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ENHANCING TEACHER - STUDENT CLASSROOM PARTICIPATION THROUGH AN INTEGRATED LEARNING TRANSFORMATION PROGRAMME (ILTP): A FIRST INSIGHT INTO A MORE INTERACTIVE EDUCATIONAL SYSTEM IN GHANA.

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AN INTEGRATED LEARNING TRANSFORMATION PROGRAMME (ILTP):
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GHANA**

Joseph Anto¹ Diana Van der Stelt² Stanley K. Dankyira² Hui Bei³

ABSTRACT

This paper presents a project based research into how teacher – student classroom participation could be enhanced through what we call an Integrated Learning Transformation Programme (ILTP) with specific reference to basic schools in the Republic of Ghana. Maxim Nyansa IT Solutions and its donor partners from the Netherlands collaborate to improve the Information and Communication Technology (ICT) education in Sub-Saharan Africa. We started this project in 2016. The project started by training IT graduates and using some of them in setting up ICT labs, training of basic school teachers in the use of computers, multimedia equipment like smart boards, etc. Prior to starting this project, we observed that government agencies responsible for ICT projects, local authorities, schools, opinion leaders and other key stakeholders were facing major difficulties in the implementation of ICT projects for schools. We analysed the root causes of failing ICT projects in schools in Africa and based on the investigations we developed a new integrated approach. Our programme is successful by connecting the dots in achieving maximal impact. Our results three year after this initiative, show great improvements in donor support, student attendance, student class participation and government agencies readiness to adopt this ILTP for managing government school's ICT based projects and other

policy directions. Our aim in this research is to make the 2030 United Nations Sustainable Development Goals No. 4 Quality of Education and No. 8 Employment, where the use of ICT is key. In general, innovations in education take at least 10 years of execution before the scientific evidence of its impacts on a new generation of young adults can be proven. This paper gives the first promising signs and expectations.

1. INTRODUCTION

Information and communication technology, ICT, plays a key role in everyday life of many people around the world. ICT refers to technologies that provide access to information through telecommunication. This includes but is not limited to real time communication between people using technologies like instant messaging, Voice over IP (VoIP), video-conferencing among others. ICT has proven over the years to be a very great tool to make teaching and learning easier for teachers and students.

ICT offers teachers and children both technological tools and resources, which are beyond the boundary of their classrooms (Almendarez, 2011; Waite, 2004). Therefore, when ICT is used properly in an integrated way taking into account all-important stakeholders, it could

support and transform the learning situation in the educational sector. Extensively studying and understanding basic skills and concepts of ICT are now highly recognized and adopted by many countries in Africa in teaching science, technology, engineering, and mathematics (STEM). ICT is essential to enable young people to develop the needed skills that correspond to the opportunities in the work environment to reflect and respond to the current pace of change (O'Dowd, 2013). Gholami et al. (2010) found that investment in ICT, education, and economic literacy can play a significant role in equalizing opportunities for marginalized groups and communities.

In the just ended African Union Summit in Addis Ababa, Ethiopia (2019), African Heads of States directed their Information Communication Technology ministers to develop a common strategic framework for Africa wide digital priorities and initiatives. (Zhao, 2019) "The Ministers are at the forefront of building a new digital Africa that leverages the tremendous potential of digital technologies to improve lives," said International Telecommunication Union (ITU) Secretary-General Houlin Zhao.

It is therefore important for countries to propound ICT policies in education as it has proven to be critical in preparing individuals in school for the job market (Hennessy et al., 2010). This impact goes beyond the so-called digital skills per se. It also involves facilitating a more interactive and creative learning process for students. This enable them to have a deeper understanding of the curriculum, and enhance 21st skills like team collaboration, cross cultural communication and creativity and problem solving skills. The growth of ICT education in Ghana is attributed to ICT policy backed by legal and legislative frameworks, which seeks to integrate it into the educational system. Ghana is among one of the African countries where the government continues to invest substantially in ICT education but unfortunately until now, these

investments do not yield proper and expected outcome.

2. RELATED RESEARCH

In this section, we look at the other research that has focused on ICT development, challenges and their proposed solutions to enhance its development.

Van Reijswoud (2009) argues that ICT projects in developing countries can become successful when adapted to local conditions and introduce the appropriate technology to increase the success of such projects. What that essentially means is that, the educational effectiveness of ICTs in undeserved countries like Ghana will depend on several activities like the appropriate design of software and hardware, the training and attitude of instructors, and the acceptance by stakeholders that different students have different needs (Said Assar et al., 2010). It also requires the willingness to experiment with effective use of ICT in education through pedagogical techniques that are different from traditional classroom teaching such as the Bloom's taxonomy.

Despite the fact that ICT have been introduced in many African countries, its expansion and adoption are still in its infant stage due to lack of effective ICT policies and a long run supporting ICT infrastructure.

Alcardo et al assert that various key success factors must be available on a technical level (electricity, internet, software and hardware devices), but also the right teacher capacity and financial resources should be in place (Alcardo et al 2019).

Tim Unwin* also proposed a framework for successful implementation of teacher training programmes making use of ICT to enhance development of ICT in Africa. According to him, practical ICT integration into the whole curriculum, integration between pre-service and in-service teacher training, development of relevant locally produced content and emphasis on the development of effective costing model among others are the

essential ingredient in making such programmes productive (Unwin*, 2005). Haßler et al (2011) also assert that all eight-participant teachers they used in their project portrayed significant use of digital tools and ICT resources into mathematical learning environment.

In as much as most of these works have done great work in identifying some challenges and proposed solutions in their respective works, they did not yet approach the problem of ICT based project in Africa holistically. Most of these works were focused on providing teachers with the skills needed to use multimedia and other tools effectively to improve their leaning.

To the best of our knowledge, no such integrated practical approach that enhances teaching and learning of ICT in developing countries exists. In the next sections, we will introduce some critical success factors in introducing ICT projects in schools in Africa; spend some time on our Integrated Learning Transformation Programme (ILTP) approach and the results so far. We will conclude with some recommendations and acknowledgment to our partners and donors who have aided in this noble research work.

3. SUCCESS FACTORS OF ICT IN AFRICA

As Maxim Nyansa IT Solutions started to launch a national campaign to introduce 21st century skills in schools in Ghana and to support that action by a

call for hardware donations and other logistical supports, some of our potential donors ask the legitimate question for the critical success factors for this type of projects in Africa. As great portion of ICT related projects in Africa are donor funded, it was imperative on us to make sure our initiative do not die as have been seen by other great starts.

In fact, when one travels through West Africa to visit schools that have benefited from computer donations in the past, you will see a mixed picture when it comes to success rates. There is scientific literature in this domain which confirms that the majority of so-called “*community development programmes*” have failed after the initial donor organization and implementing agency have left. In Ghana, we estimate that overall 90% of the ICT projects in schools have failed based on field observations and information from fellow Non-Governmental Agencies (NGOs) and government agencies.

As part of our grand plan for our ILTP, we connected with Martine Koopman, Michelle Selinger, Raymond Trippe, Stephen Agbenyo, Ken Kuguba and others who have been involved in similar projects for decades, in particular in West-Africa, but also in Europe and in other developing countries.

We have also studied various resources in scientific literature and other reports on the matter and came out with these *seven (7)* critical success factors in introducing ICT in schools in Africa.

We consulted these experts in developing our ILTP: Raymond Tripp, lecturer in 21st century learning – University of Education Leiden (<https://www.linkedin.com/in/raymondtrippe/>). Martine Koopman, an international consultant in the application of ICT4Development in schools (<https://www.linkedin.com/in/martinekoopman/>). Michelle Selinger, an international consultant in the application of ICT in schools (<https://www.linkedin.com/in/michelle-selinger-0977381/>). Stephen Agbenyo, director of Savana Signatures, NGO executing ICT projects in schools in Ghana (<https://www.linkedin.com/in/agbedela/>). Ken Kuguba (PhD) lecturer in informatics and director of Boldtech social enterprise (<https://www.linkedin.com/in/kenkubuga/>). With eduScrum students work together in an energetic, targeted, effective and efficient way (<http://eduscrum.nl/en/>)

- I. *Local community is in the lead:* Person of power (Local Chiefs, Local Government, Opinion Leaders, and School Leadership) are actively taking lead roles in these projects. School Leaders and the Chiefs in particular should be committed to the overall success of such projects as they have direct access to these facilities on a daily basis. In most African society like Ghana, chiefs are the main custodian of the land and they wield the authority to make ICT projects successful on their land. Having their full backing and support guarantees greater success of the project.
- II. *Progress and quality of implementation monitored closely:* This involves the implementing agency having their scheduled monitoring and inspection framework. Local education inspectorate (e.g. Ghana Education Service) may also be a party that monitors the progress of the project. Donor partners in the case of donor-funded projects having their tracking and monitoring facility (e.g. website) built into the whole program outline to ensure that their donated ICT resources are being utilized effectively.
- III. *Long-term financial and technical provisions are in place:* This essentially means that the programme should be self-financing or a dedicated financing scheme should be available for maintenance and replacement. Continuous training of new personnel and at least one local staff should be trained on how to take care of the basic maintenance of the hardware devices provided for use by the students and the staff.
- IV. *Programmes are tailor made for local needs:* Implementing a successful ICT project should involve having a quick scan in order to identify the start situation. Content should be adapted to the local situation and perceived needs while implementing the project systematically. This implies that NGOs that bring their own “grand design” and do not take into account the local starting point of a community or school, are bound to fail.
- V. *ICT is immediately bringing benefits to the stakeholders:* A successful ICT based project should save school staff and teachers some time on administrative chores, make educational content attractive and fun to children. Electronic exercises help students prepare well for examination.
- VI. *Basic facilities supporting the change:* Electricity connection to power computers and smartboards, a well-secured building to prevent theft, and reliable internet access are some critical facilities that are needed for such projects.
- VII. *Integrated Approach:* A very important aspect that various ICT school projects in African countries fail to do. Usually all the above factors are left on their own and that result in failure. From the infrastructure stage of setting up ICT laboratories, creating a network infrastructure, government or donor partners equipping the lab with hardware devices and their tracking activities etc. should be integrated. The teaching curriculum and attractive Online Educational Resources (OER) content should be coordinated. Training of teachers, instructors and local personnel to manage the facilities should be a grand programme fused into the overall project scope with clear line of actions. Providing schools with a school management software is also an ideal way to involve parents and teachers in

the digital transformation of the school. When there is internet available in the area they can have access via their smartphones to the information of the school: online results checking, tracking attendance of ward, payment of fees etc.

4. OUR APPROACH

Based on our extensive field research in Ghana and scientific resources in other African countries, we developed our Integrated Learning Transformation Programme (ILTP), which has the following elements:

I. Training: We organized our first pilot training programme for young IT graduates from June – August 2016. This was the beginning of our ILTP. We started by selecting 10 young IT graduates from various universities across Ghana to train them on number of modules including Hardware and Networking Infrastructural Setup, Software Engineering, Software Testing etc. This was necessary to ascertain those that have interest in ICT school projects.

Professional trainers were brought from both Ghana and Netherlands on voluntary basis to train these students the needed skills like router configurations, network architectural design, practical ICT laboratory setup and efficient and effective use of multimedia for teaching and learning. We also introduced SCRUM (Agile way of managing software projects) and Prince2 Project Management among others. We

selected those with great interest in education and further equipped them with other skills like smartboard, projector, laptop installation, usage and maintenance. EduScrum (a framework for coaching students where the responsibility for the learning process is delegated from the teacher to the students). We call these students “train the trainer” as they will be playing a pivotal role in training teachers and staff of schools in the use of ICT tools. We then notified our donor partners immediately after finishing the training programme and ready to start our first project.

II. Meeting Traditional Rulers: We were invited by the Paramount Chief of Obogu Traditional Area, Nana Oduro Apenteng Darkwa III after he heard about our work to discuss about how our foundation could help build a community laboratory to serve the students of the 14 schools in his area. Obogu is a farming community located in the Asante Akim South District of the Ashanti Region of Ghana with a population size of about 8,000. He welcomed our team, we explained to him our goal to make ICT accessible to deprived schools, and that the Obogu community is blessed to be the first benefactor. After expressing his delight and willingness to commit fully to the project, we agreed on a Memorandum of Understanding (MoU) that spelt out the responsibilities of the community, our IT consultants (Those we trained) and how to manage the infrastructure.

“I was very glad the first time I was using the computer, me for instance I was even afraid to touch the mouse, I was ... in fact I was very glad.” said by one of the student from Obogu Community project. *“In this 21st century I believe that definitely there is proliferation, advancement in Information technology and Obogu should not be exception...,”* said by a schoolteacher in Obogu. The link to these quotes can be found on our YouTube channel <https://www.youtube.com/watch?v=AtUPNPvbPyk>. The full report about our ILTP, how we started and interviews is available at <https://www.youtube.com/watch?v=X59sZEKYUDk&t=550s>

The MoU has financial obligations for the local community too, such as the cost of training the teachers, and how to ensure that the project is self-sustained when there is no donor support any more. With the help of our donor partners from Netherlands, we donated free hardware for that project. We experienced that it is important to start a project like this from the traditional rulers and get them involved in the project, before reaching out to the politicians. The chief gave us a fully furnished hall in his palace to be equipped and used as the ICT laboratory for the community. A very secured place “by design” indeed.

- III. *ICT Laboratory Setup:* Our consultants from our first training group were deployed to do the installation, network and other hardware setup. These consultants using the knowledge acquired to install smartboards, computers and projectors received from our donors. We installed Offline Learning Management Software and digital educational resources locally as internet connectivity was not available in the community when the project started.
- IV. *Train The Trainer:* This involves training all teaching staff on how to use the multimedia to teach, and also locate locally hosted content based on West African Examination Center’s (WAEC) curriculum. For our consultants, it was challenging getting some of the teachers to adapt to the new teaching environment. It is ideal to train all teachers on how to use the smartboard and not to limit it to only ICT teachers. That is important because if the rest of the teachers are not actively involved, it has the tendency not being accepted in the community and will mean that the other teaching staffs are being cut

out. The lab was officially inaugurated on September 2017 and has since been serving the whole community. Students and teachers alike expressed their joy on the project.

- V. *Specialized consultancy and Change Management:* At this stage, we make available consultants to advise the schools and the community on the way to go and the steps to take in keeping the project going. In situation where there is change in ruler ship, school leadership and perhaps different interest group come on board, if these are not managed well, it will have an impact on the project and may even stop. In the African culture, personal contact is very important. Consultants and management of our organization maintain this contact as a key element of the sustainability of each ICT project.
- VI. *Monitoring and Evaluation:* Our consultants have a schedule visit to the community to do follow up on how the facility is being used, any additional challenges or problems that the local personnel are facing and address them. We have also made contact with the Ghana Education Service (GES) to also include the laboratory as one of their routine monitoring exercises they carry during the year to also make sure the community and the students get the maximum benefit it deserves.

After the successful first execution of our approach in 2017, we expanded our concept to three other regions in Ghana, deploying successful ICT projects in schools in Eastern Region, Central Region and Upper West Region in 2018.

At the same time we continued to fine-tune and enrich our integrated approach. Thanks to our

collaboration with a like-minded NGO in India, Computer Shiksha we were able to introduce

- A 16 months video course in English to teach junior high school students digital skills on a practical level
- A remote maintenance support system where ICT staff in a school can seek assistance in computer repairs via WhatsApp video to solve any technical problem.

In the course of 2019, we felt we were ready to scale up even more and we launched a nationwide campaign dubbed “*Computer 4 Schools Ghana*” that seeks to bring computers to all schools in Ghana.

5. COMPUTERS 4 SCHOOLS GHANA

Through other Non-Governmental Organizations (NGOs), Civil Society Groups, Religious Bodies, corporate entities etc., the goal is to collect used or brand new computer hardware, refurbish them and donate to schools by establishing ICT labs across Ghana using our ILTP. The campaign have the following stages:

5.1 Donate: This is where we call on every organization to donate their used hardware to us. We have some schools and other organizations in the Netherlands that continually donate their computers hardware for such projects and we are now - like our colleagues in India -

reaching out to the corporate world in Ghana too.

5.2 Collection Point: We have collection managers at various locations in Ghana and Netherlands who accept hardware on a daily basis. We have collection points in Kumasi, Accra and various locations in the Netherlands too and we intend to expand this network in the future as campaign gather more awareness and a lot of people show interest. These collection managers are carefully chosen to ensure that the collected items are refurbished through our structured system and finally get to the final destination (Schools). We have published their address and contact information on our campaign website for verification.

5.3 Delivery: We issue tracking codes to donors and get receipt for the donated items. For larger quantities of donations, we send our logistics team with a van to the donors to issue receipt and tracking codes after collection of items.

5.4 Warehouse: We get all hardware transported from the various collection points to our warehouse in Accra where we sort them and those that are unrepairable are sent to the recycle.

The nationwide campaign to get hardware to all schools in Ghana is found here <http://www.computer4schoolsghana.org/>. Our hardware collection workflow is also clearly defined at <http://www.computer4schoolsghana.org/hardware-collection-processes/> backed by our user friendly and intuitive tracking portal <http://inventorysystem.computer4schoolsghana.org/> donated to us by Trinity Software Center. As an NGO, our full ILTP website that talks about the work and training programmes we have been organising is available at <https://www.maximnyansa.com/>.

5.5 Clean and Repair: Our consultants clean, repair and package the hardware for a new life ready to be sent to designated schools. We are constantly receiving requests from schools to get ICT Laboratory setup for them. Therefore, this phase helps in deciding which schools are in line to get items.

5.6 Setup ICT Lab: This stage is where through our earlier discussed approach we used in the pilot stage for the Obogu project, we get to the community to setup an ICT laboratory.

5.7 Track Your Contribution: With a free inventory system and website donated to us by Trinity Software Center Limited, a company with similar mission to ours, donors are able to enter a unique code assigned to donated items and see where it is located. If it has been deployed to a school, the name of the school, the location as well as the picture is displayed. It will show whether it was recycled, is at sea to Ghana, in warehouse etc. They get a sense of accomplishment and some of them have expressed their joy to see items they donated being used by schoolchildren in Africa.

5.8 Government Engagement: Until now we have been a little silent on government involvement. Here is the interesting part; with an audited trail of all goods being donated to schools available in the inventory system, we are able to discuss with the port authorities to get us reduced

import duties or waiver on these humanitarian hardware. Our first experience in importing containers full of hardware was a nightmare as it was locked up due to lack of clear understanding between us and the port authorities on the veracity of the goods being humanitarian.

6. OUTCOMES

Through the approach we adopted in managing ICT school project in Ghana, we have achieved some success since our first training programme in 2016 and our first big project in Obogu in 2017, including the following:

We have successfully trained Forty-five (45) graduates in our Integrated Learning Transformation Programme (ILTP) for execution in the various parts of Ghana.

Fifteen ICT laboratories have been so far equipped with Computer hardware across the country Ghana.

With our integrated learning transformation approach, these laboratories are in constant operation and students of multiple schools are being trained in digital skills. Smartboards and educational content is introduced into science classes for a more interactive learning process.

Ghana Investment Fund for Electronic Communication (GIFEC) under the Ministry of Communication, the government agency in Ghana responsible for the installation of ICT in educational institutions has now invited us to collaborate with them and introduce our successful approach all over Ghana.

“Schools should be supported with computers and especially if philanthropist and other NGOs will also come in to support and even parents... the teachers with this training that they have got will go a long way especially in my district to support the schools.”
– Ekumfi District Director of Education. *The member of parliament (MP) for Ekumfi also admonished and appealed to all stakeholders and companies to donate their used hardware to Maxim Nyansa for refurbishment to support other schools in Ghana. This happened after successful training of teachers ready to be deployed to various schools.* The link to the programme and all other interviews is put together in this report <https://www.youtube.com/watch?v=-qWmccQa1cc&t=3s>

Donors of hardware are increasingly interested in our approach and thanks to our tracing and tracking software; we are anticipating a constant stream of donated hardware for West-African schools.

7. CONCLUSION

In conclusion, we will like to emphasize that ICT School projects cannot be done in isolations; it needs an integrated approach with all key stakeholders. Focusing on equipping the teacher with the needed skills about ICT usage alone or just donating hardware to schools is not enough to ensure greater impact of ICT development in Africa. It involves traditional leaders taking keen interest in such projects, training of staffs, effective monitoring and evaluation and managing the changes that arises among others.

As stated in our abstract, it will take about ten years to confirm that the thousands of Junior High School students and villages benefiting from our integrated learning approach will actually have better exam results, better 21st century skills and finally a better chance on the 21st century West-African job market. While awaiting that great moment, three years after we started, we have seen great improvement in teacher – student class participation, class attendance, donors overwhelming support and government of Ghana through GIFEC readiness to adopt our ILTP to manage government school projects.

We therefore recommend civil society groups, NGOs, government agencies and any other interested party with the desire to set up an ICT school project in Africa to adopt our ILTP. We are always available to give the needed resources and program to other organisations with similar mission. We are confident that in the next 7 years we will be able to compare these outcomes with similar schools and harvest the fruits of our work when we see young Africans with a good career perspective in the this competitive job market.

8. ACKNOWLEDGMENT

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REFERENCES

- [1] Almendarez, L. (2011). Human capital theory: Implications for educational development. Available from <http://www.open.uwi.edu/sites/default/files/bnccde/belize/conference/papers2010/almendarez.html>
- [2] Waite, S. (2004). Tools for the job: a report of two surveys of information and communications technology training and use for literacy in primary schools in the West of England. *Journal of Computer Assisted Learning*, 20(1), 11-20.
- [3] O’Dowd, J. (2013). Minister emphasises the importance of ICT of primary school teacher conference [Press release]. Retrieved from <http://www.belfasttelegraph.co.uk/debateni/press-feed/minister-emphasises-theimportance-of-ict-at-primary-school-teacher-conference-29537469.html>
- [4] Zhao, H. (2019). Accelerating ICT development in Africa, together. Retrieved from <https://news.itu.int/accelerating-ict-development-in-africa-together/>
- [5] Maxwell Peparah, O. (2016). ICT Education In Ghana: An Evaluation of Challenges Associated With The Teaching And Learning Of ICT In Basic Schools In Atwima Nwabiagya District In Ashanti

Region. *European Journal of Alternative Education Studies*, 0. Retrieved from <https://oapub.org/edu/index.php/ejae/article/view/123>

[6] Hennessy, S., Onguko, B., Angondi, E., Harrison, S., Namalefe, S., Naseem, A., & Wamakote, L. (2010). Developing use of ICT to enhance teaching and learning in East African schools: a review of the literature. Cambridge, UK and Dar es Salaam, TZ: Faculty of Education, University of Cambridge and Aga Khan University Institute for Educational Development-Eastern Africa.

[7] Gholami R., Anon Higon D., Hanafizadeh P. and Emrouznejad A. (2010). Is ICT Key to Development? *Journal of Global Information Management*, 18(1): 66-83.

[8] Van Reijswoud, V. (2009). Appropriate ICT as a Tool to Increase Effectiveness in ICT4D: Theoretical considerations and illustrating cases. Available at <https://onlinelibrary.wiley.com/doi/10.1002/j.1681-4835.2009.tb00272.x>

[9] Said Assar, Redouane El Amrani, Richard T. Watson. *ICT and education : a critical role in human and social development*. Information Technology for Development, Taylor Francis (Routledge), 2010, 16 (3), pp.151-158. 10.1080/02681102.2010.506051. hal-00529533

[10] Tim Unwin* (2005) Towards a framework for the use of ICT in teacher training in Africa, *Open Learning: The Journal of Open, Distance and e-Learning*, 20:2, 113-129, DOI: 10.1080/02680510500094124

[11] Björn Haßler, Sara Hennessy, Brighton Lubasi (2011). Changing Classroom Practice using a School-Based Professional Development Approach to Introducing Digital Resources in Zambia. Available at <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.458.6035>

[12] Justine Kasigwa, Ddembe Williams and Venansius Baryamureeba, (2005). The role of ICTs and their sustainability in developing countries.

[13] Alcardo Alex Barakabitze, Anangisye William-Andy Lazaro, Neterindwa Ainea, et al., “Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities,” *Education Research International*, vol. 2019, Article ID 6946809, 29 pages, 2019. <https://doi.org/10.1155/2019/6946809>.

[14] Sara Hennessy and Brown Onguko, Zanzibar Round Table (2009). Developing use of ICT to enhance teaching and learning in East-African Schools.

[15] Charles Mahinghe Catinji (2009). Factors affecting sustainability of community based projects.

[16] Jabulisiwe Mabila, Judy van Biljon and Marleen Herselman (2017). A sustainability framework for mobile technology integration in schools: The case of resource constrained environments in South Africa, *Journal of Community Informatics*.

[17] Michelle Selinger, Peter Hamilton (2017). Models for successful schools in a digital age - a research study and literature review. Available at <http://www.edtech-ventures.com/models-for-successful-schools-in-a-digital-age/>