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# Evaluation of the success of African Digital Schools Initiative (ADSI) project in Science, Technology, English and Mathematics (STEM) teaching and learning in Transmara East Sub- County ADSI schools, Narok

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***Abstract*— The last few years has seen a rapid growth of the use of Information Communication Technologies (ICTs) in the 21st century classroom. This is because of the capability of ICT in provision of a proactive and dynamic teaching and learning environment through the partnerships between the Ministry of Education, Science and Technology (MOEST) and Global E-Schools and Communities Initiative (GESCI). Through ADSI, efforts have been made to provide ICT infrastructure and training of teachers in the implementation of collaborative learning tools, interactive learner-centered pedagogical strategies and lesson presentation software to address diverse interests and needs of the learners. The aim of the study is to determine the suitability and accessibility of ICT infrastructure in enhancing STEM teaching and learning, highlight the effectiveness of the training imparted on teachers and identify the impact of ADSI ICT infrastructure on the STEM teaching and learning among the learners. A total of 30 teachers from 5 ADSI schools in Transmara East, Narok county have been purposively sampled to complete the questionnaires for the study to find out their readiness in successful integration of ICT in STEM teaching and learning. It was found out that teacher training enabled the teachers to use computer learning applications in teaching and learning. The study concludes that the training, infrastructure quality and utilization of ICT tools made significant contribution to the success of ADSI project. The study recommends the formulation of polices by the stakeholders in the education sector for ICT implementation in STEM teaching in all schools in the republic.**

***Index Terms*— STEM teaching and learning; ICT integration; ICT infrastructure.**

## I. INTRODUCTION

The use of information and communication technologies (ICTs) in secondary education in Kenya has become a priority area among the education sectors such as the Ministry of Education Science and Technology (MOEST), Teachers Service Commission (TSC), Kenya Institute of Curriculum Development (KICD) and the Center for Mathematics, Science and Education Technology in Africa (CEMASTEA). There has been a shift towards the achievement of competencies in Science, Technology, English and Mathematics (STEM) subjects so that learners can acquire skills for team work, synthesis, analysis and practice of higher order thinking which are vital in future development.

The use of ICTs in teaching, learning and enhanced practice in STEM subjects has instilled students with a passion for discovery, inquiry and nurture skills such as persistence, teamwork, and the application of gained knowledge to new situations (Bailey, Kaufman & Subotic, 2015). The Government of Kenya is working towards a knowledge-based economy through the implementation of Vision 2030 for economic development thus has carried out vital ICT related initiatives and deployments in education over the last couple of years. This has been done because of the need of a coherent approach in the integration of ICT in teaching and learning in all subjects as well as the enhancement of development of the teacher professionally.

MOEST, KICD, TSC and CEMASTEA have recognized that ICT integration in teaching and learning is a potent vehicle in addressing the challenges in education such as access, equity and quality hence the establishment of the National ICT strategy for Education and Training. Also, the government has made steps in ICT integration through the economic stimulus project (ESP)- ICT computer for schools where 210 ICT champions and approximately 20,000 teachers were trained on the integration of ICT in education. Furthermore, MOEST has also deployed ICT infrastructure to schools through projects such E-Schools initiative and the NEPAD e-schools as well as equipping some schools with ICT resources through programs such as the provision of tablets to learners in class one (MOEST, 2014). Overall, KICD has played a role in the ICT integration in teaching and learning through emphasis on the science content digitization despite the limited technical, human and financial capacity in vetting digital content (MOEST, 2014).

MOEST struck strategic partnership with Global E-Schools and Communities Initiative (GESCI) in educating and developing teachers in Kenya on the use of ICT in education. This program started with the initiation of Strengthening Innovation and Practice in Secondary Education (SIPSE), a project which involved 10 schools in Nakuru and Machakos counties between 2013 and 2015. With the successes drawn from the SIPSE pilot program, GESCI developed the idea into African Digital Schools Initiative (ADSI) which was rolled out in four counties in Kenya. The program was implemented in 80 schools in Narok, Nyamira, Taita Taveta

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and Kiambu and has seen the enhancement of ICT skills in 800 STEM teachers and over 40,000 students. ADSI is an innovative and unique program geared towards turning secondary schools into digital schools of distinction (DSDs), building 21st century skills in STEM subjects among the learners and enhancing ICT use among the teachers so as to facilitate effective teaching and learning (GESCI, 2013).

The ADSI program was implemented because of the need to address gap in uptake of science subjects and teaching in secondary schools and provision of professional development for STEM teachers to promote participative, learner-centered and ICT-based approach in teaching and learning (GESCI, 2013). It was also meant to focus on displaying good technological practices in ICT integration through the use of integrated digital learning resources. Additionally, ADSI facilitated, supported and encouraged with methodologies that instilled learners with the practice of high order skills, project work, information literacy skills and team work.

ADSI adopted the ICT competencies from the United Nations Scientific and Cultural Organization (UNESCO) ICT Competency Framework for Teachers (ICT-CFT) where teachers worked in three ICT competency levels which include technology literacy, knowledge deepening and knowledge creation. These competencies used open educational resources (OERs) in the development of lessons plans and course modules by the teachers. ADSI project was also implemented based on Technology Pedagogy and Content Knowledge (TPACK).

The module was in three forms of knowledge that every teacher was trained to integrate ICT in teaching: Technology Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK). These modules were organized into units such as exemplary ICT lessons, charts and discussion forums, computer practical and application of templates and guidelines on TPACK classroom practice and STEM lessons plans. All these were done to transform teaching and learning effectively, realize an enhanced classroom practice, instill innovation and build the capacity of the teacher to use ICT in improving STEM education, quality and cultivation of 21st century skills among the learners (Tai, 2013).

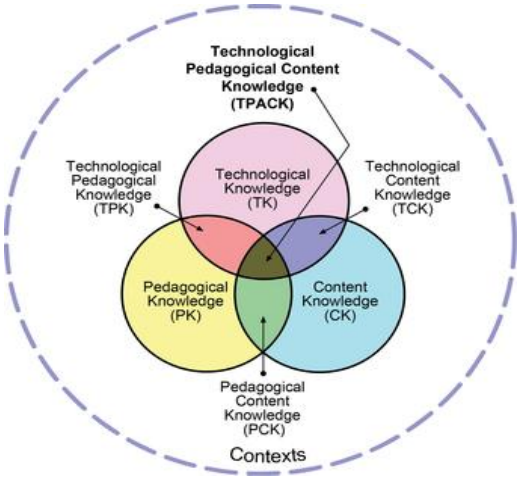


*Figure 1*: Technology, Pedagogy and Content Knowledge (Mishra & Koehler, 2006)

The main purpose of this study is to evaluate the success of ADIS project in schools in Transmara East sub county in Narok. Specifically, the study was guided by the following objectives:

(i) Determine the suitability and accessibility of ICT infrastructure in enhancing STEM teaching and learning.

(ii) Highlight the effectiveness of the training imparted on teachers on the use of ICT in teaching and learning on the learner.

(iii) Identify the impact of ADSI ICT infrastructure on the STEM teaching and learning among the learners.

## II. Methodology

**Research Design**

The study employed a survey research methodology. The five schools implementing the ADSI project in Transmara East sub county were included in the study. These schools include Murkan Secondary School, Emura Dikirr Boys High School, Olpopongi Secondary School, Abossi Girls' Secondary School and Mokondo Secondary School.

**Sample and Sampling Procedure**

In this research, a purposive sampling process was used in the selection of the five ADSI schools in the sub county. This is in agreement with Cohen et al. (2007) who note that purposive sampling is useful where the researcher handpicks cases for inclusion in the sample as they possess the particular characteristics that are being sought. the sampling was confined to five schools in the sub county based on characteristics such as:

(i) They are implementing the ADSI project.

(ii) STEM teachers have been trained in technology literacy, knowledge deepening and knowledge creation.

(iii) The schools have computer laboratories used regularly for teaching and learning.

(iv) They have five laptops, two projectors and modems provided by ADSI.

The sample consisted of 30 ADSI STEM teachers from five selected schools which are implementing the ADSI project in the sub county. The table below gives a demographic data of the teachers and principals who formed the sample for the study.

Table 1. Demographic Profile of ADSI teachers.

| **Gender** | **Frequency** | **Percentage (N=30)** |
|---|---|---|
| Male | 22 | 73% |
| Female | 8 | 27% |
| **Teaching Subjects** | | |
| Science | 10 | 33.3% |
| Technology | 2 | 6.7% |
| English | 7 | 23.3% |
| Mathematics | 5 | 16.7% |
| Science and Mathematics | 6 | 20% |

**Source:** Demographic Information on ADSI STEM teachers from Research Purposive School Sample, from Transmara East sub county, Narok on July 2019.

**Data Collection Instrument**

Data was collected from the sampled teachers using survey questionnaire, interviews and observation. Specifically, self-administered questionnaires were hand-delivered to the STEM teachers while observations were made on the installed infrastructure in the schools. The researcher was keen on the ADSI infrastructure, computer laboratories and the hardware used by the teachers.

**Findings and Discussions**

(a) Suitability and accessibility of ICT infrastructure in enhancing STEM teaching and learning.

One important aspect for the success of ICT integration in teaching and learning is the availability of ICT resources. According to Newhouse (2002), the availability of resources is strongly correlated with a curriculum that gives a pivotal support, influences and is critical in the provision of the necessary logistics on the delivery of pedagogy, learning outcomes and content. Through observation, the researcher established that all the five ADSI schools in the sub county had the required ICT facilities for a successful integration in teaching and learning. The laptops, projectors and modems were in perfect condition with internet connectivity mainly from mobile wireless gadgets. Schools which benefitted from ESP-Computer for all schools had a computer laboratory with desktops networked with cables into a local area network (LAN). These computers were easily accessible to the students since a technician was always on standby to assist the leaners in accessing the digital library created by the STEM teachers. The learners were able to access PowerPoint presentations, videos, web quests, simulations, exe materials and OERs which explained dynamic concepts and motivated the learners. It was observed that the learners were able to interact with design software such as eXe and VUE which allowed them to blend learning.

In these schools, the ADSI infrastructure were available in the computer room while the laptops and projectors were used in classrooms where power was connected either through temporary connections or permanent sockets. Additional places of storage were the principals' offices and the examination rooms which at times led to a restricted access to the resources thus hindered the integration of ICT in teaching and learning (Sa´nchez, Salinas & Harris, 2011). Ideally, ICT tools should be used daily in the classroom for teaching and learning but the ADSI infrastructure was restricted to classroom use only by the teachers and no computers were left for learners to use at will in the classroom. It was found out that the students did not interact with teachers and peers after class or during free time because the laptops were made available to the learners during lessons only hence the teaches could not coach individual learners unless a student requests such.

(b) Effectiveness of the training imparted on teachers on the use of ICT in teaching and learning.

Institutions of education has end users such as support staff, students and teachers who require effective training for an increased intention in the use of ICT in teaching and learning. GESCI, in its pilot program in Kenya and Tanzania realized that training of effective teachers is vital in the implementation of the ADSI project thus embarked on a rigorous teacher training at the beginning of every cycle in the project implementation phase. The results indicate that 56 percent of the teachers strongly agreed that the time, methods and means of training were effective hence teachers were able to attain hands-on experience on ICT integration in STEM teaching and learning. The teachers were trained on technology literacy, knowledge deepening and content creation during the implementation of the project which assisted the teachers in gaining skills on the use of ICT in teaching and learning. Through the interviews, it was found out that the demonstrations and self-practice on the development of lessons through the use of ICT tools instilled the teachers with skills in integration of ICT in the classroom. It was found out that 40% of the teachers agreed that the training led to proficiency in the development of knowledge. This was possible because the teachers were trained on the use of virtual understanding environment (VUE), a tool used to create, manage and integrate digital resources which support effective teaching and learning as well as the development of infographics using PowerPoint and real-time images or those sourced from the internet. Additionally, teachers were trained on the use of eXeLearning which is an open source and easy to use authoring application that is instrumental in assisting teachers to publish web content without becoming proficient in XML markup or HTML. Because of this knowledge, 40% of the teachers strongly agreed and agreed (33.3%) that the training led to proficiency in development of content. Furthermore, eXelearning allowed the teachers to author content with limited bandwidth connectivity or no connectivity at all and the learners are able to use the developed content without the use of internet.

Additionally, the training led to a shift in conceptual framework among the teachers as they were able to teach technology enhanced lessons in the classroom which meets the learners' needs. It was found out that 66.7% of the respondents strongly agreed that teacher training led to changes in the methodology of content delivery. Hooker (2017) agrees that the use of design software in content delivery led to sharing of knowledge between the teachers and learners hence resulted in the active teaching and learning. From the interviews, the study found out that the professional learning journey of the teacher led to a pronounced shift in conceptual frames of pedagogy and technology affordances which enhanced transfer and sharing of knowledge.

The shift in the methodology used in teaching and learning led to teacher engagement with new ways ruminated with technology which represents content and builds the students to understand difficult to teach concepts. It was noted that teachers were able to use digital tools and exemplary lesson designs that engaged the learners in knowledge creation and conceptual knowledge building activities. These activities led to improved teaching and learning activities evidenced by respondents who strongly agreed (60%) and agreed (26.7%) to this. This is attributed to the training offered to teachers on how to develop exemplary lessons through the use of simulations, images, concept mapping and infographics which enhanced existing practices with innovative ones. These led to learners being glued to the screens and were

attentive to the concept being presented in new ways as argued by McDonough & Le Baron (2009) who note that technological tools are key in transforming practice and realizing change that impact positively on learner performance and heighted innovation among the learners.

**Table 1: Effectiveness of the training imparted on teachers**

| | Strongly agree | Agree | Disagree | Strongly disa |
|---|---|---|---|---|
| Improved teaching and learning process | 18 (60%) | 8 (26.7%) | 3(10%) | 1(3.3%) |
| Developed hand-on experience in on ICT integration | 17 (56.7%) | 7 (23.3%) | 3 (10%) | 3 (10%) |
| Proficiency in content development | 12 (40%) | 10 (33.3%) | 6 (20%) | 2 (6.67% |
| Shift in teacher conceptual framework | 20 (66.7%) | 7 (23.3%) | 1 (3.3%) | 2 (6.7%) |

c) Identify the impact of ADSI ICT infrastructure on the STEM teaching and learning among the learners.

The implementation of ADSI project saw heavy investments in terms of infrastructure in all the schools implementing the project. The schools which did not previously have a computer laboratory made the necessary adjustments to put a functional computer lab in place. The principals in these schools committed themselves to provide managerial support to the project by purchasing additional laptops, equipping the computer labs with desktops, internet connectivity and provision of funds to the STEM teachers to attend trainings which were carried out at the beginning of every term. MasterCard, on the other hand, provided each school with five laptops and modems. All these investments had a great impact on the learners.

According to Morse (2018), there has been a downward trend in uptake and interest in STEM subjects in both developed and developing countries. With the implementation of the ADSI project, there has been a notable improvement in the uptake of STEM subjects in the schools. 56.7% of the respondents believed entirely that there has been a marked increase in the learners enrolling for STEM subject in the five ADSI schools in the sub county. This is attributed to the fact that ICT is crucial in changing the way the students learn and think, interest and the provision of motivation to the learners in STEM subjects in secondary school and beyond. Alismail & McGuire (2015) agree that students are able to gain deeper understanding of STEM subjects and are capable of solving complex problems with the use of ICT.

It was also found out that ICT promoted student-centered learning which appeared to leverage educational change in schools (Barakabitze et al., 2019). The teachers were able to change the perception of their learners through the exposure to simulations, videos, images and web quests. 63.3% of the teachers strongly believed that the learners' perceptions were changed as they embraced the use of ICT hence honed their skills and were engaged in deeper forms of learning through their presentations in class and the project-based learning and competitions for students organized by ADSI. From the results, it is believed that teaching using ICT in the classroom motivated teachers and learners. 72% of the respondents agreed entirely that training of teachers had a ripple effect on the learners because they were able to help learners clarify difficult to teach and learn concepts, made learners active, simplified teaching and saved time. The ADSI model provided a blended approach to teaching, as Fu (2013) affirms that the implementation of ICTs in education cannot be done in isolation but sees a combination of diverse approaches and teaching methods rooted on learning centered on the student (Muianga, Klomsri, Tedre & Mutimucuio, 2018).

In ADSI project, the roles of the teacher and the student have been changed by the integration of ICT in teaching and learning. The role that the learner play in the classroom has been changed from being traditionally passive recipients to initiators of learning and undergoes a learning process where he/she is at the center during teaching. 26.7% of the sampled teachers strongly agreed and 33.3% agreed that their roles have change to be facilitators of knowledge through the monitoring and contextualization of learning functions infused with ICT tools. The training of teachers instilled crucial ICT skills in order to develop content that are used by learners hence provided opportunities for students. Learners were also introduced to a project-based learning assignments which helped them in gaining hands-on experience on the use of ICT in the learning process. The improved infrastructure seen in the project coupled with content development to support teaching and learning and clearly set ICT policies enabled the students to access resources in the computer lab during lessons.

The respondents shared their experiences on the feeling of the students on how valuable collaboration is to learning process because of the use of modern pedagogical practices among the teachers. Muianga et. al (2018) note that collaboration enables to take an active role in the sharing of knowledge as they explore views expressed by the other students. In the problem and project-based learning, the learners showed collaboration to find information from the internet which were instrumental in solving the given problems. 50% of the respondents strongly agreed and 36.7% agreed that the use of ICT in teaching and learning prompted the learners to engage in constructive and critical thinking since they were able to evaluate and comment to each other's work with no intervention by the facilitator.

**Table 2: Impact of ADSI ICT infrastructure on the STEM teaching and learning among the learners.**

| | Strongly agree | Agree | Disagree | Strongly disa |
|---|---|---|---|---|
| Improved enrolment in STEM subjects | 17(56.7%) | 10 (33.3%) | 3(10%) | 0(0%) |
| ICT promoted student-centered learning | 19(63.3%) | 4 (13.3%) | 3 (10%) | 4 (13.4% |
| Change of student and teacher roles | 8 (26.7%) | 10 (33.3%) | 6(20%) | 6(20%) |
| Leaners engaged in constructive and critical thinking | 15 (50 %) | 11 (36.7%) | 3 (10%) | 1 (3.3%) |

## III. Conclusion

The results of this study show that the ADSI project has a positive impact on the leaners and the teachers. ICT is

influential in increasing the flexibility of learners, the way they are taught and how they learn content in the classroom. It has been seen that ADSI project has provided motivation and a rich environment for teaching and learning as it offered new challenges and possibilities for the teachers and learners. The overall finding suggests a successful ADSI program in the schools where the project has been implemented.

## IV. Recommendations

The successes of this project should be a motivation to the government of Kenya, MOEST, KICD, CEMSATEA and TSC to work together in implementing such in all the schools in the republic. Despite the huge amount of money and infrastructure invested by MasterCard on the four counties in Kenya, the education stakeholders in Kenya should pull resources together to make sure that all the schools in the republic have ICT infrastructure and well-trained teachers on how to integrate this in the modern-day teaching and learning. The study also recommends clear development of policies to ensure that teacher training colleges and universities should instill the desired skills to the teachers.

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