LEARNING WHEREEVER, WHENEVER: EDUCATION IN A SUITCASE

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Abstract

Education in a Suitcase (EIAS) is a cooperation project between researchers at the University of Iceland, Maseno University (Kenya), Shuttle Thread Ltd and the African Maths Initiative, with the main purpose of supporting learning in rural areas. The EIAS system is a portable educational system based on a small server and tablets. The system can run in areas without an Internet connection and with unstable electricity but utilises both when available. When connected to the server, learners with tablets (or smart-phones) can access the tutor-web, (a mobile-web developed at the University of Iceland), parts of Khan Academy and Wikipedia. The learners can also download e-books from the Gutenberg library, offering some 60,000 free e-books. The learners can subsequently use the tutor-web system and read the downloaded books from the Gutenberg library without being connected to the server.

The tutor-web, the main component of the EIAS system, has been used for over a decade at the University of Iceland, for teaching mathematics, statistics and computer science. This mobile-web is freely available for all learners. When using the tutor-web, learners are allocated exercises that fit their level of knowledge and after sending their answer elaborated feedback is provided. The system offers thousands of exercises in mathematics and statistics at high-school and university levels.

Experiments using the EIAS system currently take place in three very different learning environments in Kenya: Shivanga Secondary School, Takawiri Island Primary School and Navasha Maximum Security Prison. Hundreds of tablets, funded by several grants and a crowdfunding campaign, have been given to learners along with servers placed in the schools and the prison.

Keywords: Learning in rural areas, Learning environments, Mathematics education, Statistics education.

1 INTRODUCTION

Education in a Suitcase (EIAS) is a cooperation project between researchers at the University of Iceland (UI), Maseno University (MU) and the African Maths Initiative (AMI) with the main purpose of supporting learning in rural areas. Hundreds of tablets have been allocated to learners at three very different learning environments in Kenya: Shivanga Secondary School, Takawiri Island Primary School and Navasha Maximum Security Prison. The durability of the system and how the learners use the system is currently being studied together with an experiment on the possible effect the system has on learning. Before describing the studies, a brief description of the Kenyan school system as well as the EIAS system is given below.

1.1 The Kenyan school system

The national educational system in Kenya consists of three levels: compulsory primary education for eight years (beginning at age six) followed by four years at the secondary level (form I - form IV) and four years of higher education. The government provides free primary and secondary education. Students need to pass a national exam, the Kenya Certificate of Primary Education (KCPE), in order to enter the secondary level. At the end of the secondary education the students need to take another national exam, the Kenya Certificate of Secondary Education (KCSE). Students need to get a minimum grade of C+ on the KCSE to be eligible for a spot in both public and private universities. The KCPE and the KCSE are thus high-stake tests that can change the lives of Kenyan students.
1.2 The Education in a Suitcase system

The EIAS system is a portable educational system based on a small server and tablets. Since electricity can be unreliable in some parts of Kenya a high capacity battery is connected to the unstable mains. The server includes a wireless access point, which connects tablets (and other devices) in the vicinity. The server also includes a 3G modem dongle but will work as a purely local server if there is no 3G connectivity. The setup can be seen in Fig. 1.

When connected to the server, learners with tablets (or smart-phones) can access the tutor-web, (see the section below), parts of Khan Academy and Wikipedia without having access to the Internet. The learners can also download e-books from the Gutenberg library, offering around 60,000 free e-books. The learners can subsequently use the tutor-web system and read the downloaded books from the Gutenberg library without being connected to the server.

1.3 The tutor-web

The tutor-web, the main component of the EIAS system, has been used for over a decade in the University of Iceland for teaching mathematics and statistics. The mobile-web is freely available for all learners and can be accessed at http://tutor-web.net. When using the tutor-web, learners are allocated math exercises that fit their level of knowledge and after sending their answer an elaborated feedback is provided. The system offers thousands of exercises in mathematics and statistics at high school and university level. Users do not need to be connected to the Internet when answering exercises, only when downloading the exercise banks to their devices. An example of an exercise and the feedback the students receive after submitting an answer is shown in Fig. 2. A detailed description of the tutor-web system can be found in [1] and [2].
2 CASE STUDIES

Two case studies where the EIAP system has been used extensively are described below along with a short discussion on the use of the system in other places in Kenya. In the two schools, the tablets were given to the students (not the schools) so they can continue to use the tablets after graduation.

The first case study, still on going in the Takawiri Island Primary School, involves learners in the last two years of their primary education (7th and 8th grade). The hope is that using the EIAP system will help them prepare for the KCPE and also support those that continue on to secondary education and the KCSE. Studies concerning the usage and durability of the system are currently being conducted in Takawiri.

The second case study, still on going in Shivanga Secondary School, involves learners in their secondary education. The main goal is to help students advance to university education. Experiments on the possible effect that the system has on learning are currently being conducted there.

2.1 Takawiri Island Primary School

Takawiri island is located in the north-eastern part of Lake Victoria. There is no general electricity on the island and no Internet access. The Takawiri Island Primary School is however equipped with solar panels, providing a perfect test-bed for the EIAP system. The conditions on the island were described in the following manner by educators in Kenya: If you can make it work there, you can make it work everywhere!

Groups from the EIAP team have visited the island with tablets three consecutive summers, 2016, 2017 and 2018. In the first visit all students in the 8th grade (last class of primary education) were given tablets, a total of 31 students. The happy group can be seen in Fig. 3. The EIAP team met Ms. Benta Ouma for the first time that year, a teacher at the Takawiri Island Primary School. In a few hours, Benta was up to date with how to operate the server and get the tablets to connect to it. She has since been responsible for the project on the island and has done an excellent job. The students got a two-day course on how to use the tablets. None of the students had held a tablet computer before but within an hour all the students were able to download math exercises and answer them. The EIAP team visited the island again in 2017 with tablets for all students in the 7th and 8th grade, a total of 46 students, and finally in 2018 with tablets for all students in the 7th grade, 24 in total.
As mentioned above, studies on the use, possible progression and durability of the system are currently being conducted in the Takawiri Island Primary School.

The following metrics will be used to measure the usage and possible progression of the students in the system:

- Number of math problems solved by students
- Proportion of correct answers within a problem type

One simple metric will be used to measure the durability of the system:

- Number of days the system is down due to technical difficulties

### 2.2 Shivanga Secondary School

The Shivanga Secondary School is located in Kakamega county, west Kenya. The school has been the worst performing school in the county on the KCSE the past years. The EIAS team visited the school in the summer of 2018 with tablets for the students and a server for the school. Every student in form II (38 students), III (39 students) and IV (45 students) was given a tablet. The students got a short course on how to use the tablets and as in the Takawiri Island Primary School all the students were downloading math problems and answering them within an hour of receiving the tablets.

As mentioned before, an experiment on the possible effect the system has on learning is still on going at the school. Before receiving the tablets, all students at the school took a status exam in mathematics in order to measure their baseline knowledge. There are 18 problems on the exam, similar to problems used on the KCPE. The same exam will be administrated again this year and once again in 2020. The design of the study allows for comparing results of the same students between years but also the results of same age groups with and without access to the EIAS system.

The status exam has only been administrated once so comparisons between years cannot be made yet. With only the baseline data available, the following research questions are of interest:

- Is there a difference in performance between students in the different age groups (form I – IV)?
- Is there a difference in performance between female and male students?
2.3 Other uses of the EIAS system in Kenya

The EIAS system has been used for the past three years with good results in the Naivasha Maximum security prison. The case study is described in [3]. The tutor-web system has also been used in the University of Maseno and Kenyatta University for the past years. Recently a new school joined the project, St. Aloysius Gonzaga, a secondary school located in Kibera, the largest slum in East Africa.

3 RESULTS

The main results from the two case studies described above are given in the following sections.

3.1 Takawiri Island Primary School

3.1.1 Durability

One simple metric was used to measure the durability of the EIAS system on Takawiri Island: Number of days the system is down due to technical difficulties. During the three years in operation, the system has not been down for a single day due to technical difficulties. However, soon after the system was setup a technical difficulty arose: the server was not able to “phone home” from the island to send data, even when connected to a dedicated antenna set up by project members. This issue has been solved by a EIAS team member, located in Kenya, going to the island twice a year and taking the server to the mainland while data is transmitted to the EIAS main server.

3.1.2 Usage

In order to measure how much the system is being used by the students a simple metric is used: The number of math problems solved by students. 101 students have been given tablets over the past three years and together they have solved 33020 math exercises. More than 70% of the students have done more than 100 exercises while the student that has worked the most has done 2291 exercises. The female students answered on average around 386 questions and the male students 286 questions.

It is of interest to investigate whether the students show improvement while working in the system. To do that, answers from same students to similar questions are looked at. An example of such a question is shown in Fig 4. The numbers in these similar exercises are randomly generated so a student can work on the same problem but with different numbers.

![Figure 4. Exercise in the tutor-web. The numbers in the exercise are randomly generated. Students get the feedback (in yellow) after submitting their answer.](image-url)
The proportion of answers to similar questions after answering the question type once up to eight times can be seen in Fig. 5. It is clear that the students are learning from doing the exercises as the proportion of correctly answered questions is going up with number of attempts.

3.2 Shivanga Secondary School

As described above, all the students in Shivanga Secondary School took a status exam in mathematics in 2018. A boxplot showing the results, by age groups (form I – IV), can be seen in Fig. 6.

The average score in the four classes (age groups), form I – form IV, was 3.58, 3.65, 4.05 and 4.61 (on a 0 – 10 scale). Analysis of variance (ANOVA) was used to test if there is a difference in performance between male and female students and the four age groups. The difference between
male and female was not significant ($p = 0.876$) but a significant difference was found in the class variable ($p = 0.003$). A post-hoc test (Tukey test) revealed a significant difference in grades between form I and IV ($p = 0.003$) and II and IV ($p = 0.017$) but other comparisons were not significant.

It is clear by looking at the results that a large proportion of the students is not proficient in mathematics. It is also of concern how little the difference is between students in the four age groups (classes).

4 DISCUSSION

The first results of the ongoing studies and experiment within the EIAS project have been described in this paper. We have learned now that the system can easily be maintained with the help of a strong on-site team. According to the teachers at Takawiri and Shivanga, the students are enjoying the new way of learning mathematics as well as having access to Wikipedia and the Gutenberg library. A good example of the enthusiasm was demonstrated one evening during the short intro course in using the tablets, when an electricity blackout occurred. As expected, the server stayed up, running from a battery, as did the tablets. More interestingly, the students simply kept on working on their math exercises in the dark using their tablets as flashlights in order to be able to do their calculations.

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REFERENCES

