not in existence while 35 representing 8.8% indicated they did not know of the existence of such a policy. The majority of 61.7% respondents reiterated that the policy is at school level; 2.4% and 21.9% indicated it was at the regional and national level respectively while 14.1% did not know at what level the policy was operating (See figure 2).

Teachers were further asked to indicate if they would be able to describe whether the policy was being implemented in their schools as well as the strengths and weaknesses. Among the respondents, 55.3% indicated they could describe how the policy is being implemented in their schools while 30.3% responded negatively. A good number of the respondents (about 60%) added that they could describe the strengths and weaknesses of the policy. While about 29% indicated they could not describe the strengths and weaknesses, about 11% could not tell what they could do. Figure 5 gives an overview of how respondents perceived ICT policy existence and awareness in the study.

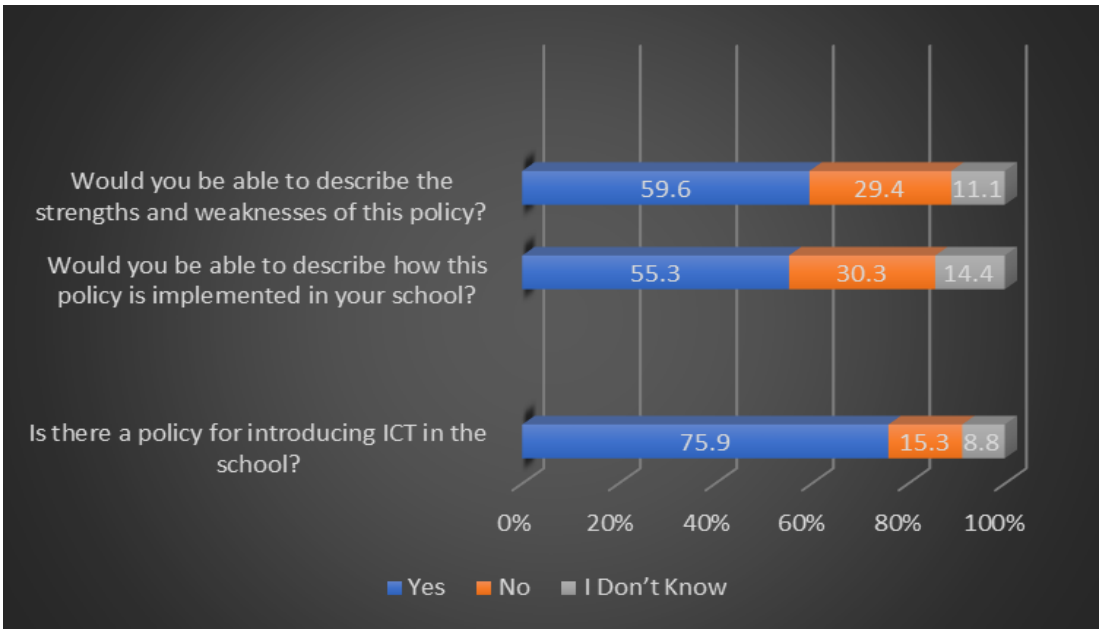

Figure 5: Teachers Views on ICT Policy Awareness in Education

In Figure 6, teacher responses on the levels they perceive implementation of ICT policy is reported.

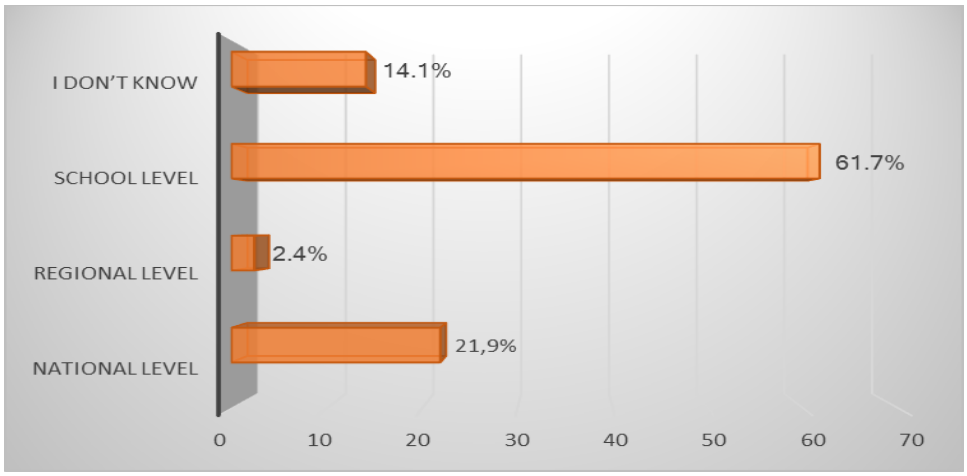

Figure 6: Teachers Views on Levels of Implementation of ICT Policy

The findings in Figure 6 seem to suggest that most of the respondents' views on level of ICT policy implementation is functional at the school level. What needs to be done however, is for the ADSI project to reinforce the dissemination of such policies to create awareness among all teachers. This is because an effective ICT policy implementation strategy or framework at school level is essential to enhance teachers' effective integration of ICT in the teaching and learning processes at classroom level. This will promote a rapid integration of ICT into the learning environment.

The teachers also expressed their views on some ICT practices that can be enhanced by an ICT policy. The results showed overall perceptions on an indicator range of strongly agree=5; Agree=4; Neither agree nor disagree=3; Disagree=2; Strongly disagree=1 to lie on a mean score of 3.12 (SD= 1.623) (i.e. approximately "neither agree or disagree").

Table 5: Perceived Usefulness of ICT Policy by Teachers

Response	Mean	Std. Deviation
Students' use of ICTs can support student-centred learning.	3.45	1.726
ICTs provide valuable resources and tools to support student learning.	3.44	1.785
ICTs can be mainly used for efficient presentations.	3.34	1.726
ICTs has enormous capacity to provide benefits in the classroom	2.76	1.593
Overall Perceptions	**3.12**	1.623

Indicators: Strongly agree=5; Agree=4; Neither agree nor disagree=3; Disagree=2; Strongly disagree=1

This would indicate a level of teacher uncertainty as to the value of ICT policy for influencing educational practice. Table 5 gives the breakdown of the means for the various items under this dimension.

Curriculum and Assessment:

Central to this domain, the study sought to evaluate baseline approaches to curriculum development and implementation of the teachers including developing ICT skills in different contexts, and incorporating in subjects a range of relevant ICT resources and productivity tools. A relatively good number of the teachers (about 60%) indicated having used an educational software which is related to their subject area. However, a very small number (about 30%) reported on the use of ICT by their students in mastering subjects taught.

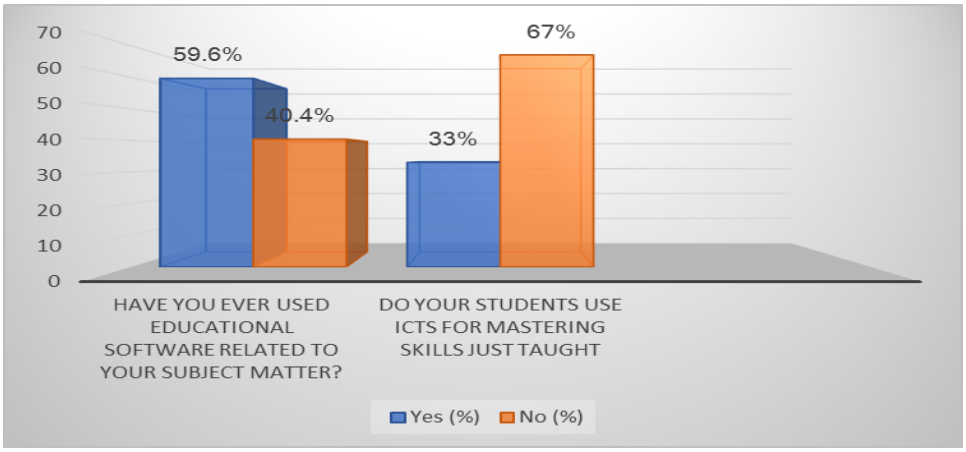

Figure 7: Teachers' Perceptions on ICT usage in their Subject taught

In general, however, the results point to low levels of teachers' use of ICT in curriculum and assessment in their various classrooms. This is reflected in their assessment of the extent of their current engagement in developing and implementing their curricula assessment with ICT. Table 7 shows an overall reported low mean score (M=2.39; SD= 1.011) of teachers' use of ICT in curriculum and assessment.

Table 6: Teachers Use of ICT in Curriculum and Assessment

Item	Mean	Std. Deviation
To what extent do you use ICTs with your students in the context of your teaching subject?	2.58	1.276
To what extent do you use educational software related to your subject matter with your students?	2.32	1.257
To what extent do you use digital artifacts from student assignments as evidence of student achievement?	1.78	1.186
To what extent do you use ICT applications to monitor, evaluate and report on student achievement?	2.89	1.541
Overall use of ICT in Curriculum and Assessment	***2.39***	***1.011***

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

Pedagogy:
The domain also sought to explore to what extent existing pedagogical practices employed by teachers adopted ICT techniques during the baseline study. The results indicate overall teacher low self-report on pedagogical practices (M=2.38; SD= 1.088) that have involved integration of various technologies, tools and digital content (such as videos, internet open education resources, social media) as part of whole class, group, and individual teacher activities that support instruction. Table 8 shows an overview of the teachers' responses.

Table 7: Teachers Use of ICT in Pedagogy

Item	Mean	Std. Deviation
To what extent do you use presentation software in your lessons?	2.11	1.267
To what extent do you use digital resources in your lessons?	2.38	1.235
To what extent do you share your experience of ICT use with other teachers?	2.66	1.304
Overall use of ICT in Pedagogy	2.38	1.088

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

The report seems to suggest that traditional forms of pedagogy supported by traditional resources dominate teaching among teachers in this context. This was reiterated by most teachers; a relatively high number (about 57%) of teachers indicated they do not design lessons plans incorporating digital resources.

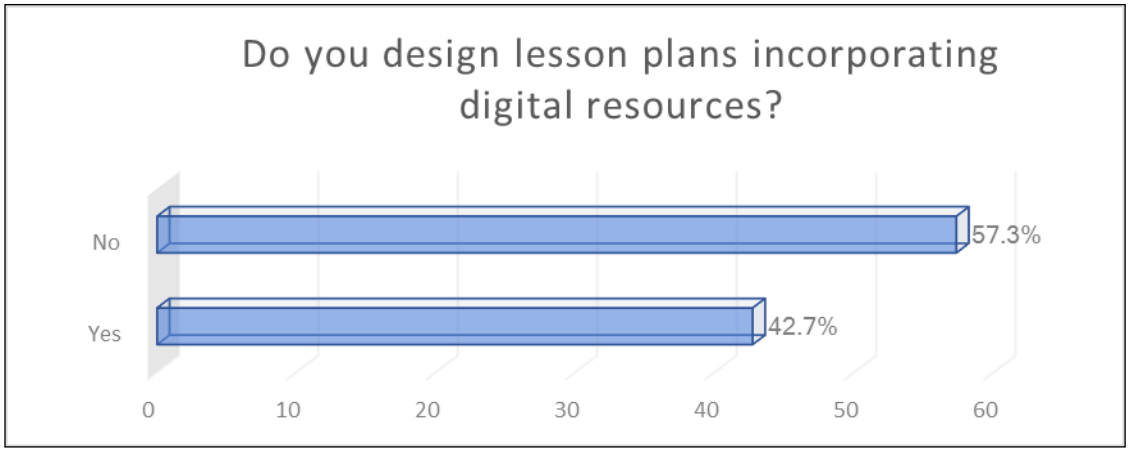

Figure 8: Teachers' perceptions on ICT usage in their Subject taught

Teachers' knowledge and skills in ICT:
This domain seeks to explore teachers' knowledge and skills in basic software and hardware operations. The domain operates on the premise that teachers learning about the tools will not only inspire them to embed the culture of ICT in their pedagogical practices but also their personal life development and professional learning. The teachers in the study reported their responses on the general knowledge and skill of ICT. The highest reported (M=3.60; SD= 1.333)

use of ICT was in "emails" followed by "word processing application" which was (M=3.23; SD= 1.573). The least was reported in teachers' use of presentation software (M=2.34; SD= 1.350).

Table 8: Teachers Use of ICT in general

Item	Mean	Std. Deviation
To what extent do you use a word processor?	3.23	1.573
To what extent do you use presentation software?	2.34	1.350
To what extent do you use a web browser?	3.12	1.561
To what extent do you use a search engine?	3.09	1.626
To what extent do you use an email address?	3.60	1.333
To what extent do you use open educational resources?	2.80	1.440
Overall General ICT Use	***3.03***	***1.160***

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

The overall score (M=3.03; SD=1.16) reported by teachers in this domain was fairly low. That notwithstanding, the teachers who indicated using ICT tools to record grades (about 88%) and maintain student records (about 79%) in their classrooms were quite high. However, the minority few indicated using ICT tools to track students attendance (about 19%). The results are shown in Figure 9.

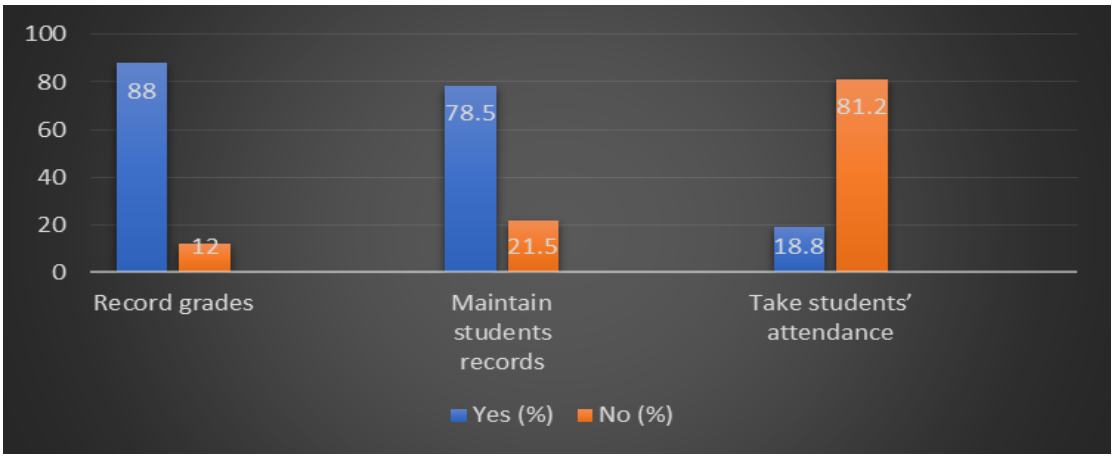

Figure 9: Teachers' Perceptions on general ICT use

Organization and Management:

Much of the complexity of integrating ICT in education derives from the multiple levels of policy implementation—classroom, school, county and national. This is also affected by the curriculum, instruction, teacher development, and assessment. The implication is that what ultimately happens in a classroom is significantly affected by decision making distributed across the levels and multiple channels of influence. It is with this in mind that the study explored standards and practices that have been put in place at the institutional level to ensure successful implementation of ICT activities in the teachers' classrooms. The teachers' responses are reported in Table 10.

Table 9: Teachers Responses on Organization and Management Domain

	Mean	Std. Deviation
To what extent do you integrate the use of a computer lab in the teaching activities?	2.11	1.303
To what extent do you use ICTs in the classroom?	2.17	1.253
To what extent do you use ICTs with your students for presentations, without altering the classroom setting?	1.84	1.143
To what extent do you use ICTs in the classroom for individual study?	1.87	1.236
To what extent do you use ICTs in the classroom for small group activities?	1.76	1.059
Overall	***1.95***	***0.989***

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

The results point to low levels of teachers' responses on items in this domain. The overall (M=1.95; S D=0.989) score is very low and calls for an immediate intervention that will promote institutional conditions of ICT deployment and integration that will underpin or support teacher ICT implementation efforts in the classroom and the computer lab. The ADSI project should aspire to promote technological infrastructure-building, human and resource development that will allow teachers to create ICT environments such as school's learning management system which will allow students to store, share and develop their work collaboratively. This should include areas for shared files, wikis and discussion forums.

Professional Teacher Learning:

Teachers can model learning by engaging in educational experimentation and innovation in collaboration with their colleagues and outside experts to produce new knowledge about learning and teaching practices. A variety of networked devices, digital resources, and electronic environments are used to create and support this community in its production of knowledge. This domain sought to explore to what extent the teachers in the study have been engaged in professional teacher learning. About 60% of the teachers involved in the study indicated that they have accessed online courses and quite a good number (about 70%) were aware of a number of internet issues related to ethics.

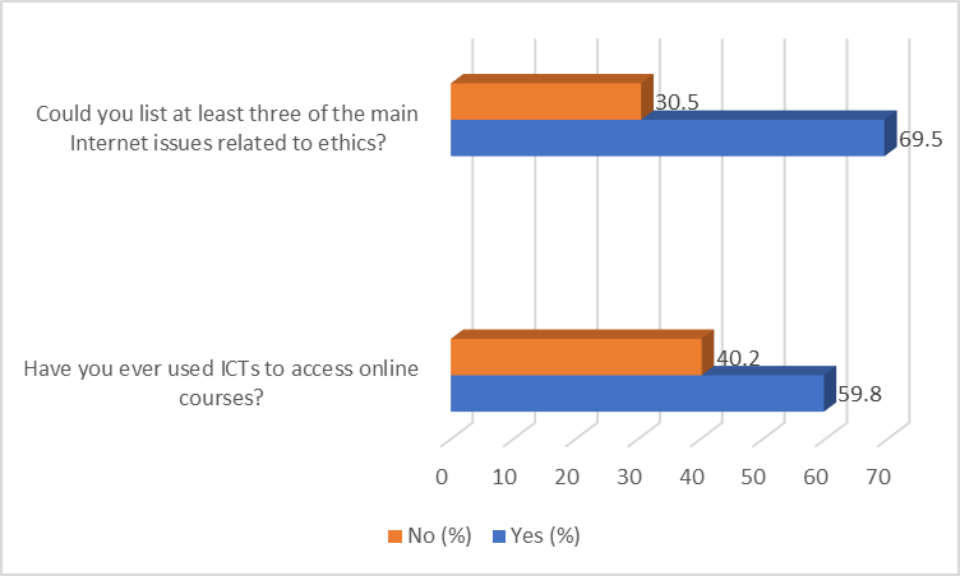

Figure 10: Teachers' Perceptions on Use of Professional Learning

The teachers also expressed their levels of competencies regarding professional teacher learning. Although there was evidence on the use of professional teacher learning strategies by some teachers to acquire additional subject matter and pedagogical knowledge in support of their own profession, the reported (M=3,09; SD=1.219) responses were quite low. This finding on teacher *use* of professional learning contrasts with teachers' high ratings of *access* to professional environments (See Table 11).

Table 10: Teachers Views on Their Professional Learning

	Mean	Std. Deviation
To what extent do you use digital resources to enhance your school productivity?	2.75	1.307
To what extent do you use digital resources to learn about your subject matter?	3.43	1.351
Overall	**3.09**	**1.219**

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

In concluding 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: Policy (3.12), ICT (3.03) professional teacher learning (3.09) with the least scores reported in curriculum and assessment (2.39), ICT-enhanced pedagogy (2.38) and organization and management (1.95) respectively.

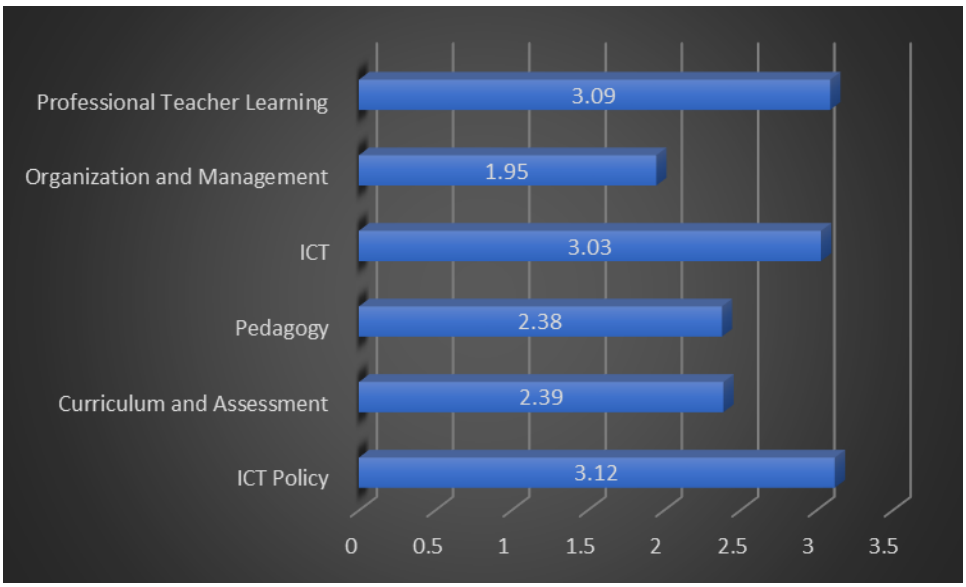

Figure 11: Competencies of Respondents across the ICT-CFT domains

These results suggest significantly low ICT competencies among teachers that relate to their technology literacy knowledge. These findings have implications on the design and implementation of training or professional development programmes going forward. The ADSI project should consider an intervention for systematically building participant capacity from a technology literacy to knowledge deepening levels of ICT use along all the domains if the ICT-CFT Framework. Much attention should be given to the domain relating to organizational and management support, Pedagogy and Curriculum and assessment (the lowest report domains in teacher self-assessment).

3.4.4 – On Teacher ICT Competencies 2

Teachers Technology, Pedagogy and Content Knowledge – TPACK

A key objective of this study was to evaluate technological pedagogical content knowledge (TPACK) of the teachers at baseline level. The methodology used included the use of items about teachers' self-efficacy toward technology use along the TPACK domains. Bandura (1977) presented self-efficacy as one's perceived ability to perform an action that will lead successfully toward a specific goal.

The focus of this survey was on practising teachers' knowledge related to the four key domains of technology integration in their practice, namely: technology knowledge on new and emerging tools (TK), technology content knowledge (how technology can support and change content) (TCK), technology pedagogy knowledge (how technology and support and transform pedagogical practices) (TPK), and technology pedagogy and content knowledge (how the teacher can holistically integrate technology into pedagogy to support content knowledge construction) (TPACK). Teachers' responses in the survey thus delineated expressed teachers' disposition toward evolving understanding and mastery of technology (TK), possibilities of teaching and learning with technology (TPK), how to use technology to increase understanding

of concepts (TCK) and the understanding of how teaching and learning change with the application of technology (TPACK).

The survey was conducted among the lesson 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, 5-strongly agree) was used. The scores were interpreted as follows: 1 is the lowest possible score, which represents a very strong negative perception, while 5 is the highest possible score which represents a very strong positive perception. The following sections give an overview of the domain by domain results of the survey.

Technology Knowledge

A total of 63 lesson teachers responded to the survey. The results show overall fairly high mean score (M=3.69, SD=0.849) for the respondent perceptions in the domain of TK. The least reported score (M=2.95, SD= 0.849) was reported in the statement 'I have had sufficient opportunities to work with different technologies' while the highest reported score (M=4.58, SD=.849) had to do with the statement 'I can learn technologies easily'. Table 12 gives an overview of the respondents across the different items in the TK domain.

Table 11: Descriptive statistics of Teachers' Responses on TK (N=63)

	M	SD	Strongly disagree (%)	Disagree (%)	Neither disagree nor agree (%)	Agree (%)	Strongly agree (%)
I know how to solve my own technical problems	3.68	1.060	4.8	7.9	23.8	41.3	22.2
I can learn technology easily	4.58	0.641	0.0	1.6	3.2	30.6	64.5
I keep up with important new technologies	3.86	1.030	3.2	6.3	22.2	38.1	30.2
I frequently play around the technology	3.80	1.138	4.9	4.9	31.1	23.0	36.1
I know a lot of different technologies	3.20	1.054	6.7	13.3	46.7	20.0	13.3
I have the technical skills I need to use technology	3.72	1.199	6.6	9.8	19.7	32.8	31.1
I have had sufficient opportunities to work with different technologies	2.95	1.179	14.5	17.7	33.5	26.6	9.6

Overall TK (M=3.69, SD=0.849)

Technological Pedagogical Knowledge Teachers who responded to the survey felt very confident in what they could do in their classroom teaching with the application of ICT (see

Table 12). More than 90% agreed or strongly agreed that they could adapt the use of technologies that they are learning about to different teaching activities, and that they were also thinking critically about their use of technology in the classroom. On average they fully agreed (M=4.10, SD=0.825) possessing TPK. The descriptive statistics for the Items on TPK are shown in Table 13.

Table 12: Descriptive statistics of Teachers Responses on TPK (N=63)

	M	SD	Strongly disagree (%)	Disagree (%)	Neither disagree nor agree (%)	Agree (%)	Strongly agree (%)
I can choose technologies that enhances the teaching approaches for a lesson	3.83	1.216	9.6	1.9	19.2	34.6	34.6
I can choose technologies that enhance student's learning for a lesson	3.79	1.109	7.7	1.9	21.2	42.3	26.9
My teacher education programme has caused me to think deeply about how technology could influence teaching approaches I use in my classroom	4.07	1.019	1.9	5.8	21.1	30.8	40.4
I am thinking critically about how to use technology in my classroom	4.46	0.813	2.0	0.0	8.0	30.0	60.0
I can adapt the use of the technologies that I am learning about to different teaching activities	4.45	0.783	2.0	0.0	5.9	35.3	56.9

Overall TPK (M=4.10, SD= 0.825)

Technology Content Knowledge

The teachers TCK were first analysed based on the subject they teach to explore if differences existed across the teacher groups. The results appeared to show some differences between the teacher groups. The highest TCK (M= 4.27, SD= 0.884) score was reported among the English teachers. About 87% of the English teachers agreed or strongly agreed that they know about

technology they can use for understanding and doing English. The next highest TCK (M= 4.17, SD= 0.408) score was reported in Technology group. All (100%) of the respondent Technology teachers agreed or strongly agreed that they know about technology they can use for understanding and doing Technology. The TCK reported for teachers in Science (M= 3.91, SD= 1.146) and Maths (M= 3.08, SD= 1.379) were high.

In spite of the differences, the overall mean value (M= 3.86, SD= 0.611) reported is high and an indication that respondents seem to perceive their capacities to select and use technology to support and change student understanding of concepts in their subject specialist area. The results indicate participant confidence to possess sufficient capacity on how they can develop understanding of concepts they teach by applying ICT. Table 14 shows the descriptive statistics of the items of TCK as demonstrated by the teachers.

Table 13: Descriptive statistics of Teachers Responses on TCK

	M	SD	Strongly disagree (%)	Disagree (%)	Neither disagree nor agree (%)	Agree (%)	Strongly agree (%)
I know about the technologies I can use for understanding and doing science	3.91	1.146	6.3	3.1	21.9	31.3	37.5
I know about the technology I can use for understanding and doing technology	4.17	0.408	0.0	0.0	0.0	83.3	16.7
I know about technologies I can use for student's understanding and doing English	4.27	0.884	0.0	6.7	6.7	40.0	46.7
I know about technologies I can use for students' understanding and doing mathematics	3.08	1.379	25.0	0.0	25.0	41.7	8.3
(Sc=32; Eng=15; Math=12; Tech= 6)			;***Overall TCK (M= 3.86; SD= 0.611***)				

Technological Pedagogical Content Knowledge

The results showed some differences across the teacher groups with the highest TPACK being reported among Technology (M= 4.40, SD= 0.632) teachers and the least among Mathematics

(M= 3.54, SD= 1.361). The overall mean value (M= 4.06, SD= 0.801) reported is high and an indication that respondents seem to possess TPACK – that is teacher perceived 'know-how' to holistically integrate technology into pedagogy to support content knowledge construction. Table 15 shows the descriptive statistics of the responses.

Table 14: Descriptive statistics of Teachers Responses on TPACK (Sc=32; Eng=15; Math=12; Tech= 6)

	M	SD	Strongly disagree (%)	Disagree (%)	Neither disagree nor agree (%)	Agree (%)	Strongly agree (%)
I can teach a lesson that appropriately combines science content, technologies and teaching approaches	4.29	0.799	0.0	2.9	11.8	38.2	47.1
I can teach a lesson that appropriately combines English content, technologies and teaching approaches	4.00	0.894	0.0	0.0	6.7	46.7	46.7
I can teach a lesson that appropriately combines technology content, technologies and teaching approaches	4.40	0.632	0.0	0.0	33.3	33.3	33.3
I can teach a lesson that appropriately combines mathematics content, technologies and teaching approaches	3.54	1.361	15.4	7.7	7.7	46.2	23.1
Overall TPACK (M=4.06, SD=0.801)							

Overall the results indicate fairly high reported scores for all the TPACK domains (approximately "agree" for all of the domains). The least reported was TK (3.69) followed by TCK (3.86) and then TPACK (4.06) and finally TPK (4.1). Thus, the results suggest that teachers in the study have sufficient levels of technological and content knowledge required to teach effectively with technology. This is summarised in Figure 12.

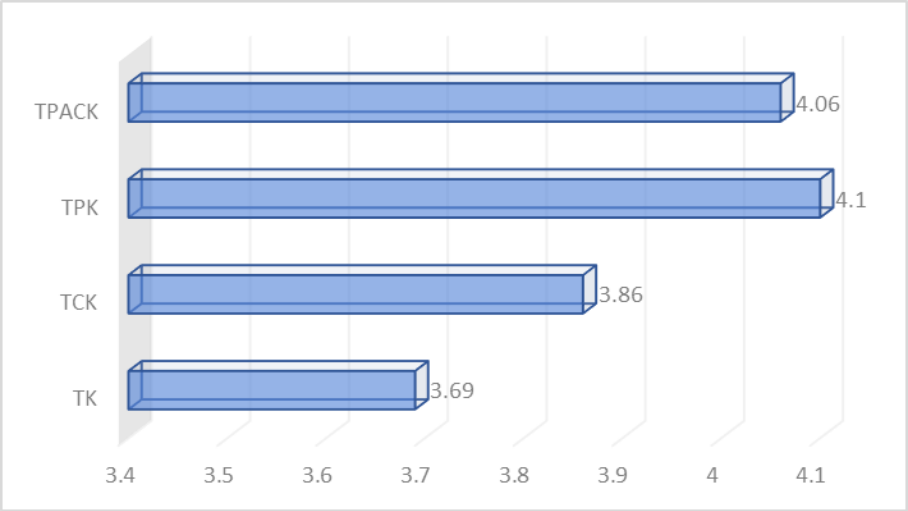

Figure 12: Descriptive Statistics of Teachers Responses on the TPACK Domains

These current results are not consistent with previous findings on the exploration made in relation to the competencies of teachers' use of ICT in schools and classroom practices (see Figure 11 from the report on Teachers Competencies). Figure 11 gave an overview of reported low competencies which demonstrate gaps in the teachers perceived knowledge and capacities under all the ICT-CFT domains: Policy (3.12), ICT (3.03) professional teacher learning (3.09) with the least scores reported in curriculum and assessment (2.39) ICT-enhanced pedagogy (2.38) and organization and management (1.95) respectively.

Contrasting the low self – reported competencies of the teachers' ICT usage in the classroom, Figure 1 shows high self – reported values of their TPACK. This result was unexpected since it would be envisaged that the teachers would be able demonstrate to a large extent what they have reported as their perceived knowledge (TPACK) in their ICT competencies in schools and classroom practices.

The analysis here therefore raises questions on the TPACK levels in this study. It seems to suggest that the teachers might have overestimated themselves regarding their perceptions on their TPACK reported which is usual of survey self-report data (Agyei and Voogt, 2011). Another reason might have been that the teachers could have misconstrued the concept of TPACK - perhaps most teachers may not have met this concept and therefore had limited understanding as to what the domains actually meant.

3.4.5 – On Teacher ICT and 21st Century Competencies Application – Classroom Observation

The observation data gave a clearer picture of the teacher's actual TPACK levels. The methodology involved the use of an observation rubric to assess TPACK evidence in observed instructions. It also included a 21st Century Skills rubric that integrated the 4Cs (Critical Thinking, Communication, Collaboration, Creativity and Innovation) and the use of technology as a learning tool. The observation instrument consisted of items which could be assessed on a four-point Likert scale: 1=Beginning, 2= Developing, 3= Approaching and 4-Ideal/Target. The

scores were interpreted as follows: 1 is the lowest possible score, which represents a very strong negative observation, while the 4 is the highest possible score which represents a very strong positive observation. The results are presented in Table 5 below.

The report shows that teachers, on the average, scored low on the TPACK domains during the lesson observations (Operating technologies effectively (M=1.53 SD=0.573)). More than 96% were observed to be beginners or developing skill levels to integrating technology in teaching. The highest domain observed was TPK (M=2.09; SD=0.752) which reports about 70% of respondents operating between beginning and developing the skill while the least was in TK (M=1.89; SD=0.599) with an overwhelming number of about 97% operating between beginning and developing stages. TPACK (M=1.93; SD=0.663) reported about 82% of teachers at the beginning and developing stages.

Table 15: Distribution of Scores on TPACK Domains from Lessons Observed (N=55)

	M	SD	Beginning (%)	Developing (%)	Approaching (%)	Ideal/ Target (%)
TK (Matching technology to both curriculum and instructional strategies)	1.89	0.599	23.6	63.6	12.7	0.0
TCK (Matching technology to curriculum)	2.02	0.618	17.9	62.5	19.6	0.0
TPK (Matching technology to instructional strategies)	2.09	0.752	21.8	48.1	27.3	1.8
TPACK (considering curriculum, pedagogy and technology all together)	1.93	0.663	25.5	56.4	18.2	0.0
Overall (Technology Logistics -Operating technologies effectively)-	**1.53**	**0.573**	**50.9**	**45.5**	**3.6**	**0.0**

Clearly, the result confirms previous findings on the exploration made in relation to the competencies of teacher's use of ICT in schools and classroom practices (see Figure 11 from the report on Teachers Competencies) which suggest that teachers in the study have very low

competencies that relate to technology literacy knowledge mainly. For the teachers to design and implement ICT-based lessons, their ICT knowledge requires deepening. This will also facilitate better classroom assessments.

The results also showed low levels of integration of the 21st century skills on a similar Likert Scale (1=Beginning, 2= Developing, 3= Approaching and 4-Ideal/Target) including: Critical Thinking (1.83), Communication (1.74), Collaboration (1.67), Creativity and Innovation (1.54) and use of technology as a learning tool (1.25) in the lessons observed. This result would be expected since the teachers' ICT competencies have been reported to be low; supporting lessons with ICT is the driving force in integrating such skills in lesson delivery.

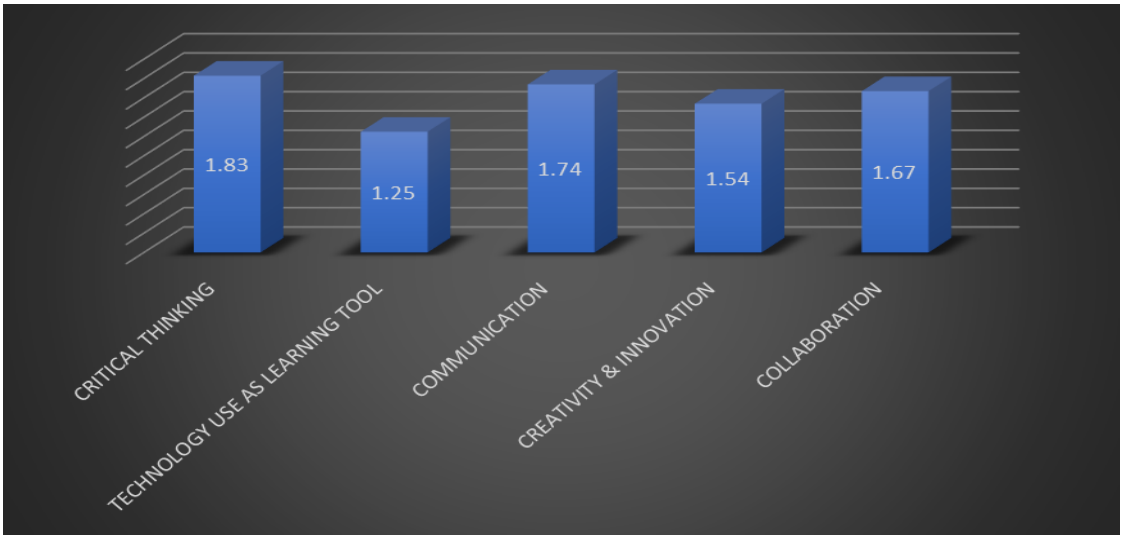

Figure 13: Descriptive Statistics of Teachers Responses on Core Skills for ICT Integration

Several implications for professional development of teachers support for technology integration can be inferred from these results. The ADSI project should consider developing a comprehensive framework for professional development that will assist teachers to develop knowledge and skills about the use of ICT to support pedagogy, content and school organization and management – and with a particular focus on developing student 21st century skills for team work, problem solving and communication. The framework should incorporate a more systematic and graduated process for ICT competency development from basic ICT skills to technology literacy skills to skills for ICT infusion in school organization and classroom practices.

3.5 Findings 4 – Students and ICT use in the STEM Classroom

The baseline research questions in this domain focused on, *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 learner improve achievement in STEM with the integration of ICT in classroom practice?*

3.5.1 Student ICT Readiness

For the students, one of the benchmarks for assessing ICT preparedness is the period of computer use among the respondents. This was measured on the student sample and the findings indicate that most of them have used computers for less than 1 year while the least proportion has used them for more than 7 years. Given the age at which most of them join secondary school, it would appear that most students are not exposed to computers at home. From the findings, those who have used computers for less than 1 year form a significant proportion of the students at 40% while those who have used computers for more than 7 years form less than 5% of the students. This finding may be due to the fact that most of the schools sampled are from predominantly rural counties, with most of the students coming from the immediate settings in which the schools are found. Analysis for the period of exposure to computers and gender shows a higher proportion of girls having been exposed to computers for a shorter period compared to boys, as indicated in Table 17.

Table 16: Period of Computer use (in Years) against gender for students

Gender	Less than 1 year	1-3 years	(3-5 years	5-7 years	7 years or more	Total
Male	109	101	50	17	12	289
Female	147	116	55	22	11	351
Total	256	217	105	39	23	640

The same analysis by county shows that Kiambu fares favourably in exposure to computers compared to the rest of the Counties. This is probably due to the county proximity to the urban centres of the Nairobi capital. On the same measure, Taita – Taveta a deep rural county with sparse population spread is the least exposed County. This is summarised in Table 18.

Table 17: Period of computer use against County for students

Name of County	Period of Computer use (in Years					Total
	Less than 1 year	1-3 years	3-5 years	5-7 years	More than 7 years	
Kiambu	63	56	31	18	12	180
Narok	69	39	20	2	3	133
Nyamira	60	58	30	9	4	161
Tita Taveta	61	52	17	6	3	139
Total	253	205	98	35	22	613

The period one has been using computers can reflect ability to perform certain tasks.

3.5.2 Student Use of ICT

A key objective of this study was to evaluate students' use of computers at school. A survey aimed at determining students' overall perception towards the use of computers during lessons was carried out.

The methodology used included the use of items about students' self-efficacy toward current practices of computer use in various subjects during their lessons. They were to indicate how often they used computers by selecting one of the options: (1) Never; (2) In some lessons; (3) In most lessons (4) In every or almost every lesson and (5) I did not study this subject/these subject

Students who responded to the survey in general felt very confident that computer use in various lessons is not a practice student engage in. More than 50% of the total respondents indicated never using computers during lessons in the various subjects: English (70.6%), Mathematics (79.2%), Humanities (68.1%), Creative Arts (53.7%) and other subject (56.4%). In most of the subjects, more than 90% indicated being in the range of either never using computers or to a small extent in most of the subjects: Science (93.9%) English (92.8%), Mathematics (93.7%) and Humanities (91.5%). Figure 14 below shows the distribution of the responses across various subjects.

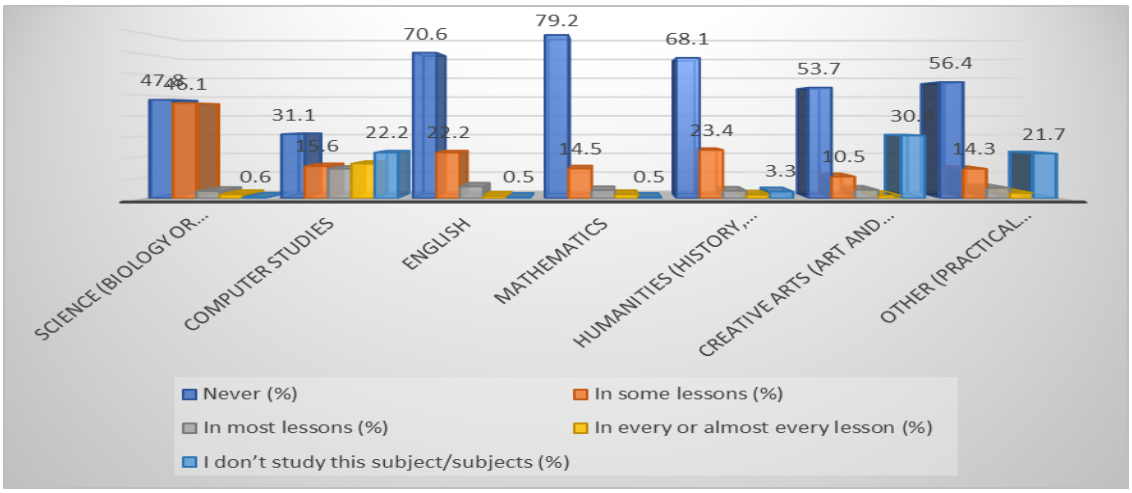

Figure 14: Student Responses on Computer Use in Various Subjects

The study also sought to explore specific tasks students are able to do with computers. Table 18 below shows students responses on the various tasks they have learnt to do with ICT. "Accessing information with a computer (65.5%)" seem to be the popular task students can perform with computers. Although, this task seems to have reported the highest percentage of respondents, the result is still unexpected because considering the kind of task within this digital age, one would envisage that most students would have learnt to access different kinds of information using computers. The results seem to suggest that students in this study may not be abreast with sufficient knowledge and skills in performing different computer tasks. This finding is reiterated in the results shown in the Table 19. The students responded negatively to all the other computer tasks; more than 50% of the respondents indicated that they are not able to do the various computer tasks in school (See Table 18). The task which had the least

score (26.1%) reported by the student was 'Working out whether to trust information from the internet'.

Table 18: Student Responses on Computer Task they have learnt

Task	Yes (%)	No (%)
Identifying references to internet sources	38.9	61.1
Accessing information with a computer	65.5	34.5
Presenting information for a given audience or purpose with a computer	34.8	65.2
Working out whether to trust information from the internet	26.1	73.9
Deciding what information is relevant to include in school work	47.5	52.5
Organizing information obtained from internet sources	31.7	68.3
Deciding where to look for information about an unfamiliar topic	49.3	50.7
Looking for different types of digital information on a topic	43.6	56.4

In spite of the low competencies of their computer use, the students reported high perceptions of computer usefulness in their academic and social lives. For all the items under the domain, a five-point Likert scale (1=strongly disagree, 5-strongly agree) was used. The scores were interpreted as follows: 1 is the lowest possible score, which represents a very strong negative perception, while the 5 is the highest possible score which represents a very strong positive perception of computer usefulness. The results indicate overall student high perceptions of the usefulness of computers. This is evident in mean figures as reported by the students (see Table 20).

Table 19: Student Perceptions of Computer Usefulness

	M	SD	Strongly disagree (%)	Disagree (%)	Neither disagree nor agree (%)	Agree (%)	Strongly agree (%)
It is very important for me to work with a computer	4.55	0.688	0.6	2.4	0.3	34.6	62.1
Learning how to use a new computer programme is very easy for me	3.78	1.205	5.2	17.8	0.6	45.8	30.5
I think using a computer is fun	3.67	1.384	11.2	16.2	0.6	37.3	34.3
I have always been good at	3.37	1.286	6.9	26.9	2.2	40.9	20.1

working with computers							
It is more fun to do my work using a computer than without a computer	3.76	1.308	7.0	19.1	1.4	36.4	36.1
I use a computer because I am very interested in the technology	3.99	1.170	4.6	13.3	1.1	40.2	40.8
I know more about computers than most people my age	2.76	1.340	18.3	38.7	2.6	29.6	10.9
I like learning how to do new things using a computer	4.39	0.877	1.4	5.8	0.6	36.3	55.8
I am able to give advice to others when they have problems with computers	3.43	1.317	9.0	25.0	2.5	41.3	22.2
I often look for new ways to do things using a computer	3.78	1.193	5.4	16.6	2.6	45.8	29.6
I enjoy using the internet to find out information	4.32	1.026	2.7	8.2	0.5	31.1	57.4

Indicators: Strongly agree=5; Agree=4; Neither agree nor disagree=3; Disagree=2; Strongly disagree=1

The highest (M= 4.55, SD = 0.688) perception was reported in the statement "It is very important for me to work with a computer" followed by the statement 'I like learning how to do new things using a computer", which had a mean of 4.39 and standard deviation of 0.877. All the other statements recorded an approximate mean of 4.00 which suggests an agreement to the various statement. The least score (M=2.76, SD = 1.340) was recorded in the statement "I know more about computers than most people my age "which is expected and a perception that aligns with the reported low use of computers.

The results here reveal that students in the study have low competencies in the use of computer for various tasks; however, the opportunity that existed for students to be trained to use computers in their learning process reflected in their high perceptions of computer usefulness in education. Thus, the findings reported here highlight areas that require further attention to enable students use computers to do various tasks in their schools and classrooms. In particular, ADSI should embark on a professional development scenario that will assist students develop skills on ways to integrate ICT in their learning processes is one of the significant issues identified in this study.

4. Conclusions and Recommendations

4.0 Introduction

The findings of the Baseline Survey are part of the ADSI project implementation team including **GESCI-KU-UON-MOEST** and other relevant stakeholders on the current status and context of ICT use in teaching and learning of STEM in the ADSI project schools in Kenya. The baseline forms the platform from which the impact of the implementation of the ADSI Project will be assessed. The findings have been presented in order to clearly and adequately capture the status and context of ICT use in STEM teaching and learning in the ADSI project schools in Kenya prior to the ADSI intervention. They are in response to the research questions of institutionalization of ICT use in teaching and learning of STEM, Digital schools of Distinction, teacher development and learners' attitude and use of ICT in STEM. They are also related to the ICT Competency Framework for Teachers, 21ST Century Skills, Technology Pedagogy and Content Knowledge.

4.1 Conclusions and Recommendations – Status of Institutionalization of ICT in the Schools

Based on the findings of the Baseline Survey, we can infer that the use of ICT in schools which has been embraced by the Government of Kenya is being institutionalized within the school operations. Plans are in place to enhance the use of ICT in teaching and learning of STEM subjects and indeed all the subjects. There is great desire and enthusiasm from the school management to raise their schools to digital schools of distinction. However, this is limited by inadequacy of ICT infrastructure and teachers' skills in ICT. Among the most well used ICT applications among the teachers was the use of word processing which ranks highest among tasks which teachers could perform on their own. One the other hand, the lowest was found to be installing software. The same scenario obtained on knowing how to perform certain computer tasks by themselves. Since installing software is the most technical of tasks, the implication is that more efforts should be put in training teachers on the more technical aspects of ICT use in schools.

The policy environment is very conducive for the use of ICTs in schools. For instance, there are efforts for ICT integration in Education for teachers in primary, secondary and TTCs by the Ministry of Education. The government has also made robust investments in ICT and initiated capacity building of teachers for ICT use and the pedagogical integration of ICT. A lot of research is going on to identify capacity gaps and needs that will inform planning for capacity building. There are also plans for curriculum reforms aimed at quality assurance on ICT subjects and policy influencing practice of ICT integration in TPD. The analysis here seems to suggest that participant understanding that ICT policy exists in educational contexts and is perceived by teachers as being functional at the school level.

From the findings, we can recommend that the ADSI project should reinforce the dissemination of such policies to create awareness among all teachers. The reason for this recommendation is that an effective ICT policy implementation strategy or framework at the school level is essential to enhance teachers' effective integration of ICT in the teaching and learning processes at classroom level. This will promote a rapid integration of ICT into the learning

environment. Related to this is a recommendation that the ADSI programme at the **School level /Classroom Practice should integrate** leadership capacity for planning and vision leveraging school affordances (opportunities and constraints) should be enhanced through training, workshops and continuous engagement in the ADSI project activities.

4.2 Conclusions and Recommendation - Status of Digital School Distinction

Based on the findings of the Baseline Survey, it could be concluded that prior to the Implementation of the ADSI Programme the status of schools in terms Digital School of Distinction Development was at an initial stage. Schools lacked adequate resources for enabling integration of ICTs in teaching and learning STEM subjects. There was also restricted and inadequate use of existing formal resources (ICT laboratories for Computer Studies) and informal resources (educational use of mobile phone, internet, and social media software). Lack of clearly defined ICT strategy, planning and standards on the path from national to school levels meant that school heads, heads of departments or teachers themselves would independently decide what direction to take. ICT was being used on peripheral areas of school productivity (student register, finances, admin) and teacher productivity (materials searches, exam paper / revision question downloads, data review trends).

The baseline highlights the need for a triangular approach of leadership, teacher and whole school development as key for effective ICT integration in secondary level schooling. **The baseline study recommend**s that school planning for ICT integration should focus on computers, e-content, internet (infrastructure); teacher training (ICT skills); curriculum integration (computer studies); ICT school budget (equipment, construction); and access to labs (ICT culture). This is based on the fact that the overall score is very low on management and organisational structure in integrating ICT in schools. This calls for an immediate intervention that will promote institutional conditions of ICT deployment and integration that will underpin or support teacher ICT implementation efforts in the classroom and the computer lab. On this score, the study recommends that the ADSI project should promote technological infrastructure-building and human and resource development that will allow teachers to create ICT environments such as school's learning management system which will allow students to store, share and develop their work collaboratively. This should include areas for shared files, wikis and discussion forums.

4.3 Conclusions and Recommendations - Status of Teacher Professional Development for ICT Integration

The results of the study suggest significantly low ICT competencies of teachers that relate to their perceived technology literacy knowledge. This finding may be inferred to be founded on the scenario obtaining prior to the implementation of the project in which case the level of competencies for teachers was very basic. These have implications on the design and implementation of training or professional development programmes going forward.

The study recommends that the ADSI project should consider an intervention for systematically building participant capacity from a technology literacy to knowledge deepening levels of ICT

use along all the domains if the ICT-CFT Framework. Much attention should be given to the domain relating to organizational and management support, Pedagogy and Curriculum and assessment (the lowest report domains in teacher self-assessment). A related recommendation is for training of teachers, including those from integrated schools, in the use of ICT for teaching and learning to be an on-going endeavor. All these efforts are in tandem with the objectives of the African Digital Schools Initiative (ADSI) project in terms of building digital school of distinction capacity for on-going teacher processional development as a life-long professional learning endeavour.

4.4 Conclusions and Recommendations - Student Attitudes Towards and Use of ICT

Generally, students' attitudes toward the use of ICT in STEM lessons are positive. However, learners' use of ICT in STEM classroom activities, assignment and projects was minimal, while the improvement of achievement in STEM with the integration of ICT in classroom practice had not yet been ascertained. Information and communication technologies (ICT) have become one of the fundamental building blocks of modern society and every child should be given an enabling environment to take advantage of ICT in school activities for improved performance. This conclusion is based on the findings which indicate that much as students in the study have low competencies in the use of computer for various tasks, their attitudes towards ICT are highly positive. Based on these positive attitudes, there is an opportunity for students to easily integrate ICT in their learning.

It is recommended that ADSI should embark on teacher professional development scenario that will assist students acquire skills on ways to integrate ICT in their learning processes. This is one of the significant issues identified in this study. Related to this, it is also **recommended that in the ADSI programme implementation** students should be encouraged to apply more ICT and refocus the use of ICT towards STEM activities inside and outside schools and use of results to improve learning and teaching and eventually impacting on their performance and development of 21st Century skills.

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APPENDICES

Appendix I: ADSI Programme Details

Description of the ADSI Model

The **African Digital Schools Initiative (ADSI)** programme aims to provide an effective, sustainable and replicable model of teacher development that can contribute to addressing the issues of declining quality, inadequate teacher supply, and very limited or non-existent integration of ICT in secondary level education in the countries of Kenya, Tanzania and Cote D'Ivoire. The ADSI proposal presents a specific and pivotal focus on the use of ICT to promote innovative practice in Science, Technology, English and Mathematics (STEM) subject teaching and learning at secondary level in the target countries.

Summary of the project objectives/activities

The ADSI proposal presents three key objectives to:

1) leverage ICTs to build a **viable, sustainable and replicable model** of teacher professional development;
2) equip teachers with pedagogical practices and methodologies that will **enable learners to acquire knowledge, attitudes, values and higher order skills** responsive to market and knowledge society needs;
3) design and operate a **systemic and systematic approach to inclusive whole school development** through successful ICT Integration.

The project activities are:

1) working with national teacher development stakeholders to d**evelop an expanded set of modular course material for the ADSI programme** based on prioritized competencies at 3 levels of country contextualized ICT Competency Framework for Teachers;
2) enhance and strengthen the **ADSI blended model of professional learning with three pronged strategies** for teacher support through f2f workshop, online community of practice and school based professional development;
3) design and develop **whole school systematic programme for building leadership capacity** in school planning progressively towards achieving 'digital school' status.

The project will employ 4 different strategies for successful and sustainable implementation:

- ***Institutionalization*** of the ADSI model within the existing education institutions through working with an Expert Working Group (EWG) at National level and a School Support Team (SST) at County level

- ***Whole School Planning and Development in ICT Integration*** through the involvement of the school leadership, STEM Teachers and other subject teachers
- ***School-based Professional Development*** and support through School-based Coordinators whose capacity will be developed to provide the first line of support in project activities at school level
- ***A Blended Learning Approach*** for the STEM teachers, and other teachers that incudes face-to-face sessions, online access to content through a Learning Management System and classroom observation sessions during ICT Integration

Rationale for the Implementation of the ADSI Project

- Secondary education has become a priority in the post-2015 education and development agenda globally and in Sub-Saharan Africa (SSA).
- Research and development points to a new focus on competencies in Science, Technology, English and Mathematics (STEM) subjects and acquisition of skills for higher order thinking, analysis and synthesis, team work and enterprise mentality as pivotal to the future development of the continent
- In Kenya, Tanzania and Cote d'Ivoire successful expansion of school systems at secondary level has brought to the fore gap issues of quality and teacher supply in general but, specifically in STEM subjects where failure rates are high, particularly in rural areas and among female students
- Kenyan, Tanzanian and Cote d'Ivoire governments are committed to ICT deployments and initiatives to address issues of access, equity & quality of provision and outcomes but a holistic framework is needed to align national and local initiatives with a coherent approach for building ICT use in teacher education and ICT enabled innovation in secondary schools
- **Into this arena the ADSI proposal seeks to contribute an innovative model for technology use in STEM teaching and learning that has been tried and validated in the SIPSE pilot project conducted in 20 secondary schools in Tanzania and Kenya during 2013 – 2015**
- The ADSI model is aligned with Sustainable Development Goals (SDGs) strategy for building innovative practice in secondary schooling as a critical lever for promoting skills development and innovative practice that is adequate and responsive to the needs of the market place and to emerging knowledge societies.

Target audience/population/ location (include reach, impact and multiplier)

- The proposed ADSI targets in Kenya are 20 school support teams, 80 schools, 800 teachers will be targeted for a multiplier effect outreach of some 40,000 students; in Tanzania 3 Teachers' Colleges, 10 school support teams, 40 schools, 400 teachers with a multiplier effect outreach of 20,000 students; in Cote d'Ivoire the target is 5 school support teams, 20 schools, 200 teachers with an outreach of some 10,000 students.
- In the 3 target countries this means that 1,400 STEM teachers will be trained across 140 schools, 35 school support teams, 140 school based leads with an outreach to some 70,000 students.

- Participating schools will be selected using pre-defined criteria to address the issues of inequality (as defined in the policies of the three countries) and gender imbalances through a dispersed geographical distribution across the three countries.

The programme extends over 5 years in Kenya and Tanzania and 2 years in Cote d'Ivoire.

Project goal and benefits (include what is innovative about this project)

- The goal of the ADSI project is to consolidate and develop a holistic expansion of the elements and the demonstrably success aspects of the SIPSE pilot model in relation to its innovation practice, whole school approach, horizontal (geographic) and (institutional) outreach and impact, and shared ownership.

- The ADSI model presents a portfolio of system-wide ICT innovation elements that can address policy coherence needs - inclusive of: blended learning teacher development, whole school involvement, school leadership capacity building; converging technologies, use and development of open education resources, an online repository of materials; digital school awards, accreditation and certification to incentivize ICT integration and progression; policy dialogues to raise awareness and influence new policy formulation and institutionalization of new/good practice

Summary of monitoring and evaluation plan

- The ADSI model of **monitoring evaluation and learning** will integrate three main approaches for tracking progress on project outputs, outcomes and impact, namely: 1) a **Logical Framework Approach (LFA**) - for monitoring key result areas linked to project objectives and output; 2) an **Outcome Mapping (OM) approach** - for monitoring changes in boundary partner behaviour linked to project outcomes; and 3) a **five level evaluation approach** from training to the classroom linked to measuring project impact

Summary of implementation details

- The ADSI blended learning model of workshops, online and school based professional learning will be implemented in **9 cycles of course work in Kenya and Tanzania over 5 years and 3 cycles in Cote d'Ivoire over 2 years** – with needs assessment and modules development carried out in first six month and annual policy forums integrated throughout cycles at national and regional levels; Every school in the project will receive 5 laptops, 2 projectors, & 5 3G modems from the project. The Schools will be expected to provide, internet bundles for the teachers, speakers for use in ICT Integration, a clean suffice for projection on the wall and electrical power.