Sustainable e-learning for theologians in hard-to-reach areas: The Bible Online Learner App

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Abstract: Madagascar is ranked at 154 on the human development index. During the dry period, it is hit by daily blackouts. Internet connections are poor. This makes e-learning difficult. My paper will present a possible solution to this problem: I will present a technical solution of how to realize e-learning systems for theologians in hard-to-reach areas by using Raspberry Pi mini-computers as servers and explain why so-called progressive web apps, which are single page-apps are now suitable for this approach; rather I will show how a client-server solution with a Raspberry Pi Server hosting an Emdros database of the Hebrew Bible and a native Android App, written in Java can provide Bible Online Learner Network Kits. The Raspberry Pis are set up as servers in independent computer networks, which do not rely on an internet connection and which are mobile access points. These servers handle the backend code, have the logic to create random exercises for the Bible OL App and send this information via a JSON string to the client app, realized as an Android app written in Java. For this client-side development I paid special attention to the challenges of computer illiterate students. I solved these challenges by using picture-based logins. As a result I developed the design für the Bible Online Learner App and the Bible Online Network Kit, which works with power banks as uninterruptable power supplies as well as a solar power kit, which enables e-learning in hard-to-reach areas in Africa even during the dry season.

Keywords: E-Learning, hard-to-reach areas, Raspberry Pi, Android App

Introduction

Madagascar is ranked at 154 on the human development index. During the dry period, it is hit by daily blackouts. Internet connections are poor. This makes e-learning in remote areas difficult. At the same time goal 4 of the Sustainable Development Goals (SDGs) is to ‚Ensure inclusive and quality education of all and promote lifelong learning'.1 It is this mismatch of realities where this paper will fill the gap. Based on an empirical study in 2015 and 2017 in Madagascar I present the technical design of a sustainable corpus-driven computer-assisted language learning Android app for learning the Biblical languages to Madagascar to improve the theological education of the pastors in the Malagasy church. I have done this as part of the GLOBAL project, which went on from 2015 to 2017 and has been funded by Danmission.

Within the GLOBAL project we asked the question, if it is possible to use a persuasive corpus-driven e-learning platform for to support the education of the future pastors and church leaders in Madagascar but we had to face a lot for challenges: Almost daily computer blackouts and sudden electricity strokes when the electricity is suddenly back, poor internet connections and

[1] http://www.un.org/sustainabledevelopment/education/

computer illiterate users. The software we used in this alien environment is called Bible Online Learner (http://bibleol.3bmoodle.dk) (Winther-Nielsen 2013a; Winther-Nielsen 2013b; Winther-Nielsen 2014; Gottschalk and Winther-Nielsen 2013), and it is a web application that runs on a server and requires a constant Internet connection. Given this starting position, it is valid to ask first if it is a realistic goal of the GLOBAL team to install a persuasive software for corpus-driven computer-assisted language learning not only at SALT but also at the seminaries of the Lutheran church that are spread throughout of Madagascar, and second, if it is possible to increase the language skills of the students at SALT so that they are prepared to serve as well- educated and computer-literate pastors and future religious leaders?

What we learned through this first pilot project regarding e-learning in hard to reach areas is, the answer is no. To really establish e-learning in areas like these it needs more than this. Therefore in this paper I show how the technical design of an e-learning system for hard-to-reach areas in the Global South needs to look like.

The resulting idea from this work is the Bible OL App. The purpose of the Bible OL App is diverse; in it's full-fledged realization the Bible OL App will over different training modules for the following areas:

- training for Biblical Hebrew and Greek for theologians in hard-to-reach areas
- training for social science in hard-to-reach areas
- finance and accounting

In this sense the design of the Bible OL App will be easy to use for people with limited computer literacy; additionally the app is specifically designed for the needs of NGOs working in the Global South. The idea is, that it is flexible in its design so that it can be adapted to the needs of other organizations and used for various training purposes.

This paper is organized as follows: In section 2 I define what I mean by the term hard-to-reach areas and explain what their features are and in the next section I lay out the advantages an disadvantages of progressive web apps. Before I introduce a client-server solution with a native Android App in the next section. Then a discussion of the meta-architecture of the Bible OL App follows and the design of an easy to use login screen will be laid out.

Features of hard-to-reach areas

In our conception of hard-to-reach areas we define these regions in the world by a number for features:

- Internet connection
  - little or no internet connection
  - The data rates are limited and expensive
- Electricity
  - Little or no electricity

  - Sudden electricity strokes
- Social Factor
  - People have little or no IT proficiency
  - People are used to use smartphones but no computers
  - A need of a specific e-learning governance to motivate students to use the e-learning app is necessary
- Smartphones
  - People mostly have Android smart phones with the following challgences
  - Old Operating Systems
  - Little Storage on the SD-Cards
  - Rare Updates

It is the task for an e-learning system in hard-to-reach areas to deal with this kind of challenges and to enable e-learning on a stable basis even in these areas.

Progressive Web Apps their features and limitations

A possible solution for e-learning in hard-to-reach areas is the use of so-called progressive web apps. These apps have a number of advantages:

- They work on all kind of smart phones
- They are well-structured apps
- They work in a client-server setup
- They work offline

However progressive web apps come with a number of disadvantages which rule them out as a realistic solution for e-learning in hard-to-reach areas: The apps work with https-protocols and using https-protocols in hard-to-reach areas is not suitable for the following reasons:

- A long lasting protocol costs a lot (> 100 Euro), which makes the development of a cheap e-learning system almost impossible
- It is difficult to setup such a system, as it needs knowledge on the ground to setup the system; this means what local people in hard to reach areas would need to be able to set up such a system, which cannot be expected in hard-to-reach areas.
- The maintenance of the system is very difficult if people on the ground do not have the necessary IT knowledge, which can only be expected with great difficulties in hard-to-reach areas.

Given these strong disadvantages for a progressive web app solution a client-server solution using the following components is certainly the better solution

Client-Server Native App Solution

Our suggestion is to use a client-server setup that is based on the following components

A Raspberry Pi Server, that:

- Hosts the Emdros Database
- Has the Logical to generate Random exercises for Bible OL
- Can generate Corpus Snippets for the Offline Use
- Is a mobile access point and creates a Bible OL Network

A native Android App, that:

- Provides the whole user interface for Bible OL and the other Modules
- Has an easy Login System with as little User interaction as Possible
- Works Offline By Saving a JSON String in the Storage of a cheap Android smart phone.

Meta-Level Architecture of a Bible OL App

The new high-level Bible OL App architecture is similar to the Bible OL architecture developed by Tøndering (2017) and consists of four components: A User Database, a number of Emdros Databases, the Server, which is located on a Raspberry Pi 3 mini-computer, which uses PHP for it's server processes, a local network over which it sends a JSON string generating the exercises in the native Bible OL Android app, which is the client in this Client-Server Architecture

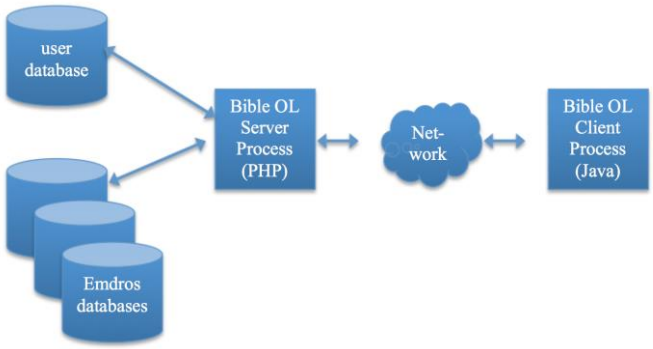

Figure 1 Bible OL network architecture

The server process runs on a Raspberry Pi 3 with a Linux operating system that supports PHP, MySQL, and Emdros. It is programmed in PHP and has access to a number of databases:

- The user database contains information about all registered users and supports the use of a picture based login in Bible OL via storing links to pictures of users hold in the file system of the Raspberry Pi 3 server; also it contains translations of Bible OL user interfaces in various languages
- A number of Emdros databases; these databases contain the text and grammatical information of the Old and New Testaments but likewise of other texts, which are relevant for learning purposes.

  (cf. Tøndering 2017)

The client is a native Android App that is distributed over the Google Play Store of any Android App or also via the Raspberry Pi 3 server, in case in the specific hard-to-reach area there is no internet connection at all. The Android App sends a request to the server to receive an exercise or some verses, which it will be able to display.

Basically what the server sends to the client (Android App) here is a JSON string, which is then processed by the Android App, which is responsible for the display of the data. All the server generates is a JSON-string, which is then received by the client and based on which it is able to generate an exercise for the user. The exchange of data in the system works as follows:

When there is a connection the Bible OL server within a Bible OL network the exchange of data works as usual in Bible OL:

1. The client requests a specific URL from the server and the text display is coded into this URL
2. The server sends the requested data to the client

In case however an offline use is desired by the user this works in a different way:

1. When logged on the server within the Bible OL network, the user is presented with a collection of texts as usual
2. Behind every text passage the user can find a download button
3. With the help of JSON strings these texts can be downloaded on the smart phone of the users

If a client requests and exercise from the Bible OL server, the data exchange works similar as in Bible OL:

1. The client requests the server to load an URL. The URL contains which quiz template it has to choose and how many questions are there to generate
2. The server sends the requested exercise to the client
3. When the user clicks on the “GRADE task” or “SAVE outcome”, the client sends the users data to the server.

In case the exercises should be used offline by the user the situation is similar as in the offline use of texts:

1. When logged on the server within the Bible OL network, the user is presented with a collection of texts as usual
2. Behind every text passage the user can find a download button
3. With the help of JSON strings these texts can be downloaded on the smart phone of the users
4. The results of the exercises a student does are saved in a JSON string on the client. This happens, when the user clicks on the "GRADE task" or "SAVE outcome" buttons
5. As soon as the user is connected to the Bible OL Network again these results get sent back to the server and can be saved for keeping track of the user's progress.

The system as such, once set up, is a mobile access point, which sends a Wifi signal to the users; this means that it will be possible to log on the server / access point through the Bible OL App and to access the data from the server as described above.

The Raspberry Pi servers are all delivered with a power bank, which can be powered with solar power by day and at as uninterruptable power supplies in case of blackouts and the sudden power strokes, when the electricity finally coems back.

Login for computer illiterate users

The Bible OL App will have a user-friendly login-screen, which is designed for the needs of African students with a picture- and emoji-based login. The idea here is simple: Instead of typing in their user names and their passwords, the users of the system see a login screen in their aps as in figure 2 below

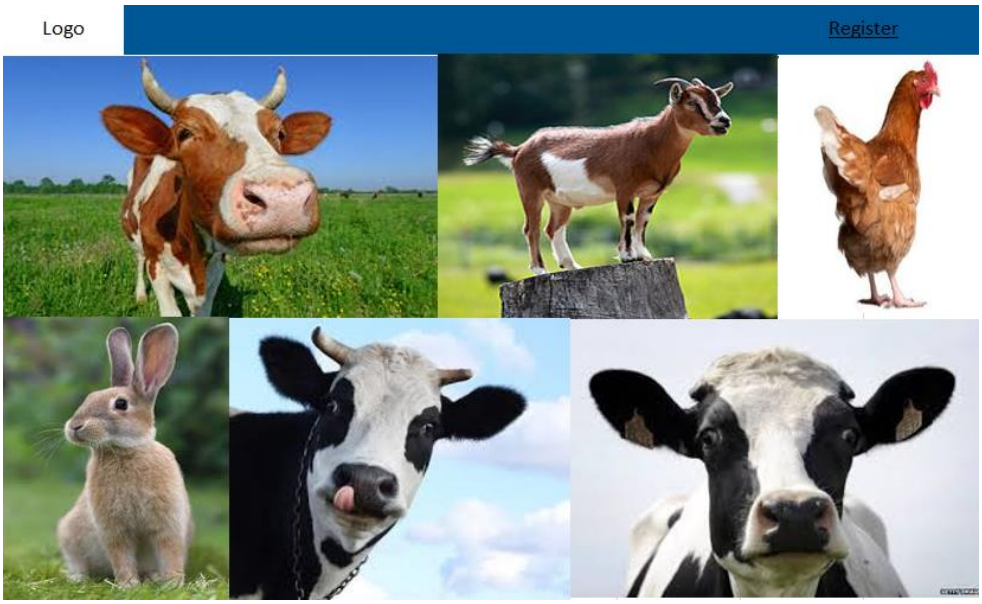

Figure 2 Bible OL App login Screen

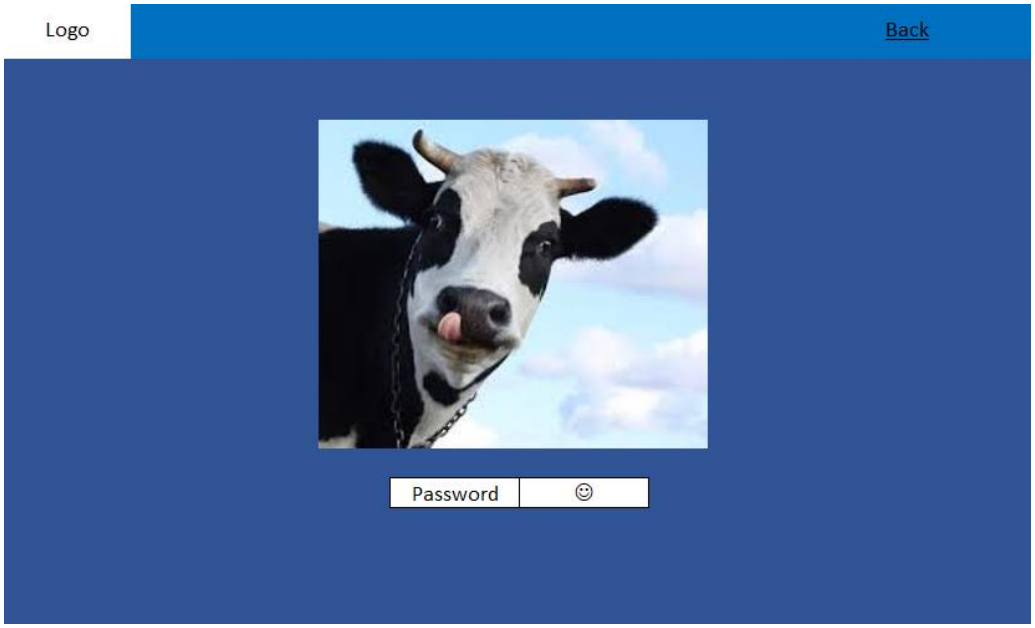

Figure 3 Bible OL Login

By simply clicking on their picture login the users receive access to the e-learning app. For their further identification they can use an emoji, which they might remember easily for logging on the system.

The reason for the installation of such a login system for the users of the Bible OL App is that our empirical study during the GLOBAL project has shown, that a classical login based on

Conclusion

The conception of the Bible OL App and the Bible OL Network as described in this paper will enable e-learning in hard-to-reach areas; what this short paper has shown is how, based on the empirical data collected in Madagascar in the years between 2015 and 2017 it was possible to develop a design for an e-learning system, which is sustainable and at the same time, which can bridge the challenges of hard-to-reach areas, i.e. no internet connection, daily electricity black-outs and users who not computer literate.

In the years to follow I wish to implement this system and test it with users in different hard-to-reach areas in Madagascar, Tanzania and other areas in countries of the Global South. Likewise my goal is to setup the Bible OL App in such a way that it enables learning for social science on a broad level as well as supporting finance and accounting in hard-to-reach areas by enabling the work within a so-called paperless office.

During this phase of the project it will be important to produce enough empirical data to proof that learning with the Bible OL App has a positive effect on learning with the system.

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