Formal learning for out-of-school children in developing countries

Hester Stubbé, Rebecca Telford, Aiman Badri

Introduction

Education for children in the developing world is in crisis. Children growing up in war are at the sharp end of global development challenges: of the 57 million primary-age children who are out of school, almost half live in conflict zones. This project is grounded in the issues of educating these children who are most in need, with a particular focus on innovative approaches to access via online and distance learning.

E-Learning Sudan (ELS) is a custom-built tablet game that provides alternative learning opportunities in Arabic to Sudanese children who are excluded from education. ELS is unique in that children can learn mathematics, without a teacher, in their own remote community, because the game itself includes instruction, practice, a learning management system, is designed to be culturally appropriate, and can also be used offline.

The game consists of two game worlds and many mini-games (44 different mini-games, 160 variations of mini-games). Game world 1 (see Figure 1) is about helping other children to achieve goals in their lives; by doing mini-games, children help others to become e.g. a goat herder or doctor. Half of the jobs are familiar jobs within the communities, like a cook, tractor owner or brick maker. The other half are known to the children, but are less well known, like a teacher, nurse, doctor or engineer. In a playful way this helps the children to broaden their future perspective.

Figure 1. Screenshot of gameworld 1

Game world 2 is a shop (see Figure 2) where children can buy and sell products. By playing the mini-games, children can increase the number of products they can sell. In a playful way, children learn that you can achieve more in life if you work hard.

Figure 2. Screenshot of Gameworld 2

Each mini-game (see Figure 3) addresses a specific mathematical concept. Some mini-games have variations that can be used for various mathematical concepts and all mathematic concepts can be practiced by several mini-games. This was done to help the children understand the mathematical concept and stay motivated at the same time. Progress through the game is based on performance: the number of correct answers within a certain time-frame decides whether children can continue to a more difficult mathematical concept. This ensures that children always work at their own level, at their own pace.

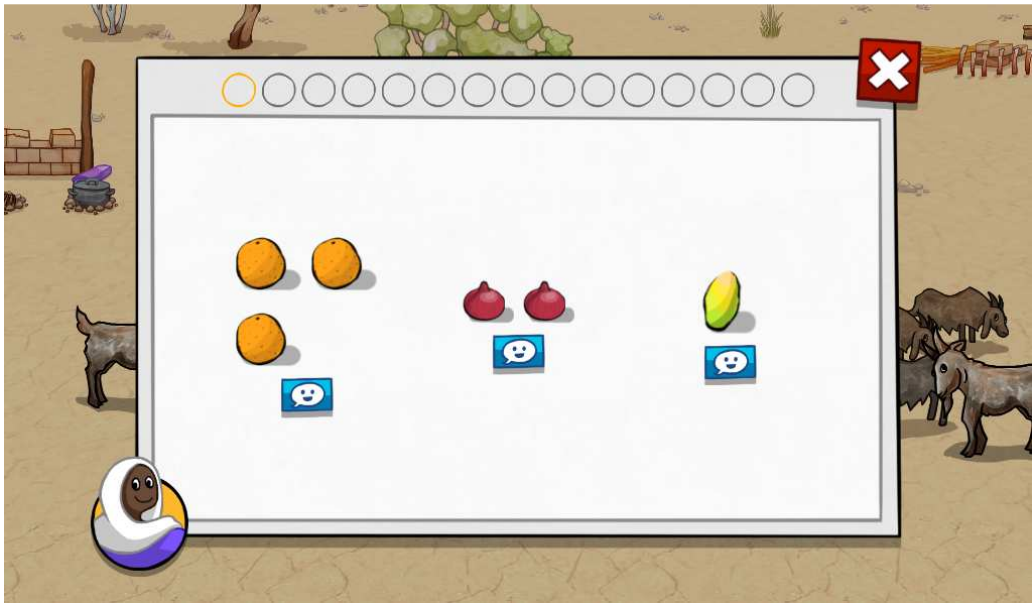

Figure 3. Mini-game: Match sound of number with the right amount

The curriculum is based on the Ministry of Education Accelerated Learning Programme (ALP) which is designed for out of school children. ELS comprises the learning goals of the first three years of mathematics under the ALP (numbers, addition, and subtraction up to 1000; multiplication, tables up to 10 and multiplication problems; division, tables up to 10 and division problems; fractions, half, third and fourth; measurements, length, weight and time; and shapes, circle, square, rectangle and

triangle). The aim is to enable children to pass the official mid-primary school exam for mathematics which qualifies children to enrol in Grade 4 in regular education.

The mathematics game was programmed in Unity3D. This software allows programming in 3D, but also supports the efficient development of an attractive 2D environment. For ELS we chose to develop a 2D environment because a 3D environment might distract children.

Learning sessions take 45 minutes a day, five days a week, and are supervised by facilitators who structure the sessions and support the children faced with minor technical issues. A management system allows tracking of all individual children at four levels: facilitator, supervisor, state and national level. Facilitators only have access to the results of the children they are supervising. Higher levels have access to all the information below their own level.

A complex multi-stakeholder project

As an innovative approach, ELS also required innovative processes. As a complex multi-stakeholder project, ELS has been made possible by the parallel development of a new e-learning infrastructure in Sudan. Whilst the programme was conceptualised by visionaries within the Ahfad University for Women, and supported by the Ministry of Education body responsible for out-of-school education (the National Council for Literacy and Adult Education, or NCLAE), there needed to be a strong ecosystem built around this. War Child Holland played a key role in brokering new relationships and bringing in technical capacity from TNO, a Dutch research institute who supported work around the curriculum, and Flavour who worked with creative partners in Sudan to produce the game itself.

Developing new partnerships and ways of working was one of the key challenges for ELS, and also one of the main areas of success. Some key learnings came out of this:

- The importance of following a shared vision: whilst the vision for ELS came from the Ahfad University for Women, the actual programme format was co-created by all the partners in a way which ensured ownership and collaboration;
- The need for flexible funding; ELS was funded by the Dutch Government, joined later by UNICEF. Whilst donor relationships are an essential part of the programme infrastructure, the flexible and responsive nature of the Dutch funding in particular meant that the partnership was able to take risks, test things out, and include capacity building and technical support wherever it was needed;
- Being prepared for pragmatism; there were contextual changes during the different phases which the partnership had to respond to whilst ensuring the essence of the programme stayed true. Phase One, for example, used reconditioned laptops, but a change in Sudanese governmental policy around imports meant that this was not possible in Phase Two. Switching to tablets required changes in software development, training and negotiations across the partners, but actually worked well as touch screen tablets allow children to write, and may be seen as more intuitive.

Two types of challenges: technological infrastructure and scaling up

Two major types of challenge were encountered within the programme. Firstly, implementation challenges mostly relating to technological infrastructure and capacity within Sudan; and secondly the challenges of taking an innovative programme to scale.

There were a range of initial challenges relating to the lack of technological infrastructure:

1. **No power available in the villages**: this was known from the start of the project, and was resolved by the installation of solar power units into the villages.
2. **No reliable internet connectivity:** Surveys showed that there is 3G connectivity in some of the villages, but this is patchy and intermittent. Whilst a partnership with Zain, a Sudanese Telcom Provider, gave free internet access via a 3G dongle in the community, it was important to design a game and a programme framework which could work offline. The game can be played offline, and children's data in the Learning Management System (LMS) are logged on the tablets. One of the two management systems which were integrated is a local system which runs on the laptop, and allows the Facilitator to download children's results and assess them. The second management system makes data available at supervisor, state and national level, and allows for different kinds of analyses at each level. Every time there is connectivity, children's results will be synchronized to a central server. Results can also be downloaded manually, and brought to the server 'by hand'.
3. **Hardware procurement challenges**: As noted, a change in policy meant that using reconditioned laptops was not possible in Phase Two, and the budget did not allow for new laptops, requiring a shift to tablets.
4. **Technical issues regarding updating the game**: The installation of the updates was done in-country by national staff, which required some technological knowledge. A technical person was put in place who supervised the installation of the updates. In addition, updates of the game sometimes did not work in Sudan, although there were no problems in The Netherlands. These issues were resolved when they occurred through close co-operation across the partnership.

The second type of challenge related to the scale up of the project, and the overall management of an innovative programme of this kind:

1. **Challenging conventional wisdom**: This is an innovation which challenged the conventional wisdom that children who had never had access to education previously could learn without access to skilled teachers using the applied game only. The project does not aim to replace teachers: rather it aims to provide quality learning opportunities to children in environments either without teachers or with semi-skilled teachers with limited resources. In order to meet this challenge, the project designed a targeted 'proof of concept' with a strong evidence collection basis to demonstrate, using internationally accepted methodologies, that children could indeed learn. This proof of concept resulted in the project gaining an additional technically skilled donor, UNICEF, for the large scale trial of the project.
2. **Credibility challenge**: Related to the above, is the credibility challenge. This is the challenge for the intervention to be seen as a credible alternative to traditional methods, not only from a learning outcomes perspective but also for the model more generally. Using internationally recognised research methodologies is part of this approach. What is also

important is developing the right strategic partnerships and slowly cultivating a circle of sector influencers who believe in your approach. To be credible, the initiative also has to be feasible. To this end, we have also focused on a fiscal analysis of the project, undertaking a value for money analysis and comparing this to other educational methodologies.

3. **Scale-up challenge**: The main challenge – and opportunity – for ELS relates to how it is scaled-up. Scale is a recognised challenge in both innovations in the developing world and in good educational practice. Two phases have been successfully completed, showing that the plan for scale is working. The next phases, which require larger trials or the replication of ELS in new contexts, will be more challenging. The strong and collaborative partnerships and the solid research base of this programme puts it in the best position for scaling up, and the focus is now on resource mobilisation.

Positive feedback

Feedback from the children and their communities has been consistently excellent during both phases of the programme. The children loved playing the game. They liked the colours, saw many different games, and enjoyed the instruction videos: '*That girl is like my big sister. If she can do this, I can do it as well!*'. They are very motivated to learn, something which was reported anecdotally from behaviour such as the speed with which children ran back to their learning session after another meeting, and by their attendance. Parents reported that they like the fact that their children are learning mathematics and how to use ICT. They believe it will give them better opportunities in the future. In addition, they felt that their children were looked after during the learning sessions, they were safer. Facilitators note that children became friendlier towards each other both in the sessions, and through visiting each other's homes. Facilitators also added that children are cleaner: to use the tablets their hands and nails should be clean, and that this is the case throughout. Research into psychosocial aspects related to the introduction of the game shows that children's self-esteem has increased. Moreover, children's future orientation has changed: now they want to become teachers, doctors or engineers, and are interested in ways to help the people in their own village and improve it. The only negative remarks from the community were related to the fact that they would like their children to learn how to read as well, and concern that the large scale trial has ended.

The Sudanese Ministry of Education has responded positively throughout the programme, playing an active partnership role and ensuring that the games are pedagogically robust and linked in to the formal national assessment and qualification systems. They have also included ELS, and a more general positive approach to digital learning and the potential for technology, in their plans to transform education in Sudan.

Learning outcomes: research method and results

One key area of success of the programme was the focus on undertaking a robust research pilot. Learning outcomes were measured in three different ways:

1. During both a small scale (N=60) and a large scale trial (N=600) a pre-post test quasi experimental design, including control groups, was followed. Two oral mathematics tests were developed, based on EGMA (Early Grade Mathematics Assessment, an internationally validated mathematics test). These tests specifically measured the content that was incorporated in the game.

2. At the end of the large scale pilot external consultants were hired to take the EGMA test with a stratified sample of the participating children.
3. All actions children took in the game were logged, registering their progress through the game.

In addition to this quantitative data, qualitative data was collected. Facilitators observed children's attendance and motivation per day; in focus group meetings children and parents shared their perceptions of the trials and the game; and 10 children were followed when they progressed to Grade 4 of regular education.

Small scale trial

The small scale trial lasted six weeks. Participants in the experimental treatment group were 67 boys and girls (age 6-11) in three remote villages in the state White Nile, who had never been to school before. The control group consisted of 19 children in a fourth remote village. The control group did not receive any formal education during the trial period. Figure 4 below shows the results on a mathematics test.

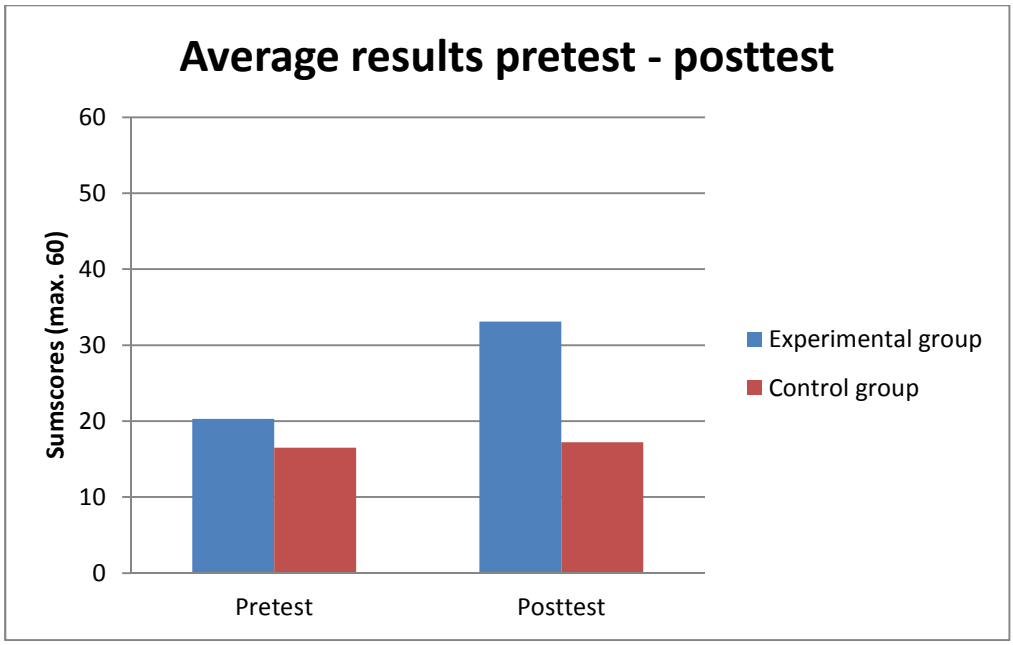

Figure 4. Average results pretest-posttest small scale trial (test A)

The experimental group had an average of 33% correct answers on the pretest (N=67, M=20.3, SD= 11.5). The control group had an average of 28% correct answers on the pretest (N=19, M=16.5, SD= 5.6). An independent T-test showed no significant differences on the scores of the pretest between the experimental group and the control group (t=-1.4283, fd=79, p=0,16). The average score of the experimental condition on the post-test was 55% correct (N=54, M=33.1, SD=15.5), the control group showed a slight increase to 29% correct answers (N=19, M=17.2, SD=5.3). An independent T-test showed significant differences on the delta scores (posttest-score minus pretest-score) between the experimental group and the control group (t=9.1, df=71, p=0.00). This means the experimental group has learned significantly more than the control group. There were no differences between boys and girls or between the participating villages.

Progress into Grade 4

After the six-week experiment the children were taught by teachers in their own villages for the rest of the school year. At the end of this period they were tested by a nearby school. Ten children were admitted to Grade 4; five children were admitted to Grade 2 (which would be normal progression); and the rest was admitted to Grade 3. The progress of the children admitted to Grade 4 was followed carefully. At the end of Grade 4, they were the top 10 of their year. This shows that the children not only learned their mathematics quickly, but also built a strong basis for further development.

Large scale trial

The large scale trial lasted five months. Participants in the experimental condition were 589 boys and girls aged 7-9 in 19 remote villages in three states in Sudan: White Nile, North Kordofan, and Gedaref. This trial has just ended and data are being analysed. Results to date (206 children) show a similar increase in scores on a mathematics test as in the small scale trial. On average the children scored 32% correct on the pre-test and 67% correct on the post-test, the increase is 35%. Figure 5, below, shows the increase in scores per age-group.

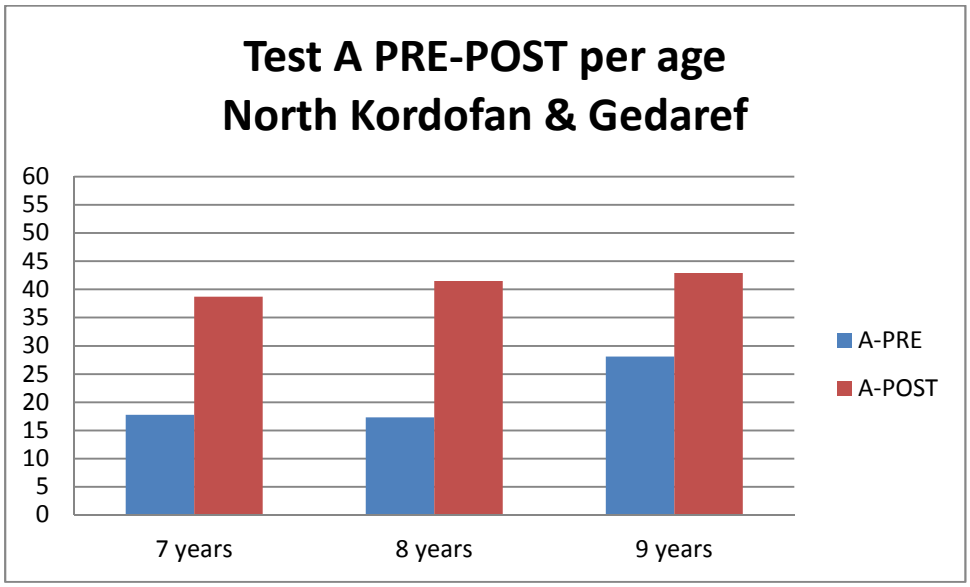

Figure 5. Average results pretest-posttest per age, large scale trial (test A)

Results EGMA

At the end of the large scale trial, external consultants took the EGMA test with a stratified sample of the children participating in the experiment: 219 boys and girls, from all the participating states and all age groups. Their results could be compared to those of Sudanese children in Grade 3 of regular school, who took the same EGMA test in 2014, after 2 years and 5 months of education. Table 1, below, shows the percentage correct on the various subtasks.

Subtasks	**Percentage correct**	
	Sudanese 3rd Grade students	E-Learning Students (5 months)
Number identification	57.6	21.6
Quantity discrimination	47.7	40.8
Addition level 1	53.5	40.5

Subtraction level 1	39	30
Shapes 1	74	92
Shapes 2	84	89.5
Missing number	22.7	23.2
Addition level 2	37	16
Subtraction level 2	27	7.6
Word problems	48.4	53.2

Table 1. Percentage correct on EGMA for Sudanese Grade 3 students and E-Learning students

On four subtasks: Shapes 1, Shapes 2, Missing number, and Word problems, the children who used the mathematics game for five months had a higher percentage correct than the Sudanese children who had attended regular school for two years and five months. On three other subtasks: Quantity discrimination, Addition level 1 and Subtraction level 1, the children playing the game only had a slightly lower score than the children who went to school. In the last three subtasks, the children playing the game had much lower scores than the children attending school. These three subtasks were (mostly) not included in the mathematics game.

Logged data

The logged data are being analysed. In the meantime preliminary findings show that most children attended the learning sessions regularly. The children played an average of 2,500 mini-games during the pilot period, consisting of 3, 5, 10 or 20 questions each. On average children completed 76% of the game (based on 6 months of learning), with some children completing 100% and others only 46%.

Future plans

The programme is currently exploring scale-up modalities in Sudan and adaptation and expansion opportunities in other countries, potentially including Jordan. Future technical e-Learning developments will most likely include the development of an applied game focused on reading skills acquisition. Again, this will be linked to the relevant country Ministry of Education curriculum.