

Walking on Water

*Making it possible for young people
to learn computing skills
regardless of circumstance.*

by Drew Buddie

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Biography

Travelling Fellow Drew Buddie has been Head of Computing at the Royal Masonic School for Girls for over 20 years. He was formerly chair of Naace, the subject association for teachers of ICT and Computing.

He was one of only two teacher members of the Royal Society's Computer Education Project Advisory Group whose report into the state of Computing education in the UK – *'After the Reboot'* – is intended to have the same positive effect on the state of Computing education as its previous one – *'Shutdown or Restart'* – had.

As a prize-winning UK eTwinning Ambassador, Drew runs much-praised educational workshops and seminars to motivate others to see the benefits of using educational technology. He has been a judge for the annual TES school awards and he has curated speakers for many educational conferences.

Drew has two children and resides in Rickmansworth with his collection of boardgames.

Glossary

3D printing - processes used to create a three-dimensional object in which material is joined or solidified under computer control to create an object.

Arduino - an open-source microcontroller platform, designed for ease of use in terms of both hardware and software.

BBC Micro Computer - a series of microcomputers and associated peripherals designed and built by the Acorn Computer company for the BBC Computer Literacy Project in 1981.

BBC Micro:bit - an ARM-based embedded system designed by the BBC for use in computer education in the UK.

BECTA - was the lead agency in the United Kingdom for promotion and integration of ICT in education.

CAD – Computer Aided Design - is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design.

CAS – Computing At Schools – a grassroots UK community of professional practice as a shared endeavour.

CNC - tools such as routers, grinders and milling machines that are guided by computer instead of by hand.

Code Week – held in October each year, it is a grass-root movement run by volunteers to promote coding.

Coding – the use of programming code to solve a problem.

Computer Science - the study of the theory, experimentation, and engineering that form the basis for the design and use of computers.

Computing – the UK school curriculum subject comprising IT, Computer Science & Digital Literacy.

Creative Commons - is one of several public copyright licenses that enable the free distribution of an otherwise copyrighted work.

CSS – cascading Style Sheets, controls the layout of multiple web pages all at once.

Digital Literacy - the set of competencies required for full participation in a knowledge society. It includes knowledge, skills, and behaviours involving the effective use of digital devices.

eTwinning - a free online community for schools in Europe for finding partners and collaborating on projects within a secure network and platform.

Fab Lab – Fabrication Laboratory (fees normally apply for use of the facilities).

Fab Lab Livre – A Fab Lab that is FREE to use to members of the local community.

Hour of Code - a one-hour introduction to computer science, a worldwide initiative held each December.

HTML - the language that describes Web pages.

ICT – the former name of the subject taught in the UK, now called 'Computing'.

IT - the application of computers to store, study, retrieve, transmit and manipulate data, or information, often in the context of a business or other enterprise.

Javascript - a high-level, dynamic and interpreted programming language.

Makey Makey - an electronic invention tool and toy that allows users to connect everyday objects to computer programs.

Minecraft – the world's most popular sandbox, world-building computer game.

OLPC – One Laptop Per Child aka the \$100Laptop - an initiative aimed at providing inexpensive laptop computers to children in the developing world as a means of bridging the digital divide.

PHP – a scripting language designed for web development.

Python – a high-level programming language for general-purpose programming.

Quilombo - a Brazilian hinterland settlement founded by people of African origin who had previously been bound by slavery.

Raspberry Pi Computer – a small, low-cost, single-board computer manufactured in the UK

Scratch – a block based programming language created by MIT Media Lab.

Skype – the most well-known example of VOIP, created in Estonia.

Sonic Pi - an open source programming environment developed by Dr Sam Aaron, designed to explore and teach programming concepts through the process of creating new sounds.

VOIP – Voice Over Internet Protocol, of which Skype is an example.

Executive Summary

We are at a time of unrivalled computing capability. Recently a computer learned chess to the standard of a Grandmaster in only four hours. A digital currency is currently setting the world's economic markets on fire. Driverless cars will soon be on our streets. Social media is being bombarded with 'fake news' to such an extent that it is influencing the way people vote. It has never been more important for people to be understand how such technology works.

Computing, more specifically the coding element, is one of the 'trendiest' school subjects of our time. Educational systems and organisations are attempting to outdo each other to assist their citizens in improving their IT capability.

Young people in particular are those who will bear the brunt of the potential for this ever-evolving technology to disrupt our lives, and so it is of vital importance that society prepares its citizens to us it, and in so-doing gain an understanding of such technology.

In visiting a variety of organisations throughout the world it has become apparent that systems are in place to address this crucial issue, but such diversity exists that we cannot become complacent that equal opportunities to benefit from such initiatives are being made available.

Countries that regularly appear at the top of annual tables due to the prowess of their educational systems, have recognised the need to develop new curricula that introduce all of the elements of computing. These countries are helping to establish a generation that is using computers to create and develop content from a very early age, by training them to code directly within the school curriculum. In short, Computational Thinking is now perceived as a life skill that is as valuable to a person as reading, writing and arithmetic, and all schools would do well to introduce this concept in their curricula as soon as possible.

Such an effect is only achievable when teachers have received adequate training, when they have become experts themselves. Computer programming was once seen as the domain of hobbyists, because its importance within the curriculum was not properly recognised. However, after the publication of the Royal Society's seminal '*Shutdown or Restart*' paper in 2012, all of that changed in the UK. Although the reports was intended to impact the UK educational system, my Fellowship has shown that the report's influence has spread throughout the world. It seems that educational experts in every country know about that report and have been inspired by it to make long-term changes to their own curriculum.

I wanted to obtain first-hand evidence of the steps taken by a variety of countries to establish new curricula focussed on the delivery of Computer Education, and my travels ensured that I was able to do this.

Not every large computing organisation has the infrastructure to develop its own educational initiatives, but some do. I saw evidence of computing companies like Rovio whose faith in their own beliefs has led to them setting up their own school near Helsinki. When staff expertise is limited Estonian schools encourage their students to use their skills to play an integral role in school network support teams. In Brazil, organisations like the Lemann Foundation and the Ayrton Senna Institute have addressed the issue of accessibility through their outreach work to schools in financially deprived areas. '*Programo tu Futuro*', an initiative of the Buenos Aires city council, has addressed the

skills shortage by providing central locations, staffed by volunteer experts, where people can learn computing skills in their own time.

It is extremely fulfilling to learn of the benevolence of organisations like Google, who use their extensive resources to support the implementation of schemes to help people living in remote locations. The British Council do likewise in collaboration with Plan Ceibal to take English teaching to primary schools in the most distant parts of Uruguay where teachers may not have such subject knowledge, nor have the inclination or motivation to learn the new language.

Volunteers played pivotal roles wherever I went during my Fellowship. Hacker spaces and Fab Labs, where freely available equipment can be accessed by those who have a need, are made even more affordable when they are centrally funded and the experts provide their support free of charge. Such capacity is only possible though when sufficient funding exists, and so it is reassuring to see so many official organisations, like the Sao Paulo prefecture, decide to spend their money in this way because it yields long-term benefits for the whole community.

Throughout all of this, the availability of good quality resources is of paramount importance. It became apparent that although there is a wealth of computer training resources written in English, there is a massive need for resources to be written in other languages – particularly ‘minority’ languages like Estonian or Finnish. It is somewhat inevitable that the lack of such resources is a major barrier to non-English speakers learning anything more than rudimentary computing skills. I found it inspirational to discover that organisations, like the Estonian ProgeTiiger initiative, are tackling this matter, supported by volunteers like the Leostes.

Encouraging disengaged students to take an interest in a subject is an approach that the 826 Valencia organisation tackles head on. Their world-famous methodology for motivating young people so that learning important skills transform their lives really is a wonder to behold. It didn’t matter to me that this organisation targets literacy rather than computing as its mission, it still serves as a wonderful example as to how young people can be cajoled into learning by providing motivated professional help within an exciting, learner-centred environment.

The importance of having access to high quality software is paramount, and in producing Scratch, the Lifelong Kindergarten at MIT Media Lab have provided the world with a truly wonderful tool. Scratch is free and Open Source, and is available in 50 different languages. Both of which factors have added to its success and with 25 million registered users, makes it one of the greatest benevolent gestures in education today. Mitch Resnick is always extremely appreciative about the accolades that his ‘greatest work’ justifiably receives.

Sadly, not all resources can be free, but initiatives like Brazil’s RUTE and the BBC Micro:bit ensure that low cost physical computing equipment can be readily accessible. However, one cannot ignore the impact of the imposition of import taxes of three or four times the item cost in countries like Brazil, which means that buying class sets of such devices soon becomes prohibitively expensive.

It is my hope that in this report provides an insight into the steps taken throughout the world to create a new generation of technology-savvy young people, because the future prosperity of the world depends on such an outcome.

Seymour Papert taught us many things, in particular he believed in the need for children to learn computing skills if they were to succeed in later life. This is true whether they live on the doorstep

of the one of the world's most exciting technology centres in Boston, one of the highest achieving academic countries in the world in Helsinki, or a Quilombo community in Brazil. Societies must learn all they can from each other in order to create an equilibrium of experiences for all.

Recommendations

1. The Government should provide incentives to successful UK technology companies to encourage them to create their own schools, as has been done by Rovio in Finland and Facebook in USA.
2. The Government should require that 'Computational Thinking' is taught as a mandatory basic skill cross-curricular theme, with the same importance attached to as it given to literacy and numeracy.
3. The Government should fund the creation of centrally-located Fab Labs or Hack Spaces which would be made free to members of the public. These would serve as hubs for learning computing skills beyond traditional school classrooms.
4. The Government should require shopping centre management companies to provide one empty unit in every newly created shopping centre for use as a formalised space for the local community. Such units should be made available on long-term contracts with a peppercorn rent.
5. The Government should investigate ways in for the provision of computing experiences to be more equitable for those in positions of personal disadvantage eg. race, gender, disability or poverty.
6. The Government should provide financial incentives for organisations to allow employees to carry out outreach work to teaching computing skills within the community.
7. The Government should consider using computing skills as a focus to increase the employability of post-18 individuals who are seeking work but who may be unable to procure specialised jobs without obtaining lengthy qualifications.
8. The Government should adapt the UK Computing curriculum so that it directly incorporates the opportunity for young people and their teachers to work on projects and tasks that directly relate to them and their community. Steps should be taken to ensure that formal qualifications also incorporate scenarios that young people can personally relate to and which solve real-life problems to help their local community.
9. The Government should provide additional Pupil Premium funding to schools to be ring-fenced for spending specifically on the provision of computing training of students.
10. The Government should simplify the process for volunteering adults to be able to teach children vital computing skills outside the classroom, whilst recognising the importance of stringent DBS checking of such adults.
11. The Government should establish an organisation like BECTA to oversee the broader development of computing education in the UK. BECTA is missed by many in the UK education sector because there is a need for the creation of a central organisation to support the teaching of computing across the curriculum, just as BECTA did with ICT. This would not

replace CAS but would complement the phenomenal work done by that grassroots organisation.

12. Teachers of Computing in the UK should be encouraged to make their published resources available in languages other than English, or to release them on a Creative Commons licence to enable others to translate them.
13. A central, easily navigable national repository of educational computing resources should be created, with teachers encouraged to contribute to the repository. Such contributions should be recognised by a nationally endorsed reward system. . There are countless UK initiatives designed to encourage young people to learn computing skills. This fragmentation can be counterproductive because many organisations in the UK are currently re-inventing the wheel or doing the same thing.
14. A qualification system should exist to enable UK schools to appoint current post-16 students in a network support role within their school, with such work counting towards fast-tracked university application or other career pathways.
15. UK companies should find ways of providing physical computing components, like the BBC Micro:bit and Raspberry Pi computers, to countries where tax duties dramatically increase the cost of items when they are imported.
16. UK manufacturers of physical computing components like the BBC Micro:bit and Raspberry Pi computers, should consider setting up manufacturing centres within other countries that have prohibitively high import taxes.
17. Schools should be encouraged to use Scratch and all of its derivative products (Snap!, NetsBlox, GP etc) throughout the computing curriculum.
18. The UK should host an annual conference as a showcase of the work done by teachers and students in the UK and further afield in the use of Scratch and other programming languages.
19. A UK organisation should host a future world Scratch conference as soon as possible.
20. The British Council should expand the eTwinning initiative to incorporate more countries so that young people all over the world can benefit from collaborating on projects. eTwinning should be used as a conduit for UK schools to provide computing help and support to schools in more deprived parts of the world.
21. Schools should be more open to the valuable ways that computer games can be used in the classroom to support learning.
22. Publishers of English-language educational computing resources should commit to publishing versions in languages other than English in order to support countries who find it difficult to source high quality resources written in their native language.

Background

The UK's educational system is widely revered. Despite not placing as high as it should in the prestigious PISA rankings, there is no doubt that educators and politicians from all over the world look up to the country for the way it approaches the way it educates its young people. It is seen as a source of innovation and inspiration to others because it is a test-bed for ideas which other countries wish to follow. Nowhere is this more evident than in the relatively recent, and somewhat controversial, decision to change the ill-performing subject of ICT to Computing, with a view that all children in the UK would be able to learn to code.



Fig. 1 - The BBC Microcomputer

Over 30 years ago, the BBC Micro Computer was the first of its kind. It was a computer designed purely for education by tying into a series of television programmes in showed viewers learned how to tinker with their devices and to write computer programmes. At this time BBC Micro Computers were introduced to schools throughout the UK so that educators could build on the TV programmes to teach the BASIC programming that would enable students to develop skills, which until that time had not previously been taught in UK schools. For many of those – mostly boys – who learned to use the BBC Micro Computer this was their first foray into programming, and would lead to them developing their interest from hobbyist to professional programmer. In fact, if you ask many computer programmers of a certain age about their influences & backgrounds, they will tell you that were it not for having use of a BBC Micro Computer at home and/or at school, then they would never have taken up a career in the computer industry.

I attended high school just before the implementation of this initiative, and so I did not have the opportunity to learn to use a computer during that part of my education. However, I was lucky enough to train as a teacher (after gaining a BSc Hons in Computer Science & Biology) and the computers which I trained to use were BBC Micro Computers – so it was a thrill to play a part in introducing young people to programming for the very first time in their lives. Despite all of the benefits that arose from this project, it was impossible to ignore the fact that it was to be short-lived. This was because it was always felt that it was too niche and the curriculum was too poorly developed, for the subject to gain enough traction to be treated as a timetabled subject in its own right for all students to pursue throughout all of the compulsory part of their education. It was just too insufficient at the time to make it much more than a subject that was an expanded hobby for all but the most dedicated people to pursue.

It is now apparent that this was an important moment in UK education, but it is one that quickly and unfortunately passed. Three decades later, what had started as an exciting adventure for many students being taught to write programs, had ended up being developed in a way that lost the impetus of the initial project. As computers had started to influence our lives more and more, the curriculum for the subject started to focus on what was seen as more important (but ultimately

trivial) elements as the subject evolved into a new subject called 'IT'. In this new school subject IT, to later be known as ICT, programming played a miniscule part of the curriculum only being taught by ever-diminishing numbers of teacher who themselves were interested in programming.

Consequently, over time the ICT curriculum became widely (and unfairly) seen as uninspiringly constructed and poorly taught because for many it became simply about learning skills based around the use of Microsoft Office. Ask any student who attended school over the past 20 years to describe their ICT experience and will be very hard to find a single one who will tell you that it was a positive one. One journalist described teachers of ICT as being '*the runts of the teaching litter*'.

With students turning off the subject in such large numbers, with school inspection reports frequently citing ICT as being poorly taught to the extent that its teachers were once described as 'the runts of the teaching litter', and with it becoming clear that there was a desperate need for more computer programmers, it was clear that something had to change.

That change was to come in the form of two seminal reports. The first of these was the '*Next Gen*' report written by Ian Livingstone & Alex Hope which explained that there was a dearth of skilled computer programmers in the UK and which called for a 'back to brass tacks' redesign of the way that IT was taught in UK schools and universities. The other report was the Royal Society's high profile investigation into the state of ICT as a subject in UK schools: the epoch-making report was '*Shutdown or Restart*' and it essentially was in full agreement with the '*Next Gen*' report that root and branch changes were required in ICT teaching in schools.

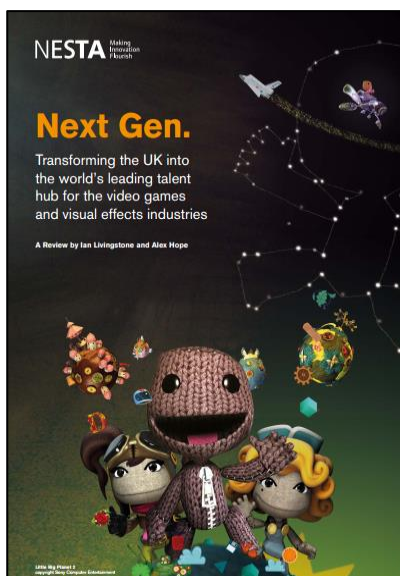


Fig. 2 - The Next Gen Report

By good fortune both reports were written at more or less the same time and landed on the desk of influential politicians who decided to act upon the advice given within them. Consequently, the subject of ICT was terminated in UK schools to be replaced with the broader but deeper subject of Computing, comprised of three elements: Digital Literacy, Information Technology (both of which had been the focus of ICT) and the important addition of Computer Science.



Fig. 3 - The Shutdown or Restart Report

This latter element would give the opportunity for schools to return to the heady days of BBC Microcomputer use three decades previously. Rather than computing being taught in an *ad hoc* way - if you were lucky - by a teacher who was a keen computer programmer, it became a mandatory skillset that every school had to deliver to its students.

Underpinning the new UK Computing curriculum is the belief that Computational Thinking is a skill that can help across the whole curriculum even if no programming is involved. Computational Thinking can be broken down into 4 parts: Abstraction, Pattern Recognition, Decomposition and Algorithms – in other words, all the elements required for problem-solving.

At this point it is important to mention one of the main tools used to teach programming in schools throughout the world: Scratch. Created as a logical continuation of the Logo-based educational ideas of Seymour Papert, Mitch Resnick and his gifted team at MIT have developed a simple block-based computing language underpinned by sound educational principles. Not only is it easy to learn for young students to learn, the fact that it is Open Source has meant that other organisations (such as Berkeley & Vanderbilt Universities) have developed their own derivative block languages from it such as Snap, GP & NetsBlox. These derivative languages are more complex than Scratch and ensure that students can extend their knowledge to do more complex projects once they are confident users of Scratch.



Fig. 4 - Seymour Papert



Fig. 5 - Scratch 2.0

By being freely available to all, Scratch is a truly exceptional gift to the educational computing world. However, an over-reliance on its use has led many people to feel that all attempts to introduce the challenges of Computer Science to the curriculum have been actually dumbed down by the use of such an apparently simplistic system. I wanted to use my research to refute this supposition.

Another recent addition to the Computing curriculum in UK schools has been the BBC Micro:bit. Designed in 2016 as a one-off celebration commemorating the 35th anniversary of the BBC Micro Computer, the BBC, in conjunction with Microsoft and a few other organisations, gifted a free BBC Micro:bit to each of the approximately 1 million 11-year-old children in the UK with the intention that the device would belong to the student, not the school.

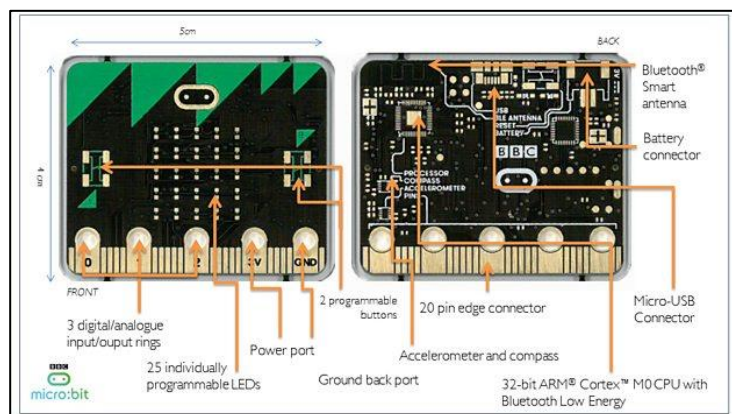


Fig. 6 - The BBC Micro:bit

It was hoped that this would encourage a whole new generation of 'tinkerers' such as those who 4 decades earlier had similarly experimented with their BBC Microcomputers. The low cost of the devices and the low point of entry in terms of skills needed to code them have ensured that BBC Micro:bit is perfectly positioned to achieve this. The charitable foundation behind the BBC Micro:bit plan to expand their use around the world and during my travels, taking some as gifts for my hosts, I hoped to see if students and teachers in other countries would benefit from the use of such devices in a similar way to how they were used in the UK.



Fig. 7 - Students using the BBC Micro:bit

The prevalence of other low cost technical equipment like those produced by Technology Will Save Us, Ohbot and the Makey Makey (made by some of the team who created Scratch) have helped to propel physical computing firmly into the Computing curriculum. The sheer affordability and simplicity of use of such devices has ensured that many students are now able to gain experiences of physical computing which would be hitherto impossible only a few years ago.

I had the privilege of seeing this for myself when I collaborated in running workshops with one of the greatest exponents of physical computing in an educational setting I ever met: the much-missed Bianca Ni Ghrogain.

After 3 years of this new curriculum it has become apparent that much is being done well in most schools, but I felt that there was also much we could learn from other countries. I wanted to find out how young people used computers in other countries around the world because I wanted to find alternative ways to implement their methodology in my own teaching and that of other Computing teachers in the UK.



Fig. 8 - Bianca Ni Ghrogain

As a well-known member of the educational community, I felt that once I had carried out my research, I could use my influence to support and help fellow Computing teachers to incorporate my findings into their teaching as well as using them to reassess my own methods of teaching. I also wanted to build bridges between this country and others so that teachers in the UK could aid teachers with less resources of governmental support for the teaching of Computing.

Journey 1 – Finland & Estonia

Espoo, Finland – Meeting with Peter Vesterbacka, Mighty Eagle, Rovio Entertainment

When Rovio released 'Angry Birds' its success was not immediate. Its initial success in Finland largely started by word of mouth recommendations, with friends and family downloading it to their mobile devices and then encouraging other people to do the same. Consequently, it became the Number One downloaded app in Finland in 2009. This was prior to the real success of iPhones, so the platform used was the Finnish Nokia brand. Pretty soon it became the Most Downloaded App with their Scandinavian neighbours which led to Apple showing an interest in making the app available on their platform which led to the app being the most downloaded across the globe for almost a year.



Fig. 11 - Angry Birds

In 2010, after reaching a total of 3 million downloads, Peter told Rovio that his target was to reach 100 million downloads. His colleagues scoffed at him and said it was impossible to achieve such a target, because until that time only the legendary Tetris had a comparable amount of downloads. Peter said he felt that society has always underestimated the need of people to communicate, and that is the reason for unexpected success of mobile technology as a platform. Thus Peter fully anticipated the forthcoming proliferation of smartphones, and this in turn led him to set such a seemingly incredible target for Rovio's little game.

In its first 12 months 'Angry Birds' achieved 50 million downloads with a further 25 million being added in December 2010, which Peter attributes to many people receiving an iPhone for Christmas and wanting to download the coolest apps to play on their device. 'Angry Birds' then reached 100 million downloads by March of 2011, much faster than even Peter had thought was possible. Peter recognises Rovio's success was due to the symbiotic relationship that they had with Apple, as the iPhone's growth led to people downloading their (free) app because it was seemingly permanently No.1 in Apple's Game chart.

The immediate consequence for Rovio upon reaching the seemingly impossible 100 million target was a self-belief that *anything* was possible. Peter's analogy is that people brought up in an arctic country like Finland are not put off when people say '*you can't walk on water*' because they know they actually *can* when it has frozen over. You see, it's all about *perspective*. Thus it was then that Rovio attained the belief that *anything* could be achieved. First you think something is impossible, but then you actually realise it is easy if the conditions are right, and then you start to build faith in your dreams.

By the time I met Peter there were over 3 billion downloads of 'Angry Birds' - meaning that almost 1 in every 2 people on the planet has a copy of the game. The company has used the Intellectual Property created by the 'Angry Birds' characters to enable them to now have 66,000 different branded consumer products (drinks, cuddly toys, clothing, stationery sets etc) around the world as well as a high-grossing Hollywood movie based on the game.

Peter estimates that 9 out of every 10 people on the planet are aware of the 'Angry Birds' brand – whether or not they have ever actually played the game – and it is interesting to compare how long well-established organisations like Disney and Marvel took to reach these sorts of figures.

Peter believes that it is good to have high expectations and that now whenever Rovio creates a new product their estimates for measuring success are much higher than they were in the light of the success of the first 'Angry Birds'.

Rovio is a large organisation which does many things and coding is not a vital skill. Peter believes that it is good to have a basic understanding of coding because it gives you an understanding of how things work. Digital Literacy is important because it helps you know how products are built, you know what is possible – then you know what is reasonable to expect your team of coders to actually do. He believes coding is good for computational thinking and logical decision-making. You can make a lot of things with code and it can be more creative than you realise – it is almost an *art* in itself.

Peter thinks coding should be actively used in art, music or cooking lessons, something that is about to happen in Finland where they are moving to project-based activities instead of discrete subjects. Coding is ideal for this sort of activity as it is suitable for use within all subjects. A teacher in such a context needs to be more than a '*domain expert*' and more of a '*coach*'. In developed countries of the people entering school more and more already now know how to read and write, and the same could be said about topics they are interested in. This puts more pressure on the teacher that they cannot always know more than the student about every aspect of the subject. School is now more about '*learning to learn*' than it has ever been before.



Fig. 12 - The Mighty Eagle himself

In his role with Rovio, Peter advises the Minister for Education about how coding could be incorporated into the Finnish education system. By observing his own children, Peter has been able to compare the success of the Finnish education system with that of the Asian education systems that also consistently sit at the top of the PISA rankings. Asian schools typically achieve their fantastic results from long school days, lots of homework and stress, whilst in Finland they achieve similar results with short school days, no homework and reduced amounts of testing. Peter has found that the emphasis on testing in South Korea means that children there do not learn something if it is not to be tested, which Peter sees as being less efficient. Because it has made children less curious. This has led to Rovio creating a spin-off education-facing organisation called '*Fun Learning*' and they have set up their own school called Fun Academy, which Peter offered me the opportunity to visit but time did not permit me to be able to do so. In this context '*Fun*' is used as a synonym for '*engagement*'. Peter gave this example to clarify his meaning:

"In Finland more boys used to speak English than girls. There is one simple reason that explains why this is the case... because boys played more [computer] games than girls and the games are all in English. This difference is becoming less pronounced now that girls are playing more [computer] games and their consumption of English language media has increased. Thus young people are compelled to learn something – English in this case – when they are engaged"

Peter is proud of the way that 'Angry Birds' has made its way into the curriculum of a subject like physics, but this outcome was not planned. He felt that they got the product so right, that many other factors went in their favour ie. the game was popular, frequently updated, challenging, well-designed, accessible, engaging etc. and teachers were almost compelled to use it in lessons, particularly when they saw the authentic use of physics as a game mechanic.

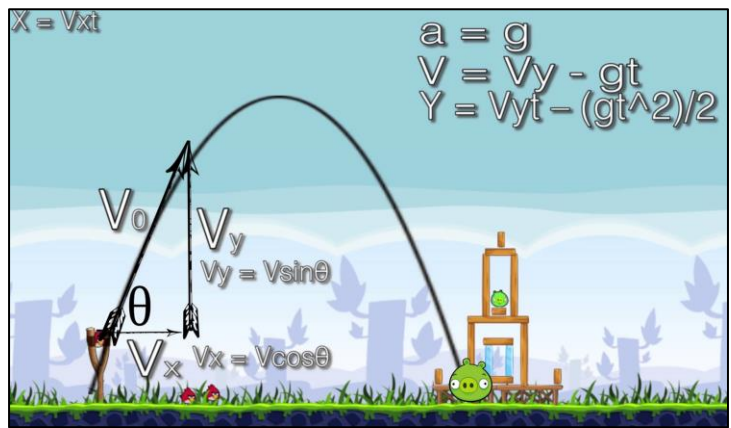


Fig. 13 - Example of the 'physics' within Angry Birds

An interesting spin-off from this is that a later 'Angry Birds' update was produced that was used to overtly teach people about the solar system for which Rovio actually worked in collaboration with NASA thereby adding further authenticity to an already popular app.



Fig. 14 - Screenshot of the NASA-endorsed version of Angry Birds

Rovio contributed 'Angry Birds' activities to Code.org for their 'Hour of Code' week [By a cool twist of fate, I was able to see students use this very activity when I visited the schools in Ititiba, Brazil!] and by doing so the characters were what engaged the students to attempt the tasks. Peter thinks the activity was brilliantly packaged by Code.org because it implied taking an hour out of your lesson would help you introduce coding

to your students, with the 'Angry Birds' characters already being known to them (remember that 9 out of 10 people on the planet know the brand?) leading to instant engagement, even if the task itself didn't.

I believe that the use of 'Angry Birds' for programming tasks helped engage teachers because of two strokes of genius. Firstly, as the game itself is seen as easy to use, teachers were able to think 'how hard can it be to do a coding activity using those characters?' Secondly, because so many children were already aware of the game mechanics underpinning 'Angry Birds', when confronted with the puzzles they had to solve, students did not have to have their goals explained to them, they were already clear ie. 'move the bird to the pig'; this inherent knowledge meant the challenge was clear to all students. Neither when teaching 100 students in my own class or in the classes in Ititiba that I was to observe later did the

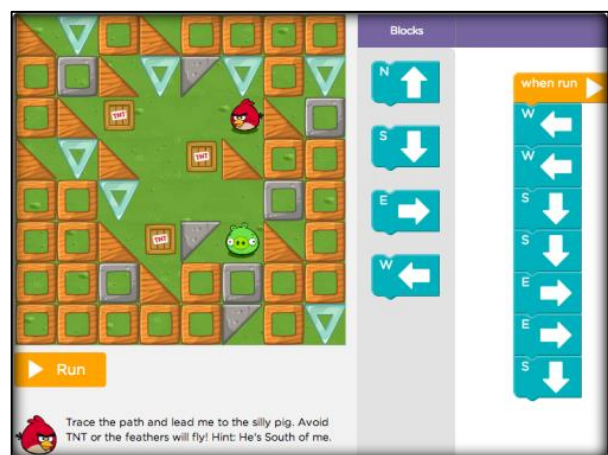


Fig. 15 - Angry Birds activity for Code.org's 'Hour of Code'

students have to have explained the goal of the task to them. Both of these elements worked exceptionally well, with the Code.org activities being incredibly popular throughout the world.

Education is competing for people's time. Peter believes to engage children we need to be '*where the kids are*' and any tool that can ameliorate this process is worth its weight in gold.

Peter believes that learning is now '*out of control*' because with the proliferation of mobile devices children can learn anywhere they want, not just in the classroom and so schools have to do a great deal now to ensure students realise why a school is important. Schools are now challenged to do more than they ever did before to justify their *raison d'être*. No longer can children only learn what you want them to learn, they are able to learn what they *choose* to learn.

Tallinn, Estonia – Meeting with Chris Holtby, UK Ambassador to Estonia



Fig. 16 - Chris Holtby, UK Ambassador to Estonia

The UK Ambassador has played a pivotal role in assisting Estonia with its attempt to incorporate the subject of computing into the school curriculum.

Using his many contacts Chris has been able to work with the Ministry of Education and help to give them examples of good practice. Chris has established links between UK educators and their counterparts in Estonia. As the UK is more than ten times the size of Estonia and is well ahead in establishing a computing curriculum, it is only right that he should offer this type of support in order to help Estonia to succeed.

I saw just how important a part Chris has played when he went out of his way to introduce me to a variety of contacts who I was able to meet later during my visit.

My conversation with Chris established that great possibilities exist for UK-based educators to collaborate with those in Estonia, and by extension other countries, to help give more students around the world the opportunity to learn computing skills at school.

Tallinn, Estonia – Meeting with Edmund, an Estonian teacher of Computing

Despite only having a population of 1.3 million people, Estonia has much to inspire its young people because the world's most famous brand of VOIP, Skype, was created in the country. But Estonia is no '*One Tech Pony*' for its government was the first in the world to be fully *e-enabled* and if some of its politicians had their way it would become known as *e-stonia*.

To encourage the next generation of computer experts the Estonian government has introduced the teaching of coding for students aged 7 to 19. But unlike other countries who taken this route, Estonia hopes not just to create coders, but so that their young people grow up with a smarter relationship with the technology they use and the Internet.

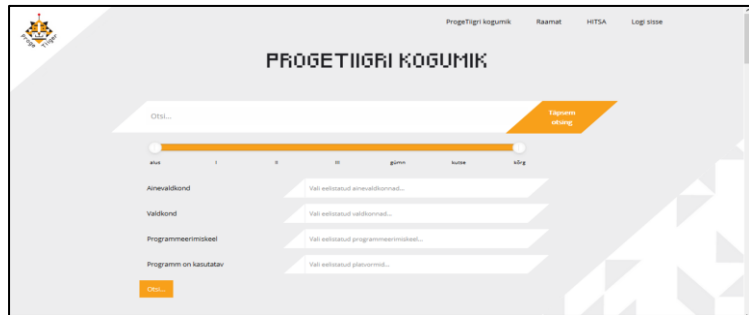


Fig. 17 - ProgeTiiger website

To help the 550 schools in the country they have set up an organisation called ProgeTiiger to help Estonian people to learn to code, but have intentions to make it an international collective, with an ultimate aim that each country would have its own micro-organisation participating as part of the larger organisation.

The founder of the project, Ave Lauringson says:

“We want to change thinking that computers and programs are just things as they are. There is an opportunity to create something, and be a smart user of technology.”

ProgeTiiger organise Codeweek and produce materials in Estonian so that those who do not speak English can participate – thereby increasing accessibility.

The organisation also encourages parents to get involved by volunteering their time to visit schools and teach students how to code. In this way, crowd-supported events have helped the organisation to thrive and it is proving popular with students.

Schools have embraced the organisation, with many headteachers using it to form a network that enables them to offer coding as a skill within their schools without having trained staff in place to do this.

The website is a one-stop shop containing a wealth of resources to help people of all levels of ability. One aspect that they concentrate particularly on is robots [a particular aspect of computing that was to keep cropping up throughout my travels]. The Estonian government is trying to support schools in their purchasing of expensive robotics equipment. A solution that many schools have come up with to make such money go further is to build their own robots from scratch using Arduino. A consequence of this is that students building such robots are becoming skilled in areas of technology not usually taught in schools – they need to *build* the robot before they can *program* the robot. They have found that students are more engaged when

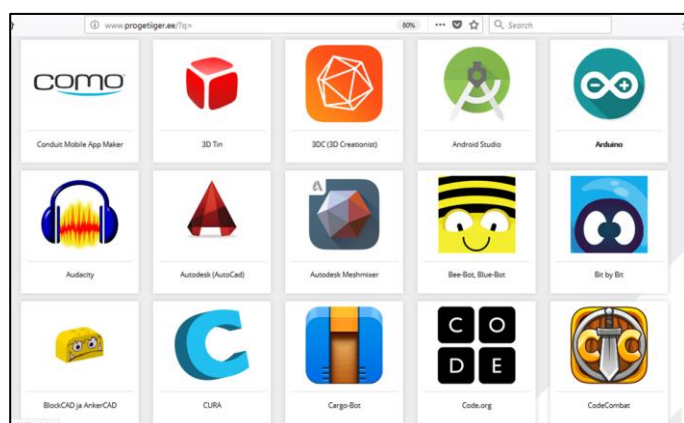


Fig. 18 - ProgeTiiger resources

programming a robot they have built themselves, than when programming a pre-built robot. This is leading to specialism by many students in the field of robotics – an exciting prospect for the future of Estonia.

It is important for Estonia to develop a strong cohort of programmers because there is currently a shortage of native Estonians who are capable of filling all of the current programming vacancies in Estonia. The decision to start teaching to primary aged schoolchildren is a long-term plan that is likely to take at least a decade and a half to bear fruit, whilst Estonia's need is more immediate than that – it needs programmers *now!* The '*structured thinking*' embodying the way of working that a programmer adopts, will lead to a generation of more creative thinkers. People in possession of such skills will be able to tackle more complex challenges. Such a way of thinking led to the creation of Skype, a product of which every Estonian is justifiably proud.

It is widely recognised that the best educational resources for helping people to program tend to be available in English. So it is a fundamental issue that affects accessibility to this profession for those Estonians who speak little English. ProgeTiiger has helped address this issue by producing a wealth of resources specifically for Estonians in their native tongue.

To encourage teacher participation in training courses the Estonian Department for Education run a competition with a prize of 10,000 Euros – the winner must have participated in training courses and have gone on to organise their own to cascade their knowledge forward by training other teachers. A spin-off consequence of this prize is that schools who did not initially participate in the project observe the success of those who did, and they become motivated to emulate such schools so as not to be left out. This accidental competition has ensured that students are the beneficiaries because now more and more schools are providing programming training in order to '*keep up with the Sepps [the most common surname in Estonia]*'.

Estonian schools are currently working in collaboration with Finnish schools to create teaching materials that can be used by teachers in both countries. By pooling their resources like this, both countries have directly benefited their students and that has to be a good thing.

Tallinn, Estonia - Visit to Gustav Adolph Grammar School

I was thrilled that Chris Holtby was able to arrange for me to visit the most prestigious school in Tallinn in order to see how they used computers. This was important to help me understand how Estonia was incubating reputedly the most computer literate children in the world.

Founded by the king of Sweden in 1631 and housed in buildings dating back to the 13th century, Gustav Adolph Grammar School is the oldest school in Estonia and one of the oldest grammar schools in the whole of Europe.

The school currently accommodates around 1100 students aged 7-19 and has built a formidable reputation for teaching the sciences, French, English and Swedish language and culture. However, its specialisation in subjects of historical importance belie the fact that the school is rapidly gaining acknowledgement for the advances it is making in the teaching of computer technology.

The use of ICT has gained such ground at this school that it features heavily in the promotional materials used by the school to recruit students. I was impressed to learn that ICT is integrated into every subject. It was strange to see in this centuries old building, anachronistically contrasting with the preponderance of busy, well-stocked computer labs with 3D printers, overflowing with Arduino computers and robotics equipment. I believe there is a lesson in this particular image which shows that tradition should never get in the way of progress if the purpose is a positive one.

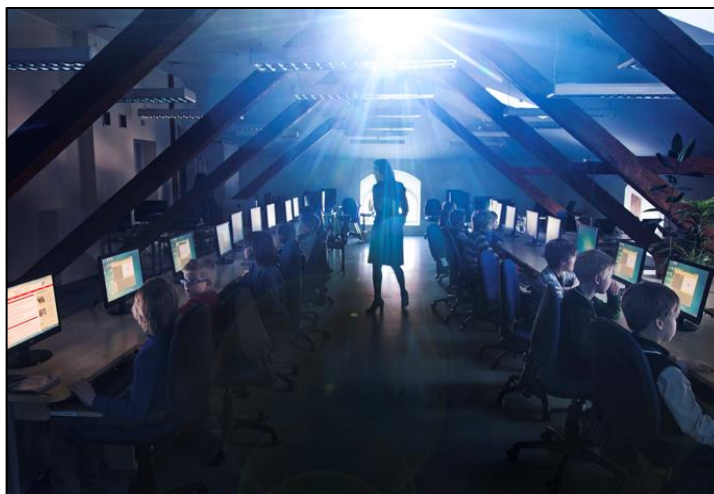


Fig. 19 - The futuristic-looking setting for Computing lessons in one of Europe's oldest schools

I saw first-hand evidence that showed how the curriculum emphasises the use of such modern technology such that from the earliest age within the school, the foundations are firmly laid for the teaching of programming.

The pupil experience of technology is enhanced by the skills of their teachers. In this school, teachers create their own electronic learning materials and many of them are so skilled in the use of the national study material resource bank (called Koolie), that they are nationally revered as experts in the field. Teachers help each other within the school by encouraging each other to use ICT in their subjects.



Fig. 20 - A maths lesson incorporating coding at Gustav Adolph Grammar school



Fig. 21 - staff responsible for teaching coding at Gustav Adolph school

It was a great honour for me that teachers and students prepared a reception for me so that I could learn more from them by interviewing them.

It was a very special moment for me, after receiving a wonderfully informative tour of the school, to be steered into a small, candlelit room containing several expectant teachers and students and a table brimming with local delicacies.

The teaching of coding began in Gustav Adolph school as long ago as 2007 by the technology teacher. As a result of excellent national publicity, the impression has been given that every school in the country actively teaches computing – but this is far removed from the reality. Gustav Adolph is very much at the forefront of the

teaching of the subject in Estonia because it has a combination of excellent facilities and very knowledgeable, motivated staff. ProgeTiiger has played a part in ensuring that the staff at this school are kept up to date with the latest tools and initiatives, and their skills are continually enhanced too.

The school does not have discrete Computing lessons, but instead teachers who want to use IT within their subject area, or for project-based problem solving, will book the IT lab and tell the

specialist teacher what it is that they want the students to do. The subject teacher then takes responsibility for the specific subject knowledge whilst the specialist IT teacher acts as a facilitator to support the students in their use of IT – this is almost team teaching.

In secondary schools the responsibility for teaching coding rests with Maths teachers – something that not all such teachers are happy about. In this school students use Scratch in Year 3 Maths lessons, which is where their programming journey begins.

A huge issue for a small country like Estonia is the scarcity of teaching resources written in their native language. This truly hinders the progress of young children who do not yet have even a rudimentary understanding of English. Likewise, it holds back any teachers who do not speak English either. The Estonian teaching community is out for resources that are in their native tongue, and so it is for this reason that ProgeTiiger was devised.

The school produces its own resources for elementary grade computing lessons and they share these with other teachers throughout the whole of Estonia. They have also piloted a project where students teach each other skills like Unity programming, and they love it so much that it is one of the activities most requested by students throughout the whole school.

The University of Tallinn plays an important role in the teaching of programming in schools and this was the third time during my visit where I had learned about their benevolence to the wider educational community within Estonia.

The demand amongst students for learning Javascript outweighed the lack of staff skills, so the school had to do what it could to ensure it could be taught for the first year at least. So, as the school does not have any teachers qualified enough to teach Javascript they have had to employ a university lecturer who is loaned to them to do so, until the teachers are skilled enough to do it themselves.

The IT department in this school has a rather unique feature, one that I was extremely excited to hear about: the IT support for the school computer network is provided by a *current*, 18-year-old student! His story is fascinating:

“I was born at the wrong time... because as I got older they started teaching programming in lower grades... but I was too old to benefit from this... and when I got to secondary school I learned that there was no compulsory coding taught in the curriculum. You can choose [in the Estonian education system] one subject for yourself though, and one of these was programming. So for two years I learned HTML and CSS and PHP. But because programming is not in the national curriculum, people who are really interested in coding like I was, do not have a place to go. So they learn on their own. A lot. But they do not know where to put all their energy. From this year in Maths it is compulsory for students to learn Javascript in their lessons. Although I am still a student I have now become one of three IT managers of the school system – the others are my classmates who I am training. The money I am earning from doing so is going help to see me through university – it is an officially recognised role within the school. But best of all I know that I have helped my school in a very important way. Before taking the role my interest in computing was sparked by learning programming languages, then when I started the role I became fascinated by hardware like cables and switches, now I am even more interested in research and my position in this school allows me a lot of opportunity to do this”

The school goes further in its use of students as facilitators, as it has its own implementation of the UK's Digital Leader scheme, whereby younger students actually lead the lessons that are taught to other students. An example of this is that of a 3D printing workshop for teachers, which will be co-taught by a 15-year-old boy and a 9-year-old girl.

Students now approach the technology teacher with their own inventions and ideas, which they have designed ready to be printed. For me this is revelatory – as one pupil said:

“Now that we have a 3D printer and we know how to use it, can we connect it with the real world? We measure things in the real world and learn how important it is to be accurate if we want the objects we print to actually work.”

Robotics and Internet of Things are current aspects of programming which the school sees as areas they will focus on over the coming year. This makes me realise how schools really do start looking to the future once basic skills are well established.

Tallinn, Estonia – Meeting Jaanus and Janika Leoste

It was a privilege to be able to spend some time with Janika and Jaanus Leoste when in Tallinn. Both are heavily involved with technology in the small country and together they have become famous as the creators of an animated cartoon series for children and a series of books associated with the show. The episodes are created by the couple, and the voices of the characters are provided by themselves and their children. Their Estonian language series Janku-Jussi is immensely popular, getting almost 1 million views a month, making it the country's most popular childrens' animated series.

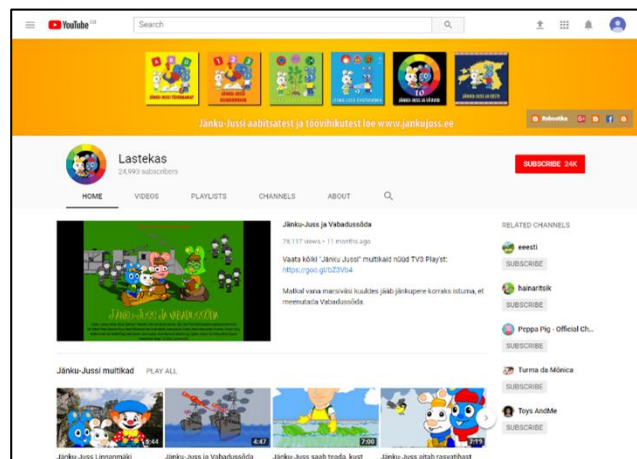


Fig. 22 - The Leoste's Youtube channel

The couple have been incredibly prolific by writing a vast number of similarly popular childrens' books associated with the video series, also in Estonian, and it is because of their emphasis on Robotics that I chose to meet up with them. Their **Robotic** book workbook gives children of 4 to 10 years a basic knowledge of the fascinating world of **robot** building using LEGO WeDo robots.

Janika ran a successful business from the age of 18, using her programming expertise to develop accounting software. She sold the business a few years later and developed her Estonian language educational channel. She more recently decided she should share her knowledge of robotics with others and so she has trained over 2000 adults (mostly teachers) in the use of different robotics platforms via face-to-face physical workshops.



Fig. 23 - The cover of the Leoste's robotic-themed book

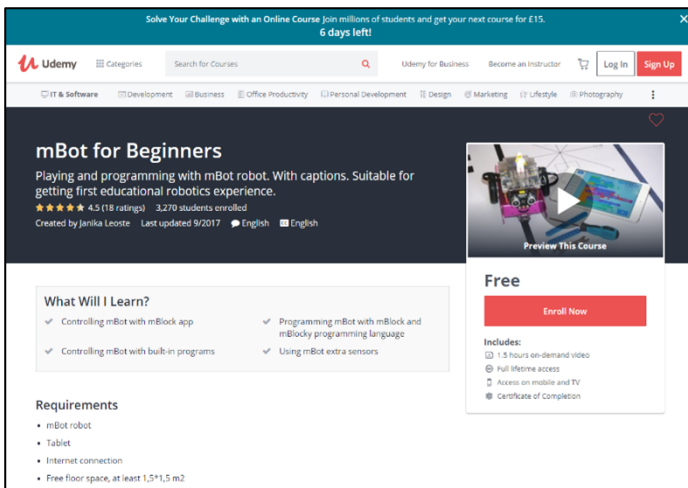


Fig. 24 - Example of Janika's FREE robotics courses

Like many other experts I met during my travels, Janika fervently believes that it is vitally important for people to learn complex ideas in their own language, instead of English, which is so generally prevalent throughout the world. By learning in Estonian, adults are able to learn within a comfort zone, instead of being prevented from being learning such skills because their grasp of English is limited. The couple are pioneers in the way that they produce resources in their native Estonian language in order to help adults and children to learn. Estonian children are bombarded with content in English as it is

readily available on the Internet, but purpose-written Estonian content is much harder to find. Janika and Jannus both emphasise the importance of the availability of native-tongue content for the success of new initiatives like robotics and programming. Janika has also carried out robotic workshops throughout Europe, specialising particularly in explaining what is meant by 'interacting with a robot'.

Unfortunately, the couple's animated shows recently fell victim to a dangerous new phenomenon. It has become popular for so-called 'parodists' to take childrens' animations and to repurpose them with darker, nastier content which totally changes the original intent of the video. It becomes worse when the young children, targeted by the parodists, are unable to tell the difference between the new videos and the original ones; and this is where the harm is done.

I was struck by the impact of the books and animations where technology, like robotics, featured. I found it clever that the cartoon characters who were presented in their episodes in many everyday situations were introduced to robotics, because in this way the viewers and readers could see that robotics use was now as commonplace as going to the park, walking the dog, painting or cooking. Seeing the characters they were familiar with being in STEAM-related activities at such an early age is bound to have a positive impact on the impressionable young readers and viewers.

The Leoste's innovative style of work is also to be commended for the way it does not use familiar gender stereotyping. Also, by using characters that children are familiar with enables the authors to increase the complexity of the topic they are covering. Their 'Robotika' book is an excellent example of this – it is totally devoid of patronising tones and simplistic diagrams, instead covering the topic in a style that befit the complexity of the topic, whilst still being accessible to their youngest readers.



Fig. 25 - Janika & Jaanus Leoste

The illustrations in the book can be coloured in by the youngest children, those slightly older can play the games which are included and the oldest readers can follow the instructions and build the robots, and all the while the books are written in the children's native tongue.

My impression is that this is a unique approach to such technical books for young children which only the famous 1980's Usborne computing books come any way close to matching.

Both remain wonderful role models for the education of indigenous people and it is clear that their videos have helped educate many children and adults about the use of technology in a language they can clearly understand.

Tampere, Finland – Meeting with Santeri Koivisto & Joel Levin, Founders of Teacher Gaming

At the time of my visit Teacher Gaming was the sole licence holder for the educational distribution of Minecraft. Their aim was to make kit acceptable for teachers to use the world's most popular computer game in the classroom. Their version of the game provided resources and an interface specifically designed to make the game more approachable for teachers with varying degrees of technical knowledge. Minecraft Edu allowed teachers to control what their students did with the software and scaffolded viable, curriculum-relevant lessons around the use of the sandbox game.

Joel began by using Minecraft in his classroom in USA and pretty soon he discovered the existence of little support for the commercial version of the game that millions of children were using at home. He connected with Santeri, a software developer and entrepreneur living in Finland and together they set up Teacher Gaming, an organisation that would be entirely focussed on supporting the use of Minecraft in the classroom.



Fig. 26 – Santeri doing what he loves best

Teacher Gaming's early relationship with Mojang, the creators of Minecraft, combined with their forward-thinking vision, enabled them to obtain the sole licence for Minecraft Edu, and so pretty soon it was used by 9,500 schools in over 40 countries.

Just prior to my visit, every school (250) in Northern Ireland had received free licences for Minecraft Edu. The intention was for it to be used to inspire creative writing, engage young people in city planning, and even teach quantum physics. This was to be done both in the classroom and in afterschool clubs.

A teacher in an Irish school described its use thus:

"I admit I was very dubious at first because I've had to put a bar on my own children using it at home, but then you see what it can do in an educational context and it can have big benefits to improve learning."

I wondered if students feel conflicted that a game they use socially is applied in the classroom environment – do they feel that their *space* has been *invaded*? Can they see the educational benefits of the game? Or do they consider more serious uses of it to be 'playing'? Joel describes the student experience beautifully:

“Everything a child can do in Minecraft can be relevant in a classroom. All of the Minecraft magic happens easily in classrooms.”

For those unaware of Minecraft it can be hard to grasp the transformative potential of the program and the reason for its popularity with children. Minecraft Edu exploits the popularity but focusses on scaffolding authentic learning experiences rather than coding within Minecraft, which is possible on platforms like the Raspberry Pi computer.

Student engagement when using Minecraft has to be seen to be believed. In my own experience, virtually 100% of students know of Minecraft even if they have never used it before. This is an enviable statistic for any piece of software, even more so when given that my students are all girls (statistically far less likely to play computer games than boys).

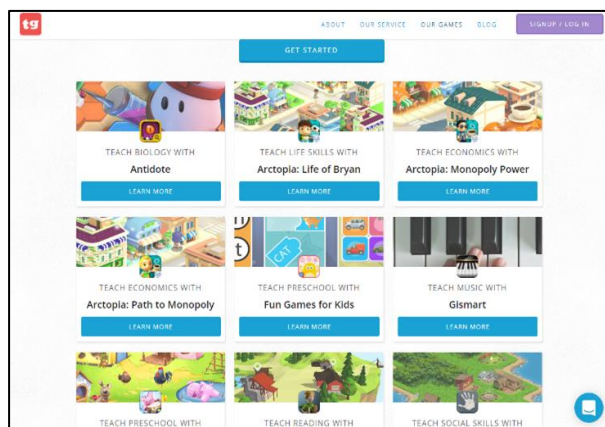


Fig. 27 - The Teacher Gaming website

Joel and Santeri are realistic that the success of their product relies heavily on student familiarity with the platform and they feel that more tools could be exploited in this way, as former teacher and educational legend Tim Rylands did years ago using ‘Myst’ to teach literacy to primary students.

They believe that in the classroom it is not only the collaborative capability of Minecraft that has value, nor is it the production of an end product. They believe that the greatest value comes from showing *how* something *is* created, by video or screenshot, because these are resources that can be more easily shared with people who are unfamiliar with Minecraft.

Santeri was eager for me to visit a school in which I would see for myself how their theory was enacted.

Tampere, Finland – Visit to Lamminpaan koulu

Throughout the 30 or more years that I have spent as an educator, it has been my dream to visit a school in Finland because it is renowned as one of the best education systems in the world. Thanks to Santeri my dream was made reality thanks to his mother, Maria-Leena Ammankoski, inviting me to watch her teach an introductory lesson about robotics to her elementary class.

The school has a focus on moving more and sitting less, studying more outdoors, to use functional methods in drama and games, to engage the students directly in learning design and the encouragement of more self- and peer-review.



Fig. 28 - Lamminpaan koulu



Fig. 29 - Pilates balls are the school seat of choice for many Finnish children

I was struck by the way that the school encouraged students to have a direct and personal influence on their own education, even down to deciding whether they wore shoes in class or not, and whether they chose to sit on a traditional school chair, or a Pilates ball!

However, of most interest to me was the inclusion of programming to students as early as Year 2, taught through the Maths curriculum. To be honest, whilst Computing departments currently exist as separate entities in UK schools, I believe that ultimately Computing (especially programming) will become part of Mathematics teaching in the future.

I thoroughly enjoyed all aspects of my visit to this wonderful school, but my most abiding memory will be learning since the 1960s it has been the law that teachers must give students a 15-minute break for every 45 minutes of instruction. This is because of the huge emphasis placed on the value of play by the Finnish educational system. It does not matter what the weather is like: snow, wind or shine students are expected to go outside for the break.

During my visit I saw for myself how students re-entered a classroom with renewed vim and vigour after their 15-minute break to continue working on the robotics project they had so abruptly left a few minutes earlier. Students also remove their shoes in the classroom.

In the classes I observed, students had carried out extensive Computing work for which the teachers were supported by Teacher Gaming who had created a curriculum especially for them. Teacher Gaming staff regularly visit the school to assist with the computer-themed lessons. I saw evidence of robotics theory and other computing applications in the students' books and pupils clearly enjoyed learning this exciting new subject. Students were incredibly engaged in a robotics activity during my visit, and the creativity I saw on display was a wonder to behold. *[Interestingly, and by coincidence, the content of this lesson was virtually identical to the ones I was to see when visiting three schools in Itatiba a year later].*



Fig. 30 - The only shoes are worn by the adults in this photo

However, I had come specifically to see how Minecraft was used, and I was completely mesmerised by what I saw. Students were using their earlier experiences within Minecraft within an art lesson. I saw collaboration take place in a form unlike anything I had ever witnessed before. I saw multiple students working on the *same* piece of art *simultaneously*. Watching 3 or four children concurrently drawing and colouring on the same piece of paper was truly a special thing to witness.



Fig. 31a - Collaboration...



Fig. 31b - ...reflection...



Fig. 31c - ...comfort



Fig. 32 - Health & Safety, where are you?

I frequently saw a relaxed environment in which the students were entirely at their ease, far removed from the Health and Safety conscious UK system. For example, I saw 8-year-old children given the freedom to use an industrial blowtorch to singe details onto the wooden animals they had created without them even wearing fireproof gloves or safety goggles. For reasons of health and safety, this scenario would be simply inconceivable in a UK school, but the students were sensible, skilled and responsible, and the teacher had complete trust in the students that they would be so.

Teaching in Finland is a well-paid, highly-regarded and much revered profession with a high barrier for entry. Consequently, the quality of teaching that students experience is of an exceptionally and consistently high standard, with students placed at the centre of every single decision made by teachers.

Journey 2 – MIT, Boston, USA

MIT, Boston – Professor Mitch Resnick, Director of Lifelong Kindergarten Group, MIT Media Lab

Professor Resnick is LEGO Papert Professor of Learning Research, and currently serves as the head of the Media Arts and Sciences academic program at MIT. Resnick's research group has developed a variety of educational tools that engage people in new types of design activities and learning experiences, including the "programmable bricks" that were the basis for the award-winning LEGO Mindstorms and StarLogo software. He also co-founded the Computer Clubhouse, an award-winning network of learning centres for youth from under-served communities.



Fig. 33 - Prof Mitch Resnick



Fig. 34 - an original \$100 Laptop

Resnick's group developed Scratch, which made it easier for young children to create their own animated stories, video games, and interactive art. Resnick is also involved in the next generation of Programmable Bricks and in the \$100 dollar laptop project [otherwise known as the One Laptop Per Child project – I would later visit Plan Ceibal who administered this project in Uruguay].

Mitch is utterly thrilled that Scratch is so popular in schools all over the world and that it connects so many subject disciplines including computing, design technology, art and media. Scratch is remarkable in that it is used inside schools and outside schools, with very young children and children at high school and beyond. His frequently used tagline of 'Many Paths, Many Styles' perfectly sums up the range of experiences that Scratch users have to share.

Sharing common values and having a common vision to help children think more creatively, reason systematically and work collaboratively, ultimately helping children to find their voice to express themselves in the world all combine to provide the rationale for the creation of Scratch.

In celebration of the power of Scratch MIT held the very first of what was to become an annual 'Scratch Day' at MIT a few years ago. Now, in 2016, 659 events were held in 74 countries all over the world on the 14th of May. It truly is a global phenomenon. There is no set 'cookie cutter' format for a Scratch Day – each host puts their own stamp on their own event, running it in a way that suits the young people that they serve. As an example, at a Scratch Day in Rwanda, held as part of their Code Week celebrations, young girls aged 8 to 18 were able to experience coding for the first time as a mobile computing unit in the form of a bus, visited their refugee Camp in the Northern Province. This was important because it meant they had access to technology that was otherwise not available to them within their camp. The organiser of the initiative, Aphrodice Montanga, hoped to train over 300 girls and their teachers over a one month period. It really is fantastic to discover that Scratch sits at the very heart of this ground-breaking and life-changing work.

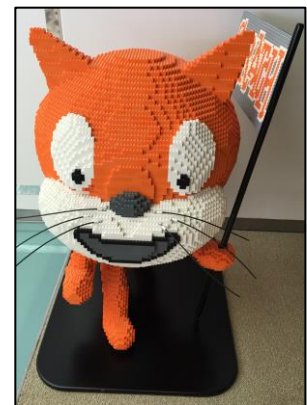


Fig. 35 - the Scratch cat is an image well-known to children all over the world

Mitch and his team regularly receive emails and letters from young people who want to give thanks for the impact that Scratch has had on them. One such child wrote to Mitch saying:

“Scratch has become a part of my life. Every morning I immediately wake up and think ‘How can I improve with Scratch?’ My friends and family don’t exactly appreciate the beauty of this website, but I do. It is art, music, games and animation compressed in visual coding blocks. And that, in my humble opinion, is pretty amazing.”

Another wrote:

“Thank you so much for everything Scratch has done for me. Scratch really is an amazing community... Scratch is a huge part of my life. I’d say 60%.”

Mitch was particularly struck by a project called ‘The Colour Divide’ from user bubble103, a young girl from South Africa. This exceptional, stunning piece of work is revelatory and shows just how far young people can take the Scratch platform if they have a creative mind.

[I was able to hear from bubble103, otherwise known as Taryn Basel later.]

Only a short time before he spoke, we learned of the death of legendary educational technologist Seymour Papert, who happened to be Mitch’s mentor and friend. Mitch shared his memories of Seymour and the impact that he had on the world of educational computing.

Seymour’s ideas and work directly impacted on the development of Scratch, and despite starting on his ground breaking work decades earlier, the impact is still felt today and has never been stronger. For example Seymour realised that young people would invest more time and effort in programming if, instead of working in an abstract world, they were able to control an object – this was how the Logo Turtle came to be created – and so Scratch is sprite-centric with the whole tool being based around ‘what can the sprite do?’

Mitch recalls six phrases that sum up Seymour’s approach to learning. Of these, one stands out as being at the very heart of the Travelling Fellowship that I have embarked on, and it is this:

“Powerful ideas matter... he lamented that people ignore that phrase... many more children are using computers nowadays but people ignore the ‘Powerful Ideas’. For Seymour the ‘Powerful Ideas’ were always central... he was talking about ideas that can cut across several disciplines... instead of ideas that could help you with one thing, it was ideas that could help you with many different things...”

MIT, Boston – Meeting with Brian Broll

As mentioned earlier, Scratch is open source software and as a consequence people have built their own more complex derivative programs using Scratch as the starting point.

Brian, a post-grad student at Institute for Software Integrated Systems, Vanderbilt University, is one such developer. He has created a program called NetsBlox. His ‘big idea’ is to take the essence of the world’s most used block based language which many young children around the world are using, Scratch, and to add distributed programming capability to it. In doing so his research has shown that it increases motivation, makes programming a social experience, combines Computer Science with other disciplines (STEM) and enhances collaboration between students.

Instead of making the fairly simplistic computer games which many young people do with Scratch, his tool enables students to use the knowledge gained from using Scratch to create complex multiplayer games. Also by



Fig. 36 - Brian Broll

accessing a wealth of data on the internet, students are able to collaborate by 'pair-programming' to create complex tools for others to use. For example, they can relatively easily, pull in hi-res pictures of the night sky and use NetsBlox to create navigable routes through the sky in real time. They can also integrate external APIs like movie data to create a movie quizzes or even multiplayer games such as 'ghost', a 2-player spelling game.

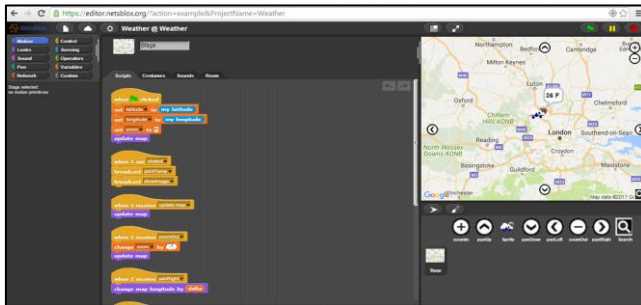


Fig. 37 - NetsBlox

I saw the NetsBlox tool in action. A map of the world called from one of the available APIs was imported as a stage in Scratch and some routines were written to determine the longitude/latitude of the location. Then when regions of the map were clicked the current temperature of that location was shown. Small amounts of further coding enabled the name of the place clicked to identified by name, and the map could be zoomed in and out in real time.

Students could use a chat facility as they are collaborating to build their program that adds further to the engagement of the task.

To the uneducated eye this may not seem like much, but it was hugely impressive to see this wonderful tool, inspired by Scratch, put in the hands of young people. In Brian's words:

"it truly opens the Internet for student programmers, it is more engaging and thus increases motivation, allows synergistic teaching of STEM/ICT. It provides a high ceiling for students, because although at its heart it uses Scratch that 5 year olds can use, NetsBlox has ensured it can be used for even the most complex of computing topics."

It is all the more remarkable that this software is freely available to children around the world and it will run on even the most basic computers. Consequently, I would expect to see it used by the sorts of schools I would be likely to visit in South America, once its development is complete.

MIT Boston – Meeting with Taryn Basel (aka Bubble103) Scratch Role Model

Taryn has taught herself to use Scratch entirely on her own. According to her she is the only Scratch user in her school in South Africa and it started as a place of solace for her, an escape from her school life where she could share her creativity with people from other countries around the world, rather than being stifled by her peers at school who did not share her interest. With over 5 years of experience using Scratch, it is fair to describe her as a Scratch veteran, despite her being only 16 years old.

The video series she produced really makes outstanding use of Scratch and it easy to see why Mitch Resnick and other members of the Lifelong Kindergarten team at MIT have such respect for her.



Fig. 38 - Taryn Basel aka bubble103

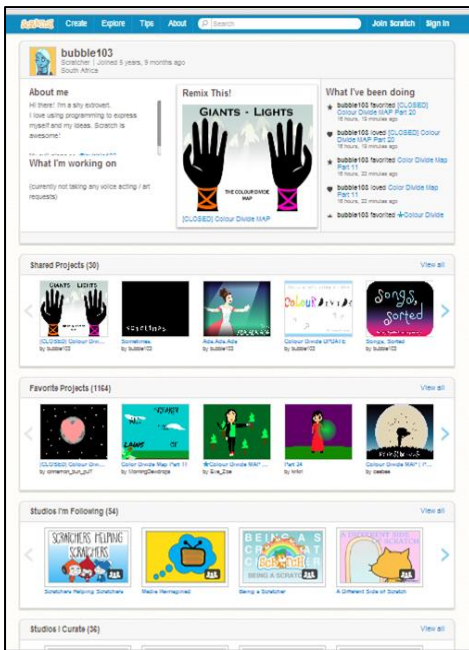


Fig. 39 - bubble103's Scratch portfolio

Despite her isolation Taryn collaborated with five other Scratchers on the online platform by roleplaying a game that they had devised – they were just having fun and getting to know each other. However, they quickly realised that they shared such common ideals that this led to the production of a short trailer for a collaboratively-written animated series that they wanted to produce. Scratch lends itself to working in this way no matter how far apart from each other the young people may live.

Taryn, a truly unique young lady, excitedly describes how despite having no prior experience of animation, the process of making an animated movie was ‘easy’ because ‘I was inspired...’, to which she adds almost as an afterthought ‘and I was comfortable enough to just try it’. As a teacher, it is truly jaw-dropping for me to hear such words from a student, because surely this is what education aspires to: inspiring children sufficiently for them to independently develop an interest in a subject.

‘The Colour Divide’ is a complex piece of work that used nearly 400 assets and 600 scripts – that is a lot for a Scratch program! The huge list of credits is testament to the number of people who collaborated on the project. Animation houses like Pixar give different animators responsibility for different characters and so it was with Taryn’s project. After the release of her trailer, produced by only five people, Taryn was excited to be approached by many other members of the Scratch community who wanted to be involved. Thus the project dramatically grew in size. Taryn helped coordinate the team of people from all over the world to make their contributions to the finished product. It was a major undertaking and was carried out with incredible professionalism.

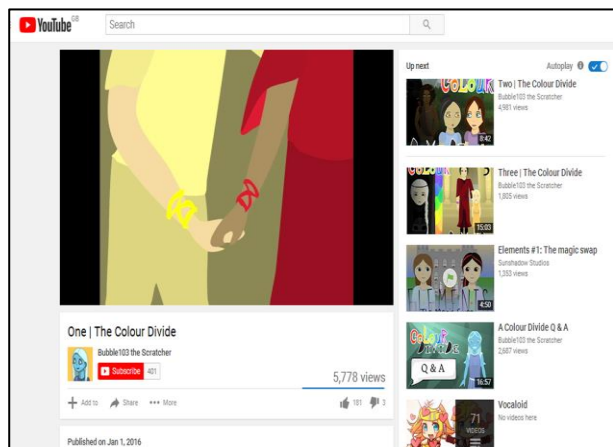


Fig. 40 – ‘The Colour Divide’ on YouTube

The music in each episode was written by other Scratchers, each of them eager for their compositions to be included in the film. This is a particularly good illustration of how many Scratchers create resources with the sole, specific purpose of making it available for other Scratchers to use in their projects. This altruism, prevalent within the community is Scratch’s greatest asset.

Taryn maturely describes the underlying message of ‘The Colour Divide’ thus:

“Society puts such pressure on you to be this one thing, but people are so much more than that, you can be so much more than that... growing up in South Africa I still see the scars left by apartheid. So each character [in the animation] is inspired by the kind of things I am still seeing now.”

That's powerful, powerful stuff. All of it facilitated by a piece of programming software designed for young children!

People say that learning to program helps give you the experience of failing and that learning to fail is an important and value lesson that more of us need to learn. Taryn expressed this better than I ever could, and by so doing perhaps she illustrated just why Scratch has become so popular with children around the world:

"... sometimes it wouldn't work or do what I wanted it to do, but that was the best part... especially as someone who has always been so afraid of getting things wrong and of making mistakes, it was so freeing to be in a space where making mistakes is the best thing you can do."

Boston – Meeting with Jenna Leschuk, Grants and Communications Manager, 826 Boston



Fig. 41 - The Boston Bigfoot Research Institute

826 Boston is a “non-profit youth writing and publishing organization that empowers traditionally underserved students ages 6-18 to find their voices, tell their stories, and gain communication skills to succeed in school and in life”.

Their services are structured around an understanding that “great leaps in learning can happen with one-on-one attention and that strong writing skills are fundamental to future success. With this understanding in mind, we provide after-school tutoring, field trips, creative writing workshops, in-school tutoring, help for English Language Learners, and in-depth publishing projects.”

The brainchild of bestselling author Dave Eggers, the 826 brand was first developed behind ‘San Francisco’s only independent Pirate Supply Store’ in San Francisco at 826 Valencia. Dave describes the concept brilliantly in his TED Prize acceptance speech and in an article in his website’s publishing arm, McSweeney’s:

“... I met a former high school teacher named Ninive Calegari and together she and I started a nonprofit writing and tutoring center called 826 Valencia. My teacher friends would tell me they had 189 students a day, and they just couldn’t provide all the one-on-one attention they wanted to—especially to the written schoolwork of students struggling with English. So we raised an army of tutor volunteers who could be called upon by teachers to assist with student writing, but with anything, really...Because of zoning obligations on our street, 826 Valencia was forced to have a retail component to the operation. And we decided to sell pirate supplies. Supplies for the working buccaneer. Has anyone been there? Yes? Then you know we sell planks, peg legs, puffy shirts, lard. We used to sell cannonballs, but our wholesaler was killing us on the shipping costs. But yes, we run a pirate store, and the retail component actually pays the rent on the building. I am not kidding. So with 826 Valencia, I became acutely aware that addressing needs in our education system sometimes required unusual approaches. I also learned how quickly the services of a nonprofit can grow to meet the needs of its constituents. Within months we went from a drop-in tutoring center to a center hosting daily field trips, evening workshops, book publishing programs, student newspapers — it never stops growing and evolving.”

So, he was working with a team of writers who had spare time on their hands, so he asked if they would like to educate students in that spare time. And thus was established a fantastic social enterprise that has helped many disenfranchised young people throughout America.

There are now seven '826' venues in the USA, staffed by 2,500 skilled volunteers offering:

- In-schools programs
- Workshops
- Field trips
- After-school tutoring
- Student publishing



Fig. 42 - The quirky entrance to the centre inspires imagination

Although the '826' brand focusses entirely on literacy, I wanted to learn about how the programme has become so successful. Can it be that a centre offering teaching of English to disenchanted schoolchildren in their own free time is so over-subscribed? What can the educational computing community learn from this?

826 Boston annually provides their free service to over 3,500 children aged 6-18 the majority of whom live locally to the centre, some travelling significant distances to attend their regular sessions. Drop-out rate is remarkably low. 826 Boston was established in 2007 after the success of previous centres elsewhere in the USA. The building is in a central location in a district of Boston with a large black community. The fun remit of the 826 concept is that the front of the building has to have a quirky retail store. So although the building used to be a car repair shop, under its new guise of the 'Greater Boston Bigfoot Research Institute' it has a new lease of life as a writing centre for young children.

Free reading library. Collection of books that the kids help curate, so they actually read them – their library is actually used. Although the nearest public library is close by, what makes this one particularly special is that a large number of the books in their library feature children of colour and as they largely serve the local black community, the children can identify with the protagonists of such books. Their staff actively seek out books they want in the library.

The first experience students have of the centre is usually as part of a school field trip and they are usually 'blown away' by the off-beat theme of the store front, before using the secret door into the main part of the writing centre. The scifi theme is so off-the-wall that it immediately breaks any barriers that the children have about what a writing centre might look like. In the end it is not as 'boring' as they thought it would be - any place with cockroaches and a giant stuffed Sasquatch in its entrance lobby just has to be cool, right?



Fig. 43 - Through the secret door lies the writing centre

Jenna says:

“Kids love it here, because no matter what their lives may be like elsewhere, as soon as they arrive they are in a safe, welcoming place where their imagination can take over for as long as they are here.”

The theme was carefully chosen because Bigfoot is something you need to have a leap of faith to believe in, and that is similar to writing.

Children go on to visit the centre once school has finished for the day and are able to complete homework there, so this makes their parents very happy. The children also work on a long-term publishing project – they are given a writing prompt and contribute to one of two books per year which are sold to the local community.



Fig. 44- Jenna Leschuk

Volunteer publishing staff proofread, edit copy and plan the layout of the book, whilst graphic designers will contribute illustrations for the book. The childrens’ photos are included in the book as authors and so when they hold the book they do so with an immense sense of pride. It cannot be underestimated just how positive an impact it has for these children to not only see their work in print, but for that work to be in a professional-looking publication which is sold to the public.

Thus, the writing centre not only contributes to improving children’s literacy, but it also builds their self-esteem and confidence. With four full-time members of staff and a massive cohort of volunteers, it is clear that the children benefit from such a supportive community.

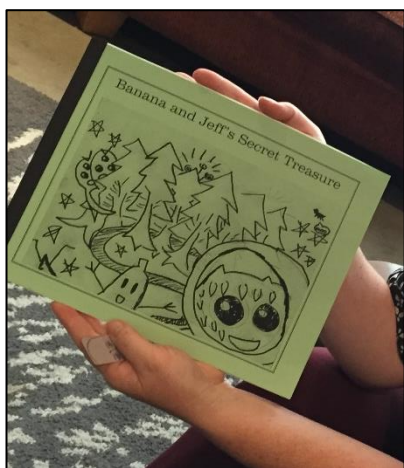


Fig. 45 - a sample student publication

My visit to this centre may seem incongruous given the theme of my research is computing and not literacy. However, I considered it crucial to do so because of one very important fact I had heard about the amount of commitment that is required for student in order for them to be involved in the programme. A piece of information that seemed to incredible for me to believe it could be true. Jenna confirmed it with me when she said that every student who attends 826 Boston has to commit to attend the centre 4 days a week for *a whole year!* This is a simply astonishing degree of commitment from young people who will already have had a long school day. I wanted to find out how it can be possible for young people to agree to this and how they see it through without dropping out.

Boston has an unusual school allocation system that is relevant to the success of the centre. The city operates a process of school allocation designed to enforce integration. Although the centre is surrounded by schools, many of the children that go to those schools are bused *in* to the area for further afield, whilst the local children are bused *out* to schools further away. This means that local

children do not or cannot stay late at their schools for clubs because they have to get the bus back to this area. Thus, for such students the centre is a godsend.

The centre measures its' success by the number of children whose literacy and confidence improves over time. Jenna attributes its greatest success as being when teachers positively evaluate the quality of the creative writing done by their students as a result of their involvement with the programme.

It was exhilarating to see for myself a prosperous student project like 826 Boston after I had heard so much about it beforehand.

Journey 3 – Argentina, Uruguay & Brazil

Rosaria – Meeting with Natalia Monjelat, Educational Researcher

By interviewing such a well-respected educational researcher as Natalia, I was privileged to have the opportunity to learn about how technology is used in Argentina to aid social inclusion.



Fig. 46 - Natalia Monjelat (left) with Mags Amond

Currently in Argentina most schools throughout the vast country have at most 30 netbook computers, a digital camera a digital projector, and crucially no training. The reason that there is no training for teachers is that it is not mandatory, so many teachers do not feel compelled spend their valuable time doing something which is not required of them.

Natalia has been involved with the creation of program.ar - a cleverly created title which is not only a web URL, but it is also Spanish for 'to program'. It was believed to be vital that such a project was set up because, the future success of Argentina as a country is reliant on something paving the way for the teaching of programming during the years of compulsory education. Without doing so the education system of Argentina will be failing its young people by not preparing them properly to compete with confident, proficient computer users from other countries.

The project makes use of Scratch to solve everyday problems. This approach was chosen for two reasons: firstly Scratch is very easy to learn for children and because it is available in Spanish it does not have a language barrier for those who speak no English. Secondly, it was felt that students would be more engaged if they were asked to produce solutions to problems they encountered in their own everyday lives, instead of being contrived problem-solving tasks that meant nothing to them.

At the outset of the project 43 teachers (with an average age of 43) were interviewed, not one of who had ever heard of Scratch before and most had never used the technology (listed above) that the school owned.

In total 13 teachers participated in the pilot project which consisted of eight 3-hour, face-to-face workshops – which were recorded for later viewing. In the sessions the participating teachers were encouraged to collaborate with each other, and this was an element that they enjoyed.

The project was comprised of three phases:

1. Exploring the problems that the teachers encountered in their own school – to try to establish the problem that was to be solved. It is recognised in Argentina that whatever is public does not belong to anyone, so some teachers wanted to look at how such objects can be better maintained. In addition other teachers felt that increasing violence amongst young people, the use of public spaces and poor family/school connections were all areas where problems existed.
2. Designing their prototype. All teachers that took part had never used Scratch before, so they had to learn how to use the software by exploration. Then they would remix pre-existing projects that other people had created, before finally developing their own programs and

storing these Scratch programs in their personal ‘backpack’. Teachers developed projects covering topics like: school hygiene, being united against bullying, and playing together as a family.

3. Sharing & reflecting. The participants were interviewed and with unanimity they stated that Scratch was a brilliant tool for creating artefacts that students would be able to identify with.

The success of the project means that it will be replicated with 120 teachers and the course – a combination of face-to-face and online sessions - will be extended to last for two years.

I have observed and experienced training courses in my own career aimed at helping teachers to learn programming, which have been, putting it as kindly as I can, of variable quality. Thus, I am in absolutely no doubt that the approach taken by Natalia and her team is innovatively ensuring that the young people of Argentina will begin to have increased programming opportunities within the curriculum, because their teachers now have the opportunity to improve their computing skills in a way that they can see is directly relevant to their daily lives.

Buenos Aires – Meeting with Emilia Saley, Coordinator, Programo tu Futuro

‘Programo tu Futuro’ (Programming Your Future) is an initiative of the Ministry of Education of the Government of the City of Buenos Aires. Its objective is to bring programming closer to the community and to promote the democratic access of citizens to technological education. It has this wonderful philosophy:

“Everyone can learn to program, you do not need to have previous knowledge or be a computer or mathematical expert, you just have to encourage them to learn something new.”

First launched in 2014, ‘Programo tu Futuro’ provides programming clubs in spaces open to the community where those interested can learn to program with the help and guidance of a mentor-programmer. There are eight of the ‘clubs’ distributed in different neighbourhoods of Buenos Aires where the weekly meetings are held. In these meetings learners gradually create their own mobile application or web platform through a dynamic and self-regulated methodology devised by the project team.



Fig. 47 - The Programo tu Futuro building is designed to inspire the local community

I was very lucky to be invited to visit a ‘Programo tu Futuro’ class taking place at one of the centres, another government-supported free programming initiative. As I arrived I was absolutely awestruck by the location of the centre and the building itself. The venue resembles a large packing container with windows, and it is situated in the middle of a public square, which when I visited was packed full of couples courting, families eating and young children playing football. It was a true hive of activity. The square is situated between two universities. These factors combine to make the location truly inspirational – the glass means that members of the public can see into the classroom and the ‘students’ by being able to see out, can feel part of the hubbub taking place outside. It is hard to properly put into words just how amazing the location was. The square had only recently been transformed into a community space where people could feel safe well into the night, as it had formerly been an inhospitable dingy place used by drug addicts, homeless people and prostitutes.

The square is also central and close to transport links, a further two factors which make it perfectly suited for 'Programo tu Futuro' to have a classroom.



Fig. 48 - People in the public space can see what is going on inside

The idea is to bring programming closer to society when it has not been part of their education and it has been supported by the Argentinian Ministry of Education. There are two structured 'Programo tu Futuro' sessions that each take place once a week – the rest of the time the centre is used as a pop-in centre for the local community to use the WiFi and have access to laptops or to learn how to repair their own broken electronic equipment. This facility is particularly useful for vulnerable people within the community.

Coding is not, and has never been formally taught within the Argentinian school curriculum. Although changes are afoot within the education system with Coding courses being piloted in some of the country's schools. This means, as many UK schoolchildren had to in the 80s, Argentinian children have largely had to learn to code on their own, as a hobby. This has contributed to a drastic need for an initiative like 'Programo tu Futuro' to be established.



Fig. 49 - A database class is underway

The age of the attendees who come to come to learn to code varies from 14-year-old school children to 60-year-old grandparents. All of them sign up to attend the weekly 2-hour courses over a four month period, to learn something they can't or didn't learn at school: to code. The lesson I had been invited to was an introduction to database use and their tutor was a volunteer professional programmer. Emelia told me that the majority of those who attend are people who want to set up their own web-based businesses

and they want to learn the skills to enable them to do it themselves. People come to learn from the professional tutors, but they also benefit from the camaraderie of their classmates and quite often the help that they give each other can be as useful as what they learn for their tutor. As a consequence it is not only their skills which develop, but their self-confidence too. There is a drop out rate of about 30% and when asked why it seems they are not particularly comfortable with the unstructured nature of the course, although it has been deliberately designed to be so. But then as the project coordinator says, you cannot please everyone all of the time.

At the end of the course all attendees are interviewed and the individual projects they have been working are shared with the rest of the group. This is treated like a competition with many prizes

on offer to the winners. The competition is the sole motivation for people to pursue the course, as no formal qualification is obtained upon its completion.

Many of those who have attended in the past have gone on to new jobs in the IT sector as a direct consequence of the skills they have learned on 'Programo tu Futuro', whilst some have used their skills to enable them to create their own companies. The project is clear evidence to me of how learning to program computers can improve people's lives, empowering by teaching them the value of lifelong education and entrepreneurship.

I was given the example of a recent student who had low self-esteem and many personal issues in her life. After attending the course she was able to build her own website to educate others about the issues she had faced, and by doing so her self-confidence grew significantly.

I was struck by the number of women attending the session I witnessed and this is attributed to the 'safe place' that the centre provides in which they can learn new skills in an unthreatening way. One of the biggest challenges that Emelia faces is in encouraging girls to participate and to learn to code. She said:

"... culturally in Argentina fathers believe that using computers is not a career for their daughters to follow. It something that only men should do. So, they actively discourage their daughters from learning to use computers. So often girls will come secretly, without their fathers knowing what they are doing. It take a great deal of confidence, which may not be apparent, for girls to attend courses like ours. This is why we do all we can to make them feel welcome."

So it is really superb to see 'Programo tu Futuro' do such ground-breaking work within their community.

Montevideo – Meeting with Miguel Brechner, President, Plan Ceibal

Plan Ceibal, now in its 10th year, is world famous for distributing, at no cost, the One Laptop Per Child to every young child in Uruguay. The government-funded department is now very large and does valuable work throughout the country, often in conjunction with the British Council.

Miguel has been Director of the organisation throughout its existence. He does not like the notion of BYOD , where students would bring their own, personal devices (most likely smartphones) into school to use) he sees that as a gimmick. He believes that once given a device, where schoolteachers can rely on everyone having the very same model of device, the process of using the devices in the classroom is much smoother and efficient.

Plan Ceibal distribute devices at three points during a young person's school life: at the very earliest age, at 6th & 7th grade and midway through high school. However, because Miguel sees tablets as 'consumer oriented' devices, he is not keen on their use in school, which is why Plan Ceibal still distributes laptop computers to children through their scheme. Having said this, he sees benefits in very young children using tablets because many of the educational apps available on tablets are focussed at Early Years children.



Fig. 50 - Miguel Bruechner & Graham Stanley

At this moment in time tablets are no good for learning to program or to interface with robots, two things at the heart of the curricular ideas Plan Ceibal believe to be of paramount importance. So that is why he is categorical in his belief that laptops are the only suitable device for young people to use for such activities, particularly when they have limited funds with which to buy such devices. Miguel's belief is that it is more important to spend a little more money to buy a laptop that has the capability to fulfil all of an individual's IT needs, than settling for a cheaper tablet which only does a fraction of the tasks you might need it to do.

It is with great justification that Miguel takes great pride in the fact that his organisation has been responsible for distributing so many resources to whole generations of children throughout the country. Without Plan Ceibal many children would never have been able to have access to a computer of their own, never mind actually owning it, as opposed to it being a family computer. Plan Ceibal is true inspiration to others about how it is possible to recognise true equality – regardless of income, remoteness of location or prior technical expertise, every single child in Uruguay has personal access to a digital device that belongs to them. This is not only *aspirational*, it is *inspirational*.

Miguel feels that education is the most important means by which to change the world. As Uruguay is a very small country with a fairly unsophisticated labour force, so for Uruguay to survive in the future Plan Ceibal is sowing the seeds of success now by creating millions of confident and competent computer literate young people. His dream is for Uruguay 'to become Estonia of Latin America'. This comparison which Miguel offered without any prior contribution from myself, provided an excellent bridge between two of my visits.

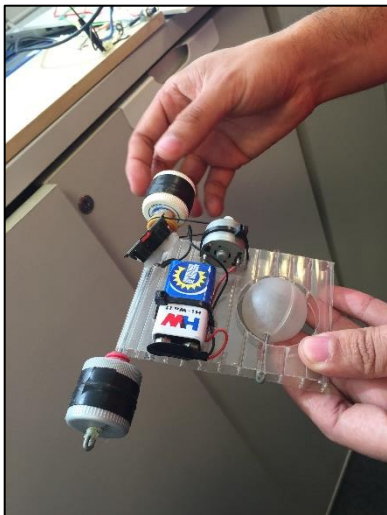


Fig. 51 - an example of a homemade robot – the ball is from an underarm deodorant bottle!

Young people are eager to give credit to Miguel and his team by recognising that their pursuit of careers in technology have only been possible because of the help that Plan Ceibal provided during their schooling. Recently, one such student won a worldwide competition to find the world's best computer programmer. Further examples include a blind boy who is studying robotics at university and another whose computing skills are so advanced he is pursuing a university education whilst still at school. It is not surprising to hear that Miguel has countless stories like these, each of them being a source of tremendous pride for Uruguay, but particularly for Plan Ceibal too. According to Miguel, a blind child living in a remote village in Uruguay would have virtually no opportunity to do more than the most menial tasks for the rest of his life, but with the help of Plan Ceibal that boy has been able to have opportunities beyond his wildest dreams.

There is a well-publicised case in Los Angeles where iPads were implemented at vast expense without anyone stopping to consider the problem they were trying to solve. This is neatly contrasted with Plan Ceibal's mission, to address the many inequalities that are so prevalent in the country. Plan Ceibal was never conceived to tackle a narrow problem like improving Mathematics capabilities, or literacy levels. Miguel believes that there are 3 fundamental elements a modern school must have: water, internet access and devices – restrict access to any one of these and schools will not thrive and create students ready to take on the modern world.

To illustrate his point Miguel told me of the Head of a school without an electricity supply, who was asked since there was only a limited budget available, if they would like a better electricity supply or Internet provision - the Head unhesitatingly chose the Internet. His rationale was that they could use the school's generator to power the school's fridge and lights, but they needed the Internet to access the world!

Such has been the success of Plan Ceibal that they have begun to re-evaluate how they work with schools. They have developed from simply supplying devices to all children to now believing that every school should have its own robotics equipment. They want this initiative to be led by the schools rather than by Plan Ceibal. They want the schools to devise their own robotics projects and then approach Plan Ceibal to provide the training or equipment that they need.

It was clear to me that Miguel has ensured that Plan Ceibal has been such a success because of his 'softly softly' approach. Although he is a hugely charismatic and hypnotically engaging individual, his ability to take this 'we'll help you but we won't push you into it' approach has been one of his greatest assets. For this reason and others, Miguel has been my hero since I first heard about the work of Plan Ceibal. I recognise that I was privileged to be given time to meet such an important and busy man and my hour spent in his company was unquestionably one of the highlights of my travels.

Montevideo - Meeting with Julieta Cayre, Executive Director, Girls in Tech

Julieta is involved with two entrepreneurial organisations and although Argentinian she now is based in Montevideo where she is CEO of Girls in Tech, Uruguay. Girls in Tech is an organisation focussed on developing and encouraging the involvement of women in technology, which in two years has seen a massive growth in its membership around the world, and particularly in Argentina and Uruguay. One focus for Girls in Tech in South America is to forge links between these two countries – something that is facilitated by their common language and proximity to each other, and the piloting of some joint programmes has taken place to ascertain how popular the organisation might be.



Fig. 52 - Julieta Cayre (centre)

Julieta's vision is to bridge the gender divide that is so prevalent in the tech world. She works with 16-18 year old girls by inviting them to participate in girls-only Hackathons. For these events girls who want to participate are put into teams and given a female technology professional who acts as their mentor. The teams are given a theme for which they have to develop solutions within a very tight 10 hour timeframe. Such an intensive period is necessary to maintain their interest and concentration, because if the project took place over a more extended period of time then the young people would be likely to reduce their involvement as their other commitments become more important to them. One difficulty the organisation faces is trying to convince the girls that the project is not related to school, otherwise they can show some reluctance to participate – they are teenagers after all! If teams develop successful projects which are deemed by the Girls in Tech experts as having good prospects, then they provide mentorships to help the teams take their idea further.

I related this initiative to a similar, successful organisation in the UK called Young Rewired State which was set up by Emma Mulqueeny. It is interesting to see such similar initiatives being organised by unrelated organisations in countries so far away from each other.

I was impressed by the commitment of the eleven permanent volunteer staff members at the very heart of Girls in Tech Uruguay. They are able to juggle their active involvement with Girls in Tech with their daily jobs in the technology industry – but I guess this helps to make them exceptional role models to the young women who are their target audience. As an example Julieta is manager of a technology incubator supports technology start-ups in the medical industry. The incubator helps the seedling start-ups to build and consolidate their business models over a six-month period so that they are able to become self-sufficient. Thus with such a range of experience Julieta is perfectly placed to be a role model for young girls in the field of technology.

A typical example of a company that Julieta has worked was founded by veterinarian. She had developed an innovative system for measuring three metrics of horses which would enable their owners to react more rapidly should the horse develop any medical issues. She spent two years developing a methodology to measure and report the metrics but needed to learn how to commercialise and develop her idea.

Although Julieta's incubator is not only aimed at women, she is working hard to encourage more women to participate, but she is finding it hard to do so, so this partially influenced her involvement with Girls in Tech.

Around 25% of tech startups that Julieta works with are founded by women, a statistic which Julieta considers significant compared to other countries. Julieta feels that this a result of girls learning more about 'business studies' at school, and by Girls in Tech encouraging such students to think about using technology in their business ideas instead of relying on older, more traditional methods.

Julieta was a business administrator and after teaching herself coding she was able to get more involved in the tech industry by becoming a 'front end developer'. Julieta feels that with such a background she now has a deeper knowledge and understanding of exactly how technology can be used to solve problems. This is important because it makes you aware of the possibilities. It can help you to see that technology is really not a difficult area despite how it might first appear.

Girls in Tech provide a free online resource, which although it is not a coding course (it runs on WordPress and there are plenty of other coding courses otherwise available online) it can be used to encourage girls to take an interest in the subject. It helps to coax them to see that technology is not just the domain of boys.

In conjunction with a similar organisation in Uruguay, Girls in Tech works with 12-year-old students in schools. Three teachers teach 20 two hour classes after school so that girls have something else to pursue as a career in addition to the other areas that may interest them.

It is interesting to see the connection between Girls in Tech and Plan Ceibal. I believe that Plan Ceibal's success with giving free computers to all young people in Uruguay has been at least partially responsible for creating young girls who are open to having some involvement with Girls in Tech.

Julieta is very proud of her team, because they are all volunteers who unquestioningly give of their valuable free time because they believe so strongly in the organisation's mission.

Itatiba – Visit to three schools



Fig. 53- the first school in Itatiba

Before describing my visit to the Ayrton Senna Institute and the 3 schools in Itatiba that they took me to, I think it is important to give a little background to the city itself and one the communities that is found there which provides the catchment for the schools.

Situated around 80km from Sao Paulo and with a name which means '*Many Rocks*' (giving some idea of its landscape, Itatiba has a population of around 120,000 people. Although it is considered to be the city with the 3rd highest quality of life in Brazil and reputedly having the 3rd highest levels of oxygen in

the world, Itatiba is not without areas of social deprivation. A particular community features markedly as one of the most deprived in the city – the '*Quilombo*'.

During the period in which the slave trade thrived over 4 million people were forcibly relocated from Africa to Brazil as slaves. These people and their descendants helped Brazil to thrive, and sadly slavery permeated every aspect of Brazilian life in those days.

Many slaves were freed as recently as 1888 when Brazil shamefully became the last country in the world to abolish slavery. Prior to this and over time, some slaves escaped from their brutal owners. They tended to set up communities hidden in remote forest areas where they were free retain and develop their cultural identity from their African roots which had been repressed during captivity. Some communities were so well-hidden and cut off from the 'outside world' that they only discovered that slavery had been abolished decades after the event.

Needless to say such communities were spartan and the people there had few amenities or possessions, and it was somewhat shocking for me to learn that it is estimated that over 2,000 such communities, with people living in such conditions, still exist throughout Brazil.

When I first decided to visit Brazil, I believed that the *favelas*, so often featured in films and news stories, were where social deprivation was at its most profound. I had never heard of quilombo before, far less was I aware that worse social deprivation could exist in the modern world.

One such community is the 'The Brotas Quilombo', which can be found on the outskirts of Itatiba. Although to the uneducated eye it appears from its skyscrapers and modern buildings that the city is thriving it is a shock to learn that along some dirt roads with no public lighting, sits this community living in extreme poverty, trying to cling on to the traditions of their ancestors who arrived here from Africa.

Although the communities have a fervent and important desire to retain their cultural roots, this has conflicted with the lack of prosperity within the community. The quilombo tend to have few professional qualifications with many working in the community's communal garden.

Consequently, it will come as no surprise that children from this community provide the catchment for the three schools I visited in Itatiba as a guest of the Ayrton Senna Institute. The organisation has determined that the future prosperity of the quilombo community lies in training its young people in modern skills, and no skills are more important in the modern world than digital skills.

So it was with great excitement and an immense amount of honour, that I readied myself to visit three schools in Itatiba.

The mentor who represents the Ayrton Senna Institute in supporting the Ititiba schools has a formal qualification in IT and so he felt compelled to use this as the basis for helping teachers and students to learn as much as possible about the use of computers. As with all the classes I attended, the sessions were in small, spartan computer rooms, with children having to share computers with each other. The Brazilian school days are divided into morning and afternoon shift, with students attending only one or the other. As computing is not taught in the Brazilian school curriculum the sessions I was able to witness were all 'out-of-school' sessions which students attended voluntarily taking place either before or after their normal school day.

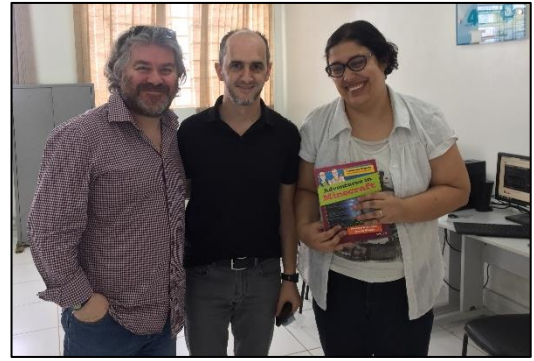


Fig. 54 - The Ayrton Senna Institute 'mentor' and classroom teacher



Fig. 55 - Peer-learning of the best kind

The sessions in the school were notable for the diversity of ages with some students so small they had to be balanced on their partner's knee. I was really touched to see the wonderful friendship that was evident between the students, and between the teachers and their students. The teachers had a beautiful, compassionate manner and this was rewarded by their students behaving impeccably as they learned new computing skills from her.

All lesson content was devised by the Ayrton Senna Institute and in the three schools I visited each was delivering the same content, but in its own slightly different way. This was also, by complete coincidence, virtually the same content I saw delivered when I visited the Finnish school.

The teacher believes that students lives are improved immeasurably by learning IT skills especially as the text that students follow is in Portuguese, their native language. This necessitates that they read the text, thereby improving their literacy and their numeracy is also enhanced by having to carry out calculations, work out angles and write out formula in order to solve problems. The collaboration that takes place is the main benefit which comes from the computing lessons – students have to work together as they are sharing their computers, and as they do so they are learning lifeskills like patience, tolerance and resilience.



Fig. 56 - The second Ititiba school I visited

These students have no access to computers at home because for the majority of the, their only use of a computer takes place during the weekly lesson, so they are unable to do any follow-up work at home. In this community the students are more likely to have access to smartphones at home than they are a computer, and so their internet access is usually only achieved through those devices and not computers.

One class teacher believed that it is a more valuable experience for her students to learn how to use a computer than it is to learn how one works or how to program one.

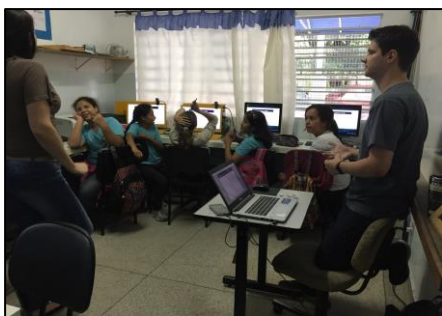


Fig. 57 - The third Ititiba school I visited

The third class I visited took place in the tiniest computer room I had ever seen. This school has not only to cope with all of the students crammed in like sardines, but it also has notoriously dreadful Internet connectivity, and on the day I arrived an engineer from the department for education was present in order to try to fix the problem. The teachers and students did the best they could but it was clear that the infrastructure limitations were the cause of deep frustration.

Again though I saw engaged students actively working on the same lesson content that I had seen in the other two schools. Despite the cramped conditions they did the best they could to carry out the activities they were set and it was rewarding for me to see their positive attitude and collaborative work ethic.

Sao Paulo – Interview with Adelmo Antonio Da Silva Eloy, Project Coordinator, Ayrton Senna Institute

The Ayrton Senna Institute is a Brazilian non-governmental organization founded by Ayrton Senna's family in November 1994, six months after Senna's death. It is presided by Viviane Senna da Silva Lalli, Ayrton's sister. It's funding comes via the management of Senna's brand and legacy as he is still seen as a national hero in his home country.

The Ayrton Senna Institute is participating in a South American Scratch conference run by Adelmo's supervisor at the University of Sao Paulo. This involvement will be very important because the world Scratch conference's working language is English, so one held in South America will enable native South Americans to participate in their native language.

The Quilombo are more integrated with society than they once were, but the Ayrton Senna Institute have still recognised that this is a particular community that can benefit from the educational work that they do. Adelmo's own great-grandfather was a slave and so he has a particular affinity and personal motivation to help Quilombo children whenever it is possible to do so.



Fig. 58- Adelmo Eloy

Ayrton Senna Institute has introduced the children to low cost physical computing tools like the Arduino and they have produced competition-winning projects. With programming, students who have little self-confidence, can create digital artefacts and then talk about them more freely than they might have done beforehand. This is because such children as I saw at the schools in Ititaba have little opportunity to share pride with others at any point in their school lives, so being able to talk about something they have created empowers them and makes them less self-conscious. This is something that the Ayrton Senna Institute has discovered in their work with students from the Quilombo communities and they take great satisfaction from the successes they have had in such schools.

As I heard in other places during my South American trip, the students are most engaged and motivated when the problems they are set are based on real world problems that affect their own lives. Setting them contrived problems is ineffective because the students are unable to determine a rationale for solving such problems as they simply can't relate to them. They will invest more effort in creating a solution for something they care about.

Like Teacher Gaming did in Finland, the Ayrton Senna Institute produces computing curriculum resources which are used by the schools they support – this is why, during my visit to Ititiba, I observed the synchrony of identical lesson content being taught on the same day in three different schools. There are 25 schools in Ititiba and the Institute has trained teachers working in 16 of them. Their numbers grow each year as, by word of mouth schools get to hear about the excellent computing work being done in other schools and they want *'a part of the action'*.

In addition to Scratch, the Institute promotes the use of App Inventor, a popular tool, which as its name suggests, enables users to create their own smartphone applications. This is used because it is the tool that best gives students with limited programming experience the capability to connect a problem with a solution with a minimum of fuss. Both Scratch and App Inventor are free, which means they are easily accessible for students living in poverty.

I explained to Adelmo about the BBC Micro:bit and gave him some as gifts. He was eager to see the devices and in particular the way in which they were distributed free to one million children throughout the UK. Adelmo saw great potential for the way in which a free BBC Micro:bit type of device could have a revolutionary effect on children like those who they serve in Brazil. I am in no doubt that this would be the case. It is pertinent to consider the size of Brazil, because although it was relatively easy given the right sponsorship and circumstances, for one million BBC Micro:bits to be distributed in the UK, or Plan Ceibal's free OLPC initiative, there are *fifty* million children in the Brazilian education system, and so the scale of implementing such an initiative in Brazil is much harder to contemplate.

Adelmo was grateful for the existence of the CAS community because even in Brazil the resources found on their site provide a lifeline to the Institute. He wishes that such infrastructure existed in Brazil to aid their educational system. The Institute has adopted the *'Master Teacher'* concept and have appointed some teachers, with specialised computing skills such as physical computing, who go round the schools in their area to lead lessons and support the classroom teachers.

I am in no doubt that Ayrton Senna would be proud to see the educational work being done by the institute which bears his name. It was truly life affirming to see such an incredible organisation so devoted to changing children's lives for the better, to epitomise what he once said:

"And so you touch this limit, something happens and you suddenly can go a little bit further. With your mind power, your determination, your instinct, and the experience as well, you can fly very high."



Fig. 59 - Ayrton Senna's formidable shadow is cast throughout the organisation that bears his name

Sao Paulo - Meeting with Todd Benson, Head of Communications & Public Affairs, Google Brazil

During our conversation Todd encouraged me to contact the Lemann Foundation and made introductions to enable me to visit them.

I discussed with him the way in which the changes from ICT to Computing in the UK had not been without its problems, which led us on to a deeper conversation about Google's role in South America.

There is a large gap between the public and private schools in Brazil, particularly when you go outside the main urban hubs of Rio, Brazilia, Sao Paulo etc. Schools in poorer parts of Brazil have access to very few computers indeed and thus students experience very little computer education at all. This has led to Google setting up an initiative called '*Google por Edu*' which works with schools and universities around the world to help provide access to less well provided schools in poorer parts of the world like some parts of Brazil This is not just confined to computer education but it can involve the use of computers to enhance education in other subject areas. For example, Google has provided some Chromebooks throughout Brazil which enables them then to use the Cloud and subsequently Google Apps, Google Earth and Google Maps in the classroom.

Todd is the Head of Communication & Current Affairs and his role is to help shape the public image of Google in Brazil – from government to the media – and constantly informing the media of new initiatives. The only division of the company that works with all of these agencies, so it is a very important role with regard to the public image of the company.



Fig. 60 - Google's Todd Benson

Taking the innovative Virtual Reality product Google Expedition as an example, Todd's team implemented an initiative over a three month period in which they took the viewers, tablets and other equipment to schools in different regions of Brazil, specifically targeting schools in poorer and more remote areas of the country. Accompanied by a journalist, Todd attended these sessions and it 'blew their minds'. Google Expedition is a 3D Virtual Reality experience which allows the user, through the use of headsets and mobile devices, at the teacher's direction, to have immersive experiences in famous buildings, places and objects around the world. Although Internet access and mobile devices which are integral parts of the Google Expedition set-up, the viewer is made of cardboard (it's actually called Google Cardboard) and so that particular element is low cost and environmentally friendly. The teacher controls everything from a central device eg. visiting the Great Wall of China, or diving in tropical waters – thereby enabling many of the Brazilian students to have an experience in the classroom that they may never have in their lifetime. It is a truly immersive virtual field trip to locations that would be unaffordable or impractical to visit in reality without the students leaving the classroom,

Teams from Google are constantly filming new footage for new Google Expeditions. The most interesting thing about this relates directly to Brazil in that they have created an expedition for the deepest parts of the Amazon. Thus, Brazilian children will be able to access remote parts of their own country (as opposed to the likes of the Louvre or Mount Everest which do not directly relate to them) through Google Expedition.

I was concerned that despite this support from Google and the low cost of some of the equipment needed, the elephant in the room still remains: how do we overcome the digital divide that had challenged me so much when I visited the schools in Ititiba? Google do not sell Chromebooks themselves they have partners who try to make them as low cost as possible, but that educational ecosystem means that Google need to work with people like Brazil's Secretary of Education to get them to form NGO's to purchase and then distribute the Chromebooks. Google also donate Chromebooks to the Lehmann Foundation (whom I was to visit later) who then distribute these to schools in poorer areas of Brazil. Increasingly smartphones have bridged the digital divide in countries like Brazil because although students in such remote places and the schools themselves are unlikely to have much direct or regular access to computers, they will have a smartphone. Todd has seen instances in Brazilian schools where there may only be 5 computers in the whole school, but 80% of the students at that school have their own smartphones – albeit out-of-date devices. Google are trying to find a way that such smartphones can be used within the classroom. This is an example of technological dreams being hit by reality: just as France has (at the time of writing) decided that students should be barred from taking smartphones out at breaks, lunchtimes and between lessons, even though the devices are already banned in French classrooms.

Todd was a journalist before joining Google, and he has moved from a declining industry to a burgeoning, growth industry. This had led him to see the massive importance of the tech industry in everyone's lives and has made it more vital, as far as he is concerned, that he does all he can to enable young people in disadvantaged areas to have as much opportunity to access technology as those in more well-off parts of the world.

Working with Google in Brazil has excited him most when seeing how speedily an organisation can solve a problem when it sets its mind to it. An example of this is the Accelerated Mobile Pages (AMP) Project: a consortium of news website publishers approached Google, concerned that if after clicking on a link on their page it took longer than 3-5 seconds for the link to load, then the user would give up and go somewhere else. Only a month later the AMP project was born, as a team of Google engineers set about solving the problem by writing code that was less cumbersome that opened news webpages almost instantaneously. A year later it is such a success that it has already become a standard. When Todd worked at Reuters such decision-making and project development could take years. This agility is one way that technology has truly been a disruptor to the status quo.

Google still gives its employees the opportunity to use 20% time if they ask for it. If they have a project in mind then a Google employee can make a proposal to use 20% of their employment time to work on the project they have devised.

Sao Paulo – Meeting with Irma Passoni, Director, Instituto de Tecnologia Social Brasil



Irma served three terms of office as Federal Deputy of Sao Paulo. She began working as a teacher in 1964 later becoming a nun for a short time to return to the world of education. She now advises educational organisations throughout the city of Sao Paulo and in particular has responsibility for establishing the 12 city-sponsored Fab Labs.

Fig. 61 - Irma Passoni & her ITS Brasil team

The inspiration for the Sao Paulo Fab Labs came from a visit by the previous mayor to the city of Barcelona where Fab Labs were very well established. Many people would have started small, setting up one or two to begin with, to ascertain their success, but not the mayor, he had grander plans - he was so struck by the potential of what he had seen that he put in place a plan to establish 12 centrally-funded Fab Labs in very poor areas of the city. ITS Brasil oversee the running of this network on behalf of the Prefeitura de Sao Paulo Inovacao e Tecnologia. Such a spread of centres across the vast city is crucially important because it provides a service to those people who need it without them having to travel vast distances as they would if there were fewer Fab Labs, or if they were concentrated only in the city centre.

The first step of the initiative was to show people the possibilities that existed for them when such technology was provided free of charge and on their doorstep, because for the vast majority the Fab Labs provided facilities of which they would have been hitherto unaware. Now people are using the Fab Labs not just to learn new skills, but to use those skills and the technology to create solutions to their own everyday community problems – such as printing spare parts for broken equipment, so that they can continue to use appliances that they could ill-afford to replace.

Irma says this:

“People who have never known the possibilities that a 3D printer can provide in making any object that is in their head into reality, really do have to have time to come to terms with the potential of a Fab Lab. They have to understand what it’s about. When they realise they can solve their own problems with that equipment and that material, it is the most important revelatory and motivational moment for them.”

They are not schools, although they may seem like they offer the same sort of services as a technical school or college. They provide access to technology facilities for young people who want to learn about STEAM-related subjects. However, at the moment most interest in the Fab Labs comes from older members of communities, people who wished they’d learned about technology at school but were unable to do so. Thus although many young people do attend the Fab Labs, their main users are adults – but training for teachers is provided which enables these teachers to take new technological skills back to the classroom.

ITS is starting to develop new programmes in response to the demands of the local communities, because as the popularity of the Fab Labs starts to grow, so too the expectations of the users starts to advance. They are finding that the equipment in each Fab Lab is insufficient to meet the demands of its user – for example there may only be four 3D printers in a particular Fab Lab, or the 3D printers may not be large enough to print the objects people want, so ITS has to equip the Fab Labs with more 3D printers – this is an expensive yet enviable indicator of the success of the Fab Labs in the city. There is nothing like Fab Labs elsewhere in the city so people have taken to them like ducks to water.

One of the success stories of the Fab Labs is Amelia, a lady who makes cakes for a living and who first attended a Fab Lab purely out of curiosity. She is unable to use one of her arms, which makes it hard for her to turn the cakes she has made, so after familiarising herself with the equipment at her local Fab Lab, she developed a solution to meet her specific accessibility requirements which could help her to carry out her daily work more efficiently. Once she had successfully achieved her first small goal, she was encouraged to build a whole set of equipment to solve the issues she encountered in her daily life. Other people – friends, neighbours, family members in particular - saw

what she had done and this led to many more people attending the Fab Labs because they wanted to solve *their* problems in a similar way. This approach in which self-sufficiency is fostered, is important because rather than having to rely on state handouts or generic equipment, people were able to discover that they could create their own bespoke solutions using their own skills – in short they embodied the spirit of lifelong learning. Consequently, not only has Amelia’s business become even more successful, but self-esteem has grown immeasurably because she has become a role model for others within her community.

I was impressed that the main example cited to illustrate the success for Fab Labs was a woman. Currently, the proportion of men:women using the city’s Fab Labs is 60:40, and although ITS have tried many methods to attract more women – including actively increasing in the number of female instructors - they keep hitting a cultural barrier whereby technology is still perceived as a being for men only. It is for this reason that female role models are worth their weight in gold.

I was also told about a local community which built a public library – including chairs and bookshelves – entirely using the facilities of a Fab Lab. The community could never have had this facility if they had waited for the local council to provide it. ITS takes great pride in the way that they have designated the Fab Labs as ‘public spaces’. Such a public project is able to use the Fab Lab facilities entirely free of charge, hence the full name of the initiative is Fab Lab *Livre* (free). However, if an individual wants to work on a personal project they need to supply their own equipment, whilst still being able to use the facilities at no cost. This is in contrast to most other Fab Labs elsewhere in the world because the user usually needs to pay a fee to utilise the facilities.

Such has been the success of the Fab Labs that the new mayor remains committed to the project, to such an extent that he would like to expand the networks – he would like to introduce a Fab Lab into every school in Sao Paulo. This is extremely reassuring for the communities who have become reliant on them because of the unrivalled access to technology that they provide.

Sao Paulo – Visit to Fab Lab Galeria Olido

Fab Lab Livre SP is a laboratory of creativity, learning and innovation accessible to anyone who is interested in creating, developing and building projects. Through the collaborative processes of creation, knowledge sharing, and the use of digital manufacturing tools, Fab Lab Livre SP brings to the population of São Paulo the possibility of learning, designing and producing different types of objects.



Fig. 62 - Fab Lab Livre Galeria Olido

Each lab is equipped with 3D printers, laser cutters, cutter plotters, CNC milling machines, computers with CAD digital drawing software, electronics and robotics equipment, and joinery and mechanical tools. I saw for myself that Fab Labs has a dynamic team that encourages shared learning and creativity through doing, conducting courses and guiding the development of projects.

As a result of a partnership between the Municipal Secretariat of Innovation and Technology of the São Paulo City Hall and the Institute of Social Technology (see my interview with Irma above), the Fab Labs are open and accessible to any member of the community who is interested in learning, developing and constructing collective or personal skills involving digital manufacturing technology, electronics, traditional techniques and artistic practices.



Fig. 63 - a variety of objects are made in a Fab Lab

Workshops, courses and lectures are offered, disseminating the production of knowledge in technology, science, art and innovation. A personalised process is used to provide teaching activities which stimulate the sharing of information and collective construction of ideas. The Fab Labs democratise access to new digital manufacturing technologies, providing the population with state-of-the-art technological tools and group experience in a collaborative and innovative environment for those, including young people, who could never otherwise have access to such equipment.



Fig. 64- Ricardo Elias Delgado

The Fab Lab Livre SP network aims to foster the development of creative and innovative ideas that benefit the community and the emergence of new professional opportunities.

It is easy to see how Fab Labs have been immensely beneficial to disadvantaged communities in Sao Paulo, particularly the young people who live therein.

Those who attended Fab Labs often didn't do so initially to build things, because they didn't know they *could* build things. In other words they may have had ideas for things they would like to create, but they would not have tried to build them because they did not individually have access to the equipment they would need to make their ideas reality. This learning new skills encouraged their creativity and led to self-improvement and a growth in self-confidence.

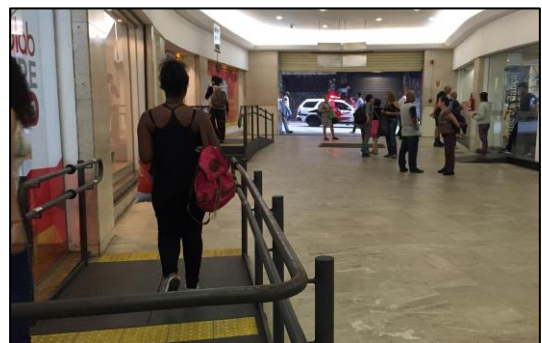


Fig. 65 – This Fab Lab is inside a busy shopping arcade

I was given two examples to illustrate the success of the Fab Lab ethos. Firstly, an elderly lady - we'll call her Anselma - recently attended the Fab Lab. She had heard about what could be done there, and wanted to create a table for her home which would be built to her own specifications. For obvious reasons, this would have been an expensive undertaking which Anselma could never have afforded to have commissioned. To make matters worse, Anselma had absolutely no previous woodworking experience. Thanks to Fab Labs she was able to build a skill set which led to her ultimately using the facilities, and with support of the staff Anselma eventually created the table she wanted. As she had made it herself, her self-esteem and pride motivated her to continue building further objects within the Fab Lab, including commissions for other people. As word of Anselma's

success spread, other members of her local community wanted to emulate her, and so they too joined the Fab Lab to work on their own projects. Then, hearing about Anselma's success, an elderly man – we'll call him Gabriel - with no prior knowledge of electronics, came to the Fab Lab with his own project: a desire to build his own robot. Gabriel had thought about doing this for many years, but his lack of experience and knowledge had held him back from doing so. Then, when he learned that a Fab Lab was in his area, and that he could use it free of charge, he started dreaming of the robot he would build and then built it. The Fab Lab had empowered him to literally make his dream a reality.

Prior to existence of Fab Labs and their provision of free public access to tools and resources, more people in Sao Paulo (population 21 million!) had access to helicopters than had access to 3D printers! In Sao Paulo, with lots of rich people having access to all the amenities and luxuries they need contrasted with a huge number of people living in poverty and without access to the most very basic amenities, a pronounced disparity is evident. The network of city Fab Labs have helped the Sao Paulo city hall to directly address this issue.

The Fab Labs provide five enabling elements that make it possible for such people to get involved:

- access to 3D printers, laser cutters, Arduino and many types of other electronics equipment
- knowledgeable staff
- long opening hours
- no cost (except for raw materials)
- regular themed workshops.

Of these, it is widely acknowledged that the most important factor is free access for those who could not otherwise pay for such a service. In this way such people can use the technology to solve their own problems rather than working on contrived projects which have no impact on their daily lives. This was similar to what I hear Natalia say in Argentina – that teachers there were more inclined to show an interest in projects that had a direct impact in their community, than in contrived situations that they could not identify with. These people have learned that it is easier to design and build something that they actually need, than having to save up to buy one when their money may be in short supply, or to have to wait for other people to provide the items that they need. Such an approach is surely beneficial to the wiser community as motivated people will encourage others to emulate them, and it will contribute to a more harmonious society that takes pride in its surroundings.

The central location of the Fab Labs, in this case within a shopping arcade in a very busy, thriving commercial district of the city, ensures that many passers-by can see the venue and the large windows ensure that it is easy to see what is going on inside, thereby intriguing members of the public and heightening their curiosity. This was similar to the central location of *the Programa to Futuro* learning pods that I saw in Buenos Aires. Hide something away and people will not know it even exists, or think it is elitist, put it in a public place and curiosity will more easily lead to engagement.

When each Fab Lab needs new equipment they either try to build it themselves if they have the skillset to do so, or they submit a bid to the ITS who oversee the supply and distribution of equipment to all of the Fab Labs in the city. Ultimately, all of the equipment belongs to Sao Paulo city hall, unless they have built it themselves.

Not only does the Fab Lab have a variety of machines available for its clients to use, it has a number of computers, which enable classes and workshops to be carried out. The Fab Lab is a popular location for teachers to meet and learn new skills – what we in the UK would call CPD. The central location of the Fab Labs makes them accessible to teachers throughout the city, whilst the expertise of the Fab Lab staff and the equipment available to them means that they have lots of opportunity to experiment with the new skills they learn before taking them back to the classroom.

I was overwhelmed by many things I saw at this Fab Lab, but most striking of all is the way that they recycled old equipment in order to build new projects. I saw a group of robots that were constructed almost entirely from recycled materials and repurposed electronic components. These simple, single-purpose robots can be built from modular components and are used to teach young people to understand how robots can fulfil simple tasks for humans without the need for complex programmed instructions.

The modular kit used to create the robots was conceived by Ricardo Cavallini and is explained on his website: rute.io. The concept comes from a desire to make electronics more affordable in Brazil. Although there has been a proliferation of electronics kits targeted at the educational community and children, there is a major drawback in Brazil – the cost of such equipment. Because such equipment usually originates outside Brazil, import and taxes result in them being marked-up to four or five times their original price. RUTE kits are not only a cheaper and simpler option for those who cannot afford such prices, they are often the only option.

Another important feature is that several of the existing kits are not fully open hardware, and do not allow replications without the payment of royalties or licenses. Being rudimentary like this helps RUTE in 4 points:

- Lower developing costs, because it does not need moulds for plastic injection, printed circuit boards or automated manufacturing.
- People in distant regions can produce their own kits, using tools and components that are easy to find.
- Possibility of using electronic scrap, which makes the kit even cheaper and eco-friendly.
- Makes understanding electronics easier. To a child, an integrated circuit board is much harder to understand than a button soldered in a connector.

RUTE's creator describes its value to young people thus:

“When used in schools, it helps to strengthen self-confidence, the ‘I can’ feeling and it brings the comprehension that everything around us can be improved and that they can do it, which is fundamental to believe that we can make the world a better place. By using the kit, kids will be able to create art and test new forms of expression, learning to use creativity to find solutions. They can explore complex ideas and without fear, dealing with the risk and understanding error as a residue of a positive process of creation and innovation, and not as something to fear and avoid at all costs. The simplicity of the kit and its uses also works as an entrance to electronic and programming logic, themes that, still today, are mistaken as something complex and exclusive. The basic concepts of electronic and of the ordinary components, such as LEDs and buttons, helps in the comprehension of sensors and actuators and in acquiring taste and losing the fear on the subject.”

RUTE really does offer exceptional opportunities for those who have limited funds and a more widespread use of this sort of programme throughout the world could see an increase in STEAM activity interest for young people who find themselves in disadvantaged situations.

Sao Paulo – Meeting with Alexandre Villares & Monica Rizzolli, arteprog



*Fig. 66 - Sandra Rocha & Alexandre Villare,
Monica Rizzolli & my Sao Paulo host, Mark
Hillary*

One of the active users of the Fab Lab is Alexandre, a Masters student and a proponent of Processing which is a programming language that he uses to teach programming design and art to young people. A video (hello.processing.org) was produced for the international Hour of Code initiative and it serves to introduce people to the potential of Processing as an accessible programming language for all.

With only 2 lines of Processing code a complete novice can draw something meaningful or recognisable – this makes it a perfect tool to get young people started with coding, and Alexandre would love to see it used more widely. It is so very quick to create interesting output with Processing and the fact that it is a language for *drawing* means it is possibly a more attractive way to get over the reluctance of some people to experiment with programming in a similar way that Sonic Pi is being used to encourage people to code with music.

Sao Paulo – Meeting with Tiago Maluta, Project Analyst, Lemann Foundation

At the time I carried out my interview, Brazil was about to host a Scratch conference for the whole of South America later in 2017 and this event is notable because unlike other Scratch conferences held around the world where the working language is English, this one will be in Spanish and Portuguese, so as to be suitable for teachers from the continent who do not speak English. Scratch is being used so brilliantly by people in South America that it is long overdue that a conference should take place in the continent for young people to share the work that they are doing.

The Lemann Foundation has relationships with many American universities which enables lots of Brazilian youths to study at notable universities such as Stanford, MIT, Yale and Columbia. When these young people return after graduating they are encouraged to set up social enterprises within Brazil to support their local communities. The technology section on the Lemann Foundation finds edtech solutions to social problems. Currently they are using a Harvard initiative to investigate what problems are prevalent in the Brazilian educational system and then they try to solve them. The Foundation also seeks to help with the huge problems occurring within school management – they try to build bridges between the schools, and the education authorities and local business. They also carry out a lot of research into the pedagogical issues encountered by teachers in their daily jobs and they look at new initiatives that occur within the Lemann Foundation as a business which can be easily transferred into the educational landscape.



*Fig. 67 - Tiago Maluta,
Lemann Foundation*

One particular concept that arose from a side project carried out within the Lemann Foundation in which the organisation encouraged all data to be made available in 'open' format eg .pdf, .csv etc. This development was then adapted and introduced within school settings to encourage schools to do the same with their resources and data. It is emerging as a model for how many other countries are considering conducting — and funding — data collection related to the increasing availability and use of various educational technologies within their education systems.

The website: <http://www.qedu.org.br> has enabled people to access a tremendous amount of this open data held about schools throughout the country.

The data shows such results as:

- Schools in urban areas have an average of 19 computers, serving an average of just over 650 students. Most of these are in administrative offices and dedicated computer labs. While classroom and mobile access are growing quickly, with 30% of teachers reporting that classrooms are now the main venue for computer use in their school, labs remain the main point of access to computing facilities overall.
- 95% percent of schools with computers are connected to the Internet, although only 39% of schools meet the minimum target of 2 Mbps for schools in Brazil.
- Almost half of public school teachers with their own laptops brought them to school, and most professional development related to technology use for teachers is a result of their own efforts

In a pioneering initiative in Brazil, the Lemann Foundation and the Institute of Technology & Society (ITS) combined to research, stimulate dialogue and, together with different sectors of society, propose solutions to bring fast internet to all schools in the country.

In a survey in 2015 it became apparent that that the use of technologies by students within schools approximated the experiences of the students at home. But without rapid internet, pupils and teachers could access all available opportunities and resources required to enhance their education.

The Lemann Foundation recognised that using the Internet at school can be a catalyst for a large-scale quality education in the country, and democratize knowledge. With that approach everyone wins: pupils, schools, and community.

This initiative was devised to enable the use of educational technologies in classrooms, because in addition to the infrastructure, it is necessary to provide a minimum speed of Internet that allows the use of the network for pedagogical purposes and there must be progressive speed targets for each school. There is also need to monitor such developments so that governments and schools can oversee the quality of the service so that connection problems can be resolved.

Mundo Maker is another one of the initiatives supported by the Lemann Foundation. Its aim is to create the optimum conditions for meaningful learning. They use experimentation and follow a 'do to learn' philosophy with regard to digital literacy experiences for children and adults in order to awaken their creative and entrepreneurial potential.

Seen from outside, a Mundo Maker workshop consists of people mixing the use of sophisticated equipment (3d printer, laser cutter) with affordable materials and tools (hammers, PVC pipes) and merging robotics and computing programming, with joinery. Whilst on the inside side are the pedagogical techniques the Mundo Maker apply in order to deliver the skills they seek to develop.

A Mundo Maker workshop is designed to specifically encourage children's: Cooperation, Critical Thinking, Creativity, Development, Teamwork, Troubleshooting, Planning, Autonomy and Resilience. It achieves this through: Project-Based Learning, Practice before theory, Socratic Questioning, Peer Learning, Design Thinking and The 'Passenger approach'.

The latter interested me, and I was intrigued to discover that it is best described thus:

"With a 'driver' it is common when group work is performed that 1 participant actually does the work and the other gives suggestions. The 'passenger driver' approach means that we promote the exchange of roles – those who were watching are encouraged to do and others have the opportunity to observe what they were doing, at another angle. The exchange of roles enriches the learning process and helps new solutions to emerge."

One profound issue facing schools in Brazil is the high cost of importing electronic components into the country. Physical computing components such as the BBC Micro:bit, Raspberry Pi computers, Makey Makeys etc all cost over three times as much as they do in the UK. This is a massive barrier to the uptake of physical computing by young people from disadvantaged communities. As I saw during my visits to the schools in Itatiba, for most students their only experience of using a computer was when they were in a classroom at school – this is in complete contrast to the experience of students in European countries where often they have access to better computers at home than they do in school!



So the Lemann Creative Learning Program, established in 2015, is a collaboration between the MIT Media Lab and the Lemann Foundation to foster creative learning in Brazilian public education. The program designs new technologies, support materials, and innovative initiatives to engage Brazilian public schools, afterschool centres, and families in learning practices that are more hands-on, creative, and centred on students' interests and ideas. The program was developed as an outcome from a competition run by the Lemann Foundation in which participants had to be already working with public schools and is now proving to be a successful way of integrating technology that schools could not otherwise afford into the classroom.

Fig. 68 - The PETE Alpha Maker - a homegrown Brazilian solution to the costly physical computing conundrum

Sao Paulo – Visit to Garoa Hacker Clube

My final port of call of my visit to South America, and thus of my Travelling Fellowship, was as a guest of the Garoa Hacker Clube in Sao Paulo, having been invited by Michael Howard, a fascinating, well-known member of the Sao Paulo technology community. It was founded in 2010 and was Brazil's first, and for a considerable time its only, Hacker Clube.

Mike went seriously out of his way to ensure that the final experience of my Fellowship travels should be as informative as possible. He did not need to be as accommodating as he was to me, but it is fitting that his altruistic approach was so typical of everyone I met throughout my Fellowship.

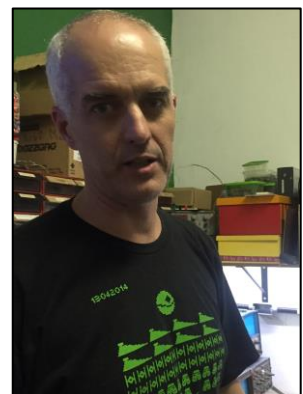


Fig. 69 - Mike Howard

Having a graffiti artist for a father, it is no surprise that Mike is at the forefront of the 'maker' scene. His father's influence is clear to see, as Mike embodies the free expression ethos that such an underground subculture represented.

I was impressed with the organisation & structure behind what amounts to no more than a club, one which figures highly in the lives of its members.

After a short guided tour of its unique and quirky location – it is really a converted house situated down a bleak-looking alleyway – I was able to see for myself the hive of industry that its members involved themselves in. Although no one under the age of 18 was present on this particular evening, they are not prevented from attending (as long as they are accompanied by an adult) if they wish to do so. Despite this, I was struck by the spread of ages of the members and the range of expertise. This particular evening was 'Arduino Night', with a focus for attendees being projects that involved the use of an Arduino – an Open Source minicomputer. One thing I did notice though, was that there were no women present. Nor, perhaps due to the meeting being in the evening, was there anyone under 18 in attendance either.



Fig. 70 - "Look for the umbrella," I was told

Founded in 2010, the theme of the Hacker Clube is 'electronics & computer technology'. The Hacker Clube takes place in a house that is rented by the organisation. One does not need to be a member to 'come by' but if you do then you are asked to become a member (or to make a donation) to support the club. All members pay a monthly fee which is enough to pay for the rent, Internet, electricity etc, and this is supplemented by the sale of beer, t-shirts and other memorabilia as well as 'pizza nights' and other one-off events. The club currently has 50 members, but this fluctuates from 30-200 throughout the year as people's circumstances change: there is no pressure on members to remain part of the club for longer than they want.

People hear about the club largely by word of mouth and it has become very well known in the city amongst IT professionals and hobbyists alike. Special events, like the 'Arduino Night' I had been invited to, attract particular people, regulars if you will. No services such as repairs are performed: people come principally to 'hang out' and to meet other people, with a love of technology being the tie that binds.

A remarkable feature of the club is that everyone is a volunteer; there are absolutely no paid staff members nor does a hierarchy of membership exist. Every member plays an equal role in cleaning, decorating, promoting etc. In addition, there are no set hours of opening apart from for regular events like this 'Arduino Night'. Instead, each member has a key for access whenever they want, and non-members can gain access if members are present. A webcam (what else?) mounted at the door, not only logs when someone has accessed the building

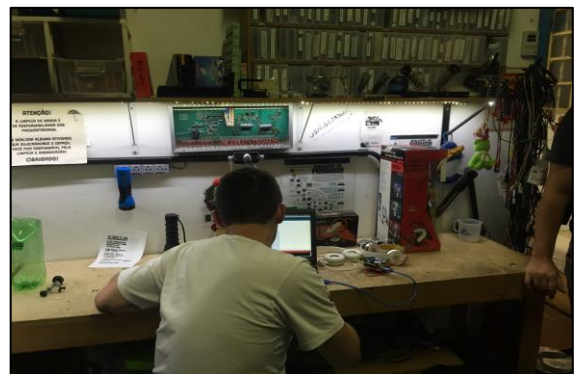


Fig. 71 - hard at work inside the Hacker Clube

and shows this on the club website, but it also indicates to other members that the club is open if they want to attend.

When I asked Michael whether people could exploit their membership by bringing broken computers to the club hoping others might repair them, his categorical response helped me to understand why I was mistaken to suggest such a thing:

“this is not like a motorcycle repair place as we don’t fix computers or perform computer services, its more like a bikers’ bar as there they would sell beer and they give advice about how to fix bikes. Now, if one night you took your broken motorcycle to ask bar regulars to repair it then they would not do so, but in that bar you could pick up advice for how to fix it yourself, and over time perhaps fellow bikers would get more hands-on with you to show you what do. Ultimately making you more knowledgeable about the repairing of bikes. They would not do it for you. So it is with the Hack Space: we give advice, support and encouragement, but we don’t fix your stuff for you.”



Fig. 72 - the Hacker Club is well stocked with electronic equipment

During my visit I could see that a range of projects were underway amongst the 20 or so attendees, and a certain camaraderie was evident as members supported and advised each other whilst they discussed the problems they were encountering with their individual projects. Much of this was done whilst eating pizza and drinking beer, so it was evident that this was a cordial, non-threatening atmosphere in which people could come together. Michael told me that this was typical of each meeting – the members are not just there for their own ends, they also enjoy showing acts of benevolence to others when they feel they can do so. The Hacker Club is a place where members, regardless of experience or ability, should feel able to learn new skills and not be afraid to ask for help whenever it is required.

Although this model is far from unique, it was wonderful to see it in practice because it showed knowledgeable people benevolently sharing advice and giving encouragement to those who wanted to learn more.

I felt deeply honoured to have been invited to eavesdrop on lots of feverish and detailed conversations during the evening – some being conducted in English on this occasion purely for my benefit. It really was a privilege and an evening I will never forget.

The welcome I was given as a complete stranger, on that particular evening perfectly epitomised all that I had discovered about the technology communities that I had visited during my travels and it was a perfect place to finish my research.

Conclusions

When I first planned my research project I did not really have any preconceived ideas about what I might discover. However, I did believe that I would find a great disparity between the access to computing experienced by children throughout the world. In the end this proved to be the case, but I was overwhelmed by the positive efforts being made by so many organisations to help young people to be prepared for a more technological future.

It is clear that many organisations have recognised that it is vital that young people grow up with an understanding of computing, even if that does not amount to an ability to actually code. This will prepare their young citizens to be able to compete in the job market with those from other countries – no one wants to be left behind.

Throughout my travels I was heartened by the incredible number of excellent digital initiatives that I saw bearing fruit within education. These initiatives are engaging students in a subject that is so relatively new that many of their teachers are barely able to keep up with progress.

It has been humbling to see many instances of skilled people, or organisations with vast funds at their disposal, who have decided that they want to attempt to improve the quality of life for disadvantaged members of their communities. When they could have decided to spend their money on a plethora of different projects or ideas, it is clear that they realise that investing in the provision of digital tools and the teaching of necessary cutting-edge skills, goes a long way to building a more harmonious, self-sufficient and engaged community.

'Community' is definitely at the very heart of every good project that I saw – without the community on your side then an initiative is doomed to failure. I saw many initiatives, especially in South America, that were specifically designed to address the needs of the individual rather than the setting of contrived scenarios that meant little to the participants. Focussing on personally relevant activities gives an important and meaningful context to the individual. It makes them more motivated to learn how to solve the problem themselves, provides motivation for them to cascade the skills they have learned to other members of their community, and encourages others to want to learn these skills so that they can emulate the examples that they see in order to solve their own problems.

We still have a long way to go to provide equal opportunity for all, and I took comfort from observing success stories like Plan Ceibal led by incredibly motivated individuals, fully funded Fab Labs made free to impoverished communities and organisations whose whole *raison d'être* really is to make life better for young people.

This project has changed my life in ways I could never have imagined when I first submitted my proposal. I hope that what I have gained from it will lead to me establishing my own solution to the inequalities of digital access faced by people in the UK and further afield, which is often caused by no more than unfortunate personal circumstance.

The Future

With regards to the gaining of technology skills, I am very positive about the future for young people. Because, as long as organisations exist such as those I investigated, like Plan Ceibal, the British Council, the Ayrton Senna Institute, Programa tu Futuro, Lifelong Kindergarten and forward thinking educational systems, then we can be assured that people are prioritising the ‘stuff that matters’ for the workers of the future.

It is often said that we are teaching students to do jobs that do not exist yet, and although this has been widely disparaged as hyperbole, it can surely not be argued that understanding computer systems and computational thinking really are fundamental skills that all young people should have if they are to be successful in the workplace of the future.

I have first-hand evidence that organisations have chosen to help communities to learn new skills because they are only too aware that by doing so their communities will become more self-sufficient and less reliant on others. It is humbling to see how such organisations have prioritised the use of their funds in this way rather than on other projects.

There is much that can be learned from the work that is being done and I would like to see less work done in ‘silos’ and more sharing of good practice.

I have four personal goals for taking my findings forward:

1. I would like to establish a not-for-profit global network to enable the sharing of good practice by the organisations doing the kind of work that I observed during my project. Such a network would encourage others to learn as I have, even if they do not have the funds to travel to see such work for themselves.
2. I would like to create a not-for-profit foundation through which schools and other businesses could recycle obsolete technology like old robotics kits, smartphones etc which would then be reconditioned and supplied to schools either in the UK, or abroad to countries like Brazil where importing new electronics equipment is so prohibitively expensive.
3. I would like to establish a not-for-profit educational programme for vulnerable young people and adults in the UK, which would enable them to learn new skills. For this I would combine the best elements I learned from 826 Valencia’s out of hours access, with Plan Ceibal’s stunning level of support, the Ayrton Senna Institute’s curricular programming and Programa tu Futuro’s use of public spaces and expert volunteers. In particular, I would like to support people of all ages who find themselves living on the street to learn new skills, because by doing so this may give them the help they need to leave the situation in which they find themselves.
4. I would like to set up at least one not-for-profit public space in the UK, like Sao Paulo’s Fab Labs, for technology training to take place. Through the examples of Buenos Aires and Sao Paulo I saw the value of training centres like these being open to all and situated in spaces like city squares or shopping centres, because those locations show that learning new skills is nothing to be ashamed of. In addition their locations fit in with people’s lives – in other words instead of making people come to you, you go to them.

For all of the above, I would learn from the exemplary model of the Lifelong Kindergarten as they did with Scratch: I would ensure that an Open Source model was followed, so that anyone could take up my ideas without cost.

I would be proud if I could achieve just one of these goals because I know that any one of them would have a positive impact on society. My recommendations, found at the start of this document are reliant on other people working from my stimulus, whereas these four personal goals are within my own control and I want to make them happen.

Obviously I will need to look for support from other organisations if I am to succeed, but I remain hopeful that anything is possible, after all thanks to the support of the Winston Churchill Memorial Trust my Travelling Fellowship has taught me that it is absolutely 100% possible to '**walk on water**'!