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ETIP – A tip to help develop IT systems for rural Kenyan education.

Exploring the potential of ICT for informal,
non-formal and formal learning in the slums of
Nairobi.

Informatics
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Abstract

This thesis explores the existing IT conditions of a Kenyan upper secondary school, with the purpose of identifying obstacles and opportunities that need to be considered in developing an IT solution. There has been previous research on IT learning in developing countries, like Jobe's Do-It-Yourself Learning in Kenya: Exploring mobile technologies for merging non-formal and informal learning from 2014, or Marwan's Empowering English through Project-Based Learning with ICT from 2015. The infrastructure for IT is rapidly improving in Kenya. With projects such as the laptop project they are showing the world that they are serious about IT usage in education. This thesis overall approach adheres to the ambitions of Action-Design-Research on a single case study made on a charity funded school in the outskirts of Nairobi. In order to establish an understanding of how IT was currently used, and desires for future developments 5 teachers and 4 students were interviewed, and 4 classroom observations were conducted. Results from his study highlights the most pressing factors and a set of design principles named the ETIP-model and the 7-ETIP design principles, named after the identified areas Educational IT-usage, TPACK-competence, Infrastructure, and Personal attitude. The conclusion is that it is important to consider all aspects of the ETIP-model and the 7-ETIP design principles, to insure important aspects of creating an IT system for rural Kenyan schools are taken into account.

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Glossary

7-ETIP design principles – The Seven design principles related to Educational IT-usage, TPACK competence, Infrastructure, and Personal attitude (see section 4.4)

ADR – Action design research

ETIP-model – a model introduced in section 4.3; based on the four components Educational IT-usage, TPACK competence, Infrastructure, and Personal attitude

ETHICS – Effective Technical and Human Implementation of Computer based System

HUFIT – Human Factors in Information Technology Project

ICT – Information and communications technology

ICT4D - Information and Communication Technologies for Development

MOOC – Massive Open Online Course

OER – Open educational resources

ORDIT – Organizational requirements definition tools

TPACK – Technological Pedagogical and Content Knowledge

1 Introduction

1.1 Background and description of the project

The usage of ICT (Information and communications technology) in school and other learning situations is increasing worldwide. Information can be reached quickly and easily, the days of only getting information from course books are gone and the Internet is full of open educational resources.

The academic field of ICT4D (Information and Communication Technologies for Development) focuses on the potential of information technologies to support the citizens of developing countries in their life-long learning (e.g. Hansson 2015, Jobe, 2014a, Heeks, 2008). Within this field of research, there is a wide-spread interest in how resources such as MOOCs (Massive open online course) (Jobe, 2014a, Breslow et al., 2013), wikis, YouTube clips, TED talks and other open educational resources (e.g. Algers, 2013) can supplement national and regional initiatives in developing countries. In this project I explore how Kenyan teachers and students use ICT services to develop their personal learning networks (PLENs) in- and outside of the school setting, where resources provided by schools are combined with (free) online educational resources (Couros, 2010). By aspiring to adopt an action-design-research approach (Sein et al. 2011) I aim to bridge the understanding of current IT-infrastructure and needs of students and teachers with the potential of design future online support for ICT4D in Kenya. The project is situated in an upper secondary school in the township Ngong in the outskirts of Nairobi.

The growing importance of technology, and especially technology in relation to education, is evident in Kenya. By 2017, primary school students all over Kenya will have access to a laptop, through the so called “laptop project”. This will allow all schools in Kenya to use digital tools as a way of learning. Fiber-optic cables are being installed too, as a way of improving the Internet connection. With this growing importance comes a greater need for better knowledge of how ICT can be used, and tools to make the process as efficient as possible.

1.2 Purpose

The purpose is to identify obstacles and opportunities that need to be considered in developing an IT solution. Furthermore, I aimed to identify some implications for design of IT that can be used in school as a tool in relation to informal, non-formal and formal learning (what Jobe, 2014a, refers to as Do-it-yourself learning – DIY-learning). This thesis identifies the obstacles and opportunities when it comes to developing an IT-system to be used in class at a rural Kenyan school. In this project I explored the existing IT situation at a Kenyan upper secondary school, referred to in this thesis as ‘school X’ for anonymity assurance, and the IT needs of teachers and students.

1.3 Description of the site of the field work

In Kenya close to 85% of children finish elementary school, but only 50% finish upper secondary school. Secondary school in Kenya is divided into Form I, II, III and IV, each taking one year (comparable to the last year of high school and the three years of upper secondary school in Sweden). School X was created to give students from the slum areas a chance to attend upper secondary school, who because of economical or social reasons wouldn’t otherwise be able to, through charitable donations from a Swedish charity. School X was partly chosen as the case for this study since ICT is a valued tool in learning at this institution. ICT is encouraged to use by providing the school with computers, other technological equipment, and also

hosting workshops for the teachers. The school is situated in the outer regions of rural Ngong town, approximately 25km southwest of Nairobi. The School has since 2015 been equipped with electricity.

1.4 Target audience

The intended audience of this study is developers of IT-systems related to education, as the focus of the paper is to identify factors related to IT-systems at school X. There is also the scientific aspect, as this report aims to contribute to the pool of information in the field of ICT4D.

1.5 Problem statement

- How is IT and digital resources used at a rural Kenyan school today?
- What are the challenges schools like this face?
- What can be some implications for further IT developments for rural Kenyan schools?

1.5.1 Limitation

I have limited my data gathering to teachers and students of school X, as that is where I conducted my fieldwork. I also limited the age group of the students interviewed to 16 years old and above, for the ethical reason concerning underage consent. Given the small number of informants my findings and conclusions are of a tentative nature and further research is needed to transfer the findings to a wider context. The case study chosen does however have interesting characteristics, which make up for the limitation on it, as it will still contribute to the understanding of the potential of ICT4D. It can also provide the base for future studies.

1.6 Method (and field study scheduling)

This section outlines how the study was conducted as well as motivates the chosen approach. There is also information on the ethical considerations made, as well as considerations regarding validity of the research.

1.6.1 Field Work

The approach of this study is by a single-case case study. Case studies are good for getting deep insight about a certain situation and *how* the people involved interoperate it. Focus is on the process and not the results, on context rather than specific variables and to discover more than prove. (Merriam, 1988) Walsham (1995) brings up that the reporting of the field data in a case study should contain details of the research site and why it was chosen, how many people were interviewed in the study, along with their professional position, during what period the research was conducted, as well as what other data sources were used. (Walsham, 1995, page 79) The reporting on the data analysis should convey how the data gathering was recorded, the method in which that data was analyzed as well as how the iterative process between the field data and the theoretical data was conducted during the duration of the study. (Walsham, 1995, page 79) This study utilizes interviews and observations as data collecting methods.

Interviews

Interviews are typically the method people prefer, as people are more likely to communicate and be attentive about reactions for what they are saying than to reading standardized questioners and formulate answers. (Rubenowitz, 1980) Interviews were conducted to gather data on the existing situation, the areas needing attention, and wishes for the future. Both students and teachers were interviewed. There were also

questions regarding the use of IT outside of a school setting, to assess whether or not a personal interest in technology has any impact on the technical educational pursuit. Since the purpose of the project is to aid in the education and learning process of the students it was important to listen to both students and teachers.

The interviews were semi-structured, that is, the questions were written beforehand and asked in a specific order, but there was still room for additional questions if there was a need for it during each interview. The interviews aimed to gather data on the existing IT situation, the obstacles and opportunities for IT in school, the wishes for the future, and the personal use of IT outside of the school setting. In order to understand how IT was used in the personal lives of the teachers and students, a set of questions based on a questionnaire about digital everyday living was developed. (Babaheidari et al, forthcoming)

The interview questions (Apps. 2 & 3) were formulated to work towards answering the research questions and greater general purpose of this thesis. Furthermore, the overall themes for the semi-structured interviews were validated in discussions with the on-site supervisor.

Selection of respondents

Special attention was paid to the gathering of female voices. This was achieved in part by conducting interviews instead of focus groups. Focus groups are good for interviewing multiple people in a short timeframe, but this could have contributed to females not getting their deserved attention, as Stewart et al. (2006) writes in the 2nd edition of *Focus Groups: Theory and Practice* “[...] women in mixed-sex groups tend to be less dominant than in all-female groups”. (Stewart et al., 2006, page 29) In the 3rd edition of *Focus Groups: Theory and Practice*, Stewart & Shamdasani write that research on sex differences show that men can be more aggressive and women more sensitive, and that men have more confidence in their abilities than women. (Stewart & Shamdasani, 2014, page 20) They go on to explain that “Therefor, the ability to create rapport and maximize the scope and depth of focus group discussion is heavily influenced by the gender composition of the group”. (Stewart & Shamdasani, 2014, page 20) As a non-experienced researcher, I therefor felt it best to conduct one on one interviews in order to assure that women had their voices heard. There was also an aspiration to have a 3-2 division of the respondents be male and female, or the other way around. Unfortunately, this was not achieved when it came to the students, with one female respondent and three male.

The division amongst the teachers interviewed were 3-2 male to female. The students were selected by the principle with the criteria of being 16 or older, and either a 2-3 division boys girls or the other way around. After I had conducted my interviews I found out one of the two ladies were under the age of 16, so for ethical reasons I chose not to include her data in this thesis. This made the final division amongst the students 3 boys and 1 girl. Since the interviews were conducted one day before a long school break, I decided not to conduct another additional interview.

Observations

The observations conducted at school X were to assess the current situation of ICT, and also the possible needs. The observations took place at 4 different lessons at the school, with 2 different student classes, 3 different subjects, and 2 different teachers.

The observations were conducted and documented guided by an observation template, which was inspired by Gyamfi & Gyaase (2015) who conducted a similar study in Ghana, but reworked to better fit the needs of this thesis. The observations were meant to generate knowledge concerning the use of IT in the classrooms, or the

lack thereof. In the cases where IT was used in the lessons, observations were focused on obstacles and success rate of the lesson. At the lessons not using technology, the observations were focused on identifying moments of the lessons what could have run smoother with the use of technology.

Table 1 shows the observation template used during the observations. It served as a structural base and point of reference, and then the observations were reworked and rewritten and organized in the tables presented in section 3.1 of this thesis.

Table 1. Observation table.

Object for Observation	Explanation of the object category	Observations
Space	The physical setting where the lesson took place	
Actors	The different participants during the observation	
Activities	Sets of related acts taking place during the teaching and learning sessions of the computer lesson session	
Objects	Artifacts and physical things available in the space facilitating the teaching and learning process	
Acts	The specific actions of the actors in the course of the session	
Events	The sets of activities that took place in the course of the observed session	
Time	When specific sequence of acts, activities and events took place that impacted of the teaching and learning session	
Goals	The efforts of the actor to achieve the learning objectives of the session	
Feelings	The feelings of the actors as they expressed them	

Time schedule

The project is divided in two phases. First an exploratory study of the existing use of ICT, which included observations and interviews at school X, then an analysis phase, which resulted in implications for design. The overall approach adheres to the ambitions of Action-Design-Research (ADR). (Sein et al. 2011) ADR is a method that starts with “Addressing a problem situation encountered in a specific organizational setting by intervening and evaluation” and later also “constructing and evaluating an IT artifact that addresses the class of problems typified by the encountered situation”. (Sein et al. 2011) However, this project could not complete a full cycle of the ADR method. The construction, implementation and evaluation of the digital solution could not be fit into the scope of the study. Further research is needed in order to complete the first ADR cycle. The ADR method does not seek out to solve a problem in the same fashion as a software engineer would, but should focus on generating knowledge. The knowledge should be applicable to solve any similar problem to the one researched. (Sein et al. 2011)

(Phase I) First, an exploratory study of the existing use of ICT at the school in Kenya was conducted. Interviews were held with selected students and members of the faculty. The interviews were, with permission, audio recorded and later transcribed for future analysis. Furthermore, observations of students' and teachers' classroom use of ICT were conducted, which were documented by field notes and later structured in a table. Phase I was concluded with tentative guidelines for design. Methodological guidelines for phase I was mostly inspired by an ethnographical approach. (Hammersley & Atkinson, 2007) Phase I spanned from March 2016 to the end of April 2016.

(Phase II) Secondly, based on the analysis of phase I, a framework of central factors important for supporting informal, non-formal and formal learning for Kenyan students (Jobe, 2014a; Jobe 2014b) were identified. Furthermore, the framework inspired a set of design principles for formal, informal, and non-formal learning and a model over socio-material aspects of designing an IT system. These are called the "7-ETIP design principles" and the "ETIP-model", respectively. This included analyzing the field data collected and comparing it to previous studies in the field of IT. This phase started in May 2016 and went on for one year.

1.6.2 Data analysis

Empirical data collected through the observations and interviews have been analyzed with the open code method. The transcriptions of the interviews and the observation tables were iteratively read through and analyzed to find common themes that could be divided into categories. Through this work, four categories emerged: Educational IT usage, TPACK-competence, Infrastructure, and Personal attitude. The second part of the analysis was to identify the relationships between these categories. Through the analysis of the empirical data and related research, the four categories are suggested to be subordinate to the dimensions of Sociality (Social) and Materiality (Material). This is presented as the ETIP-model (See Fig. 2 in chapter 4). The four categories are presented in square boxes with single or double-headed arrows indicating either influence or mutual influence. The underlying dimensions are presented as circles, which encircle the four different categories according to what or which dimension the four categories belong to.

In addition to identifying categories and meta-categories and showcasing their relationships in the ETIP-model, the analysis also resulted in a set of tentative design guidelines, the 7-ETIP design principles. (Chandra et al., 2015, Östlund, 2017) The design principles build on the results of the model (Fig. 2) and present suggestions for practical design implications.

1.7 Ethical considerations

Doing fieldwork in a foreign country, it is important to remember that there can be cultural differences that potentially could lead to misunderstandings or conflicts.

Informed consent is something one must obtain when conducting a research project. Under this falls the information demand, which refers to the participants right to be informed about what conditions apply for their participation, and also that it is voluntary to be a part of it, and that it can be terminated anytime they wanted. (Tivenius, 2015) This was handled by first having the participant read the consent form (App. 1) and being told to ask any questions they had regarding it. The consent demand is also connected to informed consent, and refers to the requirement that participants should give their consent to participate in the study. (Tivenius, 2015) This was acquired after the consent form had been understood, by reading the consent form aloud in an audio-recorded verbal contract, which the participant consented to. When

it comes to participants under the age of 16, there is also a need for parental or legal guardians consent. (Tivenius, 2015) Selecting students over the age of 16 to participate in the study circumvented this.

Another important ethical aspect to concerns confidentiality. This means that participants' involvement in the project should be anonymous, and not be possible to trace back to them, especially if the data collected from them could in any way be harmful to them. This means that their name should not be used in the report, and it should not be possible to work out the identity of the person are from other information given, such as their position at a specific company for example. (Tivenius, 2015) This was assured by referring to the participants by fictitious names, in the form of T1 (and so forth) for the teachers, and S1 (and so forth) for the students. The name of the school is also referred to as "school X" in the report, to assure anonymity.

In research, it is also very important that the data gathered is used correctly. This ethical principle refers to that the data collected should not be used for any other purpose than that of the project. (Tivenius, 2015) This was also addressed in the consent form by clearly stating what the data would be used for.

2 Related research

This chapter summarizes previous related research. The focus is on different types of learning using IT, IT in developing countries, as well as studies looking at how personal IT usage can affect IT in learning. The literary overview of this project serves to provide knowledge on the current state of different ways of learning with IT. Keywords used when searching have been: *MOOC, IT in learning, ICT in learning, formal learning, informal learning, non-formal learning, blended learning, personal learning*.

2.1 Formal, Informal and Non-Formal learning

When it comes to teaching and learning, there can usually be a distinction between formal, informal and non-formal learning. Formal learning is the traditional way of teaching, with a clear objective, location and conductor (Greenhow & Lewin 2016). Formal learning is regulated and restricted by a curriculum, syllabus, timetable and semesters (Hansson, 2015). This usually takes form where a teacher conducting a planned lesson for her students. Informal learning is the type of learning that happens unplanned, without a educational institution initiating the learning. (Greenhow & Lewin 2016) This type of learning is part of the lifelong learning process, and it is estimated that around 70-90% of all the learning a person does during their life falls into this category. (Jobe, 2014a) Informal learning can be any type of learning that happens as a result of a pursuit of understanding, but isn't driven by an educational institution. This can be watching a video on Facebook or Youtube, engaging in a conversation with a friend or watching birds in the park, just to name a few examples. Informal learning can be both a conscious and intentional way of learning, and an accidental unplanned one (Hansson, 2015). Non-formal learning is somewhere between formal and informal leaning. It is intentional learning, unlike informal learning, but it happens in a number of different settings and formats outside formal learning, unlike formal learning. (Jobe, 2014a) Jobe explains it that "Non-formal learning can include any form of study group, vocational school, apprenticeship, youth club, community program, or similar lifelong learning effort". (Jobe, 2014a) The study is voluntary, but usually attained with the guidance of a teacher or member-based study group (Hansson, 2015).

Formal, informal and non-formal learning can be supported in practice using ICT. One variant of this is using blended learning. The definition of blended learning can be summarized to be: the combination of face-to-face and ICT based learning. (Gyamfi & Gyaase, 2015) Blended learning is the intermediate between traditional classroom-based learning and distance learning over the Internet.

2.2 IT in learning situations

There are a lot of challenges relating to ICT in educational settings. One of the challenges is the one of resources. If a school is to adopt ICT into learning, there needs to be opportunities for this. That entails access to power, Internet, and technical equipment. Another aspect is that one of knowledge, knowledge of how to best use the technical equipment for a pedagogical learning situation (Tondeur, 2015). A study conducted to determine a theoretical framework for implementing ICT in a UK upper secondary school brings forth the importance of having access to equipment, and for teachers to not only know how to operate them, but know how to do it in a pedagogical manner. (Tearle, 2004) Tearle goes on to explain that these two skills, 1) operating the computer and 2) doing it in a pedagogical way, fall into two categories: practical factors and attitude and ethos. The practical factors include, non-surprisingly, all the practical needs and conditions. (Tearle, 2004, page 337) The

second category considers the way individuals, a teacher or student, views computers and technology. Are they positive to the use of ICT in schools? It also considers group impressions of these things. How does the world look at it? How does the school look at it? (Tearle, 2004, page 338) There is also the Technological Pedagogical Content Knowledge (TPACK, originally TPCK), which is a model first introduced by Mishra & Koehler (2006). The TPACK is a Venn diagram over pedagogy, content, and technology. These are the three areas of knowledge when it comes to teaching. Content refers to the knowledge of the subject matter (Mishra & Koehler, 2006, page 1026), pedagogy has to do with knowledge on how to best teach, and technology refers to not only knowledge of digital technology such as the Internet or computers, but also to books and whiteboards. (Mishra & Koehler, 2006, page 1026-1027)

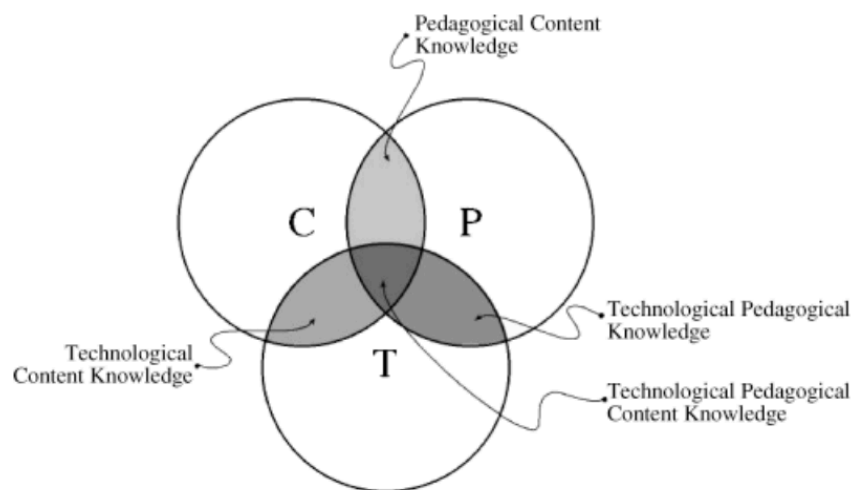


Figure 1. TPACK model (Mishra & Koehler, 2006)

What the TPACK model visualizes is how knowledge of these three subjects overlap in different ways to create additional areas of knowledge. Where all three circles overlap is where technological pedagogical content knowledge is created. “TPACK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students’ prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones.” (Mishra & Koehler, 2006, page 1029) A teacher’s attitude towards technology has been documented to play a big role in the success of ICT implementation. Tearle says “...they must believe that use of the technology can more effectively meet a higher level goal than the previous method, that technology use will not cause an unacceptable disturbance to other goals perceived as more important, and that the teacher must feel s/he has the confidence, ability and access to necessary resources to apply the technology to her/his teaching situation”. (Zhao & Cziko, 2001) Marwan claim that research shows that ICT facilities do not help with improving students learning, and that it is rather the teachers usage of ICT that has an impact. (Marwan, 2015) With this they mean that recourses themselves do not have an impact on better learning in school, but that the resources must be utilized in a proper and pedagogical manner. (Marwan, 2015, page 28) Marwan goes on to mention that teachers who are

more traditional in their teaching style, transcribing to the idea that knowledge is mediated from the teacher to the students, are more likely to opt for an ICT teaching that also follow this style. The same thing goes for teachers that focus on student involvement in the classroom; they will more likely use learner-centered ICT approaches. (Marwan, 2015, page 28)

Cullingford and Haq (2009) highlight the significance of a student's individual attitude towards school. If the student is positive towards school they are more likely to be positive towards a change in the school setting, as opposed to a student with a negative attitude, as it will be more likely a challenge to stimulate these students interest in anything. (Cullingford and Haq, 2009, page 29) One reason behind the possible disinterest in ICT in school by students raised by Cullingford and Haq is that ICT is not used in the best way. "Instead of having instant access to information, students are confronted by facts, instructions sheets and routine tasks. Instead of working at their own pace at a variety of levels, they are put into groups working to the same end. Instead of the pleasures of communication they are made to be silent, submitting to instructions."(Cullingford and Haq, 2009, page 115) The reasoning behind this is not the students or teachers, but the curriculum, with its restricting content. (page 116)

2.2.1 IT as a distraction

IT in the classroom is not guaranteed to enhance the learning situation for the students. Tallvid, et al. (2015a) explores this in their study, which identifies two categories of computer use: *sanctioned use*, which entails all computer activities that are allowed, such as tasks given by the teacher or the listening to music through headphones during individual work, and *unsanctioned use*, which refers to everything not allowed, such as playing computer games or visiting websites without an educational purpose. (Tallvid, et al., 2015a, page 240) The study shows that over the 3-year duration of the study, the use of both sanctioned and unsanctioned use increases. (Tallvid, et al., 2015 page 246)

2.3 Personal learning

Personal learning is the learning an individual does with motivation coming from themselves, and not an educational institution. It is a pursuit of knowledge outside of the classroom. Personal learning can be achieved through IT, but it is not a necessity. This section also looks to research trying to find out if there is a correlation between personal and professional IT usage and attitudes.

2.3.1 Open educational resources

Personal learning can happen in a number of different ways. Social media is one resource to be utilized when attempting personal learning. Sites such as Facebook have proven to be a great source for interaction and collaboration between people, and a great place to share resources and information. It can also help with peer support, inter-cultural language learning and also have a positive effect on both digital literacy and self-expression(Greenhow & Lewin 2016) .

MOOCs are another, quite debated, way of personal learning. MOOCs are courses that anyone can sign up for online, hosted by universities all over the world, including MIT, Harvard and Stanford. Most classes utilize video-lectures, multiple choice question testing and/or peer-to-peer grading, making it possible to enroll a high number/large volume of students. Most of the classes are offered for free, sometimes with possibility of paying in order to get a certificate upon completion of the class. There is usually no need of prior-education for the courses, which can range in subjects from math and science to humanities. There is usually a distinction within

MOOC's, often divided into three groups, xMOOCs, cMOOCs and quasi-MOOCs (Jobe 2013). The distinction between the three is usually explained by xMOOCs being based on a one-to-many relationship, cMOOCs being based on a many-to-many one (Liyanagunawardena et al., 2013), and quasi-MOOCs more being a provider of web-based resources, such as open educational resources, which little to no social interaction or grading (Jobe 2013). Despite MOOCs being a free and readily available resource in order to attain higher education, it is not commonly used in developed countries. Studies have been made to determine the typical MOOC student, and it has been found to be a young, highly educated, employed male from a developed country (Christensen et al., 2013)(Liyanagunawardena et al., 2013). The low participation level of people from developing countries can be explained by a number of different factors. The limited access to technology, the poor infrastructure in terms of the Internet, and low levels of computer literacy are a few. Technology can be costly in developing countries, and not everyone has access to the technology needed in order to enroll in a MOOC. Power outages and other occurrences of the sort can also hinder participants from being able to complete the classes. Since most MOOCs are based on video lectures and downloadable content a steady and relatively high internet speed is needed, something that is not a common thing in most developing countries. The problem of computer literacy levels being low in developing countries is also a big problem, as those levels can be low, even though the literacy levels are high (Liyanagunawardena et al., 2013). Then there are other problems, like language barriers or cultural differences. Most MOOCs are offered in English, something that might not be spoken by everyone, or being comprehended at a too low level. When it comes to cMOOCs, with their student-to-student interaction, language and cultural differences can really cause problems and misunderstandings (Liyanagunawardena et al., 2013). There is also critique against MOOCs. In *Invasion of MOOCs* Barlow writes about MOOCs in the context of colonialism. They claim that "The structural paternalism of colonialism, generally unrecognized by the colonialist, is no different from that of the formulators of the xMOOCs." (Barlow, 2006). With that Barlow means that MOOCs are designed in a way that doesn't benefit learners in developing countries.

2.4 Personal technology usage

Tearle (2004) examines the correlation between personal technology use and the use of ICT in school by teachers. Their findings reveal that a negative attitude regarding ICT does not serve as a reason for failure when it comes to implementing ICT in school, and the evidence of a positive outlook on IT correlating to success were very weak. (Tearle, 2004, page 346) Marwan (2015), on the other hand, claim that a positive outlook on technology from a teacher can aid in the usage of ICT. (Marwan, 2015, page 29) He also brings up the point that teachers who are negative towards technology might be of the belief that ICT will either provide no difference in teaching, or even harm students. If this is the case, than an ICT implementation will be useless, as the teachers could decide not to use the new ICT tools. (Marwan, 2015, page 29)

The attitude and prior experience of a student are defining factors in how they will perceive IT in a learning situation. Cullingford and Haq (2009, page 29) claim that students who have had computers at home, and are familiar with using computers for various reasons, are more likely to have a positive outlook on what a computer can add in their school life. They are more aware of the possibilities of a computer. Students who on the other hand hasn't used computers at home might arrive either

with a big expectation on the possibilities, or with a worry about the usage. (Cullingford and Haq, 2009, page 29)

2.5 Socio-technical designing

The idea of socio-technical designing comes from the consideration of humans in the design of systems concerning manual labor, for instance, coal mining. This idea, that of the human focus, was later picked up by IS designers too. Researchers such as Mumford (Mumford, 1993) with the ETHICS approach, Taylor (Taylor, 1990) with the HUFIT toolkit, and Eason, Harker and Olphert (Eason et al., 1996) behind the ORDIT method, have all been pivotal in the development and practical utilization of these ideas. A pioneering school of thought in this field was the Scandinavian participatory design movement, which after an initiative looked at workers as important co-designers when it came to developing tools and systems to be used in the workplace. (Greenbaum & Kyng, 1991)

2.6 Particular importance for this study

The related research presented above provided important input to my understanding of the potential design space for ICT4D, in particular concerning contemporary services and platforms for formal, non-formal and informal learning. Furthermore, the perspectives highlighted in the Scandinavian school and participatory design guided me towards a research approach where all relevant stakeholders (national education system, school management, teachers and students) are considered when collecting and analyzing the data.

3 Procedure and Results

The field data collected is presented with the intention of answering Walshams (1995) questions regarding what should be included in a case study. The details of the research site and why it was chosen is brought up in chapter 1.3 Description of the site of the field work. In this chapter, how many people were interviewed in the study, along with their professional position, during what period the research was conducted, as well as what other data sources were used will be explained. What follows is the gathered field data, in the form of observations and interviews. The observations and interviews were conducted from March to May 2016, at school X in Ngong, Kenya. The observations will be presented in a table, with an accompanying textual description, and the interviews will have relevant quotes and summaries described related to themes important to the study.

3.1 Observations

Observations were conducted on four different lessons. Two of the lessons were computer science, where technology was utilized, and the other two lessons were one English lesson and one Math lesson, not utilizing technology. The observations are presented in tables like the Observation table (table 1), but without the column 'explanation of the object category'.

The first observation (table 2) was of a computer science lesson. The lesson was held in the lab-room because of testing occupying the regular classroom. Up to 5 students shared a computer for the duration of the lesson, completing different assignments. There was a high sound level throughout the lesson, and not a calm setting

The second observation (table 3) was conducted during a Math lesson. The lesson did not utilize computers or projectors, instead, the whiteboard was used to write down equations to be copied down in notebooks or solved together on the board. The erasing of the board took up some time of the lesson, and the teacher had to wait for the students to copy down the board before moving on with the lesson.

The third observation (table 4) took place during an English lesson. This class was, as the math lesson, also conducted without the use of technology. The school did not have enough books for all students, so the teacher used the whiteboard to write up assignments for the students to solve together.

The final observation (table 5) was conducted during a computer science lesson. Once again students shared computers in smaller groups. A projector and the whiteboard were also used during the lesson. The classroom climate felt quite disorderly, with high sound levels and students not doing the assigned work during the lesson.

Only two of the observed lessons utilized computers for their lesson (OB1 and OB4). Before these two lessons, the computers, along with extension cords and chargers, had to be carried there by teachers and students. The process of setting up the computers and cords, and getting the class to settle down enough to start the lesson took from 10-15 minutes of the lesson time. At OB1 the class went on for 40 minutes more than the schedule said, and OB4 went on for 10 more minutes than the schedule said. I also observed other time related issues during my observations. At OB1 the teacher accidentally steps on the extension cord switch, which switches off the power to the projector, which caused it to shut off. It takes about 5 minutes to get the projector on again, and showing the projected screen to the students. At OB4, one groups' extension cord switch was not turned on, so even though their charger was plugged in the computer was not getting any power. This caused the computer to turn

off. The teacher turned the switch, and the computer could be started again, however not without losing the progress that had been made previous the computer shut off.

Table 2: First observation (OB1). Computer science lesson.

Object for observation	Observations
Space	Large cool lab-room. Not the usual setting.
Actors	Computer science Teacher, 54 students.
Activities	Three different assignments for the groups to do, given at intervals.
Objects	11 laptops, one of which is the teachers. A projector. A whiteboard. The students have pen and notebooks.
Acts	The sound level is high. People are walking around in the classroom a little. Teacher is showing information on the projector.
Events	Some students had to change groups after a while because the teacher noticed they were more than 5 people in the groups. Teacher accidentally steps on the power switch for the projector, takes about 5 minutes to get it running again. Students are talking amongst themselves as the teacher is talking. When the lesson is coming to an end one student uses the teachers computer to project a file named "test". The teacher does not notice.
Time	15.30-16.10 according to schedule. Actual lesson time 15.45-16.50
Goals	Limits the group size to 5 people. Students help each other, either amongst themselves or after instructions by the teacher. Teacher tells students to be quiet when the sound level is too high. When students answer questions the teacher repeats the answer so that everyone can hear.
Feelings	Some students seemed bored when they weren't the ones in front of the computer. Some students complained about the amount of lines needed to be written down for an assignment, while the teacher replied "There are just a few lines, I don't know why you are complaining". Students audibly sad when the teacher says the class is over.

Table 3: Second observation (OB2). Math lesson.

Object for observation	Observations
Space	Big room, but full, not much walking space between benches. One can see the whiteboard well from the back.
Actors	Teacher-student, 57 students.
Activities	Starts with announcements. Teacher going through math problems on the whiteboard, students copy down in their books
Objects	Whiteboard. Students have pens and notebooks.
Acts	The sound level was low. Teacher has to erase the board throughout the lesson because it fills up.
Events	Some students talk to each other at times. The calculations on the board are done rather quickly. The teacher waits for students to copy down equations before erasing the board.
Time	8.00-9.45
Goals	Teacher repeatedly asks students if they understand. If they want an assignment explained again the teacher does this.
Feelings	The teacher makes a joke about her bad handwriting, the students laugh.

Another observation made is the one of the students' use of technology during the lessons. While work was being conducted, there were also instances of the computers being used to other things than the teacher had assigned. At OB1, one student went up to the teachers computer when the teacher was not looking to project a document named "test" for the whole class to see. At OB4, the students using the teachers'

computer go on to look at the pictures and videos saved, instead of doing the assigned work. This gathers the attention of the classmates, and the teacher has to tell students to go back to their own computer two times.

Table 4: Third observation (OB3). English lesson.

Object for observation	Observations
Space	Adequately sized classroom. The teacher is heard from the back of the room.
Actors	Teacher-student and 32 students.
Activities	Teacher asks students for examples of eg. verbs and the students offer answers by raising their hands. The teacher writes on the whiteboard and explains. Teacher is writing a “fill in the blanks” assignment on the whiteboard from the book, as there are only 6 books on hand for the 32 students.
Objects	Whiteboard. The students have pens and notebooks.
Acts	The students take notes. When asked to pronounce some words not all students do this.
Events	Teacher brings up an example of a meme that relates to what she is teaching. Not all students know what she is referring to.
Time	9.50-10.20
Goals	Teacher asks students to raise their hands if they know the answer as “I can’t hear you if you are all talking at the same time”. Teacher engages students by pronouncing some new words together.
Feelings	Lots of laughter throughout the lesson.

Table 5: Fourth observation (OB4). Computer science lesson.

Object for observation	Observations
Space	Adequately sized classroom. Open windows, which allows for a cool temperature.
Actors	Teacher and 35 students.
Activities	Teacher walk around the classroom to see that the students are doing the assignments. The teacher is drawing an excel sheet on the whiteboard to show how the students are supposed to do it on the computer. At the end of the class an excel sheet is projected on the screen, but it is not very visible from the back.
Objects	9 laptops, one of which is the teachers (which is used by students when not used for projecting), projector, extension cords.
Acts	Sound level is high. The teacher is showing the students what to write on the board. Has not prepared what numbers should be punched in.
Events	One group accidentally erased all the numbers they punched in, so they had to start over. The students who borrowed the teachers computer are looking at pictures and videos. Students from other groups start to join to look as well. After a while the teacher notices the big gathering and tells everyone to get back to their group. This happens again a while later, and the teacher breaks up the group again. One groups’ screens turns black, the teacher then turns on the switch for the extension cord.
Time	14.10-15.55. Class settled by 14.20, and all students have left by 16.05
Goals	Teacher breaks up a large group. Teacher lets one group use his computer when he doesn’t need it. Some student groups take turns in punching in the numbers on the computer, so that everyone in the group is involved.
Feelings	Some students are laughing when they talk to each other. Some students seem bored and tired; one student is resting his head on the table. The teacher seems a little annoyed at students who are inattentive.

Looking at OB2 an OB3, where IT was not utilized, they both present examples of moments where ICT could have improved the lessons. At OB2 the teacher makes a joke about their bad handwriting, something that obviously can be an issue, if it were so bad that students could not comprehend it. There is also the issue of having to wait for the students to copy down the equations on the board. At OB3, the issue of not having enough textbooks for all the students is presented.

3.2 Interviews

What follows is a presentation of some relevant points raised in the 9 interviews with the teachers and students. The information is presented under categories that mimic some of the question areas in the interviews. Below follows table 6 and 7, which are tables of identifiers of the interviewed, split up by teachers and students. Table 6, the teachers' table, identifies the roles of the interviewed teachers, as well as the length of the recording and the recording format.

Table 6: Interview recording data - Teachers

	T1	T2	T3	T4	T5
Roles	Principal and teacher in Religion and Kiswahili	Teacher in Math's and Physics	Teacher in Math's and Physics	Teacher in Computer studies and Business studies	Teacher in Biology and Chemistry
Recording length	23:57 min	15:38 min	13:02 min	12:30 min	12:37 min
Recording format	Mp3-file from phone recording	Mp3-file from phone recording	Mp3-file from phone recording	Mp3-file from phone recording	Mp3-file from phone recording

Table 7, the students' table, identifies the gender of the interviewed students, as well as the length of the recording and the recording format.

Table 7: Interview recording data - Students

	S1	S2	S3	S4
Role	Male student	Male student	Female student	Male student
Recording length	5:39 min	7:23 min	11:43 min	17:12 min
Recording format	Mp3-file from phone recording	Mp3-file from phone recording	Mp3-file from phone recording	Mp3-file from phone recording

3.2.1 How IT is used today

From interviews with teachers and students at school X I have tried to get a picture of how IT is currently used. From the observations conducted it is clear there was not a lot of IT used in class, and the interviews tell a similar story. IT seems to mainly be used as a preparatory tool and to help assessment after class. Teachers can look up information online and then share what they have found with the students in class. T2 and T3 specifically mentioned that they use IT in class to show videos of experiments that the students can follow, or that they would not be able to perform in their classroom themselves. This shows that IT gives the opportunity to convey knowledge to the class that would have otherwise been impossible. There is also the concern that the students aren't focusing on the task at hand when they have access to technology in school. T5 mentions that IT has made their preparatory work for class run a lot

smoother, “[...] I think when I incorporate ICT it becomes simpler. Yeah it’s much simple using ICT rather than when I do it manually you know writing, takes time. But ICT I do it faster [...]”.

When it comes to the teachers’ active pursuit of IT knowledge, most teachers claim a curiosity towards new IT development. When asked if they keep up with new developments in IT, T2 and T3 claim not to, T5 doesn’t keep up as much as they would want to, T1 tries to, and T4 does keep up with new developments. To the question of the frequency of trying new IT related things during the lessons, T1, T3, and T5, answered that they do this sparsely. T4 claims that it’s not that easy to try new things, but that they test out new IT methods in smaller student groups, to see if it is something that can be applied to the whole class. T2 says that “[...] most of the time we are trying something new”. T1 and T5 express a wish for more IT training, so that the usage of IT is guaranteed to be performed in a pedagogical manner. T5 says “I want to know how can I use the IT ... so that it is effective in a learning situation, so I might use it but it is not effective”.

3.2.2 Challenges with IT use

There seem to be a lot of different challenges facing IT use at school X. Time is one issue raised by both teachers and students. Teachers raised issues of students not focusing on the tasks at hand, and also the physical challenge of moving the computers, chargers and extension cords from the teachers’ lounge to the classrooms. T2 says “[...] moving the laptops to class, it also takes part of the time, so you really have to plan if you are to use it[...]”. There is also the issue of Internet availability and power outages. Most teachers also voiced that they have to have a backup plan when planning to use IT in their lesson. This of course takes time out of the teachers’ preparatory work that could be spent on other matters. T2 and T5 will have a backup plan that achieves the same goal that the IT based plan would have, only using a different method, while T3 and T4 will teach something different, and try to revisit the planned IT lesson at a later time.

T1 voiced a concern of students not doing the assigned work once they had access to the Internet, that is, doing unsanctioned, or off-task work during lessons. T1 says “the main challenge, especially on student would be when you give them some assignment to go and do online they might end up not doing it and viewing unnecessary materials or sites, that are not actually recommended. And that one wastes a lot of their time on social media... go and chatting instead of doing assignment so you realize when you’ve given them assignment and they get access to internet they spend more time on social media then doing the assignment they end up not doing the assignment as it is required or should the assignment”. The suggestion T1 had to overcome this problem was to block certain sites, so the students cant access them. T4 also raised this concern, when talking about students who may lack motivation in learning to use the computer, saying “if they are not that much interested in the practical they prefer to do some bing-searches, show others, eh, some gifs, eh, social sites, yeah, so actually it is a challenge”. Their solution is to motivate students with information on the importance of computer literacy in the world today. S4 also addresses the off-task Internet use, in the light of the Internet connection at school, and having to buy bundles of data with their personal mobile phones. S4 says “[...] by the time you are done accessing social media maybe want to study then data run is out, so you [] so, you can’t use it”. S4’s solution is not to ban certain sites though, but to make Internet more readily available for the whole country.

S3 mentioned the issue of computer literacy levels being low. T1 mentions a concern that the students of this school are not capable of conducting research on their

own. He says “Our students are not very much so versed with the IT and the research on it so we don’t really send them to go and research on online but the teachers we do that”.

3.2.3 Wishes for the future of IT use

The wishes for IT use in class are many. All of the respondents want to see a future where IT is used more, and also more efficiently, in class. T4 says “[...] my wish is that we may have the, enough resources so that ah we can fully implement the use of ICT in class, both for teachers and student”. T3 says “[...] I would wish that we have projectors and computers positioned in class permanently so that I don’t waste time connecting, carrying the, the computers and the projectors to class, and... I would wish if we have students using our computers, several students using computers, other than just me the teacher being able to use the computer in the class. If the students also make use of the computer and Internet at the same time, and I think it will be more efficient”. T1 mentions the wish for an IT expert to come in and help the teachers in education regarding IT use in school. The wish to use IT in the lessons is there, but the knowledge on how to best do it isn’t. T5 refers back to their point of positive attitude and IT usage. They say they wish that “all the teacher plus the students will, ah, will have that positive attitude to use this IT ... Because you’ll find most of them think that when you use the IT it will take a lot of time but because I’ve used it, it in fact takes the shortest time possible than when you use the, the, the hard copy books”. The students are equally enthusiastic about IT in school, with all of them expressing a wish for more of it used educationally. S1 talks about the benefits of IT usage outside of the walls of the school, “[...] we should practice IT more and more, so that when we will get out of school we can have the necessary skills to do different types of jobs”. S3 and S4 both talk about the research aspect of having access to ICT, S3 says “And also I think when, when each and every person has maybe an equipment and ICT research will be very, will be at a higher level so forgetting something that you’ve already researched on at your own it will be very difficult” while S4 says “[...] I’d use it to get data and research on everything to transfer then share those ideas”.

3.2.4 Professional and personal IT use

When examining if personal technology usage and attitude has an impact on ICT in teaching the results are tentative in their nature. All the teachers, based on their different answers throughout the interview, seem to have a positive attitude when it comes to ICT. To the question of their wishes for IT in class, everyone answered that they wanted more of it, and better usage of it.

Students were both asked about their in school use of technology, their learning situation outside of school and their personal relationship to technology. When looking at their learning outside of school, all students mentioned that they do some type of learning using technology. Only half of them did learning outside of school not using technology. The people that did do learning outside of school not using technology did this a lot less than their outside learning using technology. All the students unanimously also claimed to be very comfortable using IT and technology.

When it comes to finding a correlation between personal IT use and the use of IT in the classroom there is not a clear distinction. Most teachers use IT in their personal lives, so there isn’t a clear correlation seen. I do however feel that more observations would need to be conducted over a longer period of time to get a better idea of how the individual teachers use IT in their lessons. For the students, it is hard to see a

correlation as their in-school usage of IT is dictated by when the teachers decide to utilize the computers in class.

4 Analysis

This chapter will present and discuss the findings based on the empirical data, presented in section 3, and is guided by frameworks identified through related research, as described in section 2. The challenges and opportunities of designing an IT solution manifested themselves, after thorough analysis of the empirical data, through an open coding analysis method, in four interrelated categories where social aspects were tightly coupled to technical dimensions of ICT4D. Hence, the analysis was inspired by ideas from the socio-technical school of thought. However, in my model, presented in section 4.3, I chose to present this as a *socio-material* design space for ICT4D since the materiality goes beyond technical dimension. The materiality also stretches into non-technical aspects of education, such as pedagogical design and content expertise reified in non-digital learning resources, and deals with learning activities that are both on-task (designed and controlled by teachers) and off-task (the result of individual and social initiatives from students).

As will be demonstrated in this chapter, the result of the study thus points at two *interrelated* dimensions, pivotal to understanding the conditions for design of situated ICT4D. The dimensions deal with, on the one hand, materiality, and on the other hand, social aspects of ICT4D. They have been compiled in a model named the ETIP-model after the four boxes in Figure 2 (**E**ducational IT usage, **T**PACK-competence, **I**nfrastructure, **P**ersonal attitude). This socio-material assemblage expresses itself accordingly: The material dimension relates primarily to infrastructure, educational IT usage, and TPACK-competence, while the social dimension connects strongly to attitude, educational IT usage, and TPACK-competence.

The analysis discussion is structured in the following way: Firstly I problematize how materiality in general, and infrastructure and educational IT usage in particular, are identified as important aspects when it comes to developing educational IT systems. Secondly, the Social aspects are highlighted, with both teachers and students personal attitudes and their impact on creating an IT system to be used for educational settings. After these two dimensions with accompanying subordinate categories are presented, the ETIP-model is explained in more detail. Finally, a section on implications of design brings forth tentative design guidelines, the 7-ETIP design principles, which relate to the four categories of the ETIP-model.

4.1 Material

Both observations and interviews identify multiple points concerning infrastructure, competence, and IT usage in school. One challenge is connected to the physical effort of moving in the computers to the classrooms. As it is now, there is not a designated computer lab, and the laptops have to be carried to the classroom either by the teacher or the students. Then there are the occasional unpredictable interruptions like power outages or instances such as in OB1, where the teacher accidentally steps on the switch for the power cord, shutting the projector off. These examples fall under the Infrastructure category, as it encompasses both the material at hand, and the ability to access it. These two examples naturally effect educational IT usage. For one, moving the computers to the classroom, instead of having a designated computer hall will of course take more time, something unexpected interruptions also will, along with the possibility of setting back any progress made by students. This could all lead to teachers deciding against using IT in their lessons. Infrastructure is also the base condition for the possibility of actually utilizing IT during the lessons. If the infrastructure is set up in such a way that there, for example, is no electrical power, the usage of computers during class is made impossible. The infrastructure not only gives the possibility of IT-usage in terms of on-task work, but also lends the potential

of off-task work. Of course, off-task work does not have the prerequisite of IT availability, but can also be done without any technical equipment.

As mentioned in the interviews with T2 and T3, IT gives an opportunity to convey information and knowledge in a way that would not be possible without the use of IT. Experiments that cannot be performed in the classroom can be shown in a video instead. This shows that IT allows for important information to be presented for the students. This is a clear example of how the infrastructure positively effects the IT usage in school, as it allows for information to be presented and accessed.

From the observations not utilizing IT, OB2 and OB3, the opportunities for ICT present themselves. At OB2, it is evident that some of the lesson time is spent waiting for all students to copy down what is written on the board, an activity that could be eliminated with the right IT tool. OB2 also brings up the possible problem of legibility of the teachers handwriting, another issue that does not exist if the infrastructure made possible for a more digital classroom. OB3 highlight another infrastructural issue of not having enough textbooks for all the students. With 32 students and only 6 textbooks for that particular class, the teacher is forced to take up lesson time copying the exercises out of the book to the board, for the whole class to see. IT could make sharing of content a lot easier, which would have the lessons running smoother, that is, infrastructure would influence the educational IT-usage positively.

4.1.1 Educational IT use

Off-task computer use during the lessons was addressed by T1, T4 and S4 in their interviews. All the correspondents had different approaches to the subject. T1 is of the belief that students, when given access to Internet, will use this to indulge in off-task work. That is, when the infrastructure allows for Internet use, it will affect the IT usage negatively. T4 sees the issue lie amongst unmotivated students, which would be a social issue, relating to the personal attitude of the effected student. S4 on the other hand, brings up the issue, not in a way that says that visiting social media sites is the issue, but that the Internet bundle runs out before the research has started, which would also relate to the infrastructure.

T1 came with a possible solution of blocking certain sites in order to keep the students from accessing websites they should not access during the lessons. This of course could prevent sites like YouTube or Facebook being used in teaching, as they are two big sites that could potentially be a distraction for the students. Tallvid (2015b) identified one of the key components for successful computer implementation to be freedom of use. That is, for no technical restrictions to be used in school, like site blockers. Instead, they found success in ethical discussions with the students. Technical restrictions, beyond blocking sites that could possibly be used for teaching and learning, also take a lot of time and knowledge in upkeep. It can be very hard to keep up with all the sites students are visiting, as new websites are launched daily. T4's solution is to motivate students of the benefits of computer literacy, not only for future job opportunities, but also for basic tasks in the everyday life. Cullingford and Haq (2009) brings up the issues of students attitudes towards school as a reason behind students disinterest in using ICT for schoolwork, which supports T4's motion. S4, since they do not believe the issue is with the visiting of the sites, but rather the limitation to Internet, wishes to see nationwide free Internet access, which would fall under the infrastructural area.

OB1 and OB4 showed that if given the opportunity, some student would engage in off-task activities instead of doing the assigned tasks. Tallvid, et al. (2015a) show results that indicate that students, when given individual computers to use, will use

them both for on- and off-task work. At OB4, the students engaging in the unsanctioned watching of pictures and videos saved on the computer attracted a crowd of students also joining in and watching their screen. They caused a distraction for large parts of the class, which the teacher had to break up at two times during the lesson. At the same time, both teachers and students express a wish to have more student involvement in the use of IT. Cullingford and Haq (2009) also touch on the limitations the curriculum puts on teaching, as a reason for the lack of motivation in some students. The restrictions of the curriculum are also something brought up by T1 when asked about how using technology is thought of when planning a lesson. T1 says “But now because somehow we are limited to whatever we are supposed to deliver in classroom we tend to give it little, little more of ehh, time or little more of eh, I don’t know how to put it but, we don’t give it more weight as compared to what is supposed to be there”, explaining that there is not as much focus on IT as one could wish, because of the expectations of the curriculum. This would lead me to come to the conclusion that when it comes to students engaging in off-task work, it seems more of a social issue, stemming either from the personal IT-attitudes of students, or the content-aspect of the TPACK-competence area.

4.2 Social

The attitude towards IT in individuals was studied, in relation to their IT usage. The results, though tentative in their nature, show that a positive attitude towards IT in general can help, or hinder, in the usage of IT in school. This shows that a personal attitude *can* affect the use of IT in school.

4.2.1 Teachers’ attitude

When looking at the attitude towards IT, the previous research shows studies both showing relations between the personal IT attitude and the professional one, and studies that claim that such correlation can’t be made. Marwan (2015) claim a correlation between a teachers’ attitude towards and the ease of working with IT in school. A positive attitude to IT contribute to an ease of use in a school setting, and a negative outlook causes the teacher to avoid using IT, as they believe it can do the students harm. T5 expressed a positive attitude towards ICT, claiming ICT facilitates her preparatory work. T5 claims to be “somewhat” comfortable using IT and technology, and that IT plays a big role in their personal work. In school, T5 uses IT for preparatory work, practical assignments for the students, and for assessment after class. In their personal life T5 claim IT plays a “big role”, with them using it for their social life, looking up information, to order items and for relaxation and fun. This shows that a positive attitude can lead to using IT and technology in class, as T5 let the students be involved in the IT usage in school. The only person that directly expressed a negative attitude when it comes to student involvement is T1, as they claim that the students will do off-task work when given access to computers, and also that the students of the school are not versed with IT and research, thus not giving them those assignments. T1 uses IT in school for preparatory work and for assessment after class, and claim to be somewhat comfortable with IT and technology. In their personal life, T1 claims IT plays a “big role”, using it for banking, governmental procedures, online shopping, social activates and for relaxation and fun. When asked about the assumed challenges and opportunities for IT in five years’ time, a slight worry is expressed, highlighting that IT is not all good, that it comes with challenges such as putting people out of work, with robots performing tasks in their place. This could be seen as a slight negative outlook on IT, and a slight fear of it. Three out of four students mentioned subjects that T1 teaches as

the subjects that use the least amount of technology, and T1 themselves claim to not use IT during the lessons. All this points to personal IT attitude influencing the educational IT usage, both in a positive and negative way.

The results are varying when reviewing the answers to teachers' curiosity, active pursuit of new knowledge and applied new IT usage. All teachers claim some degree of curiosity towards new IT development, but then it comes to actually pursuing new knowledge and testing new things, three teachers does some degree of pursuit, and only one teacher claim to be frequently trying new IT related things in the classroom. As mentioned earlier, T1 and T5 expressed a wish for more education in pedagogical IT usage. This is interesting, as T1 and T5 are both seen as examples of having a respectively negative and positive IT attitude.

4.2.2 Students' attitudes

When looking at T1's statement that the students of the school are not equipped to conduct research on their own in relation to the students' answers in the interviews, the statement lacks weight. The students unanimously claim to be "very comfortable" using IT and technology, and that IT plays a "big role" in their school life. They all also engage in learning outside of school using technology, whereas only two of the students also do learning not using technology. This seems to show that learning using IT is favored over learning without IT. The students all had wishes for more IT use in school, and most of them explicitly expressed a wish for more student involvement when it comes to technology. S4 brings up in their interview that "students like to do research on things that they don't know, on new things that are found eh maybe through research", even stating that students come together to pay for bundles of internet in order to research a certain subject. This shows that not only the willingness, but also an active pursuit, of Internet use exists amongst the students. This attitude and willingness to learn, and to learn outside of school, goes well with the MOOC approach. However, when it comes to physical difficulties, school X face the same challenges that Liyanagunawardena et al. mentions. Power outages and limited access to Internet are both challenges school X faces, which would make a MOOC approach difficult. Results indicate that while MOOCs, and other OER's, may not play a big role today, there is potential to be a complement to the resources offered by the school. The problem lies in the infrastructure of the school, rather than in the personal attitude of the students.

Going back to T2 and T3's mention of IT creating the opportunity for matters to be taught that would not have been possible to the same extent without IT, S4 also brings up ways in which information is accessed through the use of technology when talking about wishes for IT use. They say "[...] I wish to maybe download some, some textbooks or some program or videos that will make me understand something better. And also I think when, when each and every person has maybe an equipment and ICT research will be very, will be at a higher level so forgetting something that you've already researched on at your own it will be very difficult". Overall, the attitude of IT amongst the students is very positive, with mostly the infrastructure limiting the educational IT usage.

4.3 The ETIP-model

The identified material and social dimensions, derived from Mumford's (Mumford, 1993) socio-technical designing, both have a role to play in the make-up of a schools' IT situation, as both areas are important areas when it comes to IT use in school. Looking to the identified categories, the infrastructural, TPACK-competence, and educational IT usage component would be found under the material area of the model.

It includes the physical objects available, the electrical reliability, the Internet availability, the knowledge of the technical equipment used, the content taught and or learned and the best way to teach and or learn. The personal attitude and TPACK-competence, and educational IT usage appertain to the social dimension, and concerns questions about how to best mediate the knowledge at hand, and the personal opinions that can influence ones IT-usage.

As mentioned in section 1.6.2, the categories and relationships concerning the ETIP-model grew out of an open code analysis of the empirical data and results of related research.

The ETIP-model applies to both teachers and students. Personal attitude *can* influence the educational IT usage, both negatively and positively. TPACK-competence, which consists of knowledge of content, technology, and pedagogy, and their overlapping categories, naturally effects and is effected by the educational IT usage. Infrastructure influence educational IT usage, as it is the base of what can be utilized. Educational IT usage itself consists of on-task work and off-task work, similar to what Tallvid et al. (2015a) refers to as sanctioned and unsanctioned work.

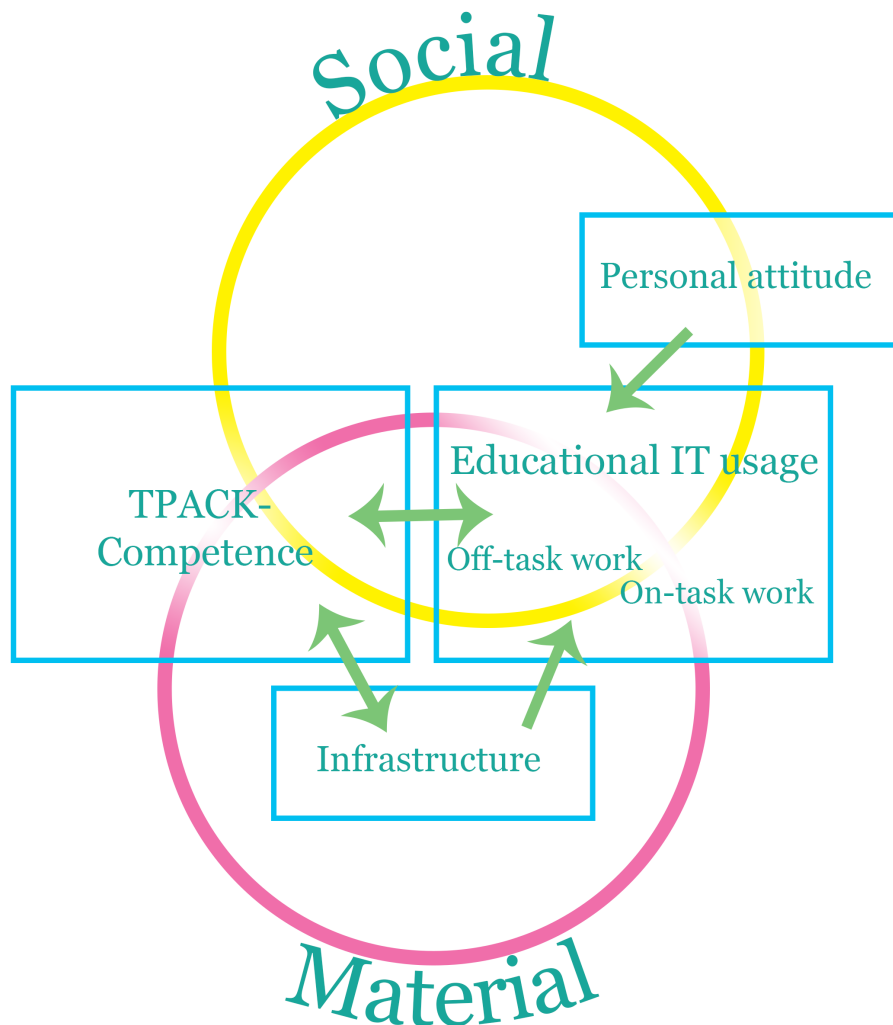


Figure 2: ETIP-model with the intersecting social and material dimensions (Double-headed arrows indicate mutual influence.)

A key competence for a teacher at school X will be to plan lessons in the digital and non-digital room. The technical component of TPACK includes digital tools and solutions, but is not limited to them. In cases like these where the infrastructure for IT and technology cannot be guaranteed, a teacher needs to be able to work both digitally and non-digitally, and be prepared for what happens if plans have to change. It is also important to get everyone positive that IT will be a help to rely on, rather than a hindrance. The ETIP-model adds to the existing knowledgebase by providing an insight into how educational IT systems need to rely on social-material and socio-material aspects when designing ICT4D. It stresses that categories in both social and material dimensions must be taken into consideration, for best designing educational IT systems in developing countries.

4.4 Implications for design

The ETIP-model can work as a guide for design and implementation of IT systems to be used in rural Kenyan education. It highlights and separates different key-components when it comes to IT-usage, which are important to consider when designing an IT system. The components are divided into two categories, social and material, with some components included in both sections. From this model, a tentative set of design principles has emerged, which serve to help build, implement and evaluate, according to ADR. I have named these design principles the 7-ETIP design principles, which stand for the seven design principles, and the categories from the ETIP-model, Educational IT-usage, TPACK-competence, Infrastructure and Personal attitude. The design principles were created as a complement to the model, to help the design of educational IT systems in developing countries. They take into account all the aspects of the ETIP-model, and thereby also the needs of teachers and students alike.

The 7-ETIP Design principles

Educational IT-usage

1. Design to help teachers and students coordinate their PLEN's

Important not to forget individuals PLEN's when designing educational IT systems, to best accommodate off- and on-task learning.

2. Design to utilize the areas in which IT is already used

Important to design systems that values areas in which IT is already used today.

TPACK-competence

3. Design to support different levels of TPACK competence

Different users will have varying levels of prior knowledge when it comes to the TPACK competence. It is important to design with these varying competence levels in mind, as to not make an over complicated or over simplified system.

Infrastructure

4. Design educational resources that supports offline learning

Because of the infrastructural issues concerning the Internet, a system designed to be used in rural Kenyan schools would need to consider the inconsistent Internet access.

5. Design for the unexpected

When interruptions to technology use are a common occurrence, the design of IT systems must bear this in mind. Power outages and other unexpected disruptions should not result in loss of progress or too much loss in time.

6. Design OER's that are based on group work

With limited material resources, one key aspect is to design systems that are, with benefit, used by a group of users.

Personal attitude

7. Design to engage users of different personal IT attitudes

The personal IT attitudes of users can vary from very positive to very negative. When designing an IT system, the design process itself can help sway users attitudes.

The design principles can serve as a guide of reference in the early stages of designing an IT system for rural Kenyan schools. The model highlights the most important areas of consideration, and should not be overlooked when considering development of a new IT system. The 7-ETIP design principles are to be considered throughout the early stages of development and design.

5 Conclusion

This thesis set out to address three research questions:

- How is IT and digital resources used at a rural Kenyan school today?
- What are the challenges schools like this face?
- What can be implications for further IT developments for rural Kenyan schools?

Below follows the results related to these research questions, as this thesis unveiled.

Firstly, how is IT and digital resources used at a rural Kenyan school today?

The results related to this research question show that IT is mostly used for preparatory work, and as an assessment after class. Some teachers utilize it during the lessons, with even fewer instances of student participation. Students are more likely to use IT based learning in out-of-school learning situations, and unanimously were for more IT usage in school.

Secondly, the challenges schools like this one face include power outages, limited access to Internet, computer illiteracy, off-task usage and limited time. The opportunities lie in the desire of students and teachers to streamline educational work, and the effective utilization of the infrastructure as it is today.

Thirdly, what can be implications for further IT developments for rural Kenyan schools? Here, a proposed solution urges to consider the ETIP- model and the 7-ETIP design principles in order to consider the different areas influence over the IT usage in school. With improved infrastructure, there are great possibilities and opportunities for school X to quickly increase the educational IT usage, which could also enhance the competence and positive attitudes of teachers and students alike.

Finally, it is important to stress the ETIP-model and the 7-ETIP design principles that have been created with the intention to be used in the design process when creating an IT system for rural Kenyan schools. The model stresses the delicate relationship between sociality and materiality as constraint and affordances for design. Neither social aspects, such as personal attitudes, nor material aspects such as infrastructure, nor overlapping aspects such as TPACK-competences and Educational IT usage, can be taken for granted.

In order to successfully innovate ICT4D through education the ETIP-model highlights that a holistic approach embracing all aspects needs to be taken with the outmost sincerity. The model and the principles have emerged through analysis of previous research and the results of the case study, and highlights the aspects which the study has revealed to be most important, namely, Educational IT-usage (which includes on- and off-task work), TPACK-competence, Infrastructure, and Personal attitude.

The possibilities for IT in rural Kenyan schools are many, but only with the appropriate social and material focus can relevant and useful IT-systems be created.

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Appendix 1 – Permission of data usage and informed consent

Permission of data usage and statement of informed consent

I hereby consent that the researcher has my permission to use my answers to their interview questions as data. I understand that the interview will be recorded for the benefit of the researcher as part of their degree, but that the recordings will be transcribed and not accessible to the public to listen to. The data anonymised will be used in a thesis that will be available for anyone to read. I understand that the data will, to the best ability of the researcher, be protected and not connected or traceable to me as a person, and that I will remain anonymous throughout the handling of this data. I understand that I at any time can chose to terminate the interview.

Appendix 2 – Interview questions for the teachers

Interview questions for teachers:

- What subjects do you teach?
- How comfortable are you using IT and technology?(Extremely, Very, Somewhat, A little, Not at all)
- How do you use IT in your work today?
 - Preparatory work, eg. looking up information, preparing presentations etc.
 - Student involved work in the classroom, eg. students prepare presentations, students look up information etc.
 - Assessment after class, eg. typing in grades, sending back graded assignments etc.
 - What are the resources you use? (degree of formal, informal, url examples)
- How often do you use ICT in your lessons? (Every lesson, a few times a week, once a week, once every two weeks, once a month, once every three months, once every 6 months, less than once every 6th month, never)
- When you plan a lesson, how much do you think of using technology in class? (Always, often, sometimes, very little, never)
- What are the challenges facing IT use in class?
 - Physical (power outage, insufficient Wi-Fi accessibility, insufficient technical equipment)
 - Knowledge based (teachers or students lack knowledge)
 - How do you overcome them?
- When you create a lesson plan using IT, do you have to have a backup plan?
 - Is the backup plan similar or different to what you would be doing with technology?
 - Do you try to execute the lesson plan using technology at a later date if it turned out you couldn't go through with it?
- What are your wishes for IT-use in class?
 - What do you see are the challenges and opportunities for ICT in the next 5 years?
- In your professional life, how big of a role does IT play?
 - Are you curious of new development in ICT?
 - Do you keep up to date with new development in ICT?
 - How often do you try new things regarding ICT in your lessons?
- Apart from your professional life, how big of a role does IT play in your life?
 - Do you do banking online?
 - Do you use IT for governmental proceedings?
 - Do you use technology for your social life (Facebook, whatsapp, etc.)?
 - Do you use IT to look up information on everyday things? (recipes, building instructions, make-up tutorial, reviews)
 - Do you order items online?
 - Do you use IT for relaxation and fun?

Appendix 3 – Interview questions for the students

- In what subjects are IT and technology used the most?
 - And the least?
- What are some challenges of IT use?
 - Physical (power outage, insufficient Wi-Fi accessibility, insufficient technical equipment)
 - Knowledge based (teachers or students lack knowledge)
 - How are they overcome?
- How comfortable are you using IT and technology? ? (Extremely, Very, Somewhat, A little, Not at all)
- How do you wish to use IT in class?
- How big of a role does IT play in your life?
 - Do you do banking online?
 - Do you use IT for governmental proceedings?
 - Do you use technology for your social life? (Facebook, whatsapp, etc.)
 - Do you use IT for relaxation and fun?
 - Do you use IT to look up information on everyday things (recipes, building instructions, make-up tutorial, reviews)
 - Do you order items online?
- Do you use technology as a way of learning outside of school?
 - In what way?
 - How often?
 - Why not? (insufficient Wi-Fi accessibility, insufficient technical equipment, no knowledge of resources available, no motivation or will to, no time to)
- Do you partake in learning outside of class not using technology? (eg. going to the library)
 - In what way?
 - How often?
 - Why not? (Difficulty getting to where the resources are, no knowledge of resources available, no motivation or will to, no time to)