EduNet 2013

Introducing E-Education in rural Kenya

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Abstract: *In many developing countries, access to public libraries and educational resources like textbooks are lacking, especially for students in rural areas. Even when these resources are available they often tend to be too expensive for the average Kenyan family. Surprisingly, the mobile cellular networks and internet connectivity in developing countries like Kenya are quite advanced and are spreading rapidly. This gives us the opportunity to utilise these services as an educational tool. This project assesses the feasibility of building an educational platform which houses electronic textbooks, accessible on various mobile devices and tablets, just like a Kindle but optimised for educational purposes. In this report we explore the possibility of designing a low-cost tablet geared to provide a suitable interface for this platform. Ultimately, the aim of the tablet is to give students in rural areas access to this educational database, which would not only provide them with a vast library of textbooks but would also give them a medium via which they could communicate with their teachers. However, this educational platform is not limited to rural areas and can be made available to anyone interested and could be used in schools all around the world. This report highlights the feasibility study for a low cost tablet and a sustainable business model that would work in rural Kenya.*

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1. Introduction

1.1 Identification of the Problem

In 2003, free primary education was introduced in Kenya and since then, there has been a rapid rise in the number of students attending primary school. The government has implemented several measures to accommodate this rise: it has introduced an increase in the educational resources, especially textbooks available to students at school, but still has not managed to meet the demand. Recently, free secondary education was introduced [1]; however students must meet a certain academic requirement in order to be able to attend. Lack of academic prowess from primary school students in rural areas restricts their enrolment into secondary school. One in five children in grade 4 has difficulty in reading a paragraph in English, a task normally achievable by a student in class 2 [2]. Consequently, majority of students drop out and the country's development is inhibited.

Although primary school is available at no cost, some expenses like textbooks must be paid for by parents. According to surveys done in Busia and Teso (small towns in western Kenya), teachers usually have textbooks to use, while there are too few available for children [3]. The survey revealed that 80% of classrooms had only one textbook available for every 20 students [3]. In addition, overall student performance in the KCSE (Kenyan Certificate of Secondary Education) has been subpar. In 2009, only 25% of students scored a C (a passing grade) or higher, with boys more likely to achieve these grades [4]. This performance was most common in government-funded schools while students in private funded schools performed better. The difference in performance partially reflects differences in facilities, teachers and other resources, while also showing the different levels of academic preparation in different schools [3]. DC. Rotich suggested in his report for the Nordic Journal of African Studies that there is *a widespread belief that the provision of textbooks can substantially improve educational outcomes in developing countries* [5].

1.2 Current solutions

In the last ten years the Kenyan government has introduced free primary and secondary education. While this has been commended and applauded by many, it has also led to several complex problems that must be addressed. They have been trying to use various methods to try and improve the education but none have actually been implemented. There have been proposals of introducing scholarship programs and health incentives for students, to name just a few. The public view is that the money that the government allocates towards education is often subject to corruption. There is no evidence of this but the little or no improvement in the educational outcomes results in the public having such negative opinions. In recent times, the government has made an effort to increase the number of teachers available. The country had an objective to employ 28,000 more teachers into the KNUT (Kenya National Union of Teachers) in the 2011-2012 academic year; however, as of now, no provision had been made for this in the annual budget. Nevertheless, the education minister, Mutula Kilonzo has asked for KES (Kenyan Shillings) Sh15.4 billion (£120 million) in the 2012/2013 budget to employ more teachers [6].

The Kilgoris project [26] is a private initiative that started in the year 1999 which has been setup in southwest Kenya to help children with their education and cater for their health. As of late, the project is providing Amazon Kindles to students in 4 schools in the area to give them access to a library of 90 books which they can read and learn from.

1.3 Our proposed solution

Our solution is to provide affordable access to educational resources using a mobile computer tablet. This tablet will contain a web-based application which will include study material such as textbooks while also giving the students a medium through which they can set up a forum with their fellow peers and teachers. The teachers will be able to post their own notes and other material on the application, thus hoping to break the existing communication barriers Kenyan students and teachers face today.

1.4 Project Vision

Our project is undertaking an ambitious task. For rural communities in Kenya, technology such as tablets is beyond their financial means. Our goal is to make the technology as affordable as possible for the people. We investigate this by theoretically designing a tablet device. In order to do this, the tablet would conform to performance and affordability specifications based on conclusions drawn from our research and findings. In addition, we feel that it is necessary to contact book publishers and mobile network operators to collectively create a service that minimises the cost to the user.

2. Research and Findings

Some background research was needed to figure out the basic necessities required to try and develop the idea and the project further. Initially, we analysed the target market and tried to justify why our proposed solution would benefit this specific target market. We also carried out a brief analysis of the current resources available in Kenya in terms of the communications and educational resources in rural areas. Finally, we investigated existing technological solutions that are being used in the education sector. Based on all our findings in this section, we were able to justify our proposal and use this to create a foundation for our project.

2.1 User Base and Affordability

Our primary target market is people residing in rural areas, which accounts for 79% of the country's population [7]. Below are some key facts and figures that help in understanding our target demographic:

- Total Population of Kenya: 41 million
- 46% of the population lives below the international poverty line [7]
- Average annual salary of a Kenyan: 164,143 KES (£1183.20) [8]
- Average annual salary of a teacher: 90,000 KES (£648.73) [8]
- 29.7 million Mobile customers in Kenya (~75% of population) [9]
- 15 million subscribers to the M-PESA mobile payment scheme [10]
- Only 3.6% of rural Kenyan households own a computer [11]

We can see from the facts and figures that Kenya still remains a developing country. There is a general problem of people not being able to meet basic nutritional requirements, let alone valuable educational resources. Furthermore, a teacher's salary is lower than that of an average Kenyan. This severely impacts the overall quality of teaching as there is no motivation to seek jobs in this sector. In this context, our service will become more significant because we are allowing students to teach themselves independently. In addition, Kenya has quite an established mobile network customer base with many users also subscribing to the mobile payment scheme, M-PESA. This is important to our project as it is reliant on the mobile network in rural areas. The M-PESA scheme is widely used to pay for daily services such as groceries and rent [12]. Thus, this can be incorporated into our model to allow the users to buy additional material. An apparent concern is the technical prowess of the Kenyan children, since access to technology is limited in rural areas. Yet our service is based on a tablet device, which has a similar interface to that of a mobile phone. Overall, we believe that we have quite a strong and credible user base for our service.

2.2 Current Educational Resources Accessibility

Access to textbooks and educational material has dropped in the last ten years due to two primary factors; inflation and increased disparity between Government and Private schools. Though the average household income has increased by 33.8% between 1998 and 2001, the inflation rate of textbooks has increased tenfold. With an average price increase of 230%, textbook purchases have drastically decreased [3]. Consequently, studies suggested that higher income families were more likely to purchase textbooks than lower income families. In addition, a large proportion of the lower income parents would purchase textbooks only if their children convinced them that the textbooks were an integral part of their education. These parents usually require further advice from teachers or previous users of the textbook before they make a purchase, highlighting the hesitancy of the average parent.

In general, government schools have limited access to educational material in comparison to private schools, due to their inherent problem of providing for a larger group. As a result, the Kenyan government implemented several policies to ensure equal textbook distribution. In particular, the government implemented the "Orange book" policy whereby schools were only allowed request textbooks from a list selected by the Ministry of Education. Likewise, schools could receive up to one textbook per course per class and therefore, the class curriculum revolved around a single textbook. However, studies show that in 2006, the government met an educational goal of three students per single textbook. In certain schools however, there is a substantial difference between the said achieved goal and the actual number of textbooks available.

2.3 Existing Communications Methods Available

There are many forms of communication available in Kenya. In terms of internet connectivity, there are Edge/GPRS and 3G services available on mobile platforms. The number of internet users in Kenya has increased by 65% to 14.3 million people in late 2011 [10]. Not only in Kenya, but in East Africa, mobile phones are the primary method to access the internet due to the relative low cost of the services offered by the mobile operators. See Appendix:Table 6 for the cost and speed comparison of some of the popular Internet service providers (ISPs) in Kenya.

Safaricom and Airtel are the two most popular mobile operators that offer internet services. The price per 5MB of download for Safaricom is 5KES (Approximately £0.03). This is a prepaid bundle and the price is discounted with an increase in the data bundle amount [12]. Similarly for Airtel, the prepaid bundle price for 5MB is 3KES (Approximately

£0.02). Airtel is slightly cheaper than Safaricom but for the needs of our project, these data bundles are affordable and should be sufficient for our application since we do not require high amounts of bandwidth. Though not ideal for users in developed countries, these speeds are sufficient for the purpose of our project.

Another factor is to consider the mobile network coverage in different regions of the country. According to Figure 1 which is a GSM coverage map of the two largest and most popular mobile network providers, we notice that the coverage is focused primarily in the developed regions of Kenya. However, Safaricom extends its GSM coverage to rural areas.

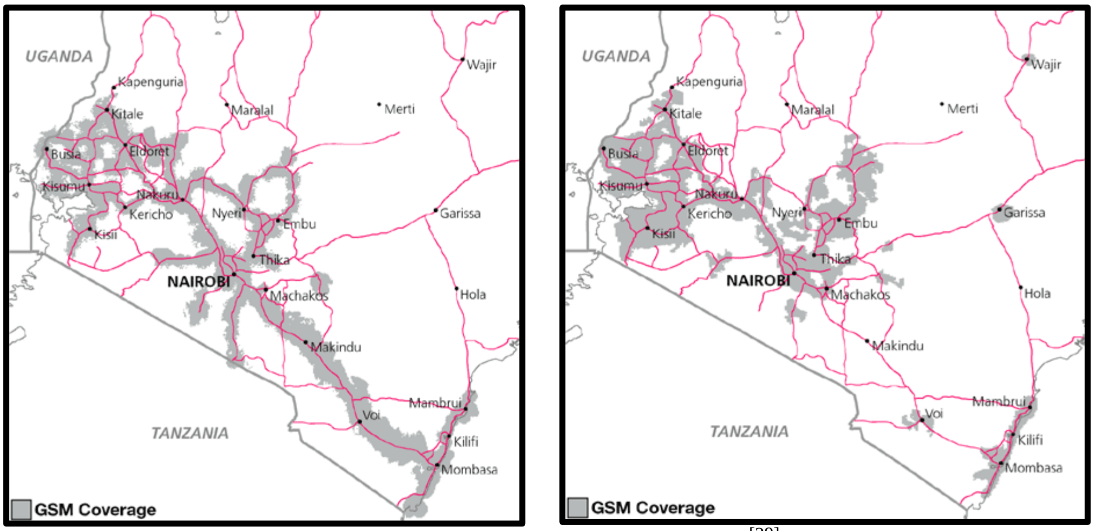

Figure1: GSM Coverage of Safaricom (Left) and Airtel (Right) [29].

2.4 Existing Technological Solutions

There are several electronic educational services available in the form of Virtual Learning Environments (VLEs), but they are usually restricted to schools in more economically developed countries as they tend to be very expensive. Aside from VLEs, there is an on-going project run by the Rwanda Development Board (RDB) that uses a bus that holds computers which drives around remote areas to give people basic Information and Communications Technology (ICT) skills [7]. This was initially started in Kenya by The Craft Silicon Foundation who called it the 'Mobile Computer Bus' [8]. This is a great way of teaching new skills to people although it is not suited for a classroom environment comprising of students. Using VLEs is not ideal since each school would require a server and many terminals, supported by a fast internet connection, all of which is simply not financially viable. We feel that our proposal of using affordable tablets with a web-based application acting as an e-book reader fits best for rural schools. This is because it gives students access to a vast library of textbooks in a single location with the added benefit of being able to communicate with others.

3. Theoretical Design of a Tablet Computer

Our decision to design a tablet ourselves stems from the fact that cost and power consumption is our priority. This means that any superfluous hardware and software applications would consume additional power and hence would need to be removed from our tablet. Our goal is to provide the most affordable educational resource possible for the students of Kenya and this design is a measure to do just that.

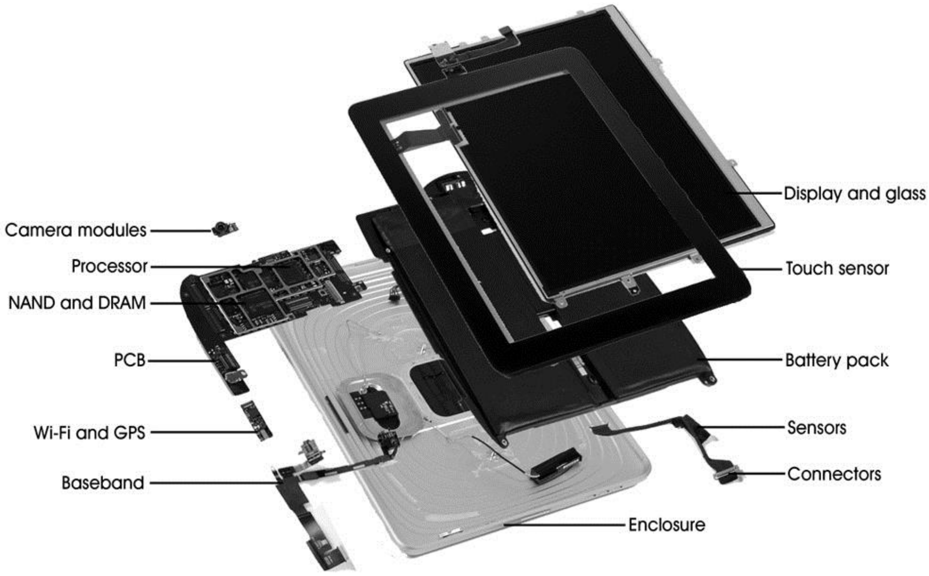

Figure 2: shows the basic components in a tablet and where they can be found inside the device. [28]

Virtually all the tablet devices on the market use a very similar set of components. The major hardware variations occur in aspects such as computing power, screen resolutions, amount and type of memory. In this section, we focus on the technicalities of the different components needed for the tablet device in order to theoretically build one. Each component is analysed comprehensively in terms of its technology and its costs. Note that many components from Figure 2 have been left out due to them being redundant in our application, for example, a camera or a GPS module.

3.1 Processor

The processor is considered as the brain of any electronic machine. Processors are classified by their architecture and the size of their data bus and are referred to as the Central Processor Unit (CPU) of devices. There are many CPU architectures used today for a variety of applications among which the ARM architecture is the most commonly used in tablets today. The design company ARM Holdings designs the basic processor architecture and then licenses this intellectual property to other companies in order to produce the chips. A popular market example is the Snapdragon processor by Qualcomm whose core is designed by ARM. It is widely used in many cell phones and tablets.

From the ARM website we can gather that the ARM11 family of processors seem to be the most widely used processor in the low-end consumer market [17]. These processors are not available off-the shelf but rather through trade contracts with ARM Holdings. Therefore, it is not possible to get the exact cost of any ARM CPU. We have also looked into an alternative to the ARM11 family, the ARM Cortex A5 which offers better performance.

In terms of the power consumption, it is normally approximated to be proportional to the CPU frequency and to the square of the CPU voltage [18].

$$P = CV^2 f$$

Where P is the power consumption of the processor, C is the capacitance, V is the power supply voltage and f is the clock frequency. The capacitance is due to power dissipated from various load capacitances in CMOS circuits [19]. Processor datasheets often contain the Thermal design power (TDP) which is the amount of power that the cooling system is required to dissipate.

From the equation, we can see that a lower clock frequency and a lower voltage supply will reduce the power consumption. We have done a comparison of the ARM Cortex A5 and ARM11 processors in *Table 1.*

	ARM11 (ARM1176JZ(F)-S)	ARM Cortex A5
Cost of Production	Low	Lower
Dhrystone Performance	1.25 DMIPS/MHz	1.57 DMIPS /MHz per core (1-4 cores)
Power Efficiency	0.07 – 0.33mW/ DMIPS	0.08 mW/DMIPS
Clock Frequency	500MHz – 1GHz	600 MHz
Number of Cores	1	1 - 4

Table 1: Comparison of ARM Cortex A5 and the ARM11 Family of Processors [20][21].

The variations in table 4 for the ARM11 are due to the variety in the process geometry of the product. The Dhrystone performance is a computer program used to benchmark the speed of CPUs. It outputs a number whose unit is the DMIPS/MHz which stands for the Dhrystone Million Instructions Per Second per Mega Hertz. The power efficiency is also measured with the Dhrystone performance in mind where it is evaluated with respect to the power consumption rather that the clock frequency.

In conclusion, the table shows that the two processors differ in the sense that the ARM Cortex A5 chip has a lower cost with better performance while yielding a lower power efficiency. However, the ARM 11 can actually vary its clock frequency and at 500MHz, it has a better power efficiency than the A5. Choosing the right processor is a difficult decision to make and it is important to weigh the specifications that we have and choose accordingly. However, we feel that if we were to make a prototype, we would trial both since they use the same Instruction set, testing for performance and battery life and then make a final decision.

3.2 Memory

The tablet will require two types of memory; volatile and non-volatile.

Volatile Memory

A tablet requires volatile memory to store data that can be accessed immediately while it is operational. The most common type is DDR2 (Double Data Rate) SDRAM (Synchronous dynamic random-access memory) and for mobile devices LPDDR, a low power alternative.

DDR2 consumes more than 50% of the system standby power; in comparison, LPDDR consumes only 25% [22]. LPDDR delivers a lower power consumption through its specialized design: it includes Temperature-compensated self-refresh (TCSR), Partial array self-refresh (PASR) and Deep power-down (DPD). TCSR [23] controls the refresh rate and varies it according to the device temperature. At high temperatures the data retention of the DRAM cells deteriorate and therefore TCSR reduces the refresh interval. Similarly, PASR [24] refreshes the capacitor in the DRAM memory cell by restoring it to its default periodically while regularly deactivating the clock to conserve power. For long durations of inactivity, the DPD [25] reduces power consumption by entering the LPDDR into power down mode.

Overall the effective cost reduction with the reduced LPDDR power consumption in different operating modes (refer to Appendix: Table 7) outweighs the initial cost. Therefore, the most suitable option for our tablet is LPDDR.

Non-Volatile Memory

Permanent data is stored on Non-volatile memory, including the operating system of tablet. The primary non-volatile memory used in current tablets is Flash: this is further divided into NOR and NAND, memory types classified by the primary logic gate present. Table 2 compares NOR and NAND flash memory.

NAND Flash Memory	NOR Flash Memory
Higher write speeds	Higher reading speed: NOR uses XIP (execute in place) to directly access an application whereas NAND requires the application to be first on the system RAM
Higher erasing speed: NOR requires 5 seconds whereas NAND only requires 5 milliseconds	More reliable: NAND requires bad block management while NOR does not
Lower power consumption	
Higher Lifespan: The lifespan of NAND is 10 times that of NOR	
Cheaper option: NAND is generally cheaper than NOR	

Table 2: Comparison between NAND and NOR Flash Memory

The common uses for NAND and NOR are data storage and code storage, respectively. The tablet will have limited code variation; however, due to possible expansion of the electronic textbook library, the tablet will have to use NAND memory. Furthermore, NAND is the better option as it meets the cost requirement of the tablet.

3.3 Touchscreen vs. Physical Keyboard

There are two main types of input methods currently used; physical keyboard and touchscreen. The choice of input depends on the user interface. The touchscreen is integrated on top of the display whilst a physical keyboard would be placed below the screen with a possible cursor. A physical keyboard is generally cheaper than a touchscreen. However, the key difference between a physical button interface and a touchscreen interface is that the latter is directly above the display output and therefore it makes the tablet more intuitive and requires less user adaptation. *Table 3* shows a comparison of touchscreens and physical keyboards.

Touchscreen	**Physical Keyboard**
The platforms for output and input are the same and therefore are considered more immersive	Physical keyboard is more responsive due to its inherent nature and familiarity with physical computer keyboards
The screen size can be maximised because the keyboard is virtual	It provides a constant space restriction which limits screen size
Users may directly navigate through the visual interface; reducing the overall delay between different operations	Physical keyboards consume power only when a physical difference is detected and therefore do not need constant monitoring

Table 3: Comparison of touchscreens and physical keyboards in tablets.

There are two main types of touchscreen technologies popular in the market today: Resistive and Capacitive. Resistive technology involves two sheets of insulating material coated with many lines of conducting material with the lines of each sheet perpendicular to the other. When the screen is pressed, the touchscreen determines the exact position of the press by measuring the resistance. The primary advantage of this technology compared to capacitive is that any object can be used to press the two sheets together. Due to the inherent simplicity, this technology is cheaper than other touchscreen technologies which use more complex designs and sensing methods. However, due to the same reason, a fair deal more pressure is required for the “touch” to be sensed. This can slow down processes such as typing and generally make the interface less intuitive. However, this also means that the screen is robust and less prone to “false” presses.

The capacitive touch screen input uses the human touch as the ground plate to dynamically simulate the capacitor and uses this to sense the touch presence. Using this, we can pinpoint the location of the touch. The main advantage over resistive touch is that there need not be much pressure applied since only the capacitance needs to be measured; also, multiple areas of the screen can be pressed simultaneously (multi-touch).

There are more complex and advanced Touchscreen technologies such as Surface Acoustic Wave and Dispersive Signal technologies, which give more accurate results with the possibilities of lower power consumption. However, due to the relative infancy of these technologies coupled with higher prices (new products), we are led to rule out these options.

In our application, many things will have to be considered, the key aspects being cost, robustness, power consumption and ease of use. Since our e-book application is based around a quite intuitive system, the benefit of having a touchscreen outweighs the use for a physical keyboard. Furthermore, the capacitive touchscreen’s significantly greater responsiveness outweighs its lack of robustness and minimal additional cost. Hence, we decided that the capacitive touchscreen is ideal.

3.4 Network Adapters and Network Protocols

Each network type requires a unique standard which is considered with the implementation of the network adapter. For a GSM network, the network adapter will need to follow the European Telecommunication Standards Institute (ETSI) standard for GSM–based products, 3GPP TS 41.101. However, with rapid development of mobile networks in Kenya, 3G coverage will become more readily available in the rural regions. Therefore, the network adapter must be compliant with the International Mobile Communication (IMT) 2000, the standard for 3G which is also backward compatible.

Similarly, there is a separate set of standards for wireless networking. Primarily the tablet will operate over mobile networks; however, in regions with limited GSM coverage, a repeater and a router will amplify the GSM coverage and allow a soft handover to ensure textbook download whilst allowing uninterrupted access to the forum. To accommodate this handover, the tablet will require IEEE 802.21, a standard for wireless networks with the ability to handover.

The repeater-router combination will only exist in certain areas. However, this will allow a possible implementation of a wireless mesh network with the repeater-router as radio nodes. This will further ensure access to the forum, due to self-healing property of the mesh network. Due the comparative cost of the repeater-router combination, wireless mesh networks would only exists at school sites.

3.5 Battery

There are three main aspects of batteries to consider when choosing one for a tablet. They are: the battery rating, which defines the power at which the battery will run (example 9.6V at 250mA), the energy stored in each battery, which is determined by the mAh (milli-Ampere hour) of the particular battery. This along with the battery rating defines the time it takes for the battery to discharge. For example, if a 3000mAH battery is rated at 250mA, it will discharge in (3000/250) = 12 hours. Lastly, the number of charge/discharge cycles before its capacity drops to below 80%. Table 4 shows the battery comparison of a range of tablets currently available on the market.

Tablet Name	Tablet Price (Approx.)	Battery Capacity (mAh)	Battery Life (hours)
Aakash tablet Ubislate 7Ci	£40	2100	4
HCL Me Tablet U1	£100	3600	4-5
Karbonn Mobiles Smart Tab 1	£90	3700	7-8
Micromax Mobile Funbook	£80	2800	5
Reliance 3G Tab V9A	£180	3400	9
Samsung Galaxy Tab 2	£220	4000	20

Table 4: Comparison of batteries in tablets currently available on the market. The data has been collected from relevant company websites.

Overall after careful consideration, we've come to the conclusion that although the battery life is quite short, the price of our tablet is our priority and hence the 2100mAH Li-Po battery is our choice. The benefit of the Lithium Polymer battery is that it gives us a high number of charge/discharge cycles without a capacity drop while also saving space on our tablet due to its small size.

3.6 Summary

Due to the theoretical nature of our design, we cannot estimate the exact price of our proposed tablet; however, when compared to the components of the Aakash tablet (*Table 4*), we found that our options were relatively less expensive and hence, on mass production, our tablet would be more affordable. *Table 5* summarises our findings.

Component	Selection
Processor	ARM Cortex A5
Memory	Volatile Memory: LPDDR Non-Volatile Memory: NAND Flash
Screen	Capacitive Touchscreen
Network Adapter	International Mobile Communication (IMT) 2000 IEEE 802.21
Battery	2100mAh lithium polymer battery

Table 5: Summary of components in theoretical design

4. Server and Software Structure Design

This section of the report focuses on the server and the software design. Our tablet software will be based on the Android Operating System (OS). This avoids the need for having to build the OS from scratch and also provides the ability to customize it.

4.1 Server

Figure 3 shows the basic system of how tablets within schools will connect via the mobile-network towers to access data on the server. In order for our system to work, it will be installed with a database package with a suitable protocol, a mobile network communications package, an access control module and an authentication module for security. The repeater and router shown in *Figure 3* can be present in schools where access to the mobile internet network is limited.

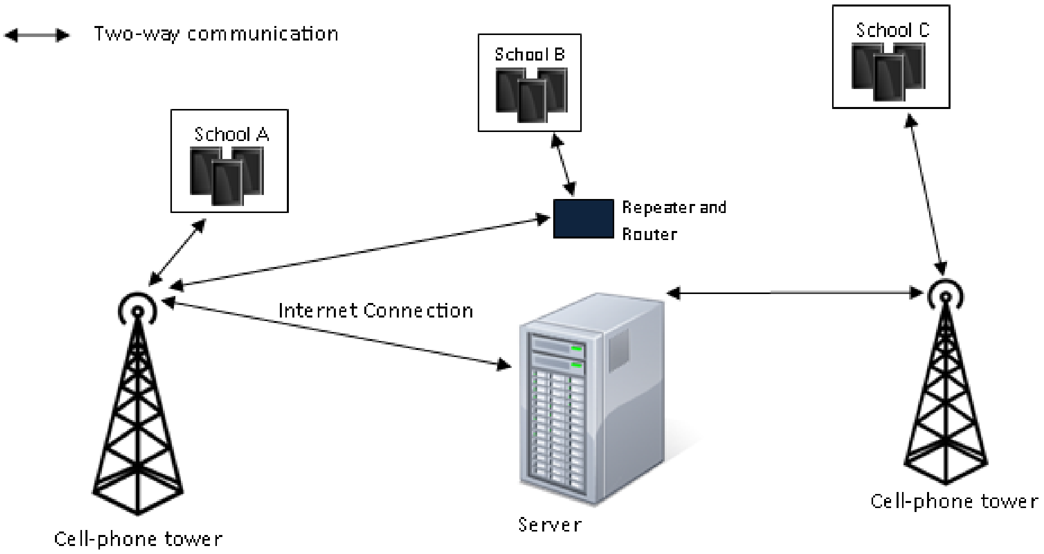

Figure 3: Graphic image of the server side of the system.

The tablet will utilise the mobile networks to access the server which holds a database of textbooks. One can download copies of these textbooks on to the tablet and thus this one-time download will minimise mobile network charges for the user. In addition to optimise the access time for the students, the tablet will only periodically check for updates during weekends. Each user will require a user account and will have information about their activity stored in the database as well. The activity refers to the forums and question/answer interfaces that students can use.

4.2 The Software

The tablet will primarily perform 4 groups of functions which will be selectable from the home screen of the application; viewing a textbook, viewing the collection, asking a question and providing a question to the forum. Some of these functions will integrate additional functions depending on the user. For example, a teacher can purchase textbook whereas a student cannot. *Figure 4* highlights the hierarchical object/data flow of the functions.

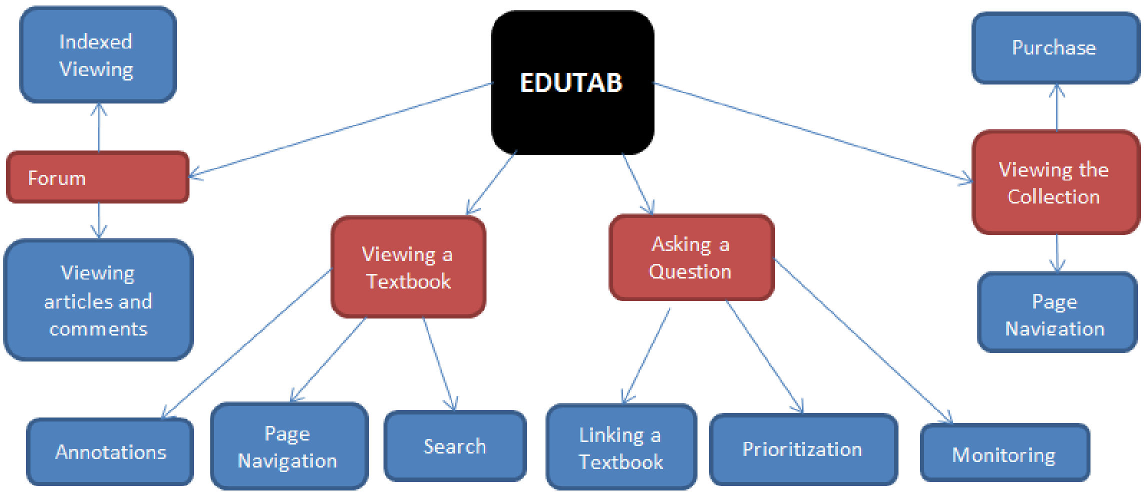

Figure 4: The red boxes represent the 4 main interfaces of the tablet whereas the blue boxes represent the different functions that can be performed within those interfaces.

Viewing the Collection

This interface will show an overview of the local collection of textbooks stored on the tablet. The collection will be displayed in a 3 by 4 grid with the textbook cover displayed and the author name below it. Distinguishable symbols will be used beside each textbook to denote the teachers' recommendations and also mandatory course material. The teacher can purchase additional textbooks from the online store using the M-PESA mobile payment scheme. If a textbook is purchased, it will then appear in the user's collection. Suitable security measures will be placed to ensure that textbooks cannot be copied onto other devices.

Viewing the Textbook

This interface presents the user with the selected textbook. It will include various standard functions such as search, page navigation, bookmarking and annotation. The search engine will follow a multistage algorithm to perform the search within the document. For example, if the user searches for "understanding of electronics", the program will initially identify the frequency of the words and prioritise the least common, in this case "electronics". Then it will attempt to locate the prioritised keywords in conjunction within a set limit. It will repeat this process as it utilises the less frequent words.

Asking a question

This interface allows students to ask questions which can be answered by fellow students and teachers as well. The information will be stored on the database in the server. This interface will be accessible from the home screen of the software and also from a textbook's page where questions had been posted previously. Appropriate symbols on the textbook page will be used to denote whether questions have been asked.

In terms of moderating the questions and answers, the students and teachers will be able to give them up to a five star rating according to the quality. Questions and answers can also be reported to be inappropriate. A teacher has the ability to delete any content if deemed inappropriate.

Answering a Question

This interface allows the user to answer a question that has been asked. The user will have to select the question he/she wants to answer. Both students and teachers can answer questions but answers by teachers will be highlighted and shown at the top of the list of answers. The ordering of the list will be based on the star rating. However, it can be changed by the user to be ordered by date as well.

5. Conclusion

From the above sections it is evident that it is possible to develop a robust, effective and affordable tablet computer which is viable for the implementation of our project. While preserving the interactivity of the tablet design, we have also kept its cost to a bare minimum. The hardware has been chosen appropriately to deal with issues such as power consumption, network speeds and overall performance. Overall, we are extremely satisfied with our theoretical design and we believe that it can go forward and become a powerful tool in assisting students with their present education needs, especially in rural Kenya.

The importance of education in the upbringing of an adolescent youth simply cannot be expressed in terms of facts and figures. A good education gives them the perfect platform to pursue their career aspirations. This cannot be achieved if they are lacking in basic resources such as textbooks. Our aim was never to revolutionise and overhaul the entire education system in Kenya, but rather to provide the students with a simple tool to assist them in their academic endeavours. We are not only reaching out to students, but also to teachers, providing them with an alternative and broader platform to interact with each other. At the end of the day, the future progress of a country is directly correlated with the upbringing of its youth. Although what we are doing is relatively small, if implemented, the impact of our project can be extremely beneficial to Kenya in the long run.

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Appendix

ISPs in Kenya	Advertised Download Speeds	Actual Speeds
Zuku (Wananchi Online)	8 Mbps	1.97 Mbps
Safaricom 3G	7.2 Mbps	0.68 -3Mbps
Safaricom Edge/GPRS	3.6Mbps	0.15 – 3.59mbps(low speeds of 0.1 in the afternoon)
Access Kenya	1.3 Mbps (peak speeds)	0.3 – 1.3 Mbps
Kenya Data Networks (KDN)	8 Mbps	0.09 – 1.25 Mbps
Airtel	3.75G	0.09 – 1.25Mbps

Table 6: Comparison of different internet service providers in Kenya. Source: *Cloud Notes Comparing Internet Speeds In Kenya* [Online]. Available from: http://file-it-africa.com/cloud-notes/comparing-internet-speeds-in-kenya [Accessed 20 January 2013].

Memory	Busy Memory (mW)	Moderate use Memory (mW)	Intermittent use Memory (mW)	Standby Memory (mW)
LPDDR1 X32, DDR333	224.8	180.2	62.0	2.0
DDR2 X16, DDR667	380.7	273.4	97.0	13.4
DDR2L X16, DDR667	267.0	192.3	68.6	9.6
DDR X16, DDR800	324.0	222.0	93.0	9.6
DDR3 X16, extrapolated to DDR667	282.0	193.5	80.3	9.5

Table 7: Power consumption for different use cases. Source: Greenberg M. *How Much Power Will a Low-Power SDRAM Save you?* Denali Software Inc. 2009. Available From: https://www.denali.com/en/whitepaper/2009/lpddr2/lpddr_marc_greenberg_article.pdf