EdTech innovations in Tanzania: Investigating student and teacher perceptions

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Dr. James Stanfield, Geoff Calder and Oscar Mlowe, Newcastle University

Muzafar Kaemdin, Human Development Innovation Fund (Palladium)

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1. Introduction

1.1 Background

According to UNESCO's 2015 report *ICT in Education in Sub-Saharan Africa,* while there is a general consensus that ICT can help enable learning and prepare students for the world of work, countries across sub-Saharan Africa continue to face a number of barriers. These include a lack of effective policies and a lack of basic infrastructure, financing and teacher training. Computers were more frequently available in secondary education and learner–computer ratios varied greatly but in general remained very high. Computer labs in schools were also found to be common in many of these countries, although electricity and internet connectivity for schools remains scarce three years later. As a result, in 2015, the use of ICT in education in these countries was still at an embryonic stage. The report concludes by highlighting the need for more in-depth research on how both teachers and pupils are using technology to help enhance learning in the classroom.

Shifting the focus to developed countries, the research suggests that technology in education faces a much more uncertain future. For example, *Students, Computers and Learning: Making the Connection* (OECD 2015) found that there had been 'no appreciable improvements' in reading, mathematics or science in those countries that had previously invested heavily in ICT in education. Among the seven countries with the highest level of internet use in school, it found three countries (Australia, New Zealand and Sweden) had experienced 'significant declines' in reading performance. Furthermore and conversely – highly achieving school systems such as South Korea and Shanghai (China) were found to have lower levels of computer use in school. The report also found that students who use computers moderately at school achieved better learning outcomes than students who use computers rarely. However, students who use computers very frequently at school were found to get worse results. The two key barriers were identified as the lack of training for teachers and the failure to use more innovative teaching methods. The report therefore recommended that schools should get much better at using pedagogies that make the most of technology.

In 2015, Hassler, Major and Hennessy (2015) also published a systematic review of the research published to date on the impact of tablet computers on learning outcomes. They examined 23 studies and found that positive learning outcomes were reported in 16 of the studies, negative learning outcomes were reported in two, and five studies found that the introduction of tablet computers had made no significant difference. However, the authors concluded that the fragmented nature of the current knowledge base together with the lack of rigorous studies had made it difficult to draw any firm conclusions, and there were still no detailed explanations as to how, or why, using tablets within certain activities and classroom contexts can improve learning outcomes. They therefore recommended that future research must move beyond exploration and instead towards more in-depth investigations. This should include taking into account both teacher and student perspectives relating to the introduction and use of tablet computers.

1.2 Research focus and aims

Taking the above into account, this small-scale study focuses on documenting student and teacher perspectives relating to the benefits and challenges of introducing tablet computers into classrooms in secondary schools being managed by two HDIF education grantees. Whilst being small scale, it is not exploratory research; rather it picks up some themes from

the literature so far discussed and aims to gain a richer picture of what is happening through the process of perspective-taking.

Primary aims of the study are to:
- Evaluate student and teacher perceptions concerning the benefits and challenges of using tablet computers to access online and offline content in classrooms in Tanzania;
- Identify any differences between male and female perceptions;
- Understand the relevance of the Principles for Digital Development; and
- Identify lessons for the future.

1.3 Participating organisations

The Human Development Innovation Fund (HDIF) is a UKAID challenge fund in Tanzania which aims to identify and support innovations that have the potential to create social impact in education, health and water, sanitation and hygiene. The programme is designed to help accelerate positive social change in human development by disrupting Tanzania's innovation environment and the intended impact is to improve human development outcomes for low-income families across Tanzania. Of the 36 grantees from Round 1 and Round 2, ten are introducing innovations in education and at least two of these projects involve the use of tablet computers in the classroom to access both offline and online content.

The Campaign for Female Education (CAMFED) is an international non-profit organisation tackling poverty and inequality by supporting girls to go to school and succeed, and empowering young women to step up as leaders of change. Since 1993, CAMFED's innovative education programmes in Zimbabwe, Zambia, Ghana, Tanzania and Malawi have directly supported more than 1.9 million students to attend primary and secondary school, and more than 4.5 million children have benefited from an improved learning environment.

The Christian Social Services Commission of Tanzania (CSSC) was established in 1992 and supports the delivery of social services to improve communities' quality of life and reduce poverty. CSSC aims to improve quality, accessibility and availability of health and education services in Tanzania through partnerships and institutional development, capacity building, and lobbying and advocacy. In collaboration with various government and non-governmental partners, CCSC coordinates the implementation of numerous health and education projects.

The School of Education, Communication and Language Sciences, Newcastle University is home to three distinct sections: Education, Applied Linguistics and Communication (ALC), and Speech and Language Sciences (SLS), as well as a number of disciplines and fields of study within and weaving between them, including education, initial teacher education, preparation and professional development, educational psychology, applied linguistics, cross-cultural communication, TESOL, speech and language sciences, and speech pathology. Research within the education section is focused on pedagogic and curriculum innovation, participatory and critical pedagogy, social justice, social renewal, international educational development and the application of pedagogic technologies.

2. Methodology

2.1 Participants

Table 1 documents the research participants, which included eight CSSC schools and nine CAMFED schools. Across both projects there was a total of 17 schools, 374 students and 23 teachers.

Table 1 Research participants

|		No. of students in focus groups	No. of teachers interviewed
CSSC	School 1	18 (8 M, 10 F)	1 (M)
	School 2	20 (10 M, 10 F)	2 (M&F)
	School 3	20 (10 M, 10 F)	1 (M)
	School 4	18 (18 M)	1 (M)
	School 5	24 (24 F)	2 (M&F)
	School 6	18 (18 M)	1 (M)
	School 7	20 (20 F)	1 (M)
	School 8	20 (20 F)	2 (M&F)
CAMFED	School 9	24 (12 M, 12 F)	2 (M&F)
	School 10	24 (12 M, 12 F)	2 (M&F)
	School 11	24 (12 M, 12 F)	2 (M&F)
	School 12	24 (12 M, 12 F)	1 (M)
	School 13	24 (12 M, 12 F)	1 (M)
	School 14	24 (12 M, 12 F)	1 (M)
	School 15	24 (12 M, 12 F)	1 (M)
	School 16	24 (12 M, 12 F)	1 (M)
	School 17	24 (12 M, 12 F)	1 (M)
Total		**374 (172 M, 202 F)**	**23 (17 M and 6 F)**

For the CAMFED project, approximately 1,300 Worldreader e-reader devices were distributed to 25 secondary schools located across Iringa District. Nine schools were selected based upon their location and ease of access. With reference to the CSSC project, tablet computers were being used in a total of 47 schools located across Tanzania. An internal CSSC document placed each school in one of the following three categories:

- Good performer (tablets are functioning and teacher moral is high);
- Moderate performer (internet connectivity is not good);
- Deprived performer (internet connectivity is good but insufficient funds to gain access; teacher moral is very low).

We therefore selected a number of schools from each category – five (Good), one (Moderate) and two (Deprived). For the purpose of convenience, we selected schools that were located in either the Morogoro or the Kilimanjaro region. Map 1 below locates each of the participating schools on a map of Tanzania.

Map 1: Participating CSSC and CAMFED schools

🟠 *CSSC schools in Manyara, Arusha, Kilimanjaro and Morogoro*

🔵 *Camfed schools in Iringa (rural) district*
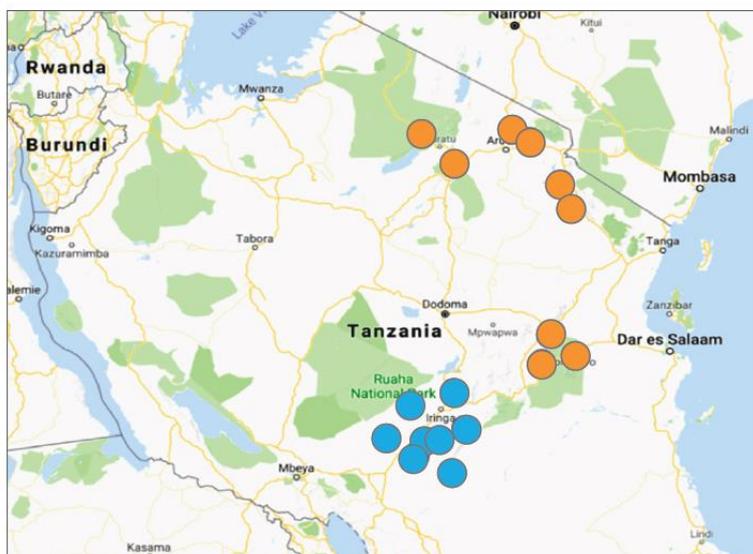
2.2 The research process

This research was carried out in close collaboration with HDIF, CSSC and CAMFED staff and the data was collected in three stages:

- Stage 1: Each selected school was visited to inform the head teacher about the research and to ask permission to carry out the research.
- Stage 2: Each selected school was visited to carry out the focus groups with students and the semi-structured interviews with teachers.
- Stage 3: Each selected school was visited to collect additional data on attendance and exam results.

2.3 Data collection

The overall research strategy was to develop a better understanding of student and teacher perceptions of the benefits and challenges of using technology in the classroom to access either offline or online content. To this end we collected the following data:

- Head teacher interviews (nine interviews at the nine CSSC schools) concerning the context in which the schools were operating and the specific challenges facing each school.
- Teacher interviews (23 individual interviews) concerning the perceived benefits and challenges of using technology in the classroom. One male and one female teacher were interviewed. If no female teacher was available then only the male teacher was interviewed.
- Student focus groups (51 separate focus groups) concerning the perceived benefits and challenges of using technology in the classroom. The following three focus groups were carried out in each school:
  - Focus Group 1: between six and eight boys from Forms 1 and 2
  - Focus Group 2: between six and eight girls from Forms 1 and 2
  - Focus Group 3: between six and eight boys and girls from Forms 1 and 2.

2.4 Data analysis

The audio recordings from each of the focus groups were transcribed and then a thematic analysis was carried out using the same systematic process. NVivo software was used to assist in the management of this process, which included the following steps:

- Group the answers from students and teachers to each question;
- Separate answers based upon gender;
- For each question, identify the key ideas;
- Review the key ideas and identify the main themes;
- Identify quotations that illustrate each theme; and
- Present the findings and discussion.

3. Findings

The findings from the case studies are presented separately, in Section 3.1 and Section 3.2, and within each case study the findings are presented thematically. Basic details of the project are provided followed by some details about the participating schools and the context in which they operate Student and teacher perceptions of the benefits and challenges of using technology in the classroom are then discussed, followed by details of the content they found most useful and their preferred additional content. In each case, student and teacher perceptions are discussed followed by a comparison of the responses provide by female and male students. Quotations included in each section reflect the dominant themes in the data relating to that particular subject. Reflecting on the findings from both case studies, three key issues are then briefly addressed: the impact on exam results, the impact of internet access, and the relevance of the Principles for Digital Development. Conclusions and key lessons for the future are then presented.

3.1 The English Literacy E-Reader Project (CAMFED)

The Campaign for Female Education (CAMFED) partnered with Worldreader to introduce English language e-readers in 25 schools to support girls in their transition between primary and secondary education. In primary schools across Tanzania, children are taught in Swahili. However, in secondary schools the language of instruction changes to English. Some children find it difficult to listen, read and write in English and this has an inevitable negative impact on exam results. The end result is reduced school attendance and higher dropout rates, in particular amongst girls. To manage this transition, Form 1 students attend a six-week government-led English orientation programme at the beginning of the school year.

The English Literacy E-Reader Project attempts to bring together the community-led structures of the CAMFED model with the innovative use of e-readers to address this specific challenge, i.e. the change of language of instruction for students transitioning from primary to secondary school. Students in Forms 1 and 2 were given access to tailored learning resources on the e-readers alongside supplementary reading material to help foster their enjoyment of reading and speaking in English. They were supported in using the e-readers by trained Learner Guides who had been selected from the project's alumni network of recent female graduates. In this project, a total of 1,300 devices were distributed to 25 pilot schools across Iringa District, in central Tanzania.

Prior to introducing the e-reader programme, the project collaborated with Worldreader and other stakeholders to develop an appropriate curriculum and digitise existing learning materials. The project also worked closely with national and district education structures to

embed the use of e-readers into the government-run English orientation programme for new Form 1 students. The primary objectives of the project included:

- Improved learning outcomes for school students by combining e-learning with new teaching methods that include self-directed and student-centred learning;
- Young women successfully navigating the transition between school and adulthood; and
- Government organisations considering how to deploy e-readers more widely.

3.1.1 The context in which the schools operate

Table 2 provides some basic details about the nine schools that took part in this research. None of the schools had access to the internet and four of the nine schools reported that they did not have electricity. While the majority of schools reported that they had a library, a majority of schools also reported that they had only moderate access to textbooks. All of the schools were following the Tanzania national curriculum.

Table 2 School size and facilities

	Male teachers	Female teachers	English teachers	No. of students	Library	Electricity	Classrooms	Access to textbooks	Internet	National curriculum
1	18	20	8	365	NO	NO	9	Mod	NO	YES
2	37	17	12	1,322	YES	YES	19	Mod	NO	YES
3	17	13	5	524	NO	YES	16	Mod	NO	YES
4	31	19	8	600	NO	NO	16	Mod	NO	YES
5	23	10	5	459	YES	NO	10	YES	NO	YES
6	26	22	7	805	YES	YES	19	NO	NO	YES
7	22	23	8	567	YES	NO	14	Mod	NO	YES
8	15	35	6	610	YES	YES	20	NO	NO	YES
9	26	9	5	1,217	YES	YES	26	Mod	NO	YES

To help shed further light on the context in which these nine schools currently operate, the head teachers from each school were interviewed and asked to identify (a) reasons why some of their pupils may not be attending school on a regular basis, and (b) specific problems that their schools were currently facing. With reference to poor attendance, the following reasons were identified:

- Lack of transport services and so some students were expected to walk long distances that were simply too great;
- Parents' lack of awareness about the importance of schooling;
- Extreme poverty at home with some students expected to be self-dependent; and
- Demoralisation of some students due to poor performance in internal exams.

Additional problems faced by the schools that were reported by the head teachers included:

- A lack of water;
- A shortage of classrooms;
- A lack of teachers' houses, hostels and dormitories;
- A lack of electricity supply; and
- A shortage of tables and chairs.

This context is important as it helps to identify some of the challenges that many EdTech projects in a developing context are faced with. This is the conflict between the desire to reach out and have an impact on those children who are most in need and the fact that the majority of schools serving this population often lack the required infrastructure and facilities to enable an Edtech innovation to be implemented and sustained in the long run. It is therefore important to note that four of the nine schools reported that they did not have electricity.

3.1.2 Perceived benefits

A total of 216 students and 12 teachers from nine schools were asked to identify the perceived benefits of using the e-reader in the classroom. The findings are listed in Table 3 in order of importance.

Table 3 Perceived benefits

Students	Teachers
Improvements in English Language skills – Increase in vocabulary, motivation, confidence, pronunciation and academic performance.	*Improvements in English Language skills* – Increase in vocabulary, understanding and pronunciation.
Practical benefits – A variety of books contained in one device, access to many different books, access to a dictionary, less wear and tear, and easier to carry.	*Practical benefits* – Access to large numbers of books anytime and anywhere, improved portability of books, quick access to learning materials.
Improvement in life skills – Improved social skills, more up to date, and greater awareness of the growth of technology.	*Additional benefits* – Improved school attendance, increased understanding in other subject areas.
Additional benefits – Reduced dependency on teachers, they help students to self-teach, help to improve school attendance, and increased understanding in other subject areas.	

The most important perceived benefits identified by both students and teachers related to the category 'Improvement in English Language skills'. Students reported that they were learning English at a faster pace, resulting in improved vocabulary in both languages (Swahili and English) and improved English pronunciation. They also reported an increase in confidence when taking part in debates and speaking with teachers. They believed that use of the e-readers was helping form the habit of reading books and answering questions as well as encouraging students to participate more in their learning. They also reported that the above was leading to improved performance in exams. Finally, students reported improved understanding and accelerated learning in other subjects.

The Practical Benefits that were identified were very similar, with the most prominent being the ability to access large numbers of books via one device – a device which was also light to carry and durable. The e-readers also enabled students to gain access to a much wider range of books than they previously had access to and some students believed that the e-readers provided access to more books than their school library. When compared to carrying a number of traditional textbooks, students found the e-reader to be much more portable.

Teachers also highlighted the practical benefits of having easy access to large numbers of different books via one portable device: 'To have a mobile library – students and teachers access many books anytime anywhere they move to' (Teacher).
Teachers suggested that by using the e-readers and improving their English, students also

benefited from increasing their understanding in other subject areas, as reflected in the following comment from a teacher: 'Students' ability to speak in English has increased and encouraged them to learn more and more'.

In two schools, teachers of other subjects had also started to experiment with using the e-readers in their classes and, as a result, they were recommending the use of e-readers across all subjects, thereby enabling more students to benefit. A teacher in one school also noted how some students in higher forms had started to borrow the e-readers to help strengthen their understanding in subject areas that they had missed when they were in the lower forms. This calls attention to the potential of this device to be used more widely by all students who have not been able to attend school on a regular basis, for whatever reason. If the e-readers are made available, then students could use this device in their own time to catch up on any content that they have missed.

The key difference between the findings for students and teachers is that students identified a different category of perceived benefits titled 'Improvement in life skills'. Students referred to benefits such as improved social skills, being more up to date, and having a greater awareness of the growth and potential of new technology. One female student also reported: 'We gain critical thinking from various story books'.

Furthermore, it was the educational story books which were identified as having an impact on behaviour and a wider positive social impact, as suggested in the following comments from female students: 'Story books help us know how to live in the community' and 'There are good and educative story books to give us social skills'.

With reference to additional benefits, both students and teachers reported an improvement in school attendance due to the use of the devices in the classroom. Also, two additional benefits were identified by students: helping students to self-teach and reduced dependency on teachers.

In two schools, teachers also referred to the growth in students teaching themselves and this is reflected in the following comments from teachers from two different schools: 'Students have gained interest in learning on their own' and 'Students can do self-teaching and come to me with very specific questions, then we sit together and discuss'.

These comments are significant because the project had previously identified 'Improved learning outcomes by combining e-learning with new teaching methods that include self-directed and student-centred learning' as a primary objective. Furthermore, they suggest that with the use of e-readers a student's education could no longer be solely dependent on the availability of a good teacher. It is clear these devices have the potential to help students teach themselves and become more independent and lifelong learners.

The responses from 108 female and 108 male students were also documented and the key difference between them relates to 'developing life and social skills and increasing technology awareness'. These benefits (referred to above) were only identified by female students. These wider educational and social benefits identified by female students are significant and they are often overlooked when research is focused entirely on 'what works' in terms of increased performance in exams. They are also often the type of benefit that only students themselves can identify.

Finally, it is important to note that there may be a number of hidden costs associated with introducing devices such as e-readers within this context – especially when students begin to perceive that they are benefiting from using the device and find it enjoyable to use. This is reflected in the following statement made by a teacher at one of the schools: 'Students are very eager in using technology, but they become demoralised when they find e-readers not

being enough'. This highlights the importance of having teachers who are adequately trained and supported, especially when groups of students are expected to share one device.

3.1.3 Perceived challenges

Both students and teachers were also asked to identify the key challenges that they faced when using the e-reader devices in the classroom. These findings are shown in Table 5 and listed in order of importance.

Table 4 Perceived challenges

Students	Teachers
Project design – Shortage of e-readers, no electricity to recharge, lack of internet access, content not related to the syllabus, lack of technical support. *Product design* – Some books do not open, students accidentally delete books, and the display sometimes fails in direct sunshine.	*Project design* – Shortage of e-readers, no electricity to recharge, lack of technical support, and content not related to syllabus.

Two categories of challenges were identified – project design and product design – and most of the challenges originate from the project design category. The two most prominent were the shortage of e-readers and the lack of electricity to recharge the devices. Students in particular highlighted their frustration with the shortage of e-readers, which resulted in large groups having to share one device. As a result, some students would lose interest if the device was dominated by one student. The students argued that if they had their own device many students would be able to research their own areas of interest, learn at a faster rate, and improve their performance in exams.

The lack of electricity in four of the nine schools also resulted in a number of obvious challenges, as noted by the following student: 'Charging e-readers is a problem because the school has no electricity'. One teacher explained how they addressed this challenge: 'We charge e-readers at our homes 7km from school'.

These two challenges raise a number of questions relating to the size of the pilot and the number of e-readers distributed to each school and how different schools were selected to take part in the pilot and if issues such as electricity were taken into account.

When female and male students were asked to identify the key challenges that they faced when using the e-reader devices in the classroom, they both reported very similar challenges. However, a number of male students stated that there were many books available on the device that were not related to the syllabus, and there were also many books that were listed in the syllabus which were not on the e-reader. One student also stated that while the books may help with spoken and written English, they do not help the student to answer exam questions. These comments highlight the exam-orientated culture that exists in Tanzania and the corresponding need for technology interventions to be directly related to improving student performance in the national exams.

3.1.4 Most useful content

Both students and teachers were asked to identify what they perceived to be the most useful content that they had access to. These findings are shown in Table 5 and listed in order of importance.

Table 5 Most useful content

Students	Teachers
• Dictionary • English pronunciation tool • Story books • Maths textbook • Biology textbook • Swahili content • English lesson books	• Dictionary • Story books • English lesson books • Biology textbook

The content that the students found useful included: the dictionary and the English pronunciation tool; story books; maths, biology and English textbooks; and Swahili content. Two additional findings are worth highlighting. Firstly, story books were identified as being useful content by a number of students and teachers. This is reinforced by the following quotation made by a teacher: 'Short stories, they make students very excited and love reading'.

Secondly, some students and teachers also identified maths and biology textbooks as being useful content: it is the content that students found most useful when using the e-readers for their own private studies. This suggests that the e-reader had already moved beyond simply helping children to improve their English language skills, towards being a device that gave students access to different textbooks in different subject areas.

3.1.5 Preferred additional content

Both students and teachers were also asked to identify what additional content they would like to have access to. The findings are shown in Table 8 and listed in order of preference.

Table 6 Preferred additional content

Students	Teachers
• Books for all other subjects which are linked to the syllabus and which are recommended by the Ministry of Education • English to Swahili dictionary	• Books for all other subjects which are linked to the syllabus and which are recommended by the Institute of Education • English to Swahili dictionary • English language learning games • Past exams and other questions for students to attempt

Additional content that both students and teachers thought would be useful included: all of books listed in the syllabus in all subject areas that have been recommended by the Ministry of Education and an English to Swahili dictionary. These findings further reinforce the potential of these e-reader devices becoming mobile libraries providing students with access to recommended textbooks across the curriculum.

Teachers also referred to the use of English language learning games and having access to previous exam papers to help students prepare for their exams, as additional content that they would like to have access to. Student access to more interactive content on these devices is hopefully a development we will see in the near future.

3.1.6 Teacher training

All of the teachers interviewed reported that they had received some form of training on how to use the e-reader in the classroom and the majority of this training took place prior to the

devices being introduced. However, in three of the nine schools the teachers said that this training was not sufficient. Furthermore, teachers in eight of the schools also reported that additional training and support was now required. This is reflected in the following statements made by teachers from three separate schools:

'I would like to receive more training because technology changes every day' (Teacher)

'We need a regular brush up so that we are able to ask questions on challenges we face while using e-readers in the classroom' (Teacher)

'We would love to receive more training so as to be able to curb challenges that I was not aware of during the training' (Teacher).

Table 7 Teacher training at nine CAMFED schools

Training	No. of schools
Received teacher training	9
Training was not sufficient	3
Additional training and support required	8

3.2 The Performance Enhancement by eLearning for Secondary Schools Project (CSSC)

The Christian Social Services Commission (CSSC) is a non-governmental organisation with a track record of delivering education in Tanzania. CSSC recognised the challenges that many students have in fully understanding the concepts of science and mathematics and therefore established links with an international partner who had expertise in creating online content. Studi Academy is based in Dar es Salaam and Sweden and together they developed a two-year pilot project titled the Performance Enhancement by eLearning for Secondary Schools. Its primary aim was to create a learning platform for tablet computers that would drive up standards in science and mathematics. The Studi e-learning platform as subsequently introduced into 47 secondary schools, which involved distributing tablet computers pre-loaded with learning content mapped to the Tanzania national curriculum. The teaching materials included animation, video and interactive exercises to stimulate learning, and teachers were trained to use a progressive learning pedagogy that places them in more of a support role by encouraging peer and group learning.

The tablet computers were typically stored and used in the school computer lab and some classrooms, and each school provided different levels of access. Students reported that they used the tablet computers between two and four times a week depending on the timetable, and the subjects being taught were biology, chemistry, maths and physics. In one school, access was also provided at the end of each day for 40 minutes and in another school, students were also given access for two hours on a Saturday. Typically, between two and six students would be sharing one tablet computer. However, in another school, desktop computers were the preferred technology and so the tablet computers were only used by students who did not have access to a desktop computer.

3.2.1 The context in which the schools operate

Table 8 provides some basic details about the eight CSSC schools that took part in the research.

Table 8 School size and facilities

	Ownership	Boys/girls/co	No. of students	Form 1	Form 2	No. of tablets	Access to textbooks	Internet	National curriculum	Library
1	Church	Boys	407	137	95	38	Yes	Yes	Yes	Yes
2	Govt	Girls	809	126	183	4	Yes	Yes	Yes	Yes
3	Church	Co	650	163	120	12	Yes	Yes	Yes	Yes
4	Church	Girls	650	-	97	20	Yes	Yes	Yes	Yes
5	Church	Girls	621	132	121	50	Yes	Yes	Yes	Yes
6	Church	Boys			81	30	Yes	Yes	Yes	Yes
7	Church	Co	700	279	115	46	Yes	Yes	Yes	Yes
8	Govt	Co	869	186	232	5	Yes	Yes	Yes	Yes

The majority (75%) are fee-paying faith-based independent schools and the remaining two schools are managed by the government. In Tanzania, the faith-based independent schools tend to perform well in the high end of the government league tables and student attendance and motivation is not generally an issue. All of the eight schools had access to the internet and all schools had electricity. Finally, each school had a library with a reasonable selection of textbooks and each school was also following the Tanzania national curriculum.

3.2.2 Perceived benefits

A total of 158 students and 11 teachers were asked how they thought students were benefiting from having access to the Studi e-learning platform and the wider internet. The findings are shown in Table 9.

Table 9 Perceived benefits

Students	Teachers
Learning benefits – Access to more and different learning materials, access to quizzes, access to video content, access to more up-to-date content and improved academic performance. *Additional benefits* – Increased attendance, learn additional skills outside of the curriculum, and enables students to teach themselves.	*Learning benefits* – Access to more and different learning materials, access to videos and quizzes, increased interest in science subjects, improved academic performance. *Additional benefits* – Improves students' self-reliance, increased student and teacher motivation.

Both students and teachers identified access to more and different types of learning materials as being the greatest benefit. The reasons why they thought students were benefiting from having access to new resources included the following:

- Studi Academy and other online resources provide much richer and more detailed content than that provided in textbooks or by the teacher;
- Video content and having access to a variety of different formats helps to simplify learning and make difficult content easier to understand;
- Online quizzes and searching for answers helps to improve student understanding. The quizzes also allow students to test their own understanding on a regular basis and they provide instant feedback;
- Online materials provide numerous links to additional relevant content; and

- An online platform enables students to share learning materials between themselves.

The students also reported using the tablet computers outside of class time to search for learning materials on the internet related to additional subjects and also to their own 'personal studies'. This included listening 'to teachers in the tablets' in video format via YouTube, as reported by the following student: 'The internet (YouTube) provides access to teachers all over the world and students can choose teachers that they understand the best'.

Students were therefore using the Studi e-learning platform and the internet to (a) deepen their understanding of what they already know, and (b) learn about new topics.

The different responses from both female and male students were also documented and they both identified very similar benefits. In particular both female and male students said that the new technology enabled students to teach themselves especially when teachers were absent or busy and it also encouraged them to learn subjects outside of the normal curriculum.

3.2.3 Perceived challenges

Both students and teachers were also asked to identify the key challenges that they faced when using the tablet computers to access the Studi e-learning platform. These findings are shown in Table 10 and listed in order of importance.

Table 10 Perceived challenges

Students	Teachers
Project design – power cuts, lack of tablets, poor internet access and high cost. *Product design* – lack of relevant content, over-reliance on multiple choice and lack of language skill learning.	*Project design* – poor internet access, lack of tablets, power cuts, lack of teacher training, students' lack of ICT skills. *Product design* – teachers unable to add or edit content, student login/registration problems.

Students identified a number of technical challenges when using the tablet computers to access the Studi platform. These included:

- The tablets not always being fully charged and therefore losing power quickly;
- Power cuts in the rainy seasons making it difficult to recharge the tablets; and
- Unreliable internet access making it difficult for all tablets to access the internet at the same time, resulting in time being wasted waiting for reconnection and lessons not being completed.

At one school, students reported that the Head of School had already purchased a new router and has plans to purchase a standby generator. Additionally, there were numerous difficulties relating to groups of students having to share one device and the fact that students need to understand English before they can use the Studi platform.

It was also expressed that students who have access to tablets at home tended to dominate the lessons at school when tablets are used, suggesting that those students who do not have access to tablet computers at home may require additional guidance and support.

3.2.4 Most useful content

Both students and teachers were asked to identify what they perceived to be the most useful content that they had access to. These findings are shown in Table 12 and listed in order of importance.

Table 11 Most useful content

Students	Teachers
• Quizzes • Videos	• Animations, audio and video content • Quizzes

The content that students and teachers found most useful was the quizzes and the videos. Students were attracted to the quizzes because they enabled them to continuously self-test and evaluate themselves, and feedback and corrections are provided instantly. One student explained this in very simple terms: 'The tablets bring questions, we answer them, and it tells us that we are right or wrong'.

The reason why students valued this feature so highly is also reflected in the following quotation: 'Some teachers put X if we get [the answer] wrong in assignments and may not come back to make corrections with us in the class, we get demoralised, but Studi does it in a different way, corrections are done immediately' (Student).

One student went as far to suggest that 'quizzes make students learn ahead of the teacher'. Teachers also referred to interactive content such as quizzes as a useful tool to help them evaluate student progress.

Content delivered in video format was seen to be effective as the combination of audio and visual helped students to improve their understanding in a short period of time. Students also enjoyed learning about a variety of different subjects (states of matter in chemistry, force and motion in physics, the digestive system and blood transfusion in biology, and geometry in maths). One student also reported learning about how the ozone layer was being destroyed by human activities.

3.2.5 Preferred additional content

Both students and teachers were also asked to identify what additional content they would like to have access to. The findings are shown in Table 12.

Table 12 Preferred additional content

Students	Teachers
• Content in different subject areas • Offline content • Each video/presentation needs to have a summary at the end • Student access to their grades • Subtitles on the videos • Essay questions • Direct contact with the developers	• Content for all lessons for all classes • Shorter videos which match lesson content • Geography and agricultural content • Add or edit content • Allow teachers to control students' accounts • Enabling subject teachers to develop content • Learning materials for Forms 3 and 4

The additional content that students would like to see on the Studi platform included content in Kiswahili, English language learning, geography, arts, agriculture, computer studies, history, business studies, art, agriculture, civics, ICT and computer skills, bookkeeping, commerce and computer studies. English was viewed as important as this would enable students to take full advantage of the available content.

Students also suggested the following additional features to the existing platform and content:

• Having access to offline content would enable learning to continue in the absence of internet access;

- There was a preference to see some questions which would require a written answer, as opposed to multiple choice, as this will help them 'gain competency in self-expression';
- Adding subtitles to video content to help support students with poor listening skills or when the tablet computers are being used in a noisy environment;
- Students having access to their test scores would help students monitor their level of performance; and
- Adding a dictionary function would save students' time from having to use search engines.

The additional content that teachers would like to see on the Studi e-learning platform included shorter videos which match the lesson content, and learning materials for Forms 3 and 4, in order to 'maintain continuity and restrict student dissatisfaction with the traditional methods'. Furthermore, teachers also expressed an interest in having the ability to add and edit content themselves and for subject teachers to be involved in developing their own content. This highlights the willingness of some teachers to make an important shift from just being a content consumer to also becoming a more proactive content producer.

3.2.6 Teacher training

Teachers from each school were asked a number of questions relating to teacher training and the results are shown in Table 13. Unfortunately it was not possible to access the training materials that were used.

Table 13 Teacher training at eight CSSC schools

Training	No. of schools
Received teacher training	7
Training was not sufficient	5
Additional training and support required	5

Table 13 shows that teachers in seven of the eight schools reported having received some form of training on how to use the Studi e-learning platform in the classroom, and the majority of this training took place prior to the tablet computers being introduced. In one school, the teacher said they had attended a three-day workshop together with six teachers from each neighbouring school, and each participant received a certificate. At another school, 61 teachers had attended the training workshop and the training was described as very good and enjoyable. However, according to one teacher the training was not sufficient and most of the teachers who attended the training were not competent enough to use tablet computers. As a result, teachers lost interest and stopped using them.
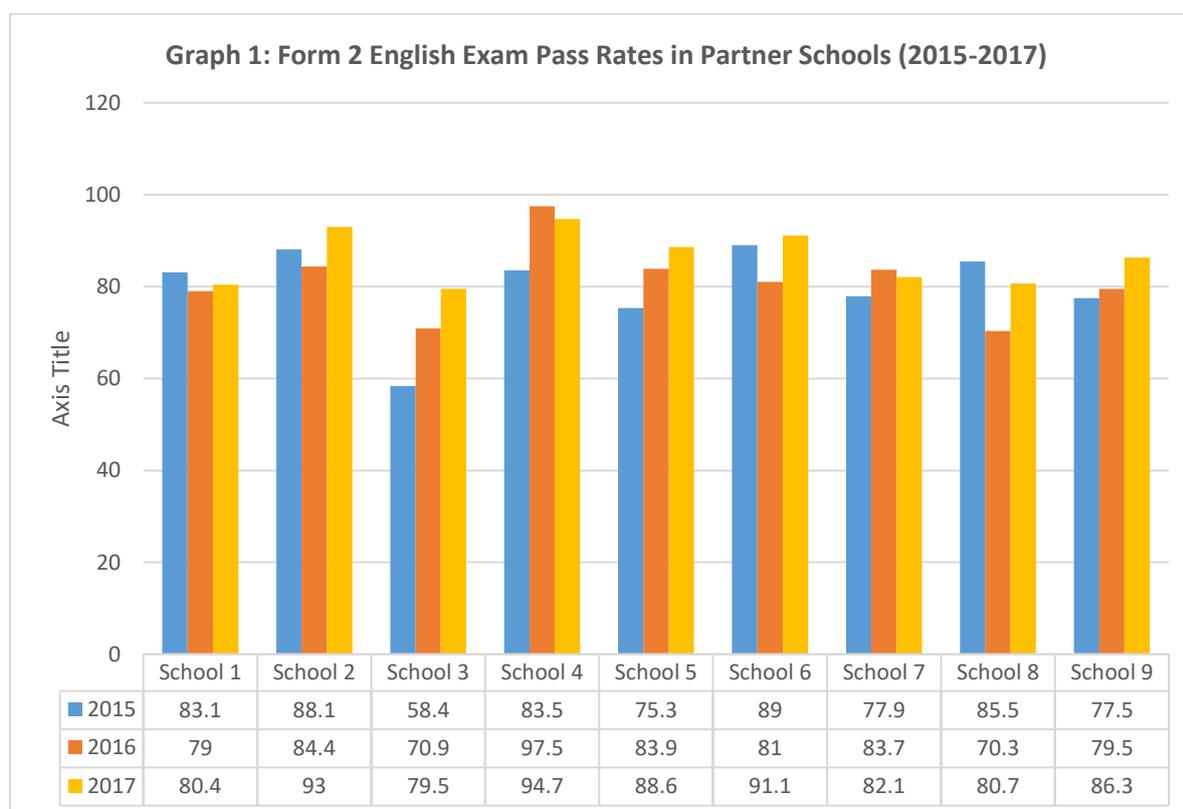
A number of teachers also stated that the training focused much more on how to use the Studi e-learning platform and not the tablet computer itself. One teacher concluded that 'the training was useful but not sufficient'. Teachers at five schools also reported that additional training and support was now required.

3.3 Impact on exam results

While the impact of the new technology on exam results has not been the primary focus of this research project,[1] the Form 2 English and STEM exam results for the 17 schools taking part in this research project are publicly available via the National Examinations Council of Tanzania (www.necta.go.tz/). Therefore, due to the ongoing interest in the impact of EdTech innovations on learning outcomes, this section will very briefly discuss these results.

3.3.1 CAMFED schools

In the nine CAMFED schools taking part in this research, both female and male students identified improvements in academic performance as a perceived benefit of using the new technology and gaining access to the new content. The English exam results in seven of the nine schools are shown in Graph 1:

Graph 1: Form 2 English Exam Pass Rates in Partner Schools (2015-2017)

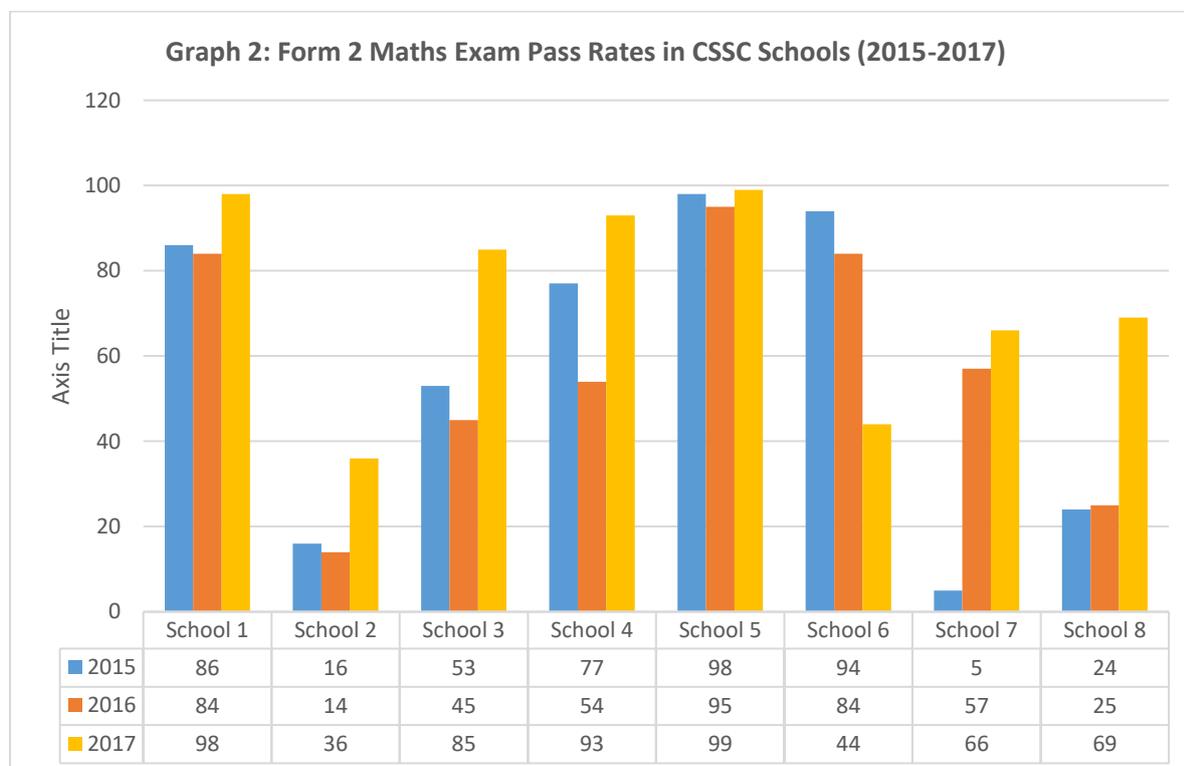|	School 1	School 2	School 3	School 4	School 5	School 6	School 7	School 8	School 9
2015	83.1	88.1	58.4	83.5	75.3	89	77.9	85.5	77.5
2016	79	84.4	70.9	97.5	83.9	81	83.7	70.3	79.5
2017	80.4	93	79.5	94.7	88.6	91.1	82.1	80.7	86.3

Graph 1 shows that in seven of the nine schools, English Form 2 pass rates increased between 2015 and 2017. School 3 experienced the largest percentage increase from 58.4% in 2015 to 79.5% in 2017 – an increase of 21.1%. However, two schools experienced a decline in pass rates – School 1 from 83.1% to 80.4% and School 8 from 85.5% to 80.7%. It is unlikely that this is the direct result of introducing the new digital service and so a number of additional local factors may help to explain this decline. If this is the case, then the increase in results experienced in the other seven schools may also have been due to a number of additional local factors and not as a direct result of introducing the new digital service.

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[1] When this research started, the CSSC and CAMFED projects were already up and running and so it was not possible to examine the impact on learning outcomes.

3.3.2 CSSC schools

In the eight CAMFED schools, both female and male students identified improvements in academic performance as a perceived benefit of using the new technology and gaining access to the new content. The Form 2 maths exam results from 2015–2017 for the eight schools taking part in this research project are shown in Graph 2.

Graph 2: Form 2 Maths Exam Pass Rates in CSSC Schools (2015-2017)

	School 1	School 2	School 3	School 4	School 5	School 6	School 7	School 8
2015	86	16	53	77	98	94	5	24
2016	84	14	45	54	95	84	57	25
2017	98	36	85	93	99	44	66	69

Graph 2 shows that in seven of the eight schools, Form 2 pass rates in maths increased between 2015 and 2017. Furthermore, Schools 2, 3, 7 and 8 each experienced a dramatic increase in pass rates, with School 7 experiencing the largest – from 5% to 66%. However, one school also experienced a dramatic decline in pass rates – School 6 from 94% to 44%. Again, it is difficult to see how this considerable decline could have been a direct result of introducing this new digital service. This raises the same question – what other local factors must first be taken into account that will help to explain these pronounced changes?

3.3.3 What is the value of this data?

Firstly, if significant sums of money are spent on introducing a new digital service which has been specially designed to improve learning outcomes in English or maths, we would expect this to have a positive impact on exam results. After all, this is what the new digital service has been designed to achieve. Therefore, the simple reporting of a positive impact on exam results tells us very little. The fact that three schools in the sample experienced a decline in results clearly suggests that other factors are at play.

Secondly, without the use of a control group we do not know if the improvement (or decline) in results is due to the introduction of the new digital service, some other factor or a combination of several factors. Due to the complex nature of classrooms, schools and the way in which children learn, a number of additional variables would therefore have to be taken into account including:

- Family background and circumstances information of each child;

- How much time students have access to the technology each week;
- If students had access to an individual device or were expected to share;
- The nature and the amount of teacher training provided;
- If innovative pedagogies were introduced at the same time;
- The existence of additional EdTech innovations in the same school;
- The nature and extent of head teacher support;
- The existence of basic infrastructure in the school such as electricity;
- Teacher agency and involvement in the design of the innovation; and
- Individual teacher attitudes towards the role and potential of technology in education.

Thirdly, even after the control group has been introduced and all of the other additional factors have been taken into account, this research data will still not help to show how cost effective the new digital service is or if it represents value for money. This is obviously a critical issue within a developing context. To address this issue, a competing digital service would need to be introduced to the control schools. A cost and benefit analysis could then be carried out comparing the impact and the costs associated with each intervention.

Fourthly, after more rigorous research has been carried out to find out which digital service provides the best value for money, the most important critical issue still remains – is this new digital service sustainable in this particular context in the short, medium and long run? Or are there, at least, any plans to make it sustainable? If the answer to these questions is no, then it is fair to question why this digital service is being piloted within this context. Even if research shows that introducing a particular digital service will have a significant positive impact on learning outcomes and this digital service represents the best value for money compared to the next best alternative, if it is not in any way sustainable within this particular context then it is difficult to see how it will add any value.

When research into the question of what works in EdTech innovations becomes divorced from the issues of value for money and sustainability, it loses its value and at worse can be misleading.

4. The relevance of the Principles for Digital Development

The Principles for Digital Development are a set of nine guidelines that were launched in 2015 to promote best practice in the implementation of digital programmes that are funded by international aid. They hope to encapsulate all of the key lessons learned within this field over the last two decades. The nine principles are:

1. Design with the user.
2. Understand the existing ecosystem.
3. Design for scale.
4. Build for sustainability.
5. Be data driven.
6. Use open standards, open data, open source, and open innovation.
7. Reuse and improve.
8. Address privacy and security.
9. Be collaborative.[2]

These nine principles were endorsed by HDIF in 2016, following the first two rounds of HDIFs' call for application for funding in 2013 and 2015. As a result, the two projects

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[2] The nine principles are now managed by the Digital Impact Alliance.

involved in this research were not assessed or evaluated with these principles in mind. This presents an opportunity to reflect on some of the challenges that they have faced and to consider if these challenges would have emerged if the two projects had (a) initially been asked to submit business plans that addressed each of the nine principles, and (b) had been monitored and evaluated using the nine principles as a framework.

The challenges that both projects faced are listed in Table 14.

Table 14 Perceived challenges

CAMFED	CSSC
Project design – Shortage of e-readers, no electricity to recharge, lack of internet access, content not related to the syllabus, lack of technical support. **Product design** – Some books do not open, students accidentally delete books, display sometimes fails in direct sunshine.	*Project design* – Shortage of tablet computers, no electricity to recharge, lack of technical support, content not related to syllabus.

Table 15 matches these challenges with one of the nine Principles for Digital Development and two principles are identified as being relevant – 'Design with the user' and 'Understand the existing ecosystem'.

Table 15 Digital principles and HDIF challenges

Principles for Digital Development	Challenges faced by HDIF grantees
Design with the user	• Content not related to the syllabus • Shortage of e-readers
Understand the existing ecosystem	• No electricity to recharge • Lack of internet access • Lack of technical support

Therefore, if these two projects had (a) initially been asked to submit business plans that addressed each of the nine principles, and (b) had been monitored and evaluated using the nine principles as a framework, then it is our belief that each of the major challenges identified would not have emerged.

5. Recommendations

The Principles for Digital Development – For future EdTech innovation projects, aid agencies should consider asking all candidates to submit proposals and business plans that address each of the nine Principles for Digital Development. These nine principles should also be used as a framework to monitor and evaluate projects throughout their life cycle.[3] This may not guarantee project success but it will help to ensure that the same basic mistakes (e.g. the lack of electricity) are not repeated time after time. It is also important to note that if successful projects are expected to embrace the principle of 'Design with the user', it will not be possible for a project team to identify the final design of a digital service before the project has started. Initial concept designs should therefore be encouraged with the knowledge that these designs may change considerably after user feedback has been integrated into the design process.

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[3] See Evaluating ICT4D Projects Against the Digital Principles: https://digitalimpactalliance.org/guest-blog-evaluating-ict4d-projects-against-the-digital-principles/

Digital civics and commissioning – Emerging areas such as digital civics and commissioning are now exploring how digital technologies can empower citizens and communities. Therefore, instead of organisations providing civic services that they think the people want, the people and communities themselves commission these services using some form of digital platform. This is still missing with most EdTech projects and innovations where external organisations introduce new technology that they think schools, teachers and students want and then see if they work or what impact they have. This new form of commissioning would enable local schools, teachers and students to think about what problems they have and then commission others to develop the appropriate and context-specific digital solutions.

Increasing focus on sustainability – together with their existing M&E frameworks, aid projects should be looking to go beyond traditional M&E and commission more applied research. This will help to generate more forward-looking evidence of the potential broader impact of EdTech pilot projects if they were taken to a larger scale. Tools that serve this particular purpose already exist such as the World Bank's infoDev Framework for the Assessment of ICT Pilot Projects. One of the nine Principles for Digital Development where there remains a significant knowledge gap is 'Build for sustainability'. Further research is therefore required to see how EdTech innovations develop over time and to identify the strategies they adopt in order to become sustainable.

6. Conclusions

In this small-scale research project, we have examined student and teacher perceptions relating to the benefits and challenges of using e-readers and tablet computers that have been deployed in classrooms in two HDIF projects. Data was collected from 17 schools, via focus groups with 374 students together and semi-structured interviews with 23 teachers. This section will briefly outline the key conclusions focusing on the key benefits and challenges identified by both students and teachers and the future potential role of the Principles for Digital Development.

6.1 The benefits

With reference to the CAMFED project, both students and teachers identified a number of different perceived benefits associated with introducing e-reader devices into the classroom and giving students access to a variety of different offline content. The following list of perceived benefits are all related to the original purpose of introducing the device – to improve English language skills, which will hopefully lead to students having a greater understanding in all other subject areas and therefore improved academic performance.

- Easy access to large numbers of different books via one portable device;
- Access to a dictionary;
- Improvements in motivation and confidence;
- Improvements in understanding English, vocabulary and speaking skills;
- Increased understanding in other subject areas; and
- Improved academic performance.

A key perceived benefit in the above list is 'Improvements in motivation and confidence', and these are both critically important when it comes to learning a new language. By transforming student access to reading materials, use of the e-readers is also improving students' self-confidence and motivating them to learn more.

The following list of additional perceived benefits identified by both students and teachers highlights the wider potential of this kind of e-reader device – over and above the potential impact on improving English language and exam results:

- Developing life and social skills;
- Increasing technology awareness;
- Encouraging students to teach themselves;
- Reduced dependency on teachers;
- Encouraging the use by teachers in other subjects;
- Older students catching up on missed content; and
- Improved school attendance.

These additional benefits suggest that in the future a student's education within this context may no longer be dependent on the availability of a good teacher. It is clear that these devices have the potential to help students teach themselves and become more independent and lifelong learners.

Female students also identified an important additional category of benefits: 'Improvement in life skills'. These benefits came from using the technology and from reading story books in English and included improvements in digital literacy, critical thinking and social skills. These wider educational and social benefits identified by students are clearly significant. However, they are often overlooked when research is focused entirely on 'what works' in terms of increased performance in exams.

With reference to the CSSC project, the following perceived benefits were identified by both students and teachers:

- Online resources provide much richer and more detailed content than that provided in textbooks or by the teacher;
- Video content and having access to a variety of different formats helps to simplify learning and make difficult content easier to understand;
- Online quizzes and searching for answers helps to improve student understanding. The quizzes also allow students to test their own understanding on a regular basis and they provide instant feedback;
- Online materials also provide numerous links to additional relevant content; and
- An online platform enables students to share learning materials between themselves.

These findings also help to identify why students find these resources so attractive.

Finally, this research project has also helped to reinforce an important point: giving schoolchildren access to digital services (i.e. access to both offline and online content) will have a much wider impact on students above and beyond improving exam results. The introduction of a new digital service that empowers children to take more control of their learning and also enables them to begin teaching themselves is a remarkable development and a step change in the field of education and development. This potential is epitomised in the following quotation from a student: 'The internet (YouTube) provides access to teachers all over the world and students can choose teachers that they understand the best'.

6.2. The challenges

There is an ongoing conflict between the desire to reach out and have an impact on those children who are most in need and the fact that many of the schools serving this population often lack the basic infrastructure and facilities that are required to enable EdTech innovations to be implemented and sustained in the long run. This problem is often

exacerbated by the way in which EdTech research and innovation projects are commissioned and the lack of involvement of students, teachers and schools within this process. This is a global issue. Typically, academics, charities or EdTech companies (or a combination of all three) apply for funding (research or innovation) with a ready-made solution of what they want to deliver and the expected impact. If the funding is awarded, projects will then seek to recruit schools to take part and free hardware is often used as an incentive. Schools and teachers are then asked to implement a new technology that they have not asked for and may not want, and which they may not be able to support both in the short and long run. The principle of 'Design with the user' is bypassed and the end result is the common problems that we have identified. The key challenges identified by both students and teachers on the two projects involved in this study include:

- Shortage of hardware;
- Lack electricity;
- Lack of internet;
- Content not related to the syllabus; and
- Lack of teacher interest, training and technical support.

As a result of having to manage these ongoing operational challenges, the two projects have invested much less time on addressing the most important challenge facing all EdTech innovations: the critical issue of sustainability.

6.3. The Principles for Digital Development

Finally, our analysis shows that the Principles for Digital Development (and two principles in particular) would have helped to address the major challenges that these two projects faced throughout the project period. These principles are 'Design with the user' and 'Understand the existing ecosystem'.

However, in their current format, the Principles for Digital Development do not help to address the important issue of teacher training:

- The training that teachers received focused more on the technical use of the device and less on how it can be integrated into existing lessons.
- Relying on teacher training at the start of a project was also not sufficient. New challenges appear each week and so ongoing support is required.
- More innovation is therefore required in the way teachers are trained and supported throughout a project and how this can be supported using mobile technology.

For an update on the potential use of mobile learning to help support teachers' ongoing professional development in Tanzania – see *E-learning for Teacher Training in Tanzania: Policy, Players, Models, and Recommendations* (Baker *et al.* 2013)

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