

# CREATING A LITERATE WORLD

*Nicholas Sayaan - Roser Viñals - Issey Masuda - Christoph Sokol - Javier Mangas*

*“Education is not the learning of facts,  
but the training of the mind to think”*

*- Albert Einstein*

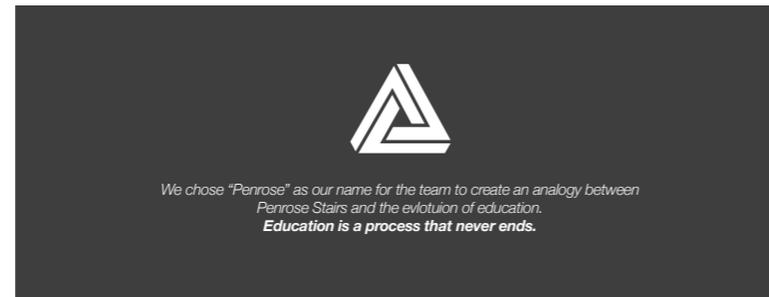


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# THE TEAM

## Why Penrose?



## Nick

*I was born and raised in Los Angeles, so I love all LA sports teams (plus Barça)! I also have backgrounds in, and passions for, both neuroscience and filmmaking. I hope to leverage these disciplines along with my current education in business, design & innovation in my future endeavors. I love*  
Team Penrose!

**Full-Time MBA with a specialization in Design & Innovation**

*"A great photograph is one that fully expresses what one feels, in the deepest sense, about what is being photographed."*  
—Ansel Adams

## Roser



*As an engineer, I really believe that technology plays a key role in the evolution of society. Particular, I have focused my interest in the field of communications which has arisen from my passion for research. Traveling and reading are my favourites hobbies.*

**Telecommunications engineering**

*You can never cross the ocean until you have the courage to lose sight of the shore.*  
—Christopher Columbus



## Issey

*I am passionate about science (especially physics!) and technology. I love movies, music and art in general and I am always looking for new projects to do and eager to learn new things.*

**Telecommunications engineering // Programmer**

*"Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand."*  
—Albert Einstein

## Christoph



*Fotographer, Painter and notorious sketcher. I always believe in the best in people and humankind. I am a dreamer, I have my head between the stars and the clouds. I am interested in how things work and why. Design enthusiast, "Weltenbummler" and a positive person full of curiosity for life, arts and science.*

**Product Designer with specialization in Transportation Design**

*"Art is a line around your thoughts"*  
—Gustav Klimt



## Javier

*Graphic designer from Barcelona in love with digital illustration, UX/UI experience and music.*

*I believe in concepts, ideas and the possibility of breaking rules. Nothing is established, you just need to figure out the way to create your own path.*

**Graphic Designer specialized in Advertising & Branding**

*"I am a great believer in luck, and I find the harder I work, the more I have of it."*  
—Thomas Jefferson

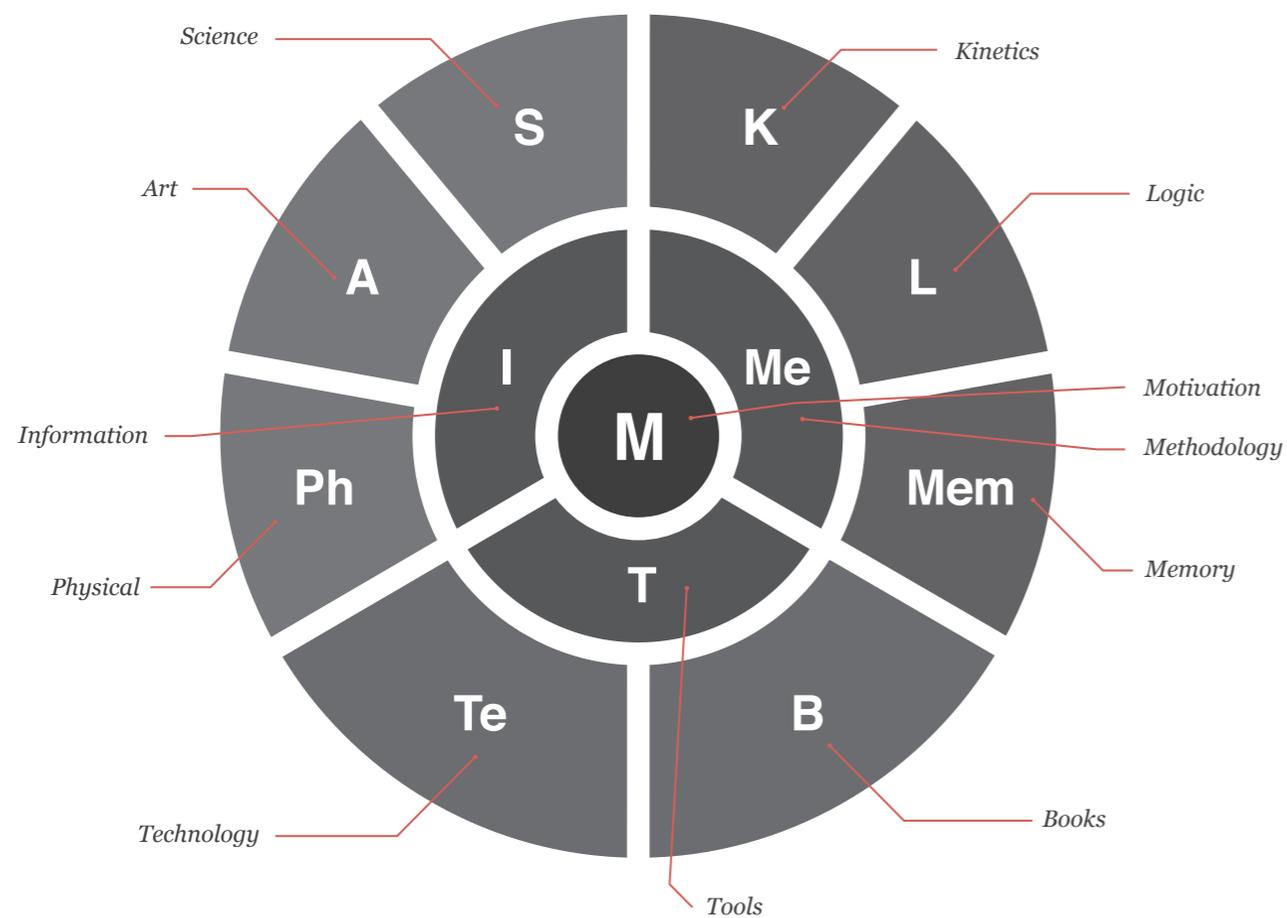


# INTRODUCTION

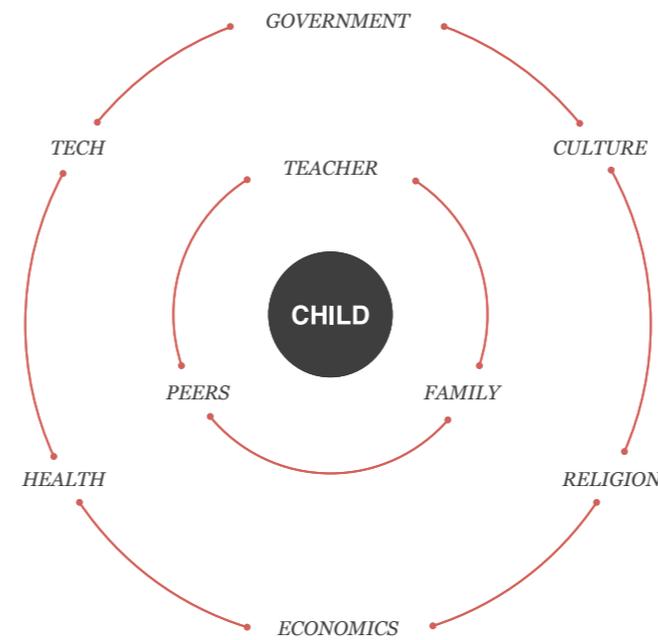
## Challenge

*How might we significantly reduce child and youth illiteracy at scale in developing countries, with the use of technology?*

Education Boson



Stakeholders



*As a starting point we made an analogy between the Higgs boson and education, and a stakeholders map to try to visualize which were the main problems and the people/organizations related to our challenge.*

*The Education Boson we based on technologies, tools and learning process to achieve education with Motivation in the center of the boson and the main key factor for education.*

# CONTEXT

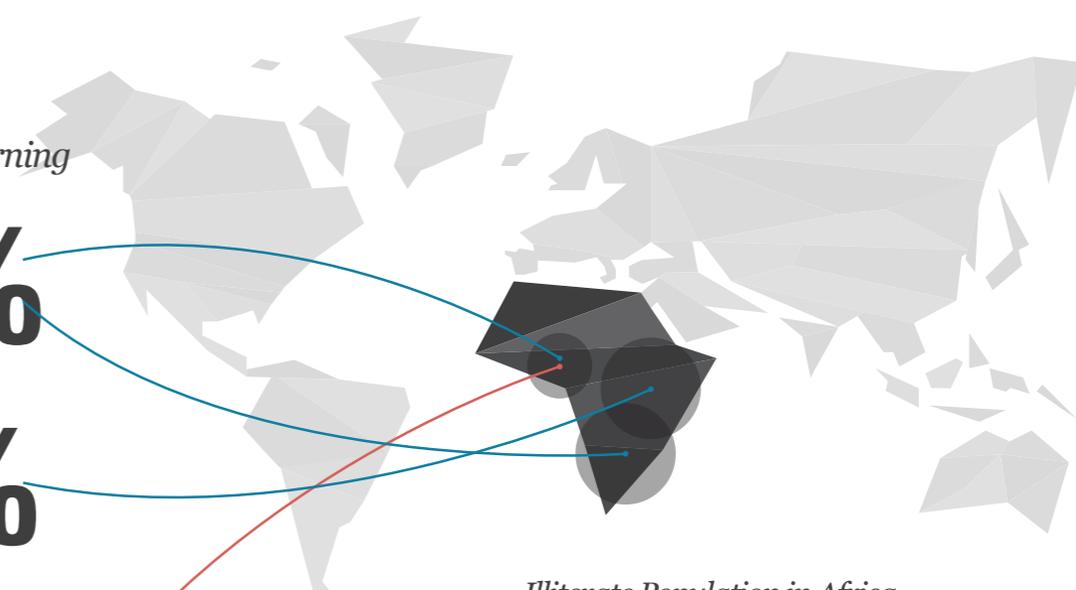


Schoolchildren not learning

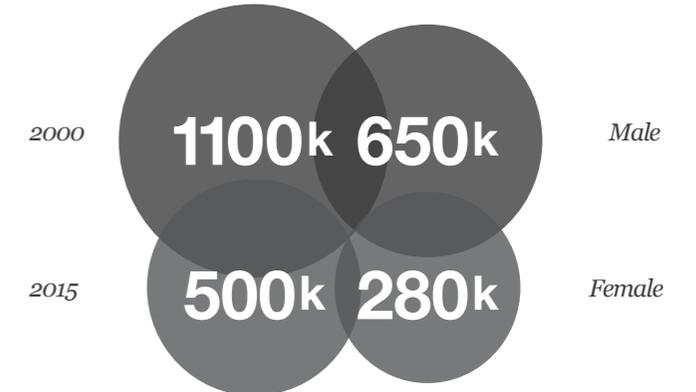
30%  
20%

Youth literacy rate

< 50%

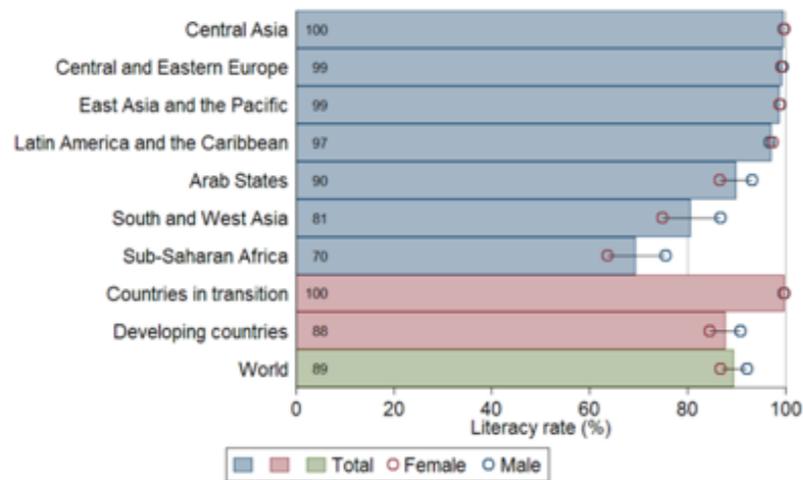


Illiterate Population in Africa



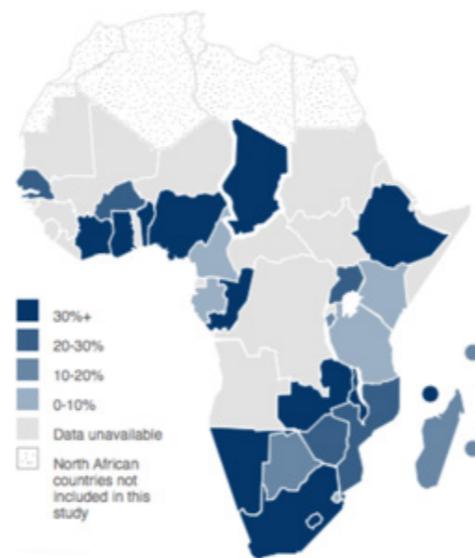
# CONTEXT

*Youth literacy rate by region and sex*



**Note:** 2011 data refer to the period 2005-2011.  
**Source:** UNESCO Institute for Statistics, May 2013.

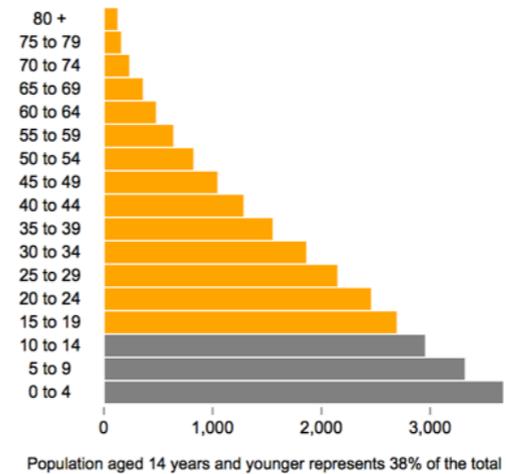
*Percent of schoolchildren not learning*



*Socio-economic indicators*

Total population (in thousands)	25,905
Annual population growth (%)	2.2
Population aged 14 years and younger (in thousands)	9,962
Rural population (% of total population)	47
Total fertility rate (births per woman)	4
Infant mortality rate (per 1,000 live births)	49
Life expectancy at birth (years)	61
Prevalence of HIV (% of population aged 15-49 years)	1.4
Poverty headcount ratio at 2 PPP\$ a day (% of population)	51.8
GDP per capita - PPP\$	2,014
Annual GDP growth (%)	7.9
Total debt service (% of GNI)	1.9
GDP in billions - PPP\$	51

*Total population by age group, 2013*



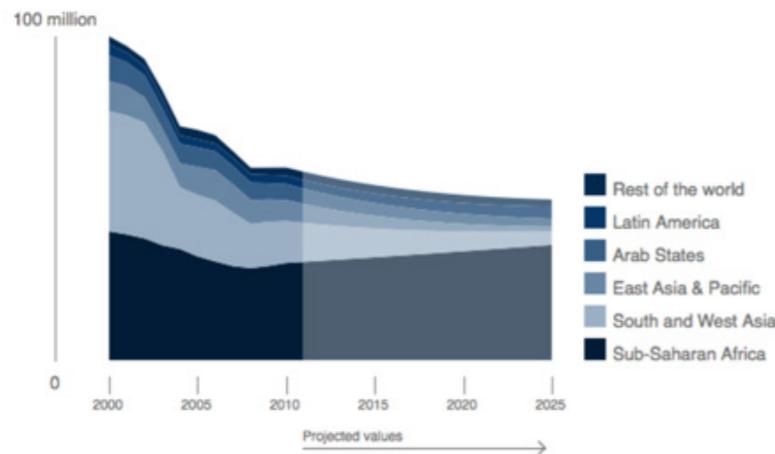
The out-of-school population in Africa is on the rise. Among children who enroll in school, **few complete their education.**

Many **children who stay in school are not learning.** In many countries, education disparities exist between rich and poor.

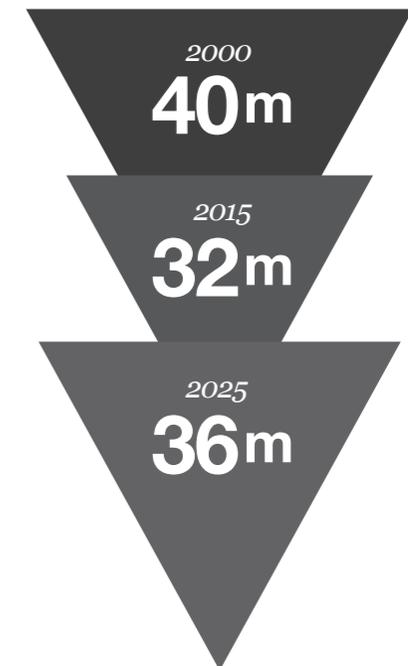
Primary and junior secondary education are supposedly tuition-free and mandatory. However, there is no way to enforce attendance since there are not enough teachers and facilities available to accommodate all students.

Many families cannot afford the other levies and school uniforms, and as a result, there are still many local children seen working in the streets during school hours.

*Out-of-school children of primary school age, 2000-2015*



*Out of School*



# TARGET



## Jennifer

*She*

7 Years  
2 Older Brothers

*Dreams*

Going to school to learn  
Become a bank manager

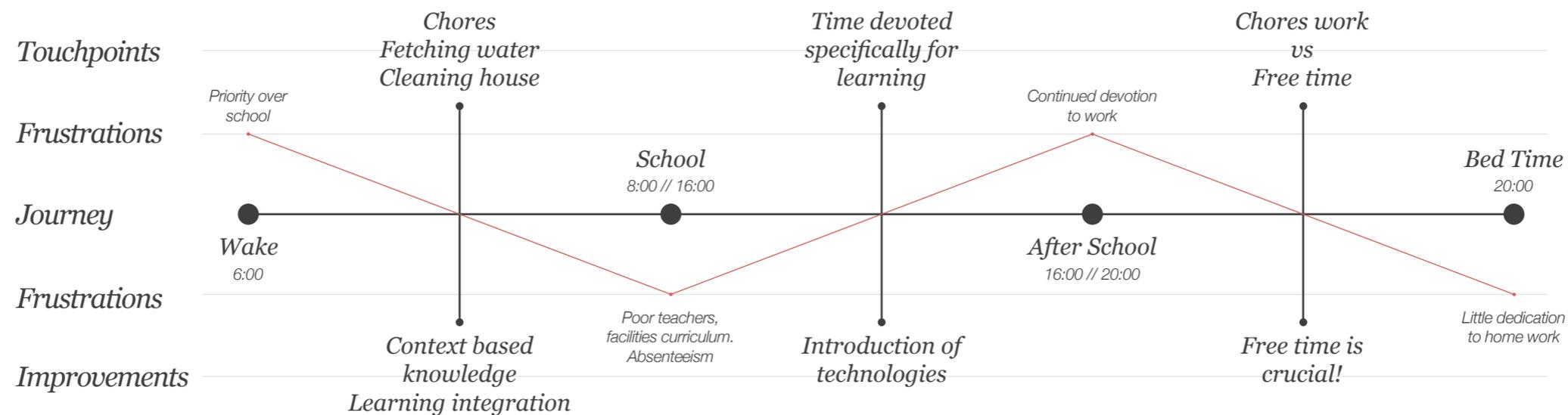
*Life*

Family  
Rural area of Ghana  
Lack of infrastructures  
Chores for the family

*Problems*

Wake up early  
Pulled out of school for work  
Basic needs not fully covered  
Long way to school

*User Journey*



# REDEFINITION

## *Challenge*

*How can we create an enriching learning experience?*

## *Problem redefinition*



### *Tools*

*How can we facilitate the access to information?*



### *Engagement*

*How can we provide a solution that helps the kids stay in the learning process?*



### *Time*

*How can we include education in their routine?*



### *Challenge*

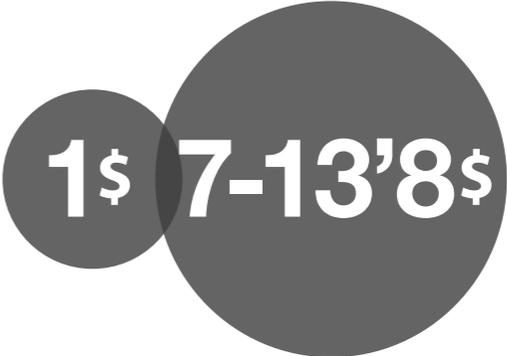
*How can we introduce new learning methodologies?*

*We redefined the main challenge once we had some knowledge related with the culture, environment and target we were focusing on.  
We defined our four main areas to focus and the questions our solution should answer to provide children with a new tool to learn without interfering with their actual day to day life.*



# EDUCATION

Investment in early childhood education



Revenue

RANGE IS EXTRAPOLATED FROM SEVERAL SOURCES:

[http://www.acgov.org/ece/documentseconomic\\_investment\\_funding.pdf](http://www.acgov.org/ece/documentseconomic_investment_funding.pdf)

<http://www.waisman.wisc.edu/cls/cbaexecsum4.html>

<http://www.ncsl.org/research/human-services/newresearch-early-education-as-economic-investme.aspx>



Year in school



Individual earnings lifetime

10%

SOURCE: EFA GMAR, UNESCO, <http://unesdoc.unesco.org/images/0019/001902/190214e.pdf>



Year in school



0.37%

Annual GDP



Basic reading skills



12%

global poverty

SOURCE: EFA GMAR, UNESCO, <http://unesdoc.unesco.org/images/0019/001902/190214e.pdf>



GDP 2014

GDP

SOURCE: EFA GMAR, UNESCO, <http://unesdoc.unesco.org/images/0019/001902/190214e.pdf>

SOURCE: <http://data.worldbank.org/country/ghana>



# IDEATION



## INSPIRATION MARKET

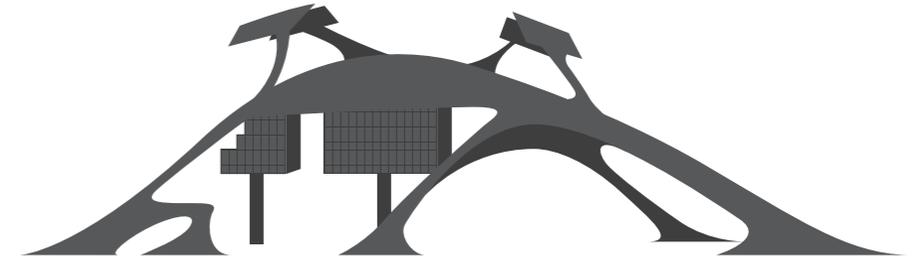
Application to inspire and motivate children with real stories from their own people that have achieved big goals in life.

Curiosity  
Educative  
Inspiring

## ART INSTALLATION

Connection between art and education, idea focus for towns or cities. Interactive game to spell words and send messages.

Gamification  
Group Activity  
Creative



## L - SURF

Interactive surfaces to enhance engagement with the course materials.

Gamification  
Interaction  
Group Activities

## KNOWLEDGE KIOSK

A central, out of school place, where information and knowledge is stored. It is accessible for all the community and tries to engage it to learn and interact in a group. It consists of activities and challenges to improve the community itself and the individual learning process.

Gamification  
Group Activity  
Community Challenges



## ENGAGED CHORES

While a lot of time is lost for children when they have to step in and do work for the better of the family this idea tries to reach these times and connect it with a playful way of learning

Gamification  
Multitasking  
Chores

# SOLUTION



## *Formal Inspiration & Research*

*The formal development of the Kiosk was based on a broad research about the culture and habits of the Ghanaian people. It is inspired from their day-to-day life and tries to solve problems with solutions they are familiar with. For example lets take the way many classes in schools are taught.*

*This sometimes happens around a tree where they have shadow and rain protection. The teacher stands at the three and uses the tree as a center point.*

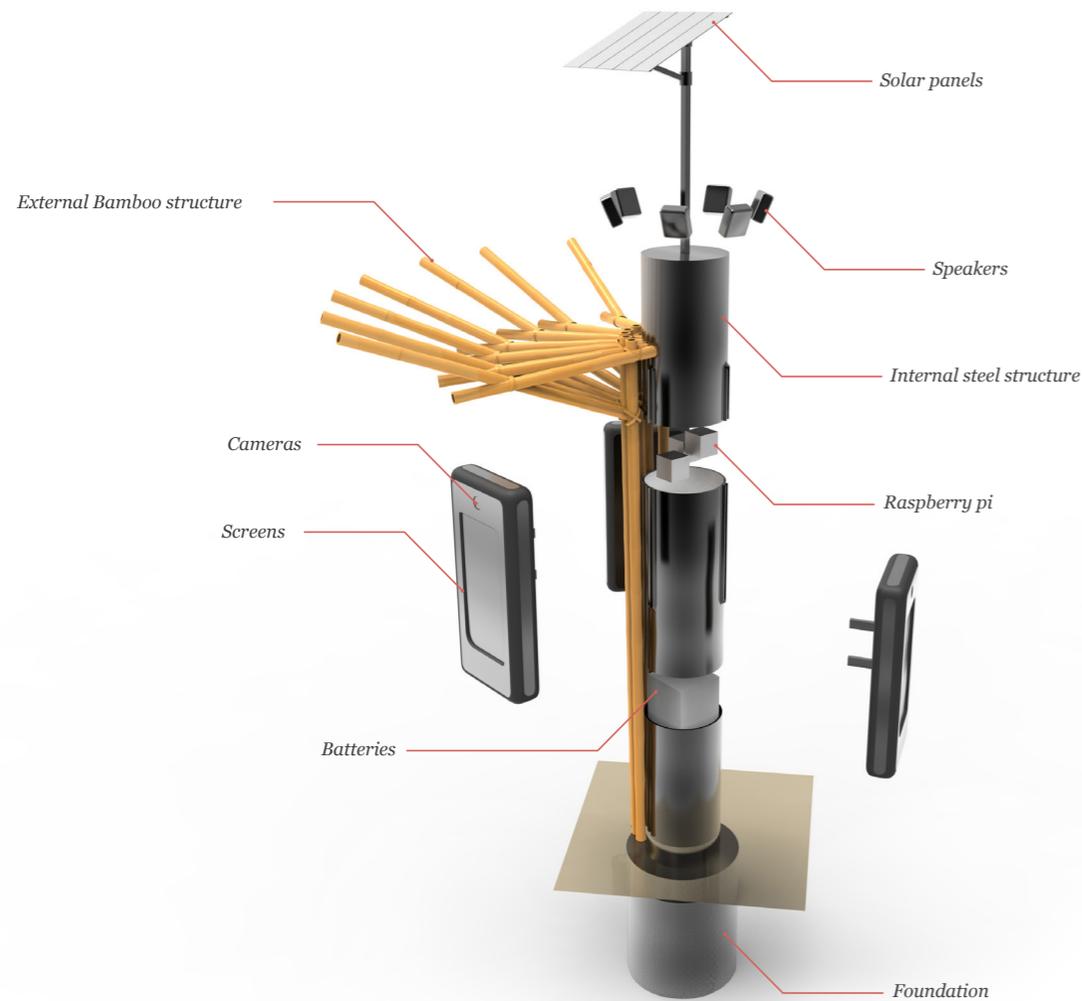


## *Integration*

*The Design and the content is an important part of our solution but the most important aspect for us is the community integration of the kiosk and the benefits the individual and the community gains from our solution. Because in the research we found that families are often forced to decide if they send their children to school or take them to farm, the schools are interfering with the families needs.*

*Our solution provides an additional value to the families and brings the importance of knowledge and education back to the main aspects of a child's life. With the locations we investigated and the way we designed it, our Kiosk brings education to the children rather than children have to walk a long way to receive education.*

# SOLUTION



## Proposals

Early proposals of the kiosk missed the cultural influences and were discarded for being too alien and outlandish for the environment it is supposed to be designed. After the investigation and the realization of Bamboo being the ideal material, different shapes were tested to see which one would be the most economic and attractive solution.

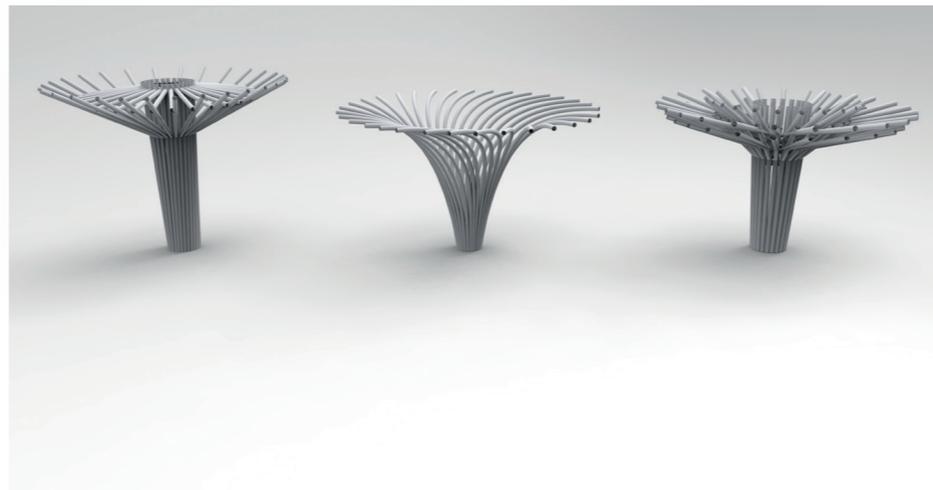
## Shape development

In the design process of the kiosk we faced many obstacles, such as price, security, familiarity and maintenance.

To tackle these problems we investigated the culture and habits of Ghana and of Africa in general. We looked for materials, which are familiar to them and with construction types that aren't too complicated. We found that Bamboo is a material they use in their daily life and is easy for them to use and is quite abundant in rural Ghana.

The Hardware of the device is stored in a stainless steel tube to protect it from environmental influences, damage and theft. To additionally secure the Kiosk we decided to design a foundation in the ground. Since we want to reach a wide variety of children and people we conceptualized the screens to be vertically moveable so kids with different heights can easily access them. The screens are protected from environmental influences and misusage.

The Bamboo structure serves for rain and sun protection and helps furthermore to integrate the Kiosk into its environment



# SOLUTION

## *Design*

*We have created two virtual teachers Bam & Boo, that help the children to interact with the Kiosk and reminds the kids to play with them.*

*It is a good way to use gamification to create a better and higher engagement with the children.*



**BAM**  
BOO



# PROJECT PROPOSAL

*Through our research and interviews, we discovered several aspects of both education/learning and the various contextual influences surrounding students themselves, specifically in Ghana. From this research we decided to reframe our challenge: how do we create an enriching learning experience? By designing our solution from this perspective, we hoped to create a service environment that would leverage several opportunities for integration into our target users' lives.*

*In terms of an educational service, we provide tools for learning in the form of **(1) learning games, (2) challenge based learning projects, and (3) access to Wikipedia**. Learning games would teach rudimentary math and literacy skills in engaging/gamified ways. For example, our prototype included a game where users learn how to write letters by tracing letters on a screen with their hands. A camera follows the motion of their movements and determines how close their tracing is to the true letter, thus assessing their competency. Challenge based learning projects would teach higher-level skills, as well as rudimentary literacy skills. Higher-level skills would include, but not be limited to, team building & teamwork, leadership, and analytical & problem solving skills. In addition to literacy, these higher-level skills would help users be even more suited for success (and more able to deal with difficulties) in future educational and professional endeavors. Content generation of games and projects would be an internal process, adding to our service's competitive advantage. Lastly, Wikipedia would give users access to information should they seek out information in addition to what is provided through the games and challenges.*

*The community experience of our solution was also highly important to us in design of both the service and the physical form of the solution itself. Great care was taken in using aesthetics that would integrate into communities well, and therefore increase acceptance. However, just as critical if not more so, is our service design, which takes into account the busy lives of children in these Ghanaian communities. Analysis of our users' daily journeys shows that great time and importance is given to duties such as fetching water, farming, working at the market, and other responsibilities that are usually critical to family survival. Users may also spend a great deal of time walking from location to location, so it was essential to make use of the sparse, yet valuable, free time that may be available to them. Through our contacts, we found that this free time was available generally in afternoons when children would access community playgrounds. Through this insight, we decided to place our knowledge kiosk, as well as design educational services, with this free time in mind.*

*Our service solution is therefore a piece of technology that integrates into student lives in addition to the education they receive in more traditional forms (i.e. school) without taking away from the necessities of day-to-day life. Our challenge based learning projects, additionally, have been designed from the perspective of engagement not only from the student standpoint, but also from the community standpoint. Through interviews we learned that older children/siblings have a highly influential role in the lives of younger children/siblings. This influence applies heavily to education, where older individuals motivate and/or take on teaching roles themselves. We leveraged this insight by designing group projects that would solve community issues as well as educate users. This would engage the community and older individuals to work with younger students to create, for example, a water filter. In addition, an "enabler" would be a part of the service to help guide, steer, and assess students during the process. The enabler is an employee of the service and would be sourced from the local community.*

*It is this combination of both non-traditional learning methodologies (gamification and challenge based learning) along with projects that leverage community relationships (community engagement and hierarchal teaching/motivation) that is the core of the Bamboo service. Furthermore, we sent sample portions of our curriculum to our contacts in Ghana for validation and testing. From their positive feedback, we saw not only the community engagement and acceptance that we hoped for, but also the availability and high interest of children to take part in our challenge based learning projects with the guidance of an enabler. We also sent a summary of our project to individuals in the Ghana Complementary Basic Education program, and they were very enthusiastic about our solution and how our curriculum could add much greater value than the current offering.*



# BUSINESS CANVAS

## REVENUE STREAMS

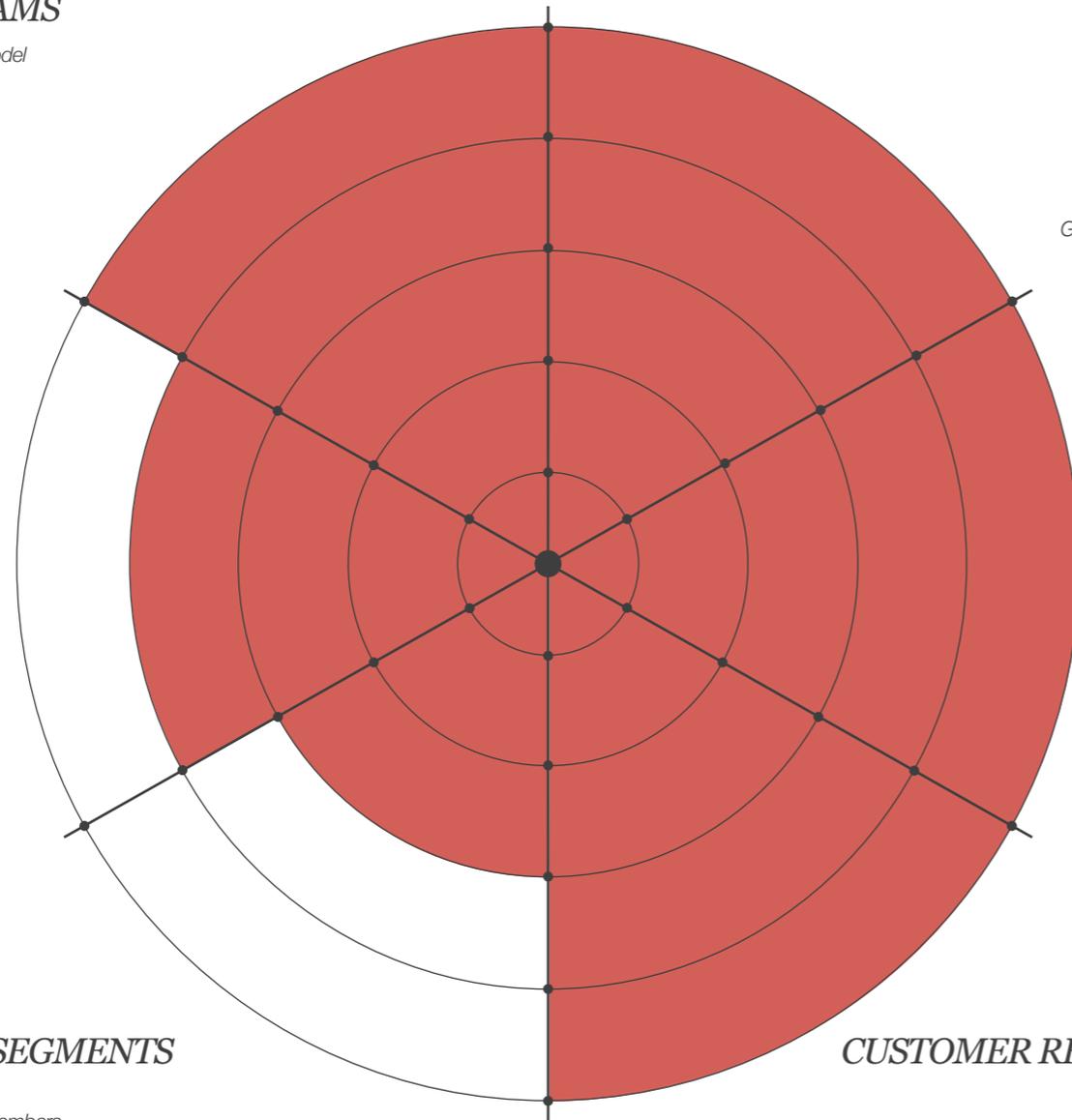
Buy-One-Get-One Business Model  
Kiosk  
Content  
E-Commerce Partnerships  
Peer-to-Peer Partnerships

## COST STRUCTURE

Kiosk Hardware Costs  
Administrative Costs  
Content and App Development

## CUSTOMER SEGMENTS

Ghanaian Children  
Ghanaian Community Members  
Schools/Teachers  
Education Institutions (e.g. museums)  
Parents



## KEY PARTNERS

UKAID  
Service  
District NGOs  
Pick & Pay  
Jumia.com  
Tonaton.com  
Kasoa.com  
Ghana Ministry of Education & Ghana Education

## VALUE PROPOSITION

Providing gamified and challenge-based education to Ghanaian children outside of traditional school  
Providing gamified and challenge-based content to parents

## CUSTOMER RELATIONSHIPS

Ghanian Communities  
NGO Network  
App Customers

## Business Model

Although we could assume that funding for our solution could be provided perpetually with government aid and NGO support, we also looked to several other opportunities to further monetize Bamboo and increase its chances of sustainability. Business models involving using Bamboo as an access point (e.g. internet and/or media), as an advertising kiosk, as part of an e-commerce or peer-to-peer platform, and as big data collection point were all researched, analyzed, and vetted for feasibility and viability. The more attractive models involved partnering with e-commerce and peer-to-peer companies/services already in place in Ghana or planning to enter the Ghanaian market. For example, we looked to Pick n Pay, the second largest "big box" and supermarket chain in South Africa as a potential partner. Because of their interest in entering the growing Ghanaian market, the Bamboo kiosk (during times when not in use for educational purposes) could be used as a shopping and point of sale station where community members could shop for goods. Delivery lockers, similar to those already in use by Amazon, could be installed for subsequent deliveries. Amazon pays between 0.5% and 2.25% of gross sales for locker service partnerships (<http://www.sacbee.com/news/local/education/article9572906.html#storylink=cpy>) and this was seen as a potential way for Bamboo to create and capture value when also utilized as an e-commerce vehicle. Nonetheless, all of these potential revenue streams were eventually dropped because our market sizing analyses demonstrated that these models were unlikely to produce enough revenue to warrant moving forward.

Our rollout schedule can be seen year-to-year through 2018 on the attached rollout sheets. This rollout schedule follows the Ghana CBE rollout schedule very closely, with the addition of Bamboo kiosk installation. Our rollout schedule also shows which responsibilities will be handled by the Penrose team and which will be outsourced to implementing partners (i.e. NGOs already operating in local districts). Again, this dividing of responsibilities is modeled after the successful deployment of the Ghana CBE program. The Assumptions sheet shows exact deployment numbers, beginning with 4 and doubling each year until 1020 total have been installed. The number of enablers and their salaries scales with deployment, with 1 enabler to be hired with each kiosk. A field team will also be recruited to help train the implementing partners in such responsibilities as community targeting and engagement as well as enabler recruitment and training. The field team will also grow, but not to the extent as enabler growth. Depreciation costs are calculated over a life of 10 years with the straight-line method and maintenance costs are assumed to be \$50 per kiosk per year. Additional assumptions, such as salaries and other overhead costs, can be seen on the Assumptions sheet, with inflation set to 3%. Both kiosk and content sales and prices are also assumed to increase by 3% each year.

With these assumptions in place, initial UKAID funding allows for development and implementation, with the last year of funding to come in 2019. Once initial government funding has ceased, cash flow is positive until 2021, but rebounds in 2023. Our Earnings after Taxes are projected to be negative only in 2023 with our minimum cash position also projected to be in 2023 (but still positive at \$105,963). Our year-end cash therefore decreases each year until 2023, but then begins to grow each year after that. In other words, initial government funding allows for both implementation of Bamboo and growth of the BOGO revenue model. Once our initial round of government funding has been depleted, the company remains solvent and liquid enough to remain viable without additional funding as BOGO revenues begin to not only cover costs, but also allow the company to become self-sustainable.



# BUSINESS MODEL

## Bamboo

### Annual Balance Sheet

USD	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>NET ASSETS</b>										
Tangible Assets (cumulative)	14,716	44,148	103,012	220,740	456,196	927,108	1,868,932	3,752,580	3,789,370	3,826,160
Depreciation (cumulative)	-1,472	-5,886	-16,188	-38,262	-83,881	-176,592	-363,485	-738,743	-1,117,680	-1,500,296
Intangible Assets	0	0	0	0	0	0	0	0	0	0
Accounts Receivable	187,500	154,055	130,642	93,255	99,762	133,581	178,865	239,501	320,691	429,406
Cash	1,139,293	1,875,025	2,421,116	2,678,501	2,740,846	2,593,422	1,963,328	105,963	538,690	1,535,992
<b>Total Assets</b>	<b>1,340,037</b>	<b>2,067,342</b>	<b>2,638,583</b>	<b>2,954,234</b>	<b>3,212,922</b>	<b>3,477,520</b>	<b>3,647,641</b>	<b>3,359,300</b>	<b>3,531,072</b>	<b>4,291,262</b>
<b>LIABILITIES AND EQUITY</b>										
Accounts Payable	14,352	15,844	18,382	23,344	33,068	52,094	87,649	158,313	162,234	164,110
Suppliers of fixed assets	0	0	0	0	0	0	0	0	0	0
Bank Debt	0	0	0	0	0	0	0	0	0	0
Equity	0	0	0	0	0	0	0	0	0	0
Retained earnings / losses	1,325,686	2,051,498	2,620,201	2,930,891	3,179,854	3,425,426	3,559,991	3,200,988	3,368,837	4,127,151
Total Stockholders Equity	1,325,686	2,051,498	2,620,201	2,930,891	3,179,854	3,425,426	3,559,991	3,200,988	3,368,837	4,127,151
<b>Total Liabilities and Equity</b>	<b>1,340,037</b>	<b>2,067,342</b>	<b>2,638,583</b>	<b>2,954,234</b>	<b>3,212,922</b>	<b>3,477,520</b>	<b>3,647,641</b>	<b>3,359,300</b>	<b>3,531,072</b>	<b>4,291,262</b>
<i>Check: Asset - liabilities</i>	0	0	0	0	0	0	0	0	0	0

### Assumptions

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>THE PROJECT</b>										
\$50 Kiosk Maintenance	621	1,021	1,821	3,421	6,621	13,021	25,821	51,421	51,921	52,421
\$800 G&A (office)	9,600	9,888	10,185	10,490	10,805	11,129	11,463	11,807	12,161	12,526
5 30000 Penrose	150,000	154,500	159,135	163,909	168,826	173,891	179,108	184,481	190,016	195,716
1 1500 Field Team	6,000	6,180	6,180	6,180	12,360	24,720	24,720	24,720	49,440	49,440
1 1500 Enablers	6,000	18,540	43,260	92,700	191,580	389,340	784,860	1,575,900	1,591,350	1,606,800
0 Content	0	0	0	0	0	0	0	0	0	0
	\$172,221.40	\$190,129.40	\$220,581.04	\$276,700.63	\$390,192.61	\$612,101.54	\$1,025,972.15	\$1,848,329.27	\$1,894,887.90	\$1,916,903.20

<b>THE MARKET</b>										
Kiosks Deployed in xxxx	4	8	16	32	64	128	256	512	10	10
total kiosks in the wild	4	12	28	60	124	252	508	1020	1030	1040
total enablers in the wild	4	12	28	60	124	252	508	1020	1030	1040
total field team in the wild	4	4	4	4	8	16	16	16	32	32
inflation	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%

UKAID	1500000	900000	600000	150000	0	0	0	0	0	0
BOGO Kiosk	-	100,000	133,900	179,292	240,072	321,457	430,430	576,346	771,728	1,033,343
BOGO Content	-	232,440	311,237	416,747	558,024	747,194	1,000,492	1,339,659	1,793,804	2,401,903



# BUSINESS MODEL

## BOGO

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
sell	Kiosk	-	10	13	17	22	29	37	48	63	82
sell	Content	-	6,500	8,450	10,985	14,281	18,565	24,134	31,374	40,787	53,022
price	Kiosk	-	10,000	10,300	10,609	10,927	11,255	11,593	11,941	12,299	12,668
price	Content	-	36	37	38	39	40	41	43	44	45
revenue	Kiosk	-	100,000	133,900	179,292	240,072	321,457	430,430	576,346	771,728	1,033,343
revenue	Content	-	232,440	311,237	416,747	558,024	747,194	1,000,492	1,339,659	1,793,804	2,401,903
<b>total revenue</b>		-	<b>332,440</b>	<b>445,137</b>	<b>596,039</b>	<b>798,096</b>	<b>1,068,650</b>	<b>1,430,923</b>	<b>1,916,005</b>	<b>2,565,531</b>	<b>3,435,246</b>
CASH	CASH	1,139,293	1,875,025	2,421,116	2,678,501	2,740,846	2,593,422	1,963,328	105,963	538,690	1,535,992
EBITDA	EBITDA	1,327,157	1,041,289	822,735	465,917	401,282	443,527	379,129	16,255	618,722	1,465,922
		1,327,157	1,373,729	1,267,872	1,061,955	1,199,378	1,512,178	1,810,052	1,932,260	3,184,253	4,901,168

Our most feasible option would be to use the Buy-One-Give-One model in concert with government aid. The BOGO business model essentially relies on the selling of a product or service to one market and then allocating a portion of that revenue to fund a product or service for another market. The latter market then receives the product or service for free or at largely reduced prices. Toms Shoes helped popularize this model, in which Toms would donate a pair of shoes in developing countries for each pair of shoes sold. We would follow a similar strategy selling both the kiosk and our content. Proceeds from those sales would help offset costs of Bamboo operations in Africa. On the "BOGO" spreadsheet one can see that kiosks would initially be sold at a premium of \$10,000 and content would be sold at \$36/year (this is calculated as a subscription of \$1.99 per month for one year plus the assumed purchase of additional content at \$0.99 once per month).

## Bamboo

### Statement of Cash Flow

USD	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
EBIT	1,325,686	1,036,874	812,434	443,843	355,662	350,816	192,236	-359,003	239,785	1,083,306
0% Taxes	0	311,062.32	243,730.056	133,152.7884	106,698.6468	105,244.9449	57,670.77158	0	719,354.9003	324,991.7318
+ D & A	1471.6	4,415	10,301	22,074	45,620	92,711	186,893	375,258	378,937	382,616
Operating Cash Flow	1,327,157	730,227	579,005	332,764	294,583	338,282	321,458	16,255	546,786	1,140,930
Capex	14,716	29,432	58,864	117,728	235,456	470,912	941,824	1,883,648	36,790	36,790
Working Capital	173,148	138,211	112,260	69,911	66,694	81,488	91,216	81,188	158,457	265,295
Investment in WC	173,148	-34,937	-25,950	-42,349	-3,217	14,794	9,728	-10,028	77,269	106,838
Investing Cash Flow	1,139,293	735,732	546,091	257,385	62,344	-147,423	-630,094	-1,857,365	432,727	997,302
Interest payment	0	0	0	0	0	0	0	0	0	0
Dividends	0	0	0	0	0	0	0	0	0	0
Increase / (decrease) in Capital	0	0	0	0	0	0	0	0	0	0
Increase / (decrease) in Debt	0	0	0	0	0	0	0	0	0	0
<b>Final cash flow (change in cash)</b>	<b>1,139,293</b>	<b>735,732</b>	<b>546,091</b>	<b>257,385</b>	<b>62,344</b>	<b>-147,423</b>	<b>-630,094</b>	<b>-1,857,365</b>	<b>432,727</b>	<b>997,302</b>
Beginning Cash	0	1,139,293	1,875,025	2,421,116	2,678,501	2,740,846	2,593,422	1,963,328	105,963	538,690
Ending Cash	<b>1,139,293</b>	<b>1,875,025</b>	<b>2,421,116</b>	<b>2,678,501</b>	<b>2,740,846</b>	<b>2,593,422</b>	<b>1,963,328</b>	<b>105,963</b>	<b>538,690</b>	<b>1,535,992</b>
Minimum cash position		105,963								



# BUSINESS MODEL

## Bamboo

### Investments (Capex)

USD	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
<b>Investments</b>										
Kiosks	14,716	29,432	58,864	117,728	235,456	470,912	941,824	1,883,648	36,790	36,790
Content	0	0	0	0	0	0	0	0	0	0
<b>Total investments in fixed assets</b>	<b>14,716</b>	<b>29,432</b>	<b>58,864</b>	<b>117,728</b>	<b>235,456</b>	<b>470,912</b>	<b>941,824</b>	<b>1,883,648</b>	<b>36,790</b>	<b>36,790</b>

life

### Depreciation & Amortization (D&A)

10 Kiosks	1,472	4,415	10,301	22,074	45,620	92,711	186,893	375,258	378,937	382,616
<b>Total D&amp;A</b>	<b>1,472</b>	<b>4,415</b>	<b>10,301</b>	<b>22,074</b>	<b>45,620</b>	<b>92,711</b>	<b>186,893</b>	<b>375,258</b>	<b>378,937</b>	<b>382,616</b>

	1 kiosk
screens	2400
Raspberry pi Model B+	150
connectivity	15
webcam	150
sensors	24
microSD card	10
solar panel	500
batteries	200
labor	30
structure	200
<b>total</b>	<b>3679</b>
annual costs	
connectivity	180
t2.small ec2 instance	163
30GB EBS	39.6
80GB S3	28.8
data transfer	10
<b>total</b>	<b>421.4</b>



# BUSINESS MODEL

## Bamboo

### Annual Profit & Loss Account

USD	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Donation	1500000	900000	600000	150000	0	0	0	0	0	0
Revenue	0	332440	445137	596039	798096	1068650	1430923	1916005	2565531	3435246
Kiosk Maintenance	621.4	1021.4	1821.4	3421.4	6621.4	13021.4	25821.4	51421.4	51921.4	52421.4
Gross Margin	1,499,379	1,231,419	1,043,316	742,617	791,474	1,055,629	1,405,101	1,864,584	2,513,610	3,382,825
Overheads (fixed costs)	172,221	190,129	220,581	276,701	390,193	612,102	1,025,972	1,848,329	1,894,888	1,916,903
EBITDA	1,327,157	1,041,289	822,735	465,917	401,282	443,527	379,129	16,255	618,722	1,465,922
% over sales	88.5%	84.5%	78.7%	62.5%	50.3%	41.5%	26.5%	0.8%	24.1%	42.7%
Depreciation & Amortization	1,472	4,415	10,301	22,074	45,620	92,711	186,893	375,258	378,937	382,616
Earnings before interest and taxes (EBIT)	1,325,686	1,036,874	812,434	443,843	355,662	350,816	192,236	-359,003	239,785	1,083,306
Interest expense (7%)	0	0	0	0	0	0	0	0	0	0
Earnings before taxes (EBT)	1,325,686	1,036,874	812,434	443,843	355,662	350,816	192,236	-359,003	239,785	1,083,306
0% Taxes	0	311062.32	243,730	133,153	106,699	105,245	57,671	0	71,935	324,992
<b>Earnings after taxes (EAT)</b>	<b>1,325,686</b>	<b>725,812</b>	<b>568,703</b>	<b>310,690</b>	<b>248,964</b>	<b>245,572</b>	<b>134,565</b>	<b>-359,003</b>	<b>167,849</b>	<b>758,314</b>

Fiscal credit

2016 TIME FRAME	CORE ACTIVITY DURING IMPLEMENTATION CYCLE	RESPONSIBILITY
JAN	Community Targeting	PENROSE
	APPLICATION AND ASSESSMENT OF POTENTIAL IMPLEMENTING PARTNERS	PENROSE
FEB	CONTENT GENERATION	PENROSE
MAR	RECRUITMENT OF FIELD STAFF / PARTNER TRAINERS	PENROSE
	FIELD STAFF TRAINING	PENROSE
APR	ORIENTATION PROGRAMMES FOR IMPLEMENTING PARTNERS W/ NEW FIELD STAFF	PENROSE
MAY	SELECTION OF COMMUNITIES AND SIGHTING OF KIOSKS	IP
JUN	COMMUNITY OUTREACH	IP
JUL	LOCAL COMMITTEES FORMATION AND ORIENTATION	IP
AUG	RECRUITMENT OF LOCAL ENABLERS	IP
SEP	ENABLER TRAINING	IP
OCT	1ST REFRESHER TRAINING FOR ENABLERS	IP
	REFLECTION MEETING FOR THE FIELD STAFF TRAINERS	PENROSE
NOV	2ND REFRESHER TRAINING FOR ENABLERS	IP
	IMPLEMENTATION REVIEW AND LESSON LEARNING/SHARING EVENT	PENROSE
	KIOSK INSTALLATION	IP
DEC	DISTRICT LAUNCH EVENTS	IP
	START OF KIOSK PROJECTS	IP
	ENABLER CELEBRATION DAY	IP



# BUSINESS MODEL

2017 TIME FRAME	CORE ACTIVITY DURING IMPLEMENTATION CYCLE	RESPONSI
JAN	IMPLEMENTATION REVIEW	PENROSE
	INITIAL FEEDBACK ANALYSIS OF PROJECTS	PENROSE
	INITIAL ASSESSMENT ANALYSIS	PENROSE
FEB	CONTENT GENERATION UPDATE BASED ON FEEDBACK	PENROSE
	ASSESSMENT UPDATE BASED ON FEEDBACK	PENROSE
	APPLICATION AND ASSESSMENT OF POTENTIAL IMPLEMENTING PARTNERS	PENROSE
MAR	ORIENTATION PROGRAMMES FOR NEW IMPLEMENTING PARTNERS	PENROSE
APR	REVIEW PROGRAMMES FOR PREVIOUS IMPLEMENTING PARTNERS	PENROSE
MAY	SELECTION OF COMMUNITIES AND SIGHTING OF KIOSKS	IP
JUN	COMMUNITY OUTREACH	IP
JUL	LOCAL COMMITTEES FORMATION AND ORIENTATION	IP
AUG	RECRUITMENT OF LOCAL ENABLERS	IP
SEP	ENABLER TRAINING	IP
OCT	1ST REFRESHER TRAINING FOR ENABLERS	IP
	REFLECTION MEETING FOR THE FIELD STAFF TRAINERS	PENROSE
NOV	2ND REFRESHER TRAINING FOR ENABLERS	IP
	2nd ROLLOUT IMPLEMENTATION REVIEW AND LESSON LEARNING/SHARING EVENT	PENROSE
	1st ROLLOUT EDUCATION REVIEW AND LESSON LEARNING/SHARING EVENT	PENROSE
	2nd ROLLOUT KIOSK INSTALLATION	IP
	KIOSK MAINTENANCE	IP
DEC	2nd ROLLOUT DISTRICT LAUNCH EVENTS	IP
	START OF KIOSK PROJECTS FOR NEW DISTRICTS	IP
	ENABLER CELEBRATION DAY	IP
	GRADUATION OF INITIAL LEARNERS/ INTEGRATION OF LEARNERS INTO FORMAL SCHOOLS	PENROSE

2018 TIME FRAME	CORE ACTIVITY DURING IMPLEMENTATION CYCLE	RESPONSI
JAN	IMPLEMENTATION REVIEW	PENROSE
	FEEDBACK ANALYSIS OF PROJECTS	PENROSE
	ASSESSMENT ANALYSIS	PENROSE
FEB	CONTENT GENERATION UPDATE BASED ON FEEDBACK	PENROSE
	ASSESSMENT UPDATE BASED ON FEEDBACK	PENROSE
	APPLICATION AND ASSESSMENT OF POTENTIAL IMPLEMENTING PARTNER	PENROSE
MAR	ORIENTATION PROGRAMMES FOR NEW IMPLEMENTING PARTNERS	PENROSE
APR	REVIEW PROGRAMMES FOR PREVIOUS IMPLEMENTING PARTNERS	PENROSE
MAY	SELECTION OF COMMUNITIES AND SIGHTING OF KIOSKS	IP
JUN	COMMUNITY OUTREACH	IP
JUL	LOCAL COMMITTEES FORMATION AND ORIENTATION	IP
AUG	RECRUITMENT OF LOCAL ENABLERS	IP
SEP	ENABLER TRAINING	IP
OCT	1ST REFRESHER TRAINING FOR ENABLERS	IP
	REFLECTION MEETING FOR THE FIELD STAFF TRAINERS	PENROSE
NOV	2ND REFRESHER TRAINING FOR ENABLERS	IP
	3rd ROLLOUT IMPLEMENTATION REVIEW AND LESSON LEARNING/SHARING EVENT	PENROSE
	1+2 ROLLOUT EDUCATION REVIEW AND LESSON LEARNING/SHARING EVENT	PENROSE
	3rd ROLLOUT KIOSK INSTALLATION	IP
	KIOSK MAINTENANCE	IP
DEC	DISTRICT LAUNCH EVENTS	IP
	START OF KIOSK PROJECTS FOR NEW DISTRICTS	IP
	ENABLER CELEBRATION DAY	IP
	GRADUATION OF LEARNERS/ INTEGRATION OF LEARNERS INTO FORMAL SCHOOLS	PENROSE

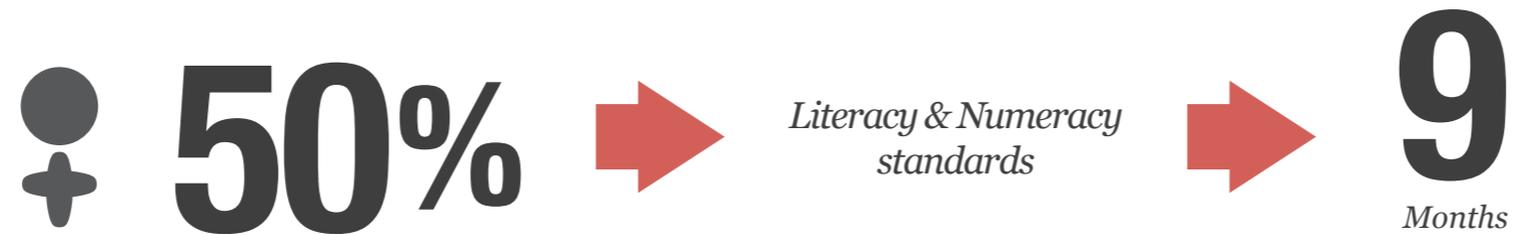


# ACTUAL PROGRAMS

## COMPLEMENTARY BASIC EDUCATION

The Government's Complementary Basic Education (CBE) programme seeks to provide out-of-school children with the literacy, numeracy and life skills in order to access primary education.

As our solution was an educational service, we first looked to bilateral government aid for both development and implementation of Bamboo. In our research we found a highly successful educational initiative already in place, the previously mentioned Ghana Complementary Basic Education program. This solution is very similar to our solution in that it sends enablers to communities to teach children outside of school. The Ghana CBE program received a budget of £2,484,444 from UKAID to be spent across 6 years (<https://devtracker.dfid.gov.uk/projects/GB-1-203330>). Because of the similarities of Bamboo and Ghana CBE, and with the same target users, we assumed initial funding of the same amount for our financial modeling. We also based our rollout schedule, with associated funding per year, on the CBE model.



Budget spend to date  
£1,917,035 (77.16%)



Project Budget  
£2,484,444

# TECHNICAL REPORT

## Technical report

Our final product has been designed from the twofold perspective of technology and socio-economics. Consequently, the technology used has been chosen so as to provide an inexpensive, sustainable, long-term self-sufficient and energy efficient solution.

In determining the technical design of our final product, we studied six different aspects explained below.



### INPUT

One of our first concerns was how to interact with children in an engaging way.

We studied four alternatives:

**Keyboard and mouse, Touch screens, Sensors, Image tracking**

The first and second options were discarded because they were not enough engaging.

Moreover, the touch screens are very fragile and are not suitable for an outdoor rural environment.

For our gesture based interface we based our input in kinnect, due to the constraints of sustainability and cost, we deeply studied how could we combine cheap sensors and low-cost image tracking to achieve an enjoyable experience with the users of Bam-boo.



### OUTPUT

Regarding the output, we studied mainly two options:

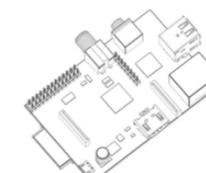
Screens: led displays, LCD screens or touch screens.

Projectors

The use of projectors has the great advantage that allows achieving a 360° experience.

However, the projectors are very fragile, expensive and they require a lot of maintenance.

Consequently, we decided to use LCD screens instead.



### HARDWARE

The motion tracking and the software need to be supported by some hardware. Our first approach was to use Arduino. However, we realized it was not enough and we decided to use Raspberry Pi instead, one for each screen.



### CLOUD

Amazon Web Services (AWS) is a secure cloud services platform that offers compute power, database storage, content delivery and other functionality.

Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale cloud computing easier. The most suitable EC2 is the T2 instances which are Burstable Performance Instances that provide a baseline level of CPU performance with the ability to burst above the baseline. Amazon Elastic Block Store (Amazon EBS) provides persistent block level storage volumes for use with Amazon EC2 instances in the AWS Cloud.



### CONNECTIVITY

Our solution needs to be connected to Internet to update its software. In Ghana, mobile phones are being progressively introduced and data services are available even in rural areas.

We proposed to use a 3G USB modem connected to the Raspberry.

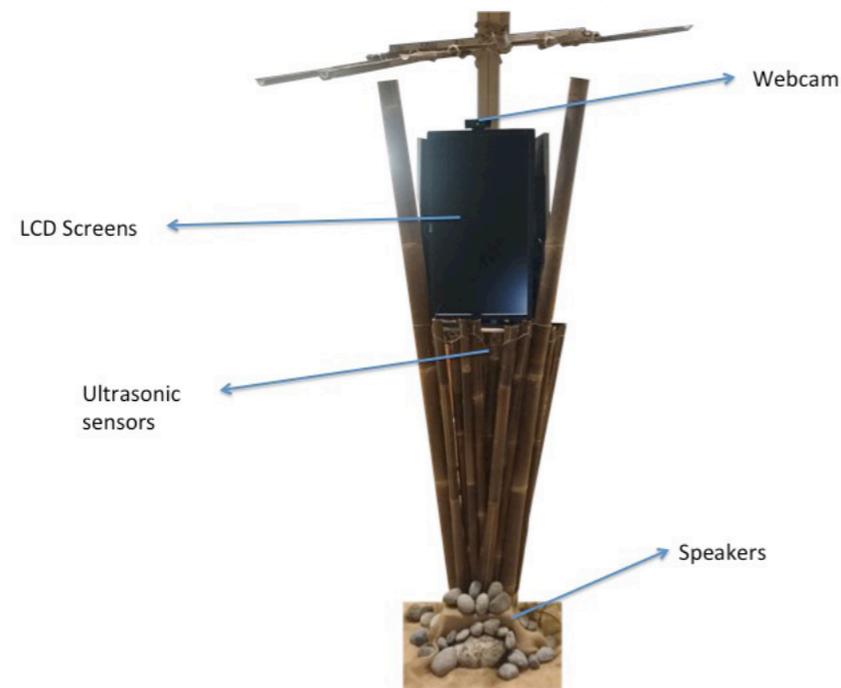


### ENERGY

Our product will use of solar energy and electricity.



# TECHNICAL REPORT



## *Proof of concept prototype*

*Our prototype included three screens connected to three computers via HDMI and secured to a wood frame covered with bamboo. In addition to the screens, a loudspeaker, a webcam and some sensors were also used to allow for user interaction.*



## *Games*

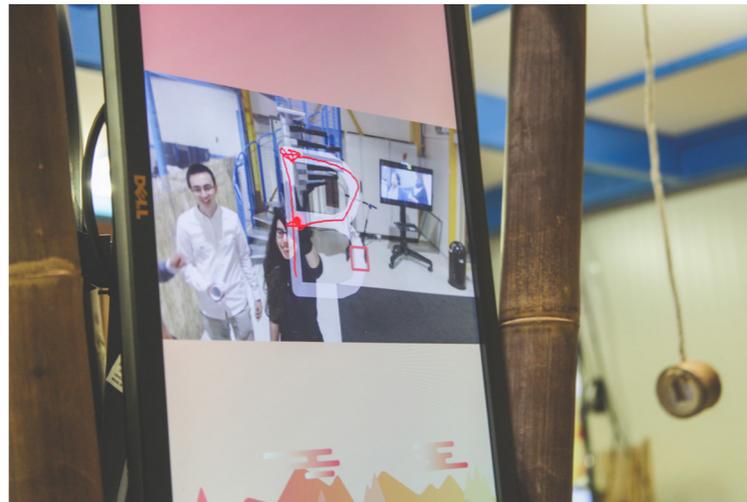
*In addition to the bacteria game, a spelling game was added. This spelling game was focused on teaching children how to write different letters of the alphabet. The distinguishing feature in this game was the interaction with the user without mouse and without touch screen, and instead using just image processing.*



## *Challenges*

*A water challenge was shown as an example of a Challenge Based Education course. The challenge included a game in which the user tried to kill the water bacteria.*

# TECHNICAL REPORT

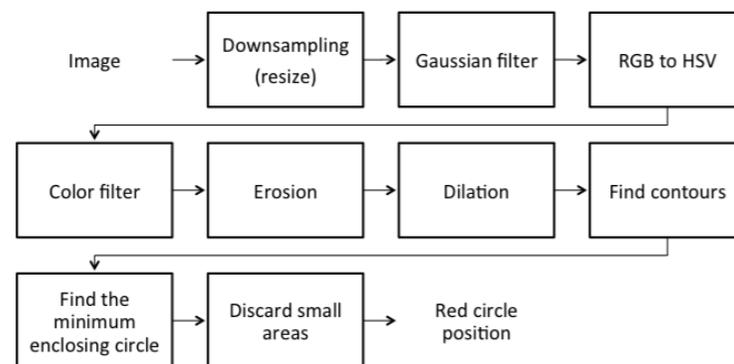


## Motion Tracking

*Low-cost image tracking was the most suitable way to manage the user's interaction as it does not require fragile touch screens and can be implemented just using only a webcam.*

*The game required an additional element apart from the webcam: a glove with a red circle. The glove allowed recognizing the position and movement of the hand.*

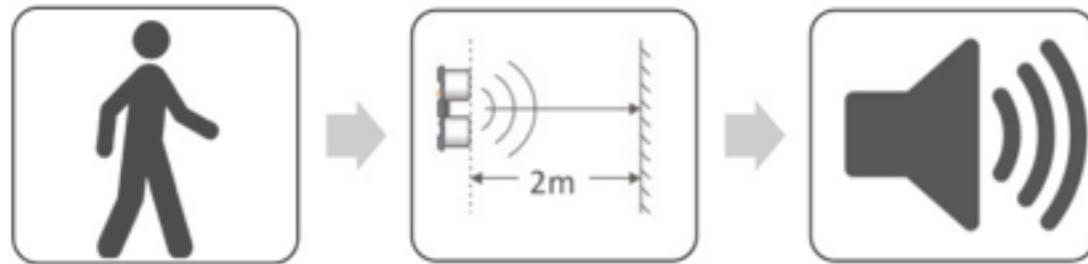
*To implement the image recognition, OpenCV library of C++ has been used. On a conceptual level, the image obtained from the webcam is decimated to decrease its size as processing the original image would be too much expensive in cost computing. In order to remove the image's noise (high frequencies), a Gaussian filter is applied. Then, the image is converted from RGB color space into HSV due to the fact that it is easier to identify the colors in this space using only one number and then choose the saturation and value (this way is easier to get rid of lightning problems). Afterwards, another filter is applied: a color filter. This filter makes a two-way thresholding operation, establishing a minimum value and a maximum one, thus creating a range of allowed values. The result of the filter is a binary image with 0 in the pixels where the original value was not inside the range, and 255 in the pixels that were inside that range. Two very common morphology operators, first erosion and then dilation, are applied to the image in order to remove extra noise. Using this binary image as a source, we find the contours of those white areas (which in the original image are our targetted red areas) and afterward we search the minimum enclosing circle of those contours. Finally, the smallest areas are discarded and we obtain the red circle. We use its enclosing circle to get the center of our red circle. A letter was printed on the screen and the trace of the hand was compared with the letter shape recognizing if it had been correctly written.*



# TECHNICAL REPORT

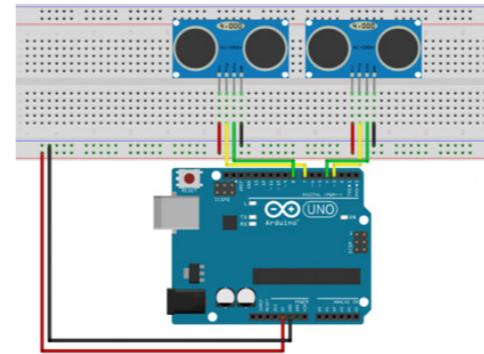
## Ultrasonic sensors

Bam and Boo interact with the children while they are playing and learning. To simulate this communication between the virtual teachers and the user we used two ultrasonic sensors with an Arduino UNO and a speaker. When people came into close proximity with Bamboo, Bam and Boo invited them to join and play with them.

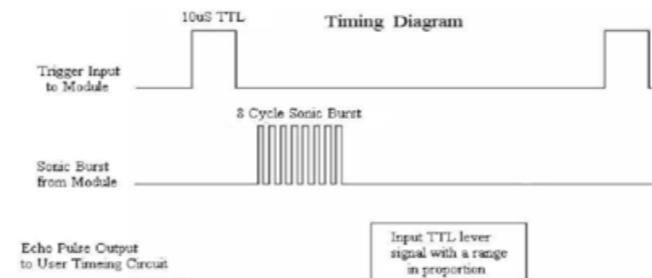


Two ultrasonic sensors, placed under two of the screens, were used in order to detect the presence of people closer than 2 m.

The ultrasonic ranging modules used, HC - SR04, provide 2cm -400cm non-contact measurement function with an accuracy that can reach to 3mm. The sensor has four pins: 5V Supply, Trigger Pulse Input, Echo Pulse Output and 0V Ground. These four pins of the two sensors were connected to the Arduino Uno that was plugged into the computer. The schematic is shown below.



<b>Working Voltage</b>	<b>DC 5 V</b>
<b>Working Current</b>	<b>15mA</b>
<b>Working Frequency</b>	<b>40Hz</b>
<b>Max Range</b>	<b>4m</b>
<b>Min Range</b>	<b>2cm</b>
<b>MeasuringAngle</b>	<b>15 degree</b>
<b>Trigger Input Signal</b>	<b>10uS TTL pulse</b>
<b>Echo Output Signal</b>	<b>Input TTL lever signal and the range in proportion</b>
<b>Dimension</b>	<b>45*20*15mm</b>



In order to start the ranging, it is necessary to supply a short 10uS pulse to the trigger input. The module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo.

When the sensor detects ultrasonic from the receiver, it will set the Echo pin to high (5V) and delay for a period (width) with proportion to distance. To obtain the distance, measure the width of Echo pin.

The Echo is a distance object that is pulse width and the range in proportion. To calculate the range through the time interval between sending the trigger signal and receiving the echo signal:

$$\text{Distance [cm]} = \frac{\text{Width of the Echo pulse [\mu s]}}{58}$$

The formula applied is a result of using the sound speed, which is 340 m/s.

# TECHNICAL REPORT

## Code

The Arduino Uno managed the input and output signals and obtained the two sensors' output distance:

```
pritarDistances2sensors 5
#define TRIGGER_PIN 3 // Arduino pin tied to trigger pin on the ultrasonic sensor.
#define ECHO_PIN 4 // Arduino pin tied to echo pin on the ultrasonic sensor.
#define ECHO_PIN2 7
#define TRIGGER_PIN2 8
#define MAX_DISTANCE 400// Maximum distance we want to ping for (in centimeters). Maximum sensor distance is rated at 400-500cm.
long duration, distance, RightSensor, LeftSensor;

void setup() {
  Serial.begin(115200); // Open serial monitor at 115200 baud to see ping results.
  pinMode(TRIGGER_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
  pinMode(TRIGGER_PIN2, OUTPUT);
  pinMode(ECHO_PIN2, INPUT);
}

void loop() {
  delay(1000);
  SonarSensor(TRIGGER_PIN, ECHO_PIN);
  RightSensor = distance;
  SonarSensor(TRIGGER_PIN2, ECHO_PIN2);
  LeftSensor = distance;
  Serial.println(LeftSensor);
  Serial.println(RightSensor);
}

void SonarSensor(int trigPin, int echoPin) {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = (duration/2) / 29.1;
}
```

Once the Arduino printed the distances measured by the two sensors, another thread in Java took those measurements and reproduced a voice track of a set of 4.

```
130 //+
131 // Handle an event on the serial port. Read the data and print it.
132 // @param eEvent
133 //+
134 //+
135 @Override
136 public synchronized void serialEvent(SerialPortEvent eEvent) {
137     if (eEvent.getEventType() == SerialPortEvent.DATA_AVAILABLE) {
138         try {
139             while (input.ready()) {
140                 String inputLine = input.readLine();
141                 int dist = Integer.parseInt(inputLine);
142                 System.out.println(inputLine);
143                 if (dist < limit && (distance1 > limit || distance1 == 0) && (distance2 > limit || distance2 == 0) && (dist != 0)) {
144                     this.reproduceAudio();
145                     wait(100);
146                 }
147                 if (cont == 0) {
148                     distance1 = dist;
149                     cont++;
150                 } else {
151                     distance2 = dist;
152                     cont--;
153                 }
154             }
155         } catch (Exception e) {
156             System.err.println(e.toString());
157         }
158         this.notifyAll();
159     }
160 }
161
162 public void reproduceAudio() throws Exception {
163     try {
164         if (contAudio > 3) {
165             contAudio = 0;
166         }
167         Media media = audios[contAudio];
168         MediaPlayer mediaPlayer = new MediaPlayer(media);
169         mediaPlayer.play();
170         contAudio++;
171     } catch (Exception fail) {
172         System.out.println(fail);
173     }
174 }
```

# EXTERNAL EXPERTS

## *Invenio*

*Invenio is an integrated digital library and repository system. This free software released by CERN provides a framework to manage content in an efficient way and it allows to store a wide number of different contents, from documents to media such as photos and videos. As it offers a Google-like search interface with high customization options it makes this software a good option for content management.*

*As our solutions is highly based on different kind of content, we thought that Invenio could be a great solution to build our own content management system above it.*

*We talked with Nick Ziogas and Zoe Lawson to know the possibilities of this software. Jens Vigen, the Head Librarian of CERN, really helped us to understand the more high level functionalities of Invenio as he is using it for some UNESCO-CERN projects related with academic world in developing countries.*



## *Other CERN technologies and experts*

*As we have explained, our solution provides an engaging interface to interact with through sensors and computer vision. To do these, we wanted a detectors and sensors expert's point of view and we could talk with Tiago Sergio Santos, which gave us a lot of input in terms of hardware considerations.*

*We also contacted João Pequenão who is working at CERN MediaLab. As he is used to explaining hard topics in a friendly way (otherwise, how is he going to explain what is CERN doing to a non- physics audience?) and also designing these learning experiences, he helped us a lot with some ideas and feedback of how to present our content to kids in an engaging way.*

## *Universities*

### **Course Design**

*One of our most important content is Challenge Based Education. To be able to create such a content, we needed guidance in course design. That's why we reached Anna Iñesta, Director of ESADE Center of Educational Innovation, who gave us a master class on course design principles. She also helped us through the design of our first CBE program for the prototype.*

### **Cooperation programs**

*One of our main problems was the feedback from our real users (people from rural areas in developing countries such as Ghana). Eva Vidal is in charge of all the cooperation programs in UPC TelecomBCN and she has a lot of experience in terms of developing countries so she was fundamental to have insights of those countries and she also provides us with contacts in the ground.*

### **Contacts from ghana**

*Ousman Umar, Banasco Seidu and Ernest Asoi, they were one of our most important contacts along the project development as they provide us with priceless feedback and they allow us to test some of our ideas in actual Ghana villages. They provide us with information about their daily life, needs, problems and culture.*

# THANK YOU



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Clio Dosi*

*“Education is the most powerful weapon  
we can use to change the world”*

*- Nelson Mandela*





**PENROSE TEAM**