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# Final Project Case Study

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# OVERVIEW

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The International Telecommunications Union (ITU)<sup>1</sup> (2015) notes Tanzania is positioned as 152 out of 166 on the global ICT Development Index (IDI), one of 42 of the Least Connected Countries (LCC) in the world. Studies note that this lack of connectivity has a direct correlation with the Least Developed Countries (LDC) with respect to low educational levels, literacy, poor infrastructure and limited or lack of electricity. Tanzania is not only behind in its communications infrastructure in relation to the socio-economic potential, it is also behind in utilising the potential of ICT for the education sector. ICT within the education sector in Tanzania has been identified as a critical enabler for the country's sustainable development. It is evident that the development of ICT across all sectors is a strategic priority for the Government of Tanzania. In order to increase the country's participation in the competitive global market and to achieve these ambitious targets, the government is actively calling on donors to fund projects to support their ICT strategies.

The Government of Tanzania Education Sector Review 2011 revealed that there are many challenges facing the sector, which include the acquisition and supply of ICT infrastructure and equipment in schools, the training of teachers and children, and the delivery of online teaching resources to support learning.

The iKnowledge project is led by Avanti Communications Ltd, an international satellite broadband provider. One of Avanti's goals is to help countries 'go digital' through the use of satellite internet in order to increase prosperity, inclusivity and security. The iKnowledge project is one of the company's large-scale educational intervention projects, where the organization works with both government and private sector to bring a combination of satellite internet with ICT equipment and capacity training for teachers in Tanzanian schools. The goal of iKnowledge is to provide access to quality education through the combination of internet connectivity, capacity building, and ICT resources.

The iKnowledge project aims to demonstrate how access to broadband via satellite can equip teachers to create an improved teaching and learning environment in both primary and secondary schools, through transformed teaching methodologies. This is realised through the provision of connectivity, capacity building training, ICT resources, and digital content delivered through an educational platform. Once these interventions are combined and supported by local and national partnerships, a comprehensive learning experience is created that contributes to an improved educational environment for teachers and learners and ultimately addresses the UN SDG 4: to "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" and SD9: to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

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<sup>1</sup> ITU Measuring the Information Society

[https://www.itu.int/en/ITUUD/Statistics/Documents/publications/mis2014/MIS2014\\_without\\_Annex\\_4.pdf](https://www.itu.int/en/ITUUD/Statistics/Documents/publications/mis2014/MIS2014_without_Annex_4.pdf)

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The project demonstrated to in-country stakeholders how satellite services can support e-education in Tanzania with a specific focus on sustainable business models and professional development and support for teachers. The success means business opportunity for Avanti would come from the wider adoption of its satellite services in Africa and beyond funded by the governments themselves and by third party donors and sponsors.

The iKnowledge project outputs:

- 312 schools provided with satellite connectivity and a total of 917 laptops and 323 projectors.
- 574 individual teachers trained and 88% reporting that the training was relevant to their needs.
- 100% of trained teachers reporting improved ICT capacity and skills.
- 90% of teachers reporting that they feel more confident to use ICT as part of their teaching.
- 34,575 students directly reached through iKnowledge since the beginning of the project.
- 79% of students report using ICT for their learning.
- 96% of students report an increase in integration of ICT resources in the classroom.

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# PROJECT PARTNERS

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**Avanti Communications** is the project lead for iKnowledge. Avanti is a leading global satellite operator based in London (U.K.) specialising in the provision of broadband Internet services for end-users and backhaul services to sites located in rural areas. All projects partners for iKnowledge are contracted via Avanti Communications.



**UK Space Agency (UKSA)** is responsible for all strategic decisions on the UK civil space programme and provide a clear, single voice for UK space ambitions. UKSA is an executive agency, sponsored by the Department for Business, Energy & Industrial Strategy. UKSA jointly funds the iKnowledge project via the International Partnerships Programme (IPP). IPP uses the UK Space sector's research and innovation strengths to deliver a sustainable, economic or societal benefit to undeveloped nations and developing economies.

iKnowledge has five delivery partners during the phase two of its delivery.



**Altech Limited** is a Tanzanian based company incorporated in 2011 specialising in supply, installation and support for VSAT technology. Altech was responsible for internet and service maintenance for all iKnowledge schools and training teachers in how to buy additional broadband through Wi-Fi Hotspots.



**Camara Education Tanzania** is a non-governmental organization and is a branch of the International Charity and Social Enterprise Camara Education, which is based and registered in Ireland, UK and USA. Camara is responsible for improving the quality of education through the combination of Avanti satellite Internet connectivity, teachers' capacity building and ICT resources in public schools across 25 regions of Tanzania, with a focus on primary schools receiving training and direct educational and technical support.



**Discovery Learning Alliance (DLA)** was established by Discovery Communications to extend its commitment to education worldwide. DLA is a non-profit organization dedicated to using the power of media to transform education and improve lives in marginalized communities around the world. DLA developed and implemented a pilot training program for eight iKnowledge schools in Arusha and Moshi that builds upon iKnowledge project infrastructure and DLA's extensive library of content and accompanying teacher training.



**Ace Africa**, a registered non-profit company in Tanzania, is the iKnowledge Monitoring and Evaluation (M&E) partner. With effective M&E systems at the core, Ace Africa has reached over 1 million beneficiaries since 2003 and received a number of international development awards. Ace Africa is the project independent Monitoring and Evaluation partner.



**Jigsaw Consult** is a social enterprise working in the international development sector, helping organisations to enhance development outcomes through evaluation, research and learning. Jigsaw Consult provide iKnowledge with Monitoring and Evaluation Consulting.

iKnowledge has four Tanzanian governmental partners.



**Universal Communications Service Access Fund (UCSAF)** is a government agency and a corporate body established to ensure availability of communication services in rural and urban underserved areas under Universal Communications Service Access Act, No. 11 of 2006, Cap 422 of the Laws of Tanzania. UCSAF collaborated with Avanti and the project partners in overall project management and coordination with the partners and to ensure that the selected schools in the project are located within the remote locations of the country. UCSAF with Avanti was also responsible for funding training for teachers to be able to undertake basic troubleshooting and maintain the ICT equipment provided.



**Tanzania Education Authority (TEA)** is a government agency and a corporate body established under the Education Fund Act No. 8 of 2001, Cap 412 of the Laws of Tanzania. TEA is charged with responsibilities of securing adequate and stable financing of education and advising the Government on new sources of revenue for ensuring adequate and stable flow of funds. TEA is also responsible for raising quality of education to increase access and equity, applying monies deposited to the fund for purposes of improvement and promotion of education, and monitoring use of funds disbursed and ensure adherence to the fund objectives. TEA facilitates communication and support between the project partners and the Tanzania ministry of education and also provide resources in overall project management and the selection of schools.



**President's Office, Regional Administration and Local Government (PO-RALG)** owns the schools and were responsible for collaboration with UCSAF and TEA to ensure the most suitable schools were selected for the project. PO-RALG is also the partner responsible to give the project staff access to the schools and was responsible for facilitating coordination and communication with regions and local government authorities to encourage their involvement in the project. **Ministry of Education, Science and Technology** worked together with the project partners in ensuring that the implementation of the project is as per the country's education policy.

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# SOLUTION

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In a report by Global E-Schools Community's Initiatives for ICT in teaching and education for Tanzania states the major gaps in the education system are:

- 1) Lack of fund for new and replacement for old ICT infrastructure;
- 2) High attrition rates of trained ICT tutors who move on to urban schools with better infrastructure;
- 3) Lack of experts in ICT Pedagogy;
- 4) Lack of experts in developing e-content and digital resources;
- 5) Inadequate funds for ICT related activities;
- 6) Inadequate bandwidth and support for network systems management; and
- 7) Lack of awareness on the potential of ICT in addressing challenges in education.

The four main ICT development barriers identified in rural located Tanzanian schools are:

- 1) Connectivity: Tanzania in general has insufficient infrastructure for communications, power and transport;
- 2) Content: The availability of local and digital education content in Tanzania is limited but progressive;
- 3) Organisation and alignment: There is persistent delay in the planning, organisational momentum, implementation of ICT projects and alignment with government policies;
- 4) People: Many Tanzanians including teachers especially in rural areas do not have adequate skills and awareness to operate computers and other ICT equipment proficiently in the context of the educational environment.

The benefit this project brings to the education system in the partner country is:

- The deployment of ICT infrastructure and supply of satellite broadband to ensure connectivity and inclusion of solar power if required;
- Sustainable source of relevant education content materials for teachers to use in classroom;
- Teachers in rural schools proficiently trained to use ICT for their professional gain and teaching; and
- Teachers in rural schools using ICT to closely align classroom lessons with the MoEST policy and educational framework.

If ICT connectivity is available to rural schools, it opens up number of new opportunities for teachers to improve how they teach and interact in the classroom. The project demonstrated to in-country stakeholders the benefits of satellite services and how it can support e-education in Tanzania to improve the educational environment for both teachers and students. This is through the provision of key core inputs and affordable or free educational content with professional development and support for teachers.

iKnowledge schools are classified into four types:

The **ICT Academy** is the *focal point/hub* of the intervention. Selected teachers from the Academy with an interest in ICT are trained by iKnowledge to improve their ICT literacy skills. These schools are equipped with satellite broadband and digital educational content on a school server to provide a platform for quality delivery of curriculum for students. Academy schools are expected to support training teachers from the Teaching Lab and Administration schools clustered around the academy in each region. We have one academy school per region.

The **ICT Teaching Labs** are *Clustered Schools* focused on teachers' integration of ICT into teaching and learning practices. These schools are also equipped with satellite broadband and digital educational content on a school server to provide a platform for quality delivery of curriculum for students. A small group of teachers from these schools are trained at the Academy school in the district. They then follow the 'train the trainer' model to train other teachers in their schools. We have three teaching lab schools per region.

The **Administration Schools** use the satellite broadband provided to support administrative work at the schools. Teachers at these schools also use the internet service provided to access online teaching materials. We have six administration schools per region.

The **Remote School** combined high speed broadband internet with solar power deployed in two regions to demonstrate the intrinsic benefit of satellite in providing internet access in remote regions of Tanzania that otherwise have limited access to both internet and grid power. We have 52 remote schools.

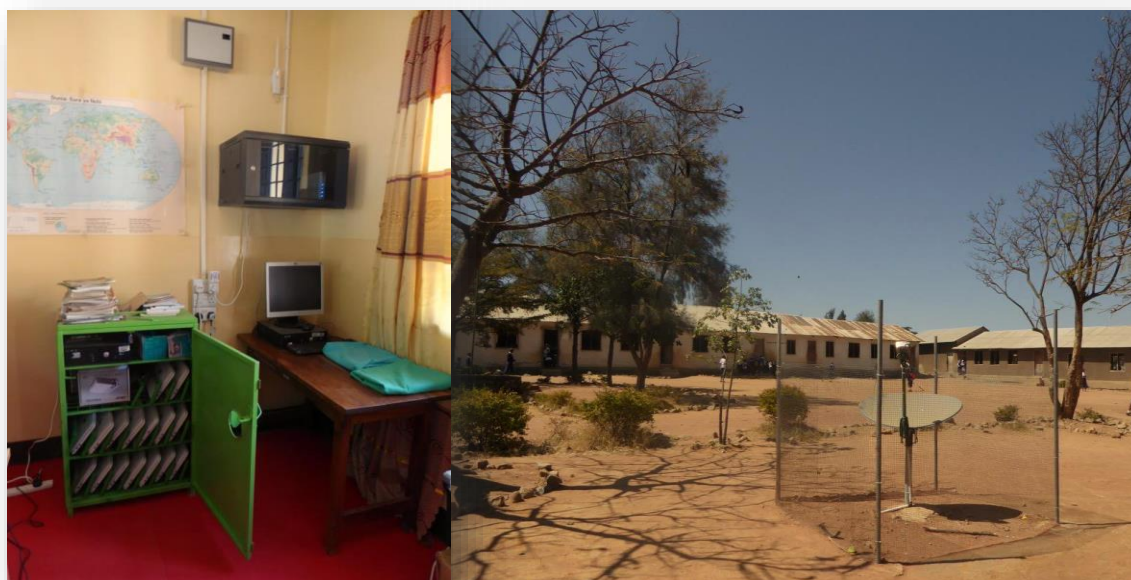


Figure 1 – iKnowledge Equipment in Academy Schools

iKnowledge provided each school with the following equipment:

Academy School	Teaching Lab School	Administration and Remote Schools
<ul style="list-style-type: none"> <li>Satellite Internet &amp; 2 Wi-Fi device</li> <li>17 Ruggedized Laptops</li> <li>School Portal &amp; Back-up Server</li> <li>2 LED Projectors</li> <li>1 pair of Speakers</li> <li>Storage Cabinet with Charging Unit</li> <li>Cabling &amp; Trunking</li> <li>Power &amp; Surge Protection for two rooms</li> <li>Whiteboard</li> </ul>	<ul style="list-style-type: none"> <li>Satellite Internet &amp; 1 Wi-Fi device</li> <li>4 Ruggedized Laptops</li> <li>School Portal</li> <li>1 LED Projector</li> <li>1 pair of Speakers</li> <li>Storage Cabinet with Charging Unit</li> <li>Cabling &amp; Trunking</li> <li>Power &amp; Surge Protection for two rooms</li> <li>Whiteboard</li> </ul>	<ul style="list-style-type: none"> <li>Satellite Internet &amp; 1 Wi-Fi device</li> <li>1 Ruggedized Laptop</li> <li>1 LED Projector</li> </ul>

We proposed a program vision for iKnowledge based on the principles of **Connect, Deliver, Train** and **Sustain**.

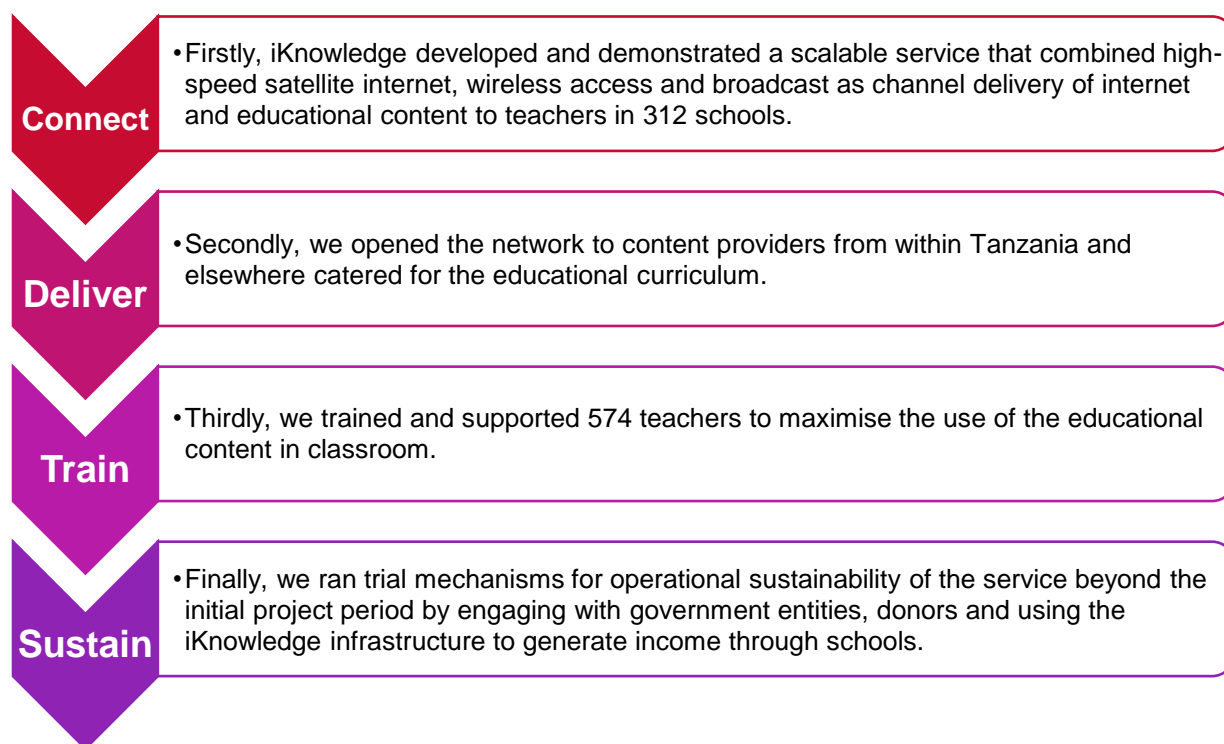


Figure 2 – iKnowledge Vision



Based on the initial proposal, we identified three key stakeholder groups for receipt of training: School Leaders, School Teachers and District Education Officials. To support and achieve each of these principles and desired impacts, the development and delivery of the iKnowledge training program was undertaken in four key stages:



Figure 3 – The Four Stages of Project Execution

### Stage 1: Research

The Research element was conducted in two stages. The initial research stage included desk research with an aim of building understanding about barriers existing in the educational context in Tanzania with the emphasis on the ICT. This was followed by the comprehensive survey conducted at school level and focusing on teacher capacity. The objective was to select out the schools that complied with the criteria defined for the project to intervene.

A key output from this stage was a formulated ICT infrastructure deployment and training Plan with documented learning objectives for each key stakeholder identified and a proposed method of delivery of training.

### Stage 2: Development

Based on the findings conducted in the research stage, a localised training program was developed for teachers. Training materials and content were delivered on an online platform:

- The teacher training was a modified version of ICT Skill-builder for Teachers;
- A specific workshop for ICT Academy personnel was also developed and focus on supporting selected teachers in delivering on-going training programs to teachers and community members in the locality as well as other technology and internet focused services:
  - This stage was also focus on identification of appropriate training programs that will be of benefit to the ICT Academy and the greater community it serves;
- School Leaders were involved in the training program for teachers and ICT Academy also received a separate workshop in managing the ICT Academy;
- Through the project, selected teachers received refresher training. The aim was to ensure that the teachers' ICT skills are strengthened. Head Teachers and respective Districts Educational Officials were involved in the training with the intention to increase the adoption and ownership of the project at the school and regional level;

- Discovery Learning Alliance (DLA) built a five day capacity building training pilot model, where all the teachers from eight selected schools located in the northern regions were trained in student centre and gender friendly pedagogy. DLA provided an additional 73 videos focusing on different subject areas that could be used as supplementary teaching material.

### **Stage 3: Delivery**

First, we deployed the following infrastructure in each school:

- Installation of 15Mbps satellite broadband and Wi-Fi Access in schools to allow teachers to use the internet to source educational materials for use in classroom teaching;
- Provision of ruggedized laptops for teachers to use to access the internet for educational resources and administration purpose;
- Provision of projectors to allow teachers to better use educational resources in classrooms;
- A total of 100 schools were equipped with Wi-Fi Hotspots powered through solar and batteries.

We then delivered a modified version of ICT Skill builder for teachers in the 25 ICT Academy schools. This was an inclusive module(s) on local and freely available online educational content and resources, and introduction to integrating resources into teaching and learning practices.

Following the delivery of the Teacher focused training; we also delivered a "Train the Trainer" workshop for talented teachers to lead the ICT Academy in each school. The workshop was focused on delivering courses and workshops that have been identified as useful for the surrounding communities and teachers from other schools that the ICT Academy will train. School leaders were provided with a one-day workshop to ensure that both teachers and ICT Academies are supported in achieving their objectives.

DLA delivered a student centred and gender friendly pedagogy training to all school teachers, school leaders and respective District Level Officials in the eight schools located in two northern regions. In addition, we provided additional 73 videos focusing on different subject that could be used as a supplementary material for teaching in eight schools as part of DLA's capacity building training module.

### **Stage 4: Sustain**

The ICT Academy provides critical support for teachers and members of the community for on-going and sustainable learning and development. Therefore, support for the ICT Academies to sustain and grow accordingly to meet the needs of their community is key.

The ICT Academies were provided with the following:

- Support for delivery of training programs;

- Support for ICT Academy trainers;
- Governance support to ensure sustainable training;
- Administrative support for training;
- New and updated training courses;
- Hardware technical support;
- Business development plan support;
- Web based train the trainer.

# Innovation



Figure 4 – Tanzania is covered with five spot beams over Avanti high speed Ka-Band satellite - HYLAS 2

This project is technologically innovative because it applies existing satellite broadband technology with multicast technology as a medium for delivery for Educational Technology intervention into schools. iKnowledge facilitated 312 Tanzanian schools with:

- High speed satellite broadband with Wi-Fi Access in schools to allow teachers to use the internet to source educational materials for use in classroom teaching;
- Multicast streaming technology to upload video content into local servers to minimise bandwidth utilisation and for video based content;
- An access to an educational portal with relevant educational content;
- Laptops for teachers to use to access the internet for educational resources and administration purposes.
- Projectors to allow teachers to use online educational resources in classroom environment;
- Deploy Wi-Fi Hotspots in 100 schools with a pay as you go service which gives schools the flexibility to buy internet access when they need it and without a monthly subscription commitment.

The content portal, aggregates and translate into local language where possible educational content for lesson planning, teaching and skill-building such as:

- Ka-Lite: Instructional videos from Khan Academy on maths, science, history, economics matching the common standard;
- Ubongo Kids: Animated edutainment TV series, watched by over 1.4 million viewers in Tanzania and available in over a million more households across East Africa;

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- Discovery Learning Alliance (DLA) with 73 educational videos suitable for the teachers to use in primary schools;
  - School Tool: A free, open source, web-based student information system for a single school, including student enrolment and demographics, grading and grade reporting, tracking student achievement of skills, competencies or outcomes, attendance, calendars and intervention tracking;
  - Epoptes: Open source computer lab management and monitoring tool;
  - Open EDx: Interactive online courses from the world's best universities and institutions;
  - TESSA: An international research and development initiative which brings together teachers and teacher educators from across sub-Saharan Africa.
  - Rachel: World Possible initiative to leverage the large volume of open and free educational course-ware and libraries available online and make them available to Emerging Countries schools and communities with limited internet access.
  - British Council: Includes a wide range of educational content for different learner and age groups:
    - British Council Learn English: English learning resources for adult learners;
    - British Council Learn English Teens: English learning resources for teens aged 13 – 17;
    - British Council Premier Skills English: English learning resources for adults and teens around the subject of football and the Premier League plus teaching resources for teachers;
    - British Council Teach English: Teaching resources and professional development resources for teachers.

In addition of the above list of content, educational websites identified throughout both phases of the project are whitelisted allowing teachers' access without consuming their allocated internet data allowance.

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# SUSTAINABILITY MODEL

The key components of the project sustainability model was to first promote the benefits arising from the educational impact of iKnowledge to all stakeholders to answer the question “why is it worth sustaining?” We achieve this through writing case studies, white paper, collaterals and dissemination through website, conference events and meetings with government stakeholders. We then reviewed other programs running in the country and question how they came about to achieving sustainability, and if not why did it fail and how we can learn from it. As part of putting a sustainable support process for equipment to ensure they are maintained in good working condition, all equipment was required to be registered with the school and government.

With close engagement with the government and private sectors, the project trialled a number of sustainability options throughout the project. One of the challenges iKnowledge faced with sustainability is to come up with an affordable model for the services provided that is easily serviceable across the entire country. We reviewed the option of parents pay for the service but later rescinded after the change in government policy where parents are no longer allowed to finance their children for school. Some schools have demonstrated the ability to generate their own income by running classes in the evening for local communities interested to improve their knowledge or purely internet café model. The school generated income model had limited success because not all schools will have self-driven champions to drive the model successfully.

iKnowledge proposed in the end a multi-tiered sustainable model which would benefit both schools, government and private entities. We introduced a pay as you go internet broadband subscription model which provide schools the flexibility to buy bandwidth when they require it without needing a monthly commitment. We ran trials in 100 schools and our results have shown that teachers were the primary customers for this model because they now have the flexibility to buy internet when they need it. The high performance of the satellite broadband made it better option to alternative mobile networks solution. To keep educational context affordable for schools to use, we ‘whitelist’ through a set of educational websites and classify them under outside their monthly data allowance. This is to ensure all iKnowledge schools have minimal access to basic educational content.

Part of our sustainability measure is to ensure equipment are maintained in good working condition. During the course of the project we trialled and discussed with our partners a number of models that balance between affordability and quality repair. The typical model for support and maintenance is by where the service provider provides first line support for school staff to call when the internet service needs troubleshooting or repair. In circumstances where a site visit is required, an engineer is sent to the school to resolve the issue. Tanzania however is a large country and in extreme geographic ends will take an engineer two days travel from the service hub. The cost may surmount to anything of up to \$1000 for a maintenance visit to cover fuel, vehicle hire, accommodation and the engineer’s salary. This traditional approach would cannibalise revenue from the internet subscription and schools unable to afford the service. iKnowledge work with our partners to include a maintenance training service to be held twice a year in two locations. School teachers are invited with expenses paid to attend training on how to

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undertake basic troubleshooting and maintenance of internet equipment. This generate two positive outcomes with teachers taking ownership to maintain the equipment provided to them and making the service sustainable beyond the lifespan of the project funding.

iKnowledge has put in place a robust ICT infrastructure in 312 Tanzanian schools which will benefit the schools and future programs that want to leverage existing services already in place. We worked closely with service providers in country to come up with an affordable satellite broadband price to entice future funding opportunities to take advantage of our schools.

Our expansion strategy is based on using iKnowledge in Tanzania as a pilot template before we expand to other countries. This ambitious project has given Avanti all the necessary lessons learn that we can take away and accomplish further when we expand to new countries. Avanti is interested to expand the program in step process over the entire Sub-Saharan region covered with our satellites. There are a number opportunities Avanti is pursuing particularly in West Africa.

The iKnowledge expansion strategy is based on the 5Cs.

- **Connectivity**: To provide schools and community with high speed internet access;
- **Computers**: All schools to have an ICT lab equipped with computers;
- **Capacity Training**: School teachers, students and communities provided with ICT capacity training;
- **Content**: School libraries furnished with the latest digital content;
- **Continuity**: A self-sustainable mechanism to keep the service running.

# RESULTS SO FAR

The project aims to demonstrate to the key government stakeholders in UK and Tanzania how access to broadband via satellite can equip teachers working in schools to deliver an improved learning environment for learners in both primary and secondary schools through impactful teaching methodologies.

The iKnowledge project outputs:

- 312 schools provided with satellite connectivity and a total of 917 laptops and 323 projectors.
- 574 individual teachers trained and 88% reporting that the training was relevant to their needs.
- 100% of trained teachers reporting improved ICT capacity and skills.
- 90% of teachers reporting that they feel more confident to use ICT as part of their teaching.
- 34,575 students directly reached through iKnowledge since the beginning of the project.
- 79% of students report using ICT for their learning.
- 96% of students report an increase in integration of ICT resources in the classroom.

The goal is realized through the provision of IPP funding and utilization of expertise in satellite broadband and multicast technology provided by Avanti. The international partners will support the project through provision of expertise in the field of education and government relations.



Figure 5 – School teachers receiving training during the ICT Skill-builder Workshop

iKnowledge manages both deployment and implementation which address the limitations that were identified in the educational sector of Tanzania:

- Connectivity;



- Capacity building training;
- ICT resources;
- E-education platform.

These inputs once combined create a comprehensive learning experience that contributes towards creation of improved educational environment to learners ultimately addressing the UN SDG 4: to “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” and SD9: to “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The project focus was in Tanzania, where teachers and children have inadequate access to educational resources. This is addressed through the means of connectivity and provision of content through which the teachers are able to access most up-to-date materials to prepare the lessons for the students.

In addition, the project addresses the problem of inadequate skills that teachers possess in order to utilize the ICT for the benefit of students. The unique approach which iKnowledge applies is to focus on training selected group of trainers who feel empowered to further disseminate the ICT knowledge.

The ultimate aim of the project is to measure how the satellite connectivity has impacted the teaching and learning environment. This is gauged through the portfolio of indicators that measure the impact it has made on the teachers. While it is recognized that the ultimate beneficiaries of the project are learners, they are considered to be indirect beneficiaries in this phase of the project.

The M&E for the iKnowledge project has been a collaborative process involving all the implementing partners. The study design involved a concurrent mixed method approach using tools and methods to obtain both qualitative and quantitative data. The research process for the End-line evaluation involved the collection and analysis of data from multiple sources to ensure maximum rigour. The data included both qualitative and quantitative designed and used by the External Evaluator. The internally tracked real time data measuring the performance of the ICT infrastructure put in place in the iKnowledge schools along the teachers accessing online resources was than triangulated with the data collected though the field data collection by the External Evaluator. This approach allowed us to achieve greater rigour of the research.

The five M&E study sites that included 20% of iKnowledge project sites, were selected based on a proportional representation of urban, rural and geographically diverse regions of the country. The results for the Phase Two were assessed in three separate evaluation points, and draws on the findings and recommendations identified in previous M&E studies which were conducted during the Phase One at various intervals over the duration of the project. These studies evidence the extent to which the anticipated output and outcomes of iKnowledge have been achieved at each stage of its trajectory.

It is clear that the provision of the satellite connectivity has impacted the education sector of Tanzania and contributed towards creating more inclusive environment for both teachers and students. The evidences of the impact measured through the portfolio of proxy indicators was gathered at various evaluation points and contributed towards building the evidence base indicating that iKnowledge has made a positive impact on both teachers and students during the course of the project. This impact particularly relates to connecting schools to the internet, providing ICT resources and educational content, and building the capacity of teachers to utilise ICT.

Key impacts identified throughout this study include the following:

- The iKnowledge platform and modular approach led to creation of different levels of intervention which resulted in varying levels of impact.
- Significant changes was noted at all intervention levels and it is evident that the provision of one laptop, a projector and connectivity to schools is sufficient to act as a catalyst for changes in ICT knowledge and practices amongst teachers and, to a lesser extent, students.
- Findings indicate that where there was a greater amount of inputs, students' have reported increased access to ICT as part of their learning.
- Face-to-face teacher training and refresher training was noted as effective method to upskill the teachers, providing teachers with more confidence to use ICT for their own use and teaching, where a greater number of teachers trained within a school creates the environment for all teachers to be motivated to learn to use ICT as part of their teaching.
- Online teacher training courses could be an affordable option when compared to the more expensive teacher training ICT courses.
- Provision of educational content through the iKnowledge portal was well received, particularly in the primary schools. The evidences indicate that the visual and digital content provided is effectively supporting teachers to teach their topics and to better engage with students in the classroom environment.
- Teachers also noted that the training and equipment provided had not only enabled them to improve their ICT skills but also saved them money and time spent on traveling long distances to access educational content or use a computer for administrative purposes.

Cost Effective Analyses (CEA) was conducted for the iKnowledge project towards the end of the project.

The design of the CEA represents two strategic areas of the project: connectivity and education. The calculations of the cost and impact included both phases of the project. As a result, two models were created; CEA1 focusing on connectivity and CEA2 focusing on education. Results from the CEA1 assessment indicate that the satellite solution is a more cost-effective option for connecting beneficiaries in schools than alternative 3G mobile options. Analysis indicates that the cost is £4.40 per beneficiary for satellite connectivity and £7.30 per beneficiary for the alternative 3G small cell network. The results for the CEA2 assessment indicate that it costs £24.90 to create improved educational environment per student using the satellite solution compared with £37.20 using traditional educational solution (training teachers, refurbishing class and provision of the educational aids, books).

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Overall the results suggests that the iKnowledge project is a more cost effective solution to deliver services to schools (connectivity and education) compared to the existing traditional alternatives. In addition, the satellite connectivity solutions permit additional benefits:

- The use of satellite multicast to deliver content and update into school portals without need to visit schools.
- Access to the educational websites available on the internet that can enrich the educational resources available to teachers and students at schools.
- Potential of provisioning of the teacher Continuous Professional Development (CPD) in the most cost efficient way which is especially important for the rural and remote schools of Tanzania.

Discovery Learning Alliance (DLA) developed and implemented a pilot training program for eight iKnowledge schools in Arusha and Moshi that builds upon Avanti's existing iKnowledge project and DLA's extensive library of content and accompanying teacher training. The training focused on helping teachers apply child-centered, gender-responsive teaching strategies and use media effectively to complement curricular objectives.

DLA Trainers focused on the following key areas: teachers' use of the equipment, application of student-centred methods, and gender balance in the classroom. The conducted classroom observations indicated that observed teachers were applying the approaches they learned during the DLA training, employed gender-sensitive language and paid attention to gender balance in their classes, such as with seating arrangements and with assigning roles to girls and boys. Across the eight schools, there were noticeable efforts at gender inclusivity, with teachers ensuring that both boys and girls assumed leadership roles in their groups, and calling on both boys and girls during question and answer.

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# LESSONS LEARNT

## Technical Lessons Learnt

1. A local in field team is required in order to efficiently support activities on the ground because they speak the local language and understand the political and cultural context.
2. It is important conduct initial research to define barriers for the intervention to overcome and identify the related parameters used for the school selection process.
3. It is vital to conduct pilots in each country before undertaking the complete rollout. This also applies to training programmes that may need refinement.
4. Clustering of deployment will reduce cost and time to install.
5. Electricity reliability is a major issue in Tanzania and can damage equipment. With additional investment, solar power with batteries is a reliable alternative. Otherwise, install an Automatic Voltage Stabiliser (AVS) in the power outlets to balance grid power fluctuations.
6. The in-country partner(s) for deployment must have nationwide presence. Small resellers often do not possess sufficient level of resources to undertake large deployments quickly, and respond promptly to maintenance issues.
7. It important to plan carefully when procuring and shipping equipment from abroad to prevent project delay.
8. Installing copper rods into the ground for the outdoor equipment can dampen or null damage from lightning strike.
9. Quality of local workmanship can vary and therefore good QA procedures must be set in place so installation engineers undertake work with diligence.
10. It is important to cooperate with the school head teacher, Government Educational Officials and the local community to promote adoption of the project.
11. Feedback captured from local communities and merchants indicate that the specific market is price sensitive where service affordability is a greater incentive than internet service speed and quality.
12. The process to register, buy and use the internet through a smartphone app or internet browser needs to be simple and easy to use.

## Government Engagement Lessons Learnt

1. Government involvement is required from the start of the project and a dedicated person from the project is required to constantly liaise with government. Memorandum of Understanding must be put in place before the project begins to ensure all government departments and partners fulfil their responsibilities in the project.
2. County level officials to be actively lobbied to increase adoption and ownership of the project. This promotes accountability for equipment care resulting in reduce risk of equipment damage or theft.
3. It is important to provide technical expertise along with maintenance training and support to the schools to ensure that the equipment is maintained after the project funding cease.

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4. It is important to continue investing relationship with the government within and beyond the project timelines to ensure all project activities are fully aligned with government expectations and plans.

#### Educational Intervention Lessons Learnt

1. In schools and classrooms where learners access ICT equipment, the number of computers available may be too limited to allow equitable access for all.
2. Additional Kiswahili educational content in-line with the curriculum and contextualised to the Tanzanian educational system should be made available for future programs.
3. Teachers may need more encouragement to be more inclusive with ICT access in teaching and learning activities.
4. Tanzanian Institute of Education recommend making the DLA video library more country specific and more closely aligned with the Tanzanian curriculum, and feature Tanzanian imagery and points of interest.
5. More effort is needed when interacting with some educational officials in the regional government because they have insufficient ICT literacy for communication.

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# THE FUTURE

There are approximate 8000 schools in Tanzania today with 6,000,000 children and 240,000 teachers. The Human Development Index place Tanzania 159 out of the 187 on education global rankings and the World Bank places Tanzania nominal GDP ranking 86 out of the 189 in global ranking.

iKnowledge places Avanti and our partners in a unique position to bolt on additional opportunity for future consideration:

1. The partners have built relationships with Tanzania at the ministerial level and iKnowledge as a name is now recognized in country with schools, hospitals, governmental organizations enquiring for additional connectivity.
2. iKnowledge satellite internet access is spread across 25 regions in both rural and urban locations with very limited competing technologies in its place opens opportunities for new verticals to make use of the ground satellite infrastructure. The additional verticals for consideration are in the health, farming, astronomy and meteorological sectors.
3. The educational training materials developed through iKnowledge for the primary school teachers can be readily expanded to more schools across the country and in other countries across the globe.
4. The multicast content server built for the project is able to host vast amount of compatible online resources that are not just specific to education. Additional, the content server built by Avanti allows real time monitoring and evaluation resulting in better transparency of how the user access the contents stored becomes a valuable measuring KPI tool for future projects.
5. iKnowledge was a greenfield intervention piloting the educational solution enabled through the satellite connectivity. The intervention created a platform for mutual learning and gathering valuable lessons to adjust the service for the future phases and potential scaling up. The stencil in which iKnowledge was developed in Tanzania can be extended to more countries.