Making the most of technology in education
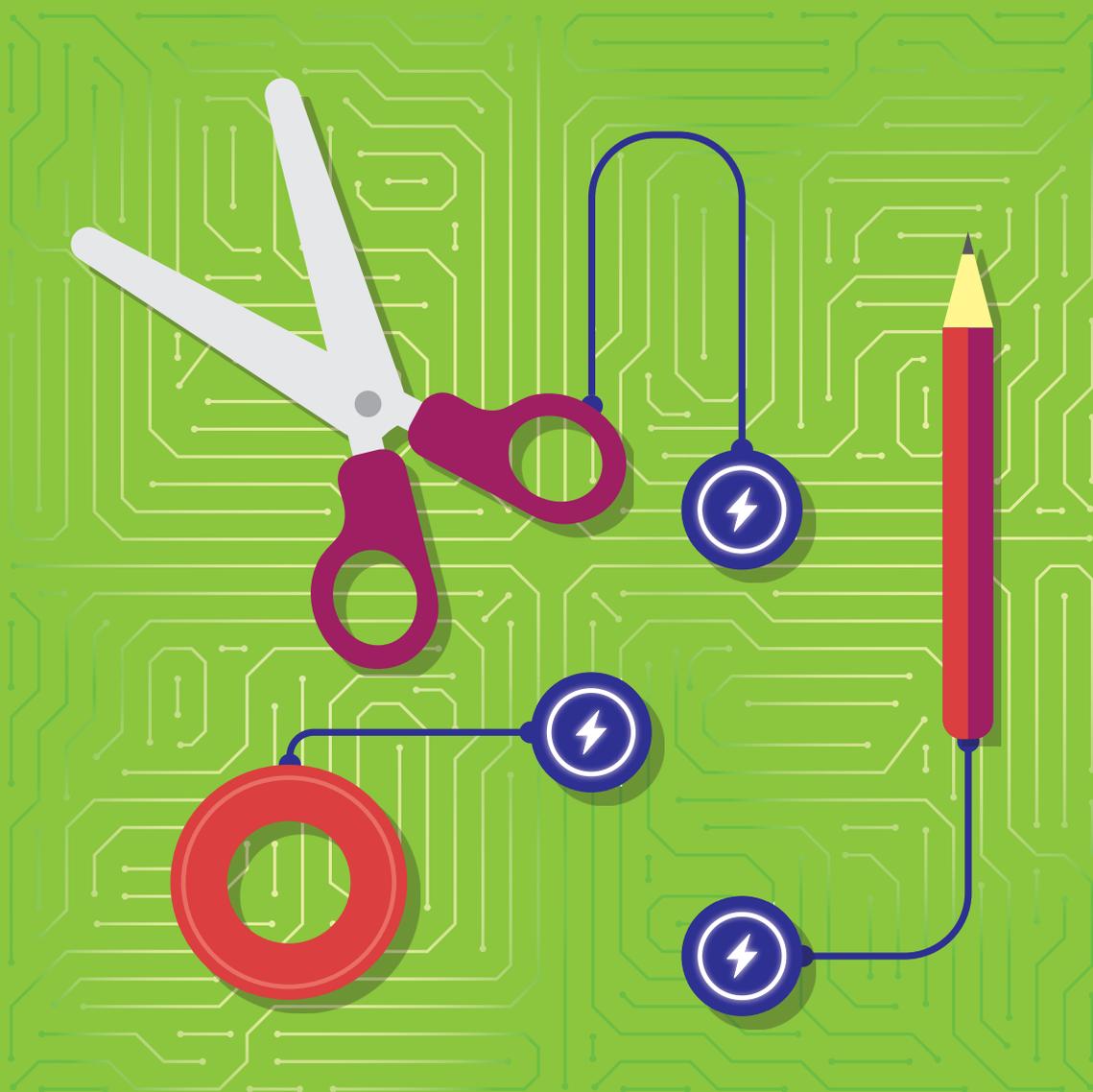
Lessons from school systems around the world

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June 2019

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We use our expertise, skills and funding in areas where there are big challenges facing society.
Nesta is based in the UK and supported by a financial endowment.
We work with partners around the globe to bring bold ideas to life to change the world for good.
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About Nesta Italia

Nesta Italia tests and grows new ideas to address Italy's most pressing societal challenges. Based in Turin, Nesta Italia is a partnership between the global innovation foundation Nesta, and Compagnia di San Paolo, one of Italy's largest and oldest philanthropic foundations. Nesta Italia supports innovation in education; inclusion and urban policies; health and ageing; and the arts and cultural heritage – using Nesta's proven innovation methods to encourage social innovation in Italy. We use our knowledge, networks, funding and skills – working in partnership with others across Italy, including governments, businesses and charities.
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Fondazione per la Scuola is an operative unit of Compagnia di San Paolo, established with the mission to contribute to the full enhancement of school autonomy. Its activity is divided into three main axes: the promotion of equal opportunities, social inclusion and the relationship between school and territory; improvement in terms of quality and equity of school autonomy, with particular attention to those operating in complex contexts; improvement of the schools management processes through the provision of digital infrastructures and training.
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Making the most of technology in education

Lessons from school systems around the world

Foreword

Innovation in education is nothing new. There have always been innovative schools, and since the 19th century, in particular, many have tried out radically different ways of teaching. More recently the pace of innovation has accelerated as technologies – from whiteboards to ipads - have offered the potential to transform every aspect of teaching and learning.

But innovation has always been harder than it appears. One very common pattern has been the creation of wonderful single-school examples that were too expensive, or too dependent on exceptional teachers to have any chance of being replicated. An opposite problem was reform programmes run at the level of whole systems at once, without experimentation and testing, which invariably ran into problems.

Meanwhile within the world of EdTech there has been a very particular, but worryingly consistent, pattern of failure. There has been no shortage of exciting technologies. But the failure to engage teachers has meant that most did little or anything to improve educational outcomes. Bill Gates recently commented that at least they probably haven't done any harm. But we should be able to expect better.

So how can we? How can school systems make the most of many maturing technologies we have around us – AI, AR, VR and others - which should be able to make learning more exciting, more engaging and more personal?

This report grows out of a deep partnership between Compagnia di San Paolo and Nesta who have worked together in many fields to advance innovations for the common good.

It surveys some of the good answers and draws out some clear recommendations on how to do things better. Its central message is simple. Collaborate more deeply, and sooner, in design, experimentation and adoption and you're more likely to grow innovations that actually work and serve children.

I hope this message will be acted on so that in Italy, and elsewhere, a much more constructive partnership can be forged between the creative technologists and educators.

And I hope that, as a result, our schools really can play a full part in the Fourth Industrial Revolution which is happening all around us.

Geoff Mulgan
Chief Executive of Nesta and President of Nesta Italia

Introduction

Education is our most powerful tool to improve and shape the lives of young people, but our school systems around the world face huge problems. These problems vary from country to country - from vastly unequal access or crises in teacher recruitment, to the growing costs of modernisation or stalling social mobility - and should leave us with some concern about the future.

With our concern should come a degree of optimism. While the challenges our school systems face are big, technology - designed, used and implemented effectively - is providing an increasingly sophisticated set of tools to help us address them. We can find inspiring examples of the benefits for teachers and learners, often with dramatic improvements across a range of measures from attainment or attendance, to parental engagement or teacher workload.

However, examples of technology achieving impact at scale and impacting on school systems as a whole (beyond the particular context of a small number of schools) are rarer than we might think. And while we can find extraordinarily clever pieces of software and hardware, often EdTech is too far-removed from the immediate concerns and context of teachers and learners in the classroom. There remains a marked gap between the excitement surrounding a technology-enabled school-system of the future and the reality of technology in most classrooms today.

This report examines nine examples - three in Italy, three in the rest of Europe, and three in the rest of the world - of inspiring practice where technology is impacting on large numbers of teachers and learners. Drawing lessons from shared problems and successful approaches from across these examples, this report provides recommendations for making the most of technology in school systems.

These recommendations are grouped in three sections. The first relates to scale. How can we ensure that the benefits of investment in technology are felt more widely, and that the exciting practice seen in exceptional schools can be felt elsewhere? The second relates to schools. How can we gain buy-in from schools to wider programmes of change? And how can school leaders support their school community to make the most of change in their school? The third relates to philanthropic foundations. Foundations emerge from many of our case studies as playing a vital role in supporting innovation and brokering complex relationships within our school systems. We explore how foundations can use their resources and status outside government to support innovation and EdTech.

Summary of recommendations

Summary of recommendations to reach scale:

1. Design and test with the toughest conditions in mind, not the easiest. For technology companies this means reaching more users. For governments this means ensuring more equitable access.

2. Invest in training and support alongside hardware and software. For companies, governments and foundations alike, this is a crucial requirement.

3. Technology companies must balance consistency of offering alongside flexibility of context.

4. Governments must invest in infrastructure to gather and use data more effectively and openly.

Summary of recommendations for motivating school buy-in, and advice for teachers leading change in their school:

For organisations seeking 'buy-in' from schools:
1. Provide a clear vision driven by outcomes (not technology) that addresses an urgent need.

2. Describe a credible path to delivery with high-intensity support during initial implementation.

3. Create an opportunity for teachers to be part of a wider community or network of learning.

For teachers leading change in their school:
1. Take advice from other school leaders as described in 'Box 2: '10 Top Tips' for school leaders'.

Summary of recommendations for philanthropic foundations:

1. Support riskier high-potential early-stage ideas through grant-funding.

2. Plug gaps in funding pipeline with flexible and patient capital.

3. Support business models or subsidise tools to reach those most in need.

4. Prioritise experimentation alongside evaluation.

5. Broker relationships between different school-system stakeholders.
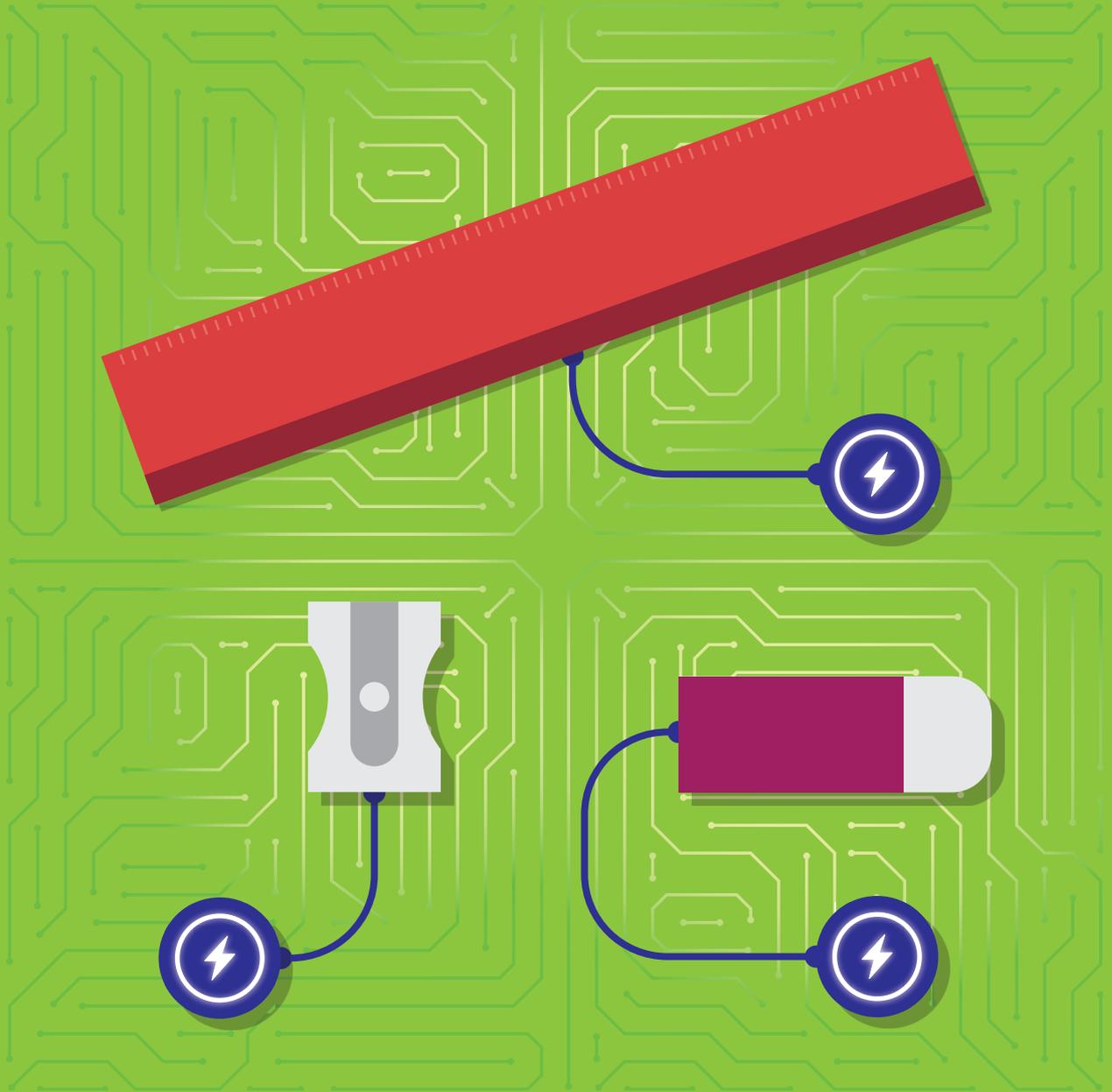
Methodology

Positioning this research

This report builds on - and complements - a growing body of related literature. A review of 48 publications (published by organisations including the OECD, The World Bank, Innovation Unit, WISE and many others) carried out as part of this research revealed two distinct broad areas of interest that it is useful to reflect on and position this report alongside.

The first focuses on technology in the classroom or individual school. Vitally important, this body of literature often asks questions about changing pedagogy and school context. The second focuses on larger processes of system-change. Equally important, this body of literature asks questions about policy levers and the complex relationships between the different stakeholders in our school systems.

Drawing on lessons from nine examples around the world, this report brings together aspects of both of these areas of interest. The research (through the methodology described below) has reflected on macro-level considerations of school-systems as a whole (particularly their complexity and the brokering of relationships between stakeholders) and the micro-level considerations of school context (particularly supporting teachers to benefit from the opportunities of technology within their specific context).

Methodology

Our research is primarily built on interviews and workshops with a wide range of stakeholders involved in using technology in school systems - from policymakers and funders, to technology companies and teachers in classrooms. Although we draw inspiration from the wider literature and practice around the world, at the core of this report are nine case studies of inspiring practice.

Firstly, we set out to surface examples of interesting practice using technology in school systems through a series of interviews with experts involved in school-systems around the world (see Acknowledgements). Through this process we identified 42 examples in more than 20 countries which form a long-list of examples (see Appendix).

Three key factors guided our search.

Firstly, we were open to a wide range of technology from individual products to more systematic change programmes attached to investment in technology. This decision was made to reflect the shared nature of the challenges faced when implementing technology of any type in school systems.

Secondly, we recognised that 'good' outcomes vary across different contexts. Our research covers examples operating in very different conditions (political, geographical, pedagogical, digital, financial, and more). Although we sought out examples supported by existing evaluation, we were agnostic about intended outcomes.

Thirdly, and perhaps most importantly, we only considered innovations operating at a reasonable scale, not isolated practice in individual schools.

From this long-list of practice, we identified a small number of factors to act as a framework through which to narrow our selection of examples across two workshops to the nine case studies featured in the report. These factors included:
- **Scale** - Impacting on a significant number of schools, with consequences for a school system as well as individual learners.
- **Teachers** - Empowering teachers or altering their role in significant ways.
- **Context** - Remaining sensitive to the local context of a school system.
- **Complexity** - Leveraging unusual partnerships between a wide range of actors in our school systems, often sparking innovation from the bottom-up rather than vertically from government.

Given our particular interest in Italy, balanced by a desire to learn from practice around the world, we sought three case studies from Italy, three from the rest of Europe, and three from the rest of the world.

In order to combine insights about the macro-level of a programme and the micro-level of an individual school, for each case study we interviewed school leaders within schools impacted by a programme as well as those overseeing wider implementation. Many of the insights gained from our interviews with teachers and schools leaders form our '10 Top Tips for school leaders' and 'A closer look on the ground' sections of our case studies.

Why Edtech?

School systems have remained relatively resistant to technological transformation, particularly when compared with other sectors such as finance, media or healthcare. And while technology has transformed aspects of our education sector - from distance learning universities, to the unprecedented access to knowledge made possible by the growth of the internet - schools systems have not seen such wholesale transformation.

But EdTech is a powerful tool. In the handful of examples explored in this report (covering a wide range of EdTech, see Box 1), we find extraordinary benefits for students, teachers and whole communities. In some cases, this is through innovating teaching and learning, improving outcomes for students. At other times, we see technology used to make our education systems fairer, vastly increasing access to information and higher-quality learning opportunities for the most disadvantaged. We also find technology improving the efficacy of our school systems, gathering and sharing insights drawn from data and supporting teachers to make better use of their time. Finally, we see technology used to increase engagement in learning, bringing families and the wider community together with schools with a renewed focus on the benefits of education for children's futures.

And perhaps, in our increasingly digital world, the need for more widespread and effective use of technology is inevitable. As EdTech grows more and more sophisticated, whether by using more data or enabling increasingly personalised learning through artificial intelligence (AIEd tools), the ability of EdTech to accelerate change is growing[1].

Box 1: **Defining 'EdTech'**

'EdTech', 'EduTech', 'Learning Tech', 'ICT in education' or 'education technology' refer to a wide set of technologies used in many different contexts. Although definitions vary, in this report we look at examples of EdTech encompassing hardware, software and infrastructure.

Hardware: *Physical devices (such as laptops, tablets, etc.) used to facilitate effective teaching and learning.*

Software: *Programmes or applications used to facilitate effective teaching and learning.*

Infrastructure: *The 'collection of hardware, software, networks, data centers, facilities and related equipment used to develop, test, operate, monitor, manage and/or support information technology services'[2].*

Alongside evidence of the potential benefits of using technology effectively, we also find significant problems in school systems around the world that add a degree of urgency to school improvement and the potential of technology. These problems are perceived in varying forms across the world - from pressures on funding, excessive teacher workload, shifting demands on school-leavers in the labour market, or the need to dramatically improve access to education provision. For example, the United Nations' Sustainable Development Goal 4 (to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'[3]) requires extending school provision to the 264 million children and young people not in school, and improving provision for the 330 million children in school but not learning[4]. With successful implementation and appropriate support, EdTech can play a central role in addressing these problems (as we see in the case studies in this report).

Three challenges for EdTech

However, the case for technology in our schools is often undermined by apparent difficulty of implementing and using EdTech effectively. It is not hard to find cautionary tales that highlight how investment in EdTech does not necessarily imply improvement - and many of those interviewed as part of this research were able to provide equally valuable insights from an understanding of what doesn't work, as from what does work. Before exploring our case studies of innovative practice in more detail, this section frames three key challenges facing effective use of technology and data in schools at the heart of this report.

Scale

One of the biggest challenges is scale. Across the world we find many examples of inspiring practice in a single school where technology has been truly transformative, with visible and measurable benefits for students. But we find many fewer examples of where this inspiring practice has managed to diffuse through a wider school system.

Such 'islands of innovation'[5] are typified by a visionary leader and uncommon access to particular resources (from hardware and software to proximity and relationships with cultural organisations or businesses). These instances should be celebrated and offer many opportunities for wider learning. However, the inspiring practice of individual schools struggles to diffuse through wider school systems. As such, the case studies in this report are made up of products or programmes that have impacted on larger numbers of schools and students.

Complexity

Secondly, with scale comes complexity. Not only there are school systems inherently complicated - with competing outcomes, priorities, social contexts, pedagogical theories and stakeholders - technology brings a new layer of complexity. Investment in technology presents opportunities for a more diverse range of organisations and people to play an increasingly important role in our school systems - from private companies and philanthropic foundations, to the creators and disseminators of online content.

As Valerie Hannon, Co-Founder of the Innovation Unit, describes:
> 'It is no longer appropriate or adequate to refer to 'education systems' as comprising government (and private providers) plus schools'[6].

Instead, the school system encompasses a much wider group of interconnected actors. Rigid vertical top-down models of school systems, where decision-making trickles down from government, are increasingly being disrupted by the new opportunities and information provided by technology and data, enabling more grassroots movements and entrepreneurial uses of data to drive innovation within schools. Interestingly, with complexity comes opportunity. This report highlights interesting examples of how the involvement of different types of organisations, methods and approaches can be harnessed to drive innovation.

Generating impact

The excitement surrounding the potential opportunity of EdTech has led to increasing private investment, with global investment funding of the sector reaching $9.56 billion dollars in 2017 according to some reports[7]. But there remains a big gap between the excitement of the market and the reality of EdTech felt by learners and teachers in schools. And while financial support for EdTech is welcome (although there are notable gaps in financial support), there are a number of challenges that are difficult to address without more strategic support.

A recurring problem is the difficulty of connecting the EdTech sector more explicitly with the practicalities of our school systems (each of which have different but specific challenges) and designing tools that meet the real needs of teachers and learners. Too often, technology is developed with insufficient understanding of school practice, pedagogy or context and is therefore insufficiently sensitive to the changing demands of schools, classrooms, teachers and students - inhibiting the potential to generate impact.

The sector also struggles with evidence. Generating high quality evidence is difficult, and the presentation of different types of evidence (from user-reviews to more robust forms) is inconsistent. Education myths - such as 'learning styles' - remain commonly cited by technology companies[8]. This means that those programmes with a strong evidence-base struggle to differentiate themselves.

Some governments and foundations are seeking to provide more strategic support to help EdTech overcome some of these challenges through long-term strategies. For example, the Chinese government announced plans to spend $30 billion on EdTech by 2020[9]. More recently the UK government announced its new £10m EdTech Strategy[10], which includes plans for an 'EdTech Innovation Testbed', being launched in partnership with Nesta, which will see schools mobilised to help evaluate and test technology products. The case studies in this report present a number of different approaches that help technology to be sensitive to the needs of schools and engage communities of teachers in the development and implementation of EdTech.

In the case studies and the 'Shared themes and recommendations' that follow, we identify a number of generalisable insights into how programmes, products and groups of schools around the world have developed strategies and approaches to grapple with these challenges.

Shared themes and recommendations

The case studies presented in this report are varied - with different tools and organisations working to tackle different challenges in very different contexts. As described in our methodology, we specifically sought out examples that leveraged unusual partnerships, empowered teachers or altered their role, and that impacted on a wider system rather than a single school. Despite this wide range, there are a remarkable number of similarities, both in terms of the difficulties that ambitious technology-enabled programmes in schools face, and also in the successful strategies adopted to help overcome those difficulties.

We found that technology, when operating at scale across many schools, makes our school systems more complicated. In part, this is because it requires many different organisations, from teacher training providers to start-ups, with different interests, priorities and skills coming together. In turn, this often requires our school systems to become more dynamic in order to successfully implement and benefit from the potential that investment in technology might bring.
An interesting tension emerges from this, between efforts of our school systems to be more dynamic - for example through uses of data, leveraging unusual partnership, or developing new skills - and the need to remain sensitive to the needs and contexts of individual schools, teachers and pupils.

This chapter of the report does not present a 'single way' for approaching this issue. Nor it is a comprehensive roadmap for technology in schools (indeed, there are many considerations that are not discussed at all - from basic connectivity requirements to different political contexts around the world). Instead, we draw a series of generalisable lessons and recommendations from the case studies examined. These shared themes and recommendations are grouped under three headings.

The first relates to scale. How can we ensure that the benefits of investment in technology are felt more widely, and that the exciting practice seen in exceptional schools can be adopted elsewhere?
The second relates to schools. How can we gain buy-in from schools to wider programmes of change? And how can school leaders support their school community to make the most of change in their school?
The third relates to philanthropic foundations. Foundations emerge across many of our case studies, often playing a vital role in supporting innovation and brokering complex relationships. We explore how foundations can use their resources and status outside government to support innovation and EdTech.

1. Striving for scale

Supporting sustained improvement across large numbers of schools is extremely difficult. While many schools are 'islands of innovation'[11] - individual schools breaking the mould to achieve extraordinary things - the inspiring practice of these 'islands' often struggles to diffuse through our school system as a whole. Rather than examine individual inspiring schools, this report focuses on innovative programmes or products that have impacted on large numbers of schools, and - crucially - that have leveraged the complex relationships between different schools to do so.

This section draws out shared approaches across the selected case studies to realising impact at scale across multiple schools. Some of these recommendations could be applied both to technology companies looking to scale individual products, or policymakers looking to rollout programmes across regions.

Design and test with the toughest conditions in mind, not the easiest:
In order to reach more people (whether to be financially sustainable or to reach those most in need), tools need to be able to be used in the toughest conditions - not just in city centres with faster internet or in schools with a highly engaged parent community. This should be considered from the outset. For example, when designing the roll-out of Khan Academy in Brazil (see Case Study 9) reaching students in rural areas was essential to its financial viability given the high upfront cost of translating the Khan Academy platform. Therefore, rather than design and test for schools in São Paolo - with faster connectivity and more hardware devices - the platform was designed to operate with a low minimum connectivity speed.

Of course, prioritising the toughest conditions within a school system is likely to impact on the types of activities possible and may lead to a lowering of expectations for a programme. However, this is likely to increase the chances of an activity reaching those most in need. Testing in difficult conditions may also lead to a steeper learning curve (i.e. lessons about what does and does not work will present themselves more quickly). However, in the long-term, this may well save time and resources by avoiding approaches that are not sustainable.

Prioritise investment in training and support alongside hardware and software: Successful scaling of EdTech requires physical infrastructure - from electricity and internet connection, to appropriate hardware in schools or homes. A long-term strategic vision for a region or nation, supported by appropriate investment, is required to ensure that schools are equipped with the physical infrastructure to use whichever technologies would be most beneficial.

However, this vision should be linked to a long-term plan to invest in the human capabilities of a school system too. For schools to benefit from technology, teachers - who will be responsible for making decisions about when and how technology will be used in classrooms - must have both the skills and confidence to use technology impactfully. More systematic approaches to continuing professional development (CPD) are required, and uptake of training around the world varies wildly. The UK's Education Policy Institute's 2016 report found that while teachers in England spent an average of 4 days on CPD opportunities, teachers in Shanghai averaged 40 days.

In some instances, investment in human capabilities can be explicitly interwoven with investment in physical infrastructure and the fostering of a network of teachers around a common vision featuring technology (see Case Study: Riconnessioni).

Balance consistency alongside flexibility: No technology has an impact on learning in its own right, and even the best technology can be implemented poorly. An innovation's value is dependent on how it is used in a given context. As Hallgarten et al. note,

> "It is not simply a case of fidelity: replicating and adopting an innovation beyond its initial context."[12]

Technology programmes must balance the need to tackle a single problem consistently across many schools, with the need to create space for schools and teachers to adapt how they use a technology to their school's setting. Sometimes this is the flexibility to decide which tools to use. For example, the Welsh Government has prioritised the curation of a range of different digital tools through its online 'Hwb' - giving teachers the flexibility to adapt a suite of different tools to their own needs and practice (see Case Study 5). In other examples, this is the flexibility designed into individual tools to support being used in different ways.

Invest in data infrastructure to gather and use data effectively:
As programmes or products scale to reach more learners, teachers or schools, valuable insights can be gained. However, this is only possible with systems in place to gather and use data effectively. This will include ensuring clear legal procedures and frameworks for data-sharing, the collection of data without adding excessive burden to teachers and schools, and actionable insights disseminated widely.

Currently, many efforts to leverage data are taking place in silos within individual organisations. System-wide leadership on issues such as data interoperability, supporting appropriate sharing of open datasets and introducing regulation to ensure responsible sharing of data will be increasingly important to ensure that the potential benefits of a network effect are realised across schools.

Summary of recommendations to reach scale:

1. Design and test with the toughest conditions in mind, not the easiest. For technology companies this means reaching more users. For governments this means ensuring more equitable access.

2. Invest in training and support alongside hardware and software. For companies, governments and foundations alike, this is a crucial requirement.

3. Technology companies must balance consistency of offering alongside flexibility of context.

4. Governments must invest in infrastructure to gather and use data more effectively and openly.

2. Harnessing teachers as drivers of change

Most often, it is teachers who are the arbiters of when and how a technology is used in their school or classroom. They are also the ones with the most valuable insights into their own practice and the needs of students. This positions teachers with great potential to positively contribute to the impactful use of technology in schools.

However, this potential often remains unfulfilled. Across many of the interviews with teachers carried out as part of this research was a sense that technological change was something that happened 'to teachers' rather than 'with teachers'. Too often, top-down programmes of change are imposed on schools leaving teachers - who in most schools are highly-trained professionals with unequalled insight into practice in their classrooms - repositioned as someone whose job is 'largely to implement protocols and carry out instructions'[13].

As Michael Fullan writes:
> "If you take any hundred or so books on change, the message all boils down to one word: motivation. If one's theory of action does not motivate people to put in the effort– individually and collectively – that is necessary to get results, improvement is not possible"[14].

In this section we look at approaches to motivate and engage school leaders and teachers as active agents contributing to the success of the case studies in this report. These can be broken down into two categories: motivating school 'buy-in' to programmes of change, and advice for school leaders to motivate 'buy-in' from teachers within schools and increase the likelihood of lasting impact from the introduction of technology.

School 'Buy-in'

A clear vision driven by outcomes (not technology) that addresses an urgent need: Too often the 'technology' part can dominate the vision of a product or programme, rather than its impact on teachers and learners. In this report each case study has a powerful vision driven by learning or social outcomes, for which technology is just a tool. Even where technology is presented as a tool towards an outcome, that outcome must be sufficiently urgent. As Colin Hegarty, Founder and CEO of HegartyMaths, argues, 'The first thing you need to scale a solution is a genuine problem that schools feel a need to address'.

Provide a credible path to delivery, with high-intensity support during initial implementation: The school is a high-stakes environment for first using a new technology, with little room for manoeuvre if problems occur. The importance of training and support alongside the rollout of new hardware or software has already been emphasised (see 'Scale'), but this is particularly important during the initial phases of a change programme. Articulating a clear and credible delivery plan - with contingencies to provide extra support if problems occur, particularly during initial implementation - was repeatedly cited by school leaders as vital to assuring schools of the likely success of a programme.

Create an opportunity for teachers to be part of a wider community or network of learning: In many of the case studies, schools were motivated to engage with a programme through clearly articulated opportunities for learning from their peers. These can be structured through more formal

networks of schools disseminating best practice (see Case Study 5) or informal networks online (such as the Facebook groups used by teachers using Khan Academy in Brazil, see Case Study 9). These networks should be linked to efforts to ensure sufficient attention is paid to teacher training and capacity building and are helpful in ensuring that the impact of a programme remains sustainable after any initial implementation support decreases.

'10 Top-Tips' for school leaders

Alongside ensuring the 'buy-in' of schools, a recurring theme within the examples explored was the role of school leaders. School leaders hold a powerful position in offering a vision for a school's improvement, providing necessary support for staff throughout implementation, and generating the enthusiasm and commitment of a school community of teachers, parents and students towards a programme or product. Below are '10 Top Tips' collated from interviews with the headteachers and teachers interviewed as part of this research.

> ## Box 2: '10 Top Tips' for school leaders
>
> **1. It's about the problem, not the technology.** Whether identifying which technology product or features your school might benefit from, or if trying to communicate the importance of a tool to your school - clearly define the problem you are trying to solve *first*, then how technology can help.
>
> **2. Don't over-promise (and risk under-delivering).** Be honest about the impact you expect to see in your school. Over-promising will, in the long-run, lead to disappointment.
>
> **3. Time is precious.** Introducing a new technology requires time for teachers to familiarise themselves with new ways of working, but teacher time is one of the most rare commodities in schools. Try to find ways to free up colleagues' time to allow them to get to grips with a new technology, or ensure that support such as training can be offered in ways that are flexible to their commitments.
>
> **4. Take it slow.** Where possible, find ways to introduce change slowly.
>
> Use staggered implementation or ongoing training to ensure that teachers are helped to move gradually out of a potential 'comfort zone'.
>
> **5. Start with those most motivated.** The best motivation for a school community is seeing improvement. If appropriate, allow those who are most on board with a project to lead the way, giving time and space to show those who are more skeptical that there is potential for benefits.
>
> **6. Teacher development should be ongoing, rather than a one-off event.** Developing a culture of learning for staff is the most sustainable way to ensure your school community can confidently adapt to change. This will mean variation in the types of development offered to staff - from more formal training to shorter 'Show and Tell' sessions.
>
> **7. Support peer-to-peer networks.** Whether within or between school communities, try to stimulate sharing of learning between peers.

Where some more formal training or advice struggles, learning directly from peers in similar circumstances can be more successful.

8. Think about recruitment.
Sometimes more specialist support may be necessary. Consider if an IT lead or similar resource might be required in your school. Failing that, consider whether particularly enthusiastic members of the school community can act as 'Edtech champions' and a first point of call for troubleshooting or queries.

9. Allow funds for maintenance.
Particularly for hardware, allocating specific funds for the ongoing maintenance of products may be important.

10. Evaluate impact and give feedback.
Schedule points to take stock and reflect on how impactful a given technology has been. Try to identify impact measures and gauge the opinions of staff and students. Be sure to give this feedback to the technology supplier.

Summary of recommendations for motivating school buy-in, and advice for teachers leading change in their school:

For organisations seeking 'buy-in' from schools:
1. Provide a clear vision driven by outcomes (not technology) that addresses an urgent need.
2. Describe a credible path to delivery with high-intensity support during initial implementation.
3. Create an opportunity for teachers to be part of a wider community or network of learning.

For teachers leading change in their school:
1. Take advice from other school leaders as described in 'Box 2: '10 Top Tips' for school leaders'.

3. The role of philanthropic foundations

The complexity of school systems cannot be overstated. A hallmark of the programmes and innovations explored in this report is collaboration between a wide range of actors - including government, foundations, NGOs, entrepreneurs, large technology companies, community organisations and more. As the Omidyar Network's recent report describes, 'scaling and sustaining Equitable EdTech requires much more than eager learners and motivated educators. It demands the alignment of multiple actors across sectors in local ecosystems'[15].

This presents challenges. Collaboration between different types of organisations in structurally complicated systems is inherently difficult. However, it also presents new opportunities for non-government actors, particularly foundations and philanthropic organisations, to play an increasingly important role in improving schools in the future.

Perhaps surprisingly, the important - and often very innovative - role of foundations in supporting EdTech at scale emerges from the examples in this report. With considerable resources, a detachment from government and often an appetite for risk which is rare in school systems, foundations

can achieve a lot. Technology presents unique opportunities. It is a single 'investable asset' that often brings together many different elements of a school system, from accountability to teaching and learning.

In this section we make recommendations drawn from the examples explored in this report for how foundations can use their unusual status to support the improvement of school systems through investment in technology. In particular, we look at their ability to provide different forms of financial support, and to broker different relationships between the many stakeholders in our complex school systems.

Support riskier high-potential early-stage ideas through grant-funding:
Foundations are using grant-funding to support riskier, but high-potential innovations. With often only quite small amounts of money, these riskier investments can help prototypes or ideas transition to investable products.

For example, eKool (see Case Study 4) or HegartyMaths (see Case Study 7) both received small amounts of funding from Look@World Foundation[16] and SHINE[17] organisations respectively. This funding was crucial in providing space, time and legitimacy to ideas and early tools which have gone on to become highly impactful and widely used products. Such financial support should be tied to an effort to try and achieve financial sustainability through other forms of support, from business mentoring to introductions to sources of private capital.

Plugging gaps in funding pipeline with flexible and patient capital:
Even after early stage support (like that supported through high-potential grant-funding), there remain areas in the development pipeline of innovative products or services where it is more difficult to attract funding. There are particular challenges for innovations which have already passed a pilot stage, but which have not yet seen widespread adoption. Importantly, this finance should be long-term in approach and patient to the particular demands and timeframes associated with developing a commercially sustainable EdTech tool.

Support business models or subsidise tools to reach those most in need:
Foundations and philanthropic funding can support business models to ensure that the benefits of a technology are felt equitably - even in the poorest or least digitally-connected schools and communities. This may involve supporting 'freemium' services, subsidised products or more flexible finance for users.

For example, the Manaiakalani Education Trust facilitates a micro-financing lease-to-buy scheme enabling families to pay $3.50 per week across three years to own their child's netbook device. The decision not to provide the devices for free was a deliberate effort to foster parental engagement in the project (see Case Study 8: Manaiakalani). In Brazil, the Lemann Foundation has used its support to spread the use of Khan Academy and enable learners to access its resources that were previously unable to (see Case Study 9).

Prioritise experimentation alongside evaluation: Experimentation in school systems remains very difficult. For understandable reasons - from safeguarding issues, to a desire to ensure equal provision for all - schools

are tightly controlled and highly regulated. Similarly, schools and teachers themselves are often reluctant to experiment, with concerns over demands on time or the possibility of negative consequences.

However, experimentation is vital in developing, testing and improving innovations. On one level, this is about prioritising and funding high-quality independent evaluations which sit alongside products or programmes (eg. Case Study 1 or Case Study 9: Lemann Foundation and Khan Academy). But we also find instances where non-government actors have been able to create a culture of experimentation which is explicitly linked to evaluation and rapid improvement. As Michael Barber writes, 'In essence, education systems need to think more like lean start-ups'[18].

The rapid A/B testing and continuous evaluation implemented in all Bridge International Academies (see Case Study 6) is a striking example of this 'lean start-up' mentality in practice. A centralised 'Learning Lab' uses over 100 million data points collected each year from their network of schools to test and improve learning materials.

We also find foundations leading the growing number of 'EdTech testbeds' in school systems around the world. These 'testbeds' are explicit efforts to mobilise groups of schools to create space for experimentation and testing[19]. Although models for 'testbeds' around the world vary, these testbeds are often enabled by philanthropic funding attached to an appetite for experimentation. Examples include MindCET's testbed in Israel[20], or the work of Digital Promise[21], iZone[22] and the Silicon Valley Education Foundation[23] in the US.

Broker relationships between different school-system stakeholders:
Foundations can play an important role bringing together a range of different organisations and brokering relationships as a trusted partner. As described in 'The role of foundations', school systems are complex with an increasingly wide range of different organisations involved in the enabling and delivery of teaching.
Strategic partnerships and collaborations are vital for technology products or programmes to operate at scale and can take many forms - from governments showcasing 'best in class' innovations (see Case Study 4 and the role of the Estonian Government's e-Estonia initiative), to schools acting as design partners in the implementation of major reforms (see Case Study 5 and the role of 'Pioneer Schools').

Summary of recommendations for foundations:

1. Support riskier high-potential early-stage ideas through grant-funding.

2. Plug gaps in funding pipeline with flexible and patient capital.

3. Support business models or subsidise tools to reach those most in need.

4. Prioritise experimentation alongside evaluation.

5. Broker relationships between different school-system stakeholders.

Key innovation factors and case studies

This section presents the nine case studies explored as part of this report. To help navigate the case studies, we have identified five potential 'interesting features' which are associated with one or more of the case studies (look out for their icons as you read through the case studies).

Teachers

How can teachers take advantage of innovation programmes in schools? Hallmarks of the most successful education systems around the world include happy, highly-trained, respected and motivated teachers. As school systems evolve and innovate, they must bring teachers with them. Case studies marked with this icon highlight interesting efforts to address these challenges and opportunities in different contexts - from boosting skills and confidence, to evolving the role of the teacher.

Networks

What role can networks play to help school systems to innovate? School systems are inherently complicated and bring together many different people, organisations, assets, ideas and skills. But some networks use this complexity to provide new opportunities. Case studies marked with this icon highlight how networks - between schools, teachers or parents - can support the introduction of technology in school systems.

Social Hook

How can investment in technology be used to tackle other, seemingly unrelated, social issues? Technology is often typified by efforts to increase reach and efficiency. But investment in technology in schools can present interesting opportunities to tackle a range of different issues - from social exclusion and poverty, to migration and curriculum redesign. Case studies marked with this icon highlight how technology can be used as a hook to tackle a range of different social issues.

Non-Government Action

What is the role of non-government action when improving school systems? Technology presents an opportunity for non-government actors - from foundations or NGOs to for-profit companies - to play a much more significant role in day-to-day life of schools around the world. Case studies marked with this icon highlight how non-government action - whether through money, skills, or methods brought by different actors - is generating new opportunities and challenges for school systems.

Scale

What are the barriers to scale, and how can scale be leveraged for additional benefit? Scaling technology in school systems has many challenges - from building physical digital infrastructure to ensuring appropriate training provision. More interestingly, scale also presents unique opportunities for school systems to become more efficient and intelligent. Case studies marked with this icon highlight interesting efforts to leverage scale.

EKOOL

Key innovation factors: Scale; Non-Government Action
Location: Estonia
Scale: 400 Schools in Estonia, 10,000 teachers and 120,000 students
Vision: eKool is a platform that provides an easy way for parents, teachers and children to collaborate and organise all the information necessary for teaching and learning.

DIGITAL PIONEER SCHOOLS & THE WELSH GOVERNMENT'S STRATEGY ON DIGITAL COMPETENCY

Key innovation factors: Teachers; Social Hook
Location: Wales
Scale: 13 'Digital Pioneer Schools' experimenting to feed into a curriculum for all schools in Wales.
Vision: To test and experiment with the design of a new curriculum to support all students to develop critical digital competencies.

THE LEMANN FOUNDATION and KHAN ACADEMY

Key innovation factors: Teachers; Scale; Non-Government Action
Location: Brazil
Scale: 70,000 students and 2,500 teachers across several hundred pilot schools (with 2.6 million students in Brazil having registered to access resources outside of the pilot).
Vision: To use technology to enable all children in Brazil to have access to quality learning resources, and to help Brazil's teachers and education system to adapt to the changes that technology brings.

RICONNESSIONI

Key innovation factors: Teachers; Non-Government Action; Scale
Location: Italy
Scale: Riconnessioni involves 350 schools, 98,000 students and 1,800 teachers in Turin and neighbouring municipalities.
Vision: Overcome the physical and cultural barriers that prevent schools from innovating and developing new skills through super-fast broadband connectivity.

SCUOLE DADA

Key innovation factors: Teachers; Networks
Location: Italy
Scale: 30 Schools
Vision: Improving classrooms' technological equipment to foster schools' spatial organisations and consequently improve the learning environment and teaching activities management.

BOOK IN PROGRESS

Key innovation factors: Teachers; Network; Non-Government Action
Location: Italy
Scale: 88 Schools
Vision: Using digital technologies to help teachers and students to collaboratively produce educational resources and share these within a network. Creating a new learning model focused on accessibility, inclusivity and flexibility of resources.
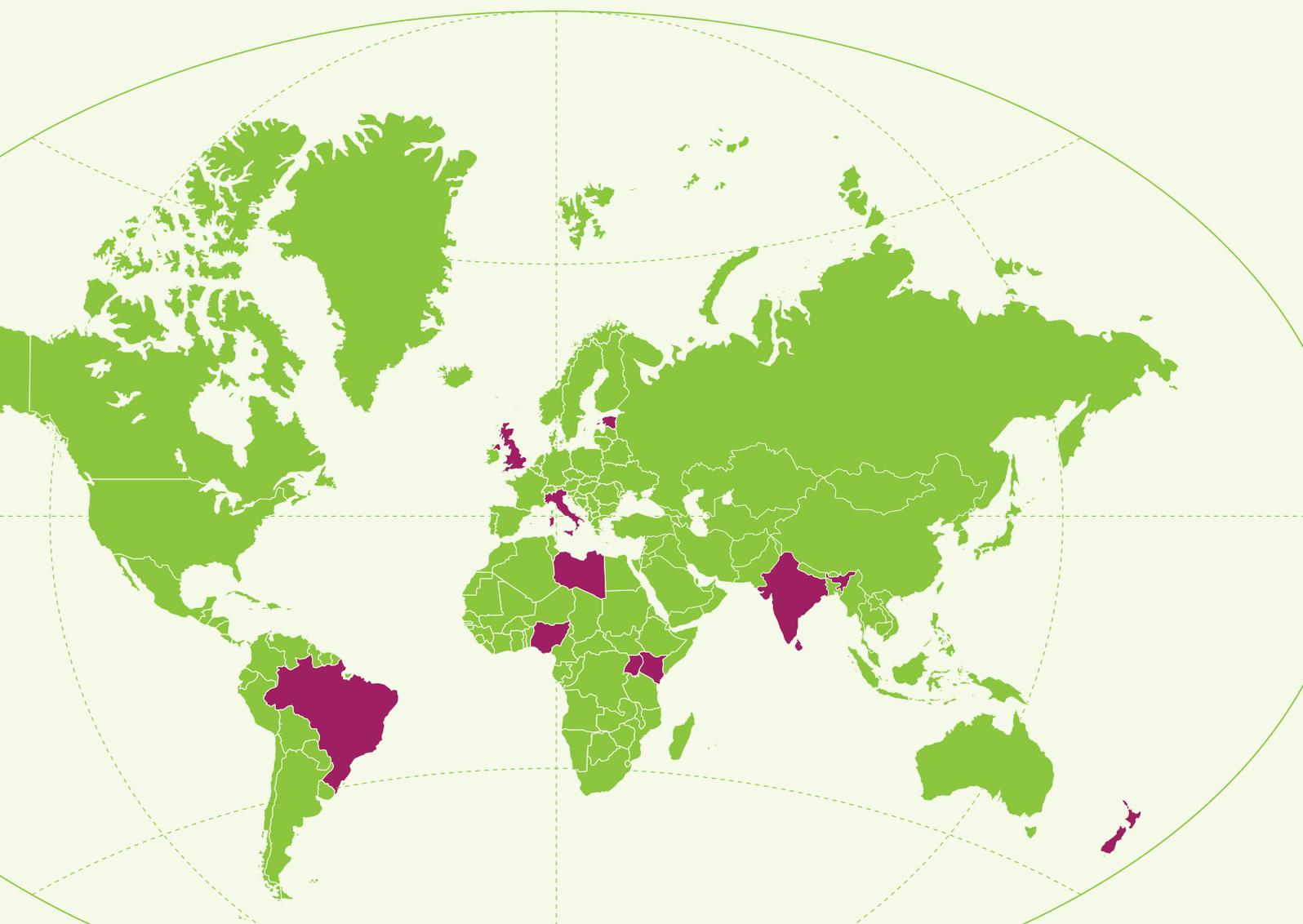
BRIDGE INTERNATIONAL ACADEMIES

Key innovation factors: Teachers; Scale
Location: Kenya, Uganda, Nigeria, Liberia, India
Scale: Over 400,000 children across 520 schools
Vision: Using technology to improve the standard and consistency of education in areas where schools typically had under-qualified teachers, low-attendance, high inconsistency and low attainment.

HEGARTYMATHS

Key innovation factors: Teachers; Scale
Location: United Kingdom
Scale: 1,200 schools in the UK with 1.2 million users.
Vision: To help students use maths homework time to learn.

MANAIAKALANI

Key innovation factors: Social Hook; Teachers; Non-Government Action
Location: New Zealand
Scale: 78 schools
Vision: To use digital technology to bridge and enrich learning in school and at home, and to act as a hook to raise outcomes for disadvantaged students.

1. Riconnessioni

Teachers and students coding together during an Aula 2030 workshop

Riconnessioni ('Reconnections') seeks to prepare young people for a changing future, one which is more connected and requires a wider range of skills. The project equips Italian primary and lower secondary schools with a fast internet connection, combining technology infrastructure with teacher training. Riconnessioni involves around 350 schools and has trained more than 1,800 teachers and 80 headteachers and heads of administrative staff. At its core, the project also aims to build a community of teachers, students, and parents, enabling schools to become powerful agents of social change.

Context

Internet access in schools in Italy is relatively poor, with a high degree of inconsistency. According to a recent survey by the digital observatory of the Politecnico di Milano[24], 33% of Italian school pupils cannot connect from their school. Where the internet is used, this is mainly restricted to administrative and basic search functions, such as sending and receiving emails or searching for information[25].

Training on the use of technology in the classroom is not yet widespread, and attitudes towards the educational value of technology varies enormously.

Through this experimental project in Turin, Riconnessioni hopes to act as a model for the transformation of Italian schools on a national scale, providing an example of what is achievable and inspiring a roadmap for other regions in Italy.

How it works

Riconnessioni is a three-year project (2017 - 2020) accompanying schools as they transform to prepare students for a new future using technology, exploiting its potential for social and cultural inclusion. The initiative is led by Compagnia di San Paolo[26], one of the largest philanthropic foundations in Europe, and it is structured around three strands:

> 1. *Providing infrastructure and supporting high quality Wi-Fi:* Riconnessioni provides 10Gbps optical fibre broadband to all participating schools with the collaboration and support of Open Fiber, one of the leading Italian telecommunication players. The project then supports headteachers and technical staff in redesigning their internal wireless networks and provides surveys of the schools' existing infrastructure to identify connectivity gaps and actions required to reach optimal coverage.

> 2. *Leadership through innovation:* The project trains headteachers and heads of administrative staff on digital transformation and change management, best practice exchange, and how to optimise procurement and reduce administrative burdens through the setting up of networks of schools.

> 3. *An ambitious teacher training programme:* Riconnessioni supports teachers through continuing professional development programmes. Alongside improving teacher practice, this aims to create a community of teachers, parents, and students who are empowered to come together to co-design the future of teaching.

The project started in January 2017 and in its two years of activity has engaged more than 100 schools. To this date, approximately 110 schools have been connected with fiber optic broadband and around 250 have been involved in the programme through training workshops for headteachers, teachers and parents.

Teacher empowerment

Although investment in technology infrastructure is the most visible aspect of Riconnessioni, the programme has prioritised teacher training and confidence building through its training programme 'Aula 2030'. Its design recognises that investment in technology alone is not sufficient, without also introducing changes in the practice and culture of teachers using technology.

As Lorenzo Benussi, Riconnessioni Programme Leader, pointed out, "We want to demonstrate that investments in hardware and infrastructure bring positive change in schools when teachers are empowered to use digital tools and collaborate among each other. It is important to plan activities of capacity building that put teachers at the center, letting them propose innovative teaching and management methods based on their experience and on their classrooms' needs."

Teachers shooting a stop motion video during an Aula 2030 workshop

To date, 1,750 hours of training for Aula 2030 have been provided, based on two different formats:

1. *Teachers' Room* - A structured training course for teachers involving consideration of both new learning resources and new teaching methods made possible by enhanced internet connectivity. This training format has been applied to a number of areas: school administration processes, the creation of digital contents and evaluation, innovative and inclusive teaching techniques, computational thinking, audiovisual storytelling, contemporary languages.

2. *Classroom for Everyone* - A community of teachers, parents and students who together with international experts plan to prepare for the school of the future. This training format has been applied to a number of areas including: digital communication, digital classroom, advanced computational thinking, tinkering and PP&S (Problem Posing & Solving). Many of these courses are provided in partnership with school publishers including Pearson, DeAgostini, Giunti, FME Education as well as local charities and other foundations.

The workshops are open to feedback and reflections from the community of teachers and parents, for the addition of new functions and course topics. This process ensures teachers are at the centre of the training programme, their classroom needs are prioritised and the workshops' content stays relevant over time. A key driving force behind the programme is the identification of areas in which technology can foster inclusion and address social issues. Teachers, parents, and the wider school community are engaged in discussions and co-design sessions aimed at exploring the role of technology in solving problems which matter to them. Riconnessioni uses this methodology across all training formats, addressing topics such as cultural integration, social inclusion of disadvantaged students, digital citizenship education, development of critical thinking, online communication, and children's rights.

Brokering partnerships and leveraging strengths

Riconnessioni is a complex project building on a wide range of skills, expertise relationships and resources. Strategic partnerships to leverage different capabilities have been crucial. The project is supported by a far-reaching partnership which includes the Ministry of Education, the Municipality of Turin, the National Research Council, ASVAPP (Regional Agency for the Evaluation of Public Policy), the technology company Open Fiber, Università di Torino, GARR (the Italian national computer network for universities and research), and other foundations.

Fondazione per la Scuola leads the project, acting to broker relationships between school leaders and teachers and the wider network of partners. The Ministry is involved in the programme to learn from Fondazione per la Scuola's expertise in teacher training and collect data and information useful to inform policy-making, ASVAPP monitors and evaluates the results in the different phases of implementation, Open Fiber directly contributes to the technological development, the Municipality of Turin is responsible for authorizing the implementation of the programme and ensuring the programme complies with the current regulations.

Classroom of Istituto Comprensivo Sandro Pertini, Turin

The "Istituto Comprensivo Sandro Pertini" is a school in Turin (primary through secondary, ages 6 to 14) with 120 teachers and 950 students. The institute was one of the first schools to participate in the Riconnessioni programme and receive fiber-optic broadband (January 2017).

Bringing about change in a complex organisation such as a school, with its own processes, cultures and behaviours, takes time and effort. The Riconnessioni programme places emphasis on the importance of headteachers driving change in their own schools.

In order to build consensus and avoid conflictual reactions, Elena Cappai, Headteacher of Istituto comprensivo Sandro Pertini, organised a series of meetings with staff to discuss opportunities available thanks to technology. As a result, the school prioritised using the Riconnessioni investment to reduce the burden of administrative tasks in her school.

In the initial phase, training activities involved small groups of teachers only, with the goal of triggering peer training courses in a second phase. The small group was selected without barriers to access, on a fully voluntary basis. Training was then added to the list of recognised compulsory courses, enabling teachers, managers and other figures inside the school to gain credits periodically required by the Italian school system to certify their permanent training activities.

As Elena Cappai observed, "the implementation of training courses dedicated to innovation can be very complex and should be planned with a strategy able to make them accessible for everyone".

Clear benefits were found early on. For example, for the first time teachers were able to record student assessments on the *Ministry of Education* platform immediately, right after the teachers committee rather than manually transcribe it in the offline forms and leave this task to administrative officers.

Elena Cappai, Headteacher, suggested three lessons from her experience. Firstly, each step should be communicated gradually to teachers and to different staff members, so that practicalities and the reasoning behind each phase of the implementation can sink in. Secondly, finding the right balance between voluntary and compulsory involvement of teachers within programmes is critical. Thirdly, change takes time. Expectations of students and teachers must be managed carefully to avoid disappointment and maintain enthusiasm.

2. Scuole Dada

Classroom of the Istituto Comprensivo 3 di Modena (IC Modena 3) school, member of the Scuole Dada network

The Scuole Dada (Didattica per Ambienti di Apprendimento) is a new educational model conceived by a grassroots network of teachers and headteachers to transform classrooms into laboratories for specific subjects, through technology, furniture and other tools. Scuole Dada has attracted support from other school leaders[27] and now has 30 schools across Italy that are experimenting with the model.

Context

Using technology and other tools to transform the spatial and physical learning environment of a classroom is particularly innovative in Italy's schools system. In the majority of Italian schools, students are divided in classes and assigned to specific rooms. Instead of students moving from classroom to classroom (as it is common in many school systems), teachers move from classroom to classroom. This means classrooms are rarely equipped with subject-specific tools to support digital learning, and few Italian schools are able to alter and innovate the physical learning environment.

Scuole Dada is a whole-school approach to changing the physical learning environment to enable teachers to adopt new teaching methods. The Scuole Dada model is driven by teachers and headteachers from the bottom up, rather than by a central government directive from the top-down. This has advantages - teachers and schools have a strong sense of buy-in to the project, are committed to a single vision for their school, and relationships between school members are strong. However, there are challenges too. Implementation of the Scuole Dada model has profound implications for the day-to-day running of a school and is, initially at least, highly disruptive. Led by the headteacher, each school:

1. Converts classrooms into 'laboratories', equipping them with technological tools selected by teachers and students depending on the subject taught.
2. Support teachers to manage the new tools and feel confident to adapt their practice to a new environment.

Space for building teachers' and students confidence

The model creates dedicated spaces for subject departments. This enables teachers to customise their teaching activities to a learning environment over which they have much more control. For example, teachers have opened their classrooms to inspiring people from their local area, built subject specific libraries in their classroom, and experimented with the use of technology specific to their needs or subject areas. As Daniele Barca (Headteacher of the Istituto Comprensivo 3 di Modena) observes, "Dada gives teachers more time and confidence to manage the innovation of their role through new spatial organisations and dedicated technologies."

The Dada model aims to include students in its own implementation, providing opportunities for further skill development and buy-in from the school community. From painting classrooms or developing apps to manage school communication, students are intimately involved in the process of change. Research[28] conducted by Università degli Studi di Roma "La Sapienza" indicates that nurturing the school community (that have embarked on the Dada model) has been a key factor in its success[29].

Classroom of the IC Modena 3 school, member of the Scuole Dada network

The Liceo Scientifico Kennedy in Rome, with 80 teachers and 870 students, was the first school to experiment with the Dada School model in 2014. A commission and a research group was formed on a voluntary basis by teachers to plan the different phases of implementation. Lydia Cangemi, Headteacher of Liceo Scientifico Kennedy, emphasised the importance of going slowly to allow school staff and parents to adjust to new ways of working that were outside of their comfort zone. However, a certain level of confidence was required to take the first step. She added, "Courage is an essential attitude to implement these kinds of projects, if you stop at the first bureaucratic obstacle you can hardly experiment, for school leaders there is always a risk to take".

Involvement of the whole teaching staff and wider community was essential from the outset. The transformation of the physical infrastructure of the building was possible thanks to public funding, but also to the voluntary contribution of resources in-kind, offered by teachers and student family members. For example, parents with architecture qualifications advised on spatial planning while lawyers assisted with administrative and regulation concerns.

The spatial transformation made possible a range of technological transformation. For example, an electronic register was introduced in the first year alongside digitisation of a number of other administrative functions. Teacher training was introduced to help the staff make better use of the technology provided in each of the classrooms thanks to the programme investments (such as interactive whiteboards enabling the use of specific classroom teaching applications, design software, word processing or calculation, video and films, music, radio and television, email, access to Internet and the educational network of the institute, videoconferences).

An evaluation framework has been developed in collaboration with the Faculty of Psychology and Pedagogy of the Rome Sapienza University[30]. The goal of this evaluation is to learn how the reorganisation of school spaces is impacting on students' learning. This evaluation and monitoring has been useful to the school's staff to understand what has been working, and make changes in practice. Since transforming into a Scuole Dada school, the school has registered an increase in enrolment requests up to its maximum capacity.

3. Book in Progress

Book in Progress teachers meeting in December 2018, I.I.S.S. Ettore Majorana in Brindisi

Book in Progress is a programme empowering teachers to create and share their own digital learning resources. The savings achieved from not needing to buy textbooks allow parents to purchase hardware necessary to access the new digital learning resources.

Context

New laws were introduced in 2012 and 2013 to encourage the autonomous production of digital educational resources by schools and teachers[31], opening up new opportunities for innovation in a sector dominated by a small number of large textbook producing companies. The widespread use of digital resources is often limited by insufficient access to digital hardware in classrooms[32].

How it works

"Book in Progress" seizes on the opportunity presented by the laws introduced in 2012 and 2013 it and aims to replace physical textbooks[33] with online learning resources created by teachers themselves. Thanks to the project, resources are now up-to date, they reflect classes differences

and interests, and are created together with pupils, giving more freedom to teaching practices. Set up by one teacher in 2009, the programme has been adopted in 88 schools.

The three main pillars of the programme are:

1. The promotion of teacher-led creation of learning resources based on digital devices.

> *The first pillar* aims to enable teachers to personalise their lessons and enrich them through the creation of a set of digital resources and contents, replacing the traditional textbook. The set of digital resources consists of content and reflections that emerge when talking to the students, taking into account differences and interests and creating new teaching materials. Interestingly, the introduction of new learning resources has prompted a reinvigorated discussion about pedagogy. As Nadia Cattaneo (Tosi Headteacher) said, "Book in Progress was like a Trojan Horse which deconstructed the usual didactic routine".

2. The creation of an open and supportive community of schools to encourage participation.

> Basic information needed by teachers to prepare a lesson are provided by the network coordinators and distributed to the schools. Book in Progress has a steering committee and each subject has a coordinator at national level. To ensure engagement among teachers, physical meetings are crucial. They provide an opportunity for training and help teachers master the Book in Progress approach.

3. The creation of specific procurement agreements to ensure every student can access digital tools and learning activities both in classrooms and at home.

> *The third pillar* is related to the procurement strategy implemented in order to ensure equal and complete access to digital tools for pupils and families. Headteachers and teachers estimates potential families' savings from not buying textbooks is about 350/400€ per year[34]. A data that confirms the benefits of investing in digital devices[35]. Where possible, schools receive help to apply for grants needed to secure capital to invest in hardware, sign preferential procurement partnerships with technology providers or are offered the tablets as loan for use.

<u>Improving collaboration among teachers and among schools</u>

The Book in Progress programme aims to increase collaboration both among teachers and among schools. For example, a network of teachers across the country created video-lessons and provided online assistance on how the programme works for students and teachers. Such national networks for teachers are rare. As Benedetto Di Rienzo, a headteacher involved in the project, comments, "The programme recognises the weakness of a system that for many years has not encouraged teachers to work in groups."

<u>Ensuring control of resources and accessibility to digital tools through partnerships</u>

In order to comply with the national education standards and include the new curricula among the experimental practices advocated and accepted by the government, in 2014 the programme joined INDIRE "avanguardie educative", the national government network of schools developing innovative models of structural and teaching innovation. INDIRE is the benchmark for educational research in Italy, and was created in collaboration with the Ministry of Education of the Italian Government.

Partnerships have been vital to increase access to digital devices and consequently digital learning resources. Thanks to an agreement with Apple, schools participating in the programme were able to achieve favourable rates for schools members and students who could purchase or loan ipads and access the resources created with Book in Progress. In some cases (as the one presented below) families were surveyed by the schools' administrative officers to better understand their financial constraints. Following the survey, customised contracts were prepared to meet families' needs.

Classroom of the Istituto Tecnico Economico Enrico Tosi, Busto Arsizio

The Istituto Tecnico Enrico Tosi joined the programme in 2009, as one of the first schools to test this new approach.

As Nadia Cattaneo, Headteacher of the Institute, pointed out, "introducing innovative projects can be tricky and sometimes they are met with a certain level of scepticism and immobilism".

Building trust in the programme and buy-in from staff was therefore a priority. To initiate the programme, Cattaneo prioritised offering training for volunteers within the school who acted as 'pioneer' teachers. By staggering the implementation and involving the most enthusiastic first, these teachers could act as ambassadors for the project within the school.

The turning point of the project occurred in the 2014-2015 school year, when each department of the school transformed the contents into a set of digital materials that replaced textbooks.

Families were helped to buy-in to the project and many invested small amounts of their own money into buying digital tools that could support teachers in conducting digitally-based teaching activities in classes. For those unable to invest their own money other routes were explored. For example, some applied for grant funds to purchase tablets. Surveys were also carried out to understand which families needed more support to purchase products.

4. eKool
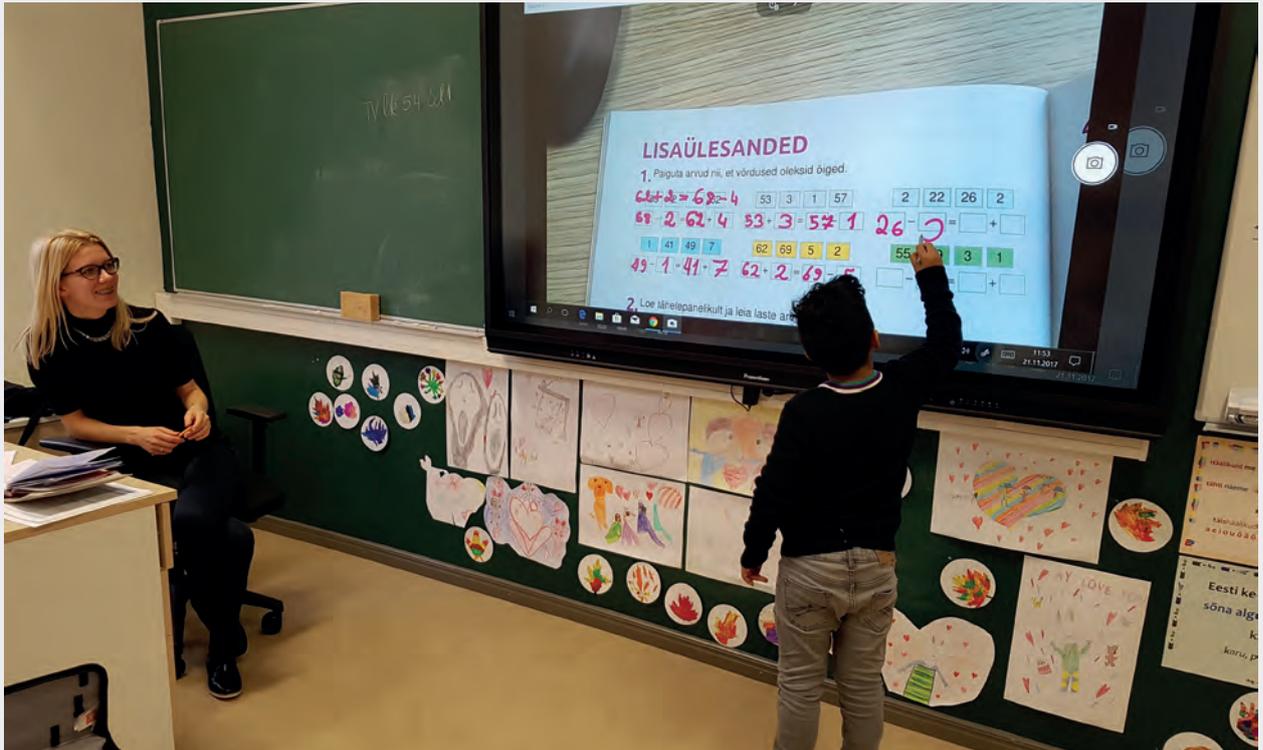
Classroom of Gustav Adolf Grammar School, Tallinn

eKool is a school management IT platform that brings teachers, pupils, families, schools and supervisory bodies together. As well as helping parents to understand and engage with their children's activities in schools, data collected from the platform is used by local authorities to understand activity in schools. With strategic support from the Estonian government the platform has scaled to be used in 85% of schools in Estonia.

Context

Estonia boasts some of the most digitally advanced public sector services in the world[36]. Its government has a long history of pioneering public sector technology[37], from 'e-tax[38]' to 'e-residency[39]'. e-Estonia is a government initiative to support digital transformation in a wide range of sectors, including education. Through the Estonian Education Information System (EHIS), the government also supports a database of information about education progress, including graduation documents, curriculum and other details.

For example, the most common use of EHIS is for students applying to university to simply transfer details of their education history to the desired university. eKool is a product which has been championed as a success story by the e-Estonia initiative.

The eKool platform enables teachers to input grades, attendance records and any other relevant information into an easy-to-use platform. It also enables teachers to message parents directly. Headteachers can access and manage school statistics, reporting and timetables. Data collected from eKool feeds the Estonian Education Information System (EHIS)[40]. District administrators have access to the latest statistical reports on demand, making it easy to consolidate data across the district's schools.

As Kätlin Kalde, Tallinn City Government, Department of Education, commented,

> "Municipal schools in Tallinn have used eKool already for more than 10 years, it serves as a schools' diary system for teachers, students and parents. Teachers do not carry any paper diaries with them to mark students' notes, absences, other information. Everything is done digitally"

Students can read their own grades and keep track of what homework has been assigned each day. They also have an option of saving their best work in their own personal e-portfolios.

Partnerships and support from government

The initiative began as a non-profit project incubated internally by the Look@World Foundation in Estonia, a private foundation which backs experimental solutions to support education, science and culture by encouraging and diffusing the use of Internet and ICT[41]. The project received support during its early stages until it became sustainable and spun-out as a private company.

eKool's association with the government's e-Estonia initiative has also been helpful to achieve larger adoption of the school management IT platform in schools.

Achieving sustainability through a suitable business model

The eKool web-based version is free of charge for pupils, parents and teachers. Part of its revenue is raised through advertisements related to education. In addition to the free main functionality, clients can subscribe to additional paid services. Schools pay a monthly fee for eKool services depending on the number of students enrolled in that school (50 euros for schools with less than 250 pupils, or more depending on this quantitative factor[42]). The monthly fee covers the hosting of the eKool web application, user support and general software development costs.

Classroom of Gustav Adolf Grammar School, Tallinn

Established in 1631, the Gustav Adolf Grammar school is one of Europe's oldest grammar schools. It is a municipal school with about 1,400 students aged 7 to 19 and around 100 teachers. eKool was adopted by the school in 2005. All teachers are members of eKool, and the majority of parents in the school have voluntarily registered on the platform.

Lilian Reinmets, Development Manager at Gustav Adolf Grammar School told us that "from the school's perspective, the eKool platform is about having all the information in one place, where anyone interested can access information as they wish, whenever. It is easy to keep track of everything, for the students and parents."

Data about students is stored on the platform and teachers can access reports and feedback from other teachers about students in their class, covering performance and behaviour. At the end of the school year, data can be transferred to the EHIS database, which is used by municipalities to see a snapshot of education progress and achievement.

The school has invested heavily in staff expertise to ensure the platform is used to its full potential. A Head IT administrator is tasked with adding and arranging learning groups and fields of study, creating diaries for teachers for different subjects, and assisting with day-to-day management.

Three further administrators assist with data collection and organisation.

eKool has tried to prioritise service alongside the product itself. The company organises workshops for school leaders every August, in addition to online training modules. It also provides a permanent maintenance service for issues or difficulties in understanding certain tasks. eKool administration collects feedback from schools, local IT technicians and other users, to enable more effective programme use. Lilian Reinmets commented, "give feedback and new ideas to make the system better. Don't be afraid of new technologies, take the best out of it for you."

5. Digital Pioneer Schools & the Welsh Government's Strategy on Digital Competency

Classroom of of the digital pioneer Cadoxton Primary School, Barry

The Digital Pioneer Schools are a network of schools drawn from across Wales by the Welsh Government to support the development of a curriculum which incorporates digital competence and to share learning between schools in Wales[43].

Country

In 2017 the Welsh Government published an action plan for 2017-2021, setting out how their education system would move forward, including a commitment to provide high level digital skills to all their learners. Following an independent review of the curriculum, which was published in Wales in 2015[44]. The Welsh Government introduced a 'Digital Competence Framework'[45], with digital competence one of three cross-curricular responsibilities, alongside literacy and numeracy. The framework focuses on developing a broad set of digital skills required in our increasingly digital world. These span four main strands: citizenship, interacting and collaborating, producing, data and computational thinking.

Alongside the introduction of the new digital competence framework and the work of 'Digital Pioneer Schools', two major government investment programmes have been important. The first is called 'Hwb'. The Hwb platform, hosts a national collection of digital tools and resources to support education in Wales. Hwb enables its users to access online resources anywhere, at any time and from a range of web-enabled devices. It also provides tools to help education practitioners create and share their own resources and assignments. According to the data provided by the Welsh Government[46] since March 2018 over 84% of schools are actively engaged in Hwb with around 450,000 active accounts. On 30 April 2019, Hwb became the home for the new draft Curriculum for Wales 2022[47].

The second is the Learning in Digital Wales (LiDW) Grant Programme, where Welsh Government invested approximately £39 million improving the broadband connectivity and technology infrastructure in schools. All eligible primary schools were provided with a connection providing at least 10 Mbps and an additional £10,000 grant to improve in-school infrastructure. Secondary schools were provided with connection at 100Mbps with £20,000 being provided to improve the in-school infrastructure. Delivery was completed in Summer 2016 and broadband upgrades were provided to around 960 schools in Wales mainly via fibre circuits procured through the Welsh Government Public Sector Broadband Aggregation (PSBA) network.

How it works

The Welsh Government has a co-construction approach to education and work closely with a range of partners who contribute to the development of policy. The 'Digital Pioneer Schools' are a network of schools who, together with partners from Estyn and regional education Consortia, worked with the Welsh Government to develop and test the new 'Digital Competence Framework' before it was rollout to all schools in Wales in September 2016. Alongside supporting the Government, working with their regional education consortia, the network of schools also acts as a centre of knowledge and support for other schools in their area through outreach and training.

The Welsh Government's approach has aimed to balance a desire to drive change, with an understanding that the different capacities and contexts of schools bring different challenges. Through the Digital Pioneer Schools, the Government is able to experiment and test with confidence that the schools involved are equipped to manage this extra responsibility. There are a number of different features of their work which highlight this.

A school and teacher-led approach
Rather than mandate the exact content and implementation of the new framework, through the Digital Pioneer Schools network, the government involved schools in the development process. This is helping to gain buy-in from schools, while also stress-testing the framework in real settings.

This approach is mirrored in the Hwb platform. Rather than specifying exactly which digital tools teachers should use, the Hwb platform provides a central repository of tools. Teachers are given the choice over which tools are most suited to their needs, and which they like the most.

As Louise Williams, Teacher at Cadoxton Primary School (a Digital Pioneer School), observes, this gives teachers a huge amount of choice:

> "software such as Microsoft office 365, google classroom, J2easy, Encyclopaedia Britannica along with a vast amount of resources made by teachers for teachers and all with a single sign on. It means that any part of the Digital framework can be taught freely in Wales, as long as you have good kit!"

Moreover, through Hwb and the Digital Pioneer Schools the government has enabled the creation of a network for shared learning between schools and government, but also between Digital Pioneer Schools and other schools across Wales . The schools involved in the programme act as hubs for sharing learning, sometimes offering training for teachers from other schools facilitated via their Consortia.

A closer look on the ground:
Cadoxton Primary School, Barry, Wales

Classroom of the digital pioneer Cadoxton Primary School, Barry

Cadoxton Primary School is a Digital Pioneer School in Barry, Wales. Once home to the largest coal port in the world, it is now an area with high levels of disadvantage.

Before being named a Digital Pioneer School, Cadoxton Primary School had a vision for teaching and learning which saw digital competency as a key requirement of its students. The school has been an enthusiastic 'early-adopter' of technology under the leadership of its headteacher, Janet Hayward.

Acclimatising staff to the introduction of technology, continuous (rather than a one-off) training, and ensuring staff can see tangible benefits to technology has been central to the implementation plan in the school. The school's strategy has been to introduce change slowly, with many opportunities for feedback and training. This means training is varied, ranging from more formal professional development courses to less formal 'show-and-tell' meetings with staff. As Louise Williams, Digital Lead at Cadoxton Primary School commented, "Start with a vision - an idea of what you want to achieve. Don't just buy kit and hope teachers will use it. Introduce things slowly, provide support, put technology in the hands of teachers, but help them understand that often the children are the experts!".

The school management regularly carry out an audit of teachers and learning support assistants in school, enabling senior staff to identify training needs and weaknesses. This approach has been adopted more widely, and the Government now hosts an audit tool on its Hwb platform that can be used by all schools in Wales.

Support from the Government, through investments in connectivity and the Hwb platform, has been essential. However the school has also adopted an entrepreneurial approach to attract funding and opportunities to introduce technology. In a community where access to IT devices is highly varied, this is seen as a way to leverage external organisations and partnerships in ensuring to ensure more opportunities and equal access to devices in the school. For example, the school has partnerships with local businesses and regularly applies for external grant funding.

6. Bridge International Academies

Teachers trained by Bridge International Academies delivering a lesson in Kenya

Bridge International Academies is a private company which works with governments to either set-up and run schools in underserved areas or offer resources and training to improve teaching and learning in existing government schools. Its network of low-cost private schools operates across Africa and Asia. Its model relies on teachers using an e-reader to download and follow prescribed lesson plans.

Context

Bridge International Academies align their work with an effort to achieve the UN's Sustainable Development Goal Number Four: "to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"[48]. About 262 million children are not in schooling across the world, with particularly low rates of attendance in sub-Saharan Africa, Northern Africa and Western Asia[49]. Even when children are in school, problems persist on a huge scale. A further 330 million children are estimated to be 'in school not learning the basics'[50].

Through creating new schools and improving existing schools, Bridge International Academies aims to impact significantly on both of these measures.

Bridge International Academies have two strands of work. The first is a chain of more than 500 low-cost private schools educating over 100,000 children. The second involves partnerships with governments to provide lesson plans and teacher training in existing schools. Common to both strands are three problems:
1. Low consistency of teacher quality within and between schools;
2. Lack of quality lessons plans and teaching materials linked to the national curriculum of a given country;
3. Lack of data and accountability as to what is happening inside classroom.

The Bridge International Academies model has three main components:

1. They develop a set of extremely detailed lesson plans - including mandated pauses for reflection and instructions to look up at the class - which act as scripts for teachers to adhere to strictly within their lessons. This strict adherence is seen as vital to tackling the low consistency of teacher quality within the countries their schools operate in. Developing the lesson plans is time-intensive effort, building from the national curriculum (in some cases there are no existing national textbooks from which to build on). Fast feedback loops are built into the design phase, with lesson plans being created, tested and iterated daily. Whole school timetables are then built, linked to the lesson plans, to ensure that learning in each subject area is sequenced to meet each government's priorities and examination systems.

2. The model relies on each teacher using an e-reader tablet. Each morning, a school's headteacher uses a smartphone to set up a WiFi hotspot. Teachers then download the daily lesson plans onto their e-reader. The tablet and lesson plans act as a script for the teacher to deliver a lesson. This aims to ensure consistency of provision and access to higher-quality teaching resources.

3. Bridge International Academies invest in teacher training. All teachers in their academies take part in a 15-day residential training course. When offering teacher training to teachers in existing government schools, training follows a similar format. For example, working with the Nigerian Government, 6,603 teachers and 845 Headmasters attended one of five 10-day training courses. Training courses are large, not highly personalised, and focus overwhelmingly on practice and repetition.

The Bridge International Academies model has been controversial[51] for some. Criticisms centre on two issues: its status as a for-profit company competing with state providers and its use of 'scripted education', which can stifle teachers' creativity and reduce their role to a class monitor rather than active and professionally trained expert in teaching and learning. Bridge International Academies have invested time and resource into multiple independent evaluations of their work which shows significant gains in student attainment in their schools[52]. Regardless of criticisms, there are key learnings that can be taken from the approach that Bridge International Academy have taken to the use of data across their schools.

Teachers trained by Bridge International Academies delivering a lesson in Nigeria

Data and scale to gain insights

Leveraging the scale of the BIA network of schools and teachers has been central to the organisation of the network and its processes. BIA collect over 100 million data points each year tracking the performance and attendance of teachers and pupils in every school, and during teacher training courses. For example, at the end of each day of training, trainee teachers are given an "exit ticket" of multiple choice questions, which provides data allowing trainers to gauge trainees' mastery of the core concepts of the day.

The scale of the network provides an unusual opportunity for gaining actionable insights from trends or patterns.

> "It's a crime not to think about scale in certain contexts, when the need is high and the data is available to you"
> (Chaitra Murlidhar, Director or Leadership and Development).

A 'Learning Lab' with staff in the USA and in-country, analyses data and coordinates A/B testing in clusters of schools to test small changes to either teacher training or the lesson plans themselves. For example, having noticed that vocabulary in some science lesson plans was too advanced for the literacy level of some students, different options were tested to see which increased the lesson-plan completion rate.

This culture of 'test and learn' is embedded in the organisation. For example, a regular 'Shark Tank' meeting (based on the US TV format for entrepreneurs) provides a forum for staff to suggest new ideas to improve the network.

7. HegartyMaths

Colin Hegarty working with his students

HegartyMaths is an adaptive learning platform providing students access to high-quality maths learning resources. Its core goal is to help students use maths homework time to learn, rather than practice what they already know.

Context

Teacher workload is a growing crisis in the UK. Excessive administration is leaving teachers with less time to do what they are trained to do: devote time and expertise to teaching young people. Eighty-four per cent of respondents to NASUWT's 2017 survey identified workload as their number one concern[53]. This is impacting on schools' ability to recruit and retain staff.

Education policy is devolved to the four countries that make up the UK. Within each of these countries, schools remain fairly autonomous and most IT purchasing is carried out by individual schools. This has created quite a fragmented marketplace in which EdTech companies must work hard to make sales to individual schools.

In 2011 Colin Hegarty, a maths teacher in England, began making YouTube videos to try to help his students gain more benefit from the time spent doing homework and maths revision. The success of these early YouTube videos led to the development of a more sophisticated platform, which combines curriculum-aligned resources, the ability to set personalised and scaffolded assignments for individual students, pupil progress tracking, and the ability for teachers to provide feedback.

> "The main problem with homework is that students are just practicing, rather than learning - so they get the things they know right, and the things they don't know wrong. Technology systems with tracking, marking and explanations help students to learn from their homework" (Colin Hegarty, Founder of HegartyMaths)

The full HegartyMaths platform launched in 2016. Since then, it has scaled to 1,200 schools in the UK with 1.2 million children using the platform.

Growing usage of the platform provides rich sources of data to improve the platform and its resources, and to engage with teachers in new ways. Colin Hegarty noted,
> "We're lucky - we have 1.2m students and 19,000 teachers using the platform. We can see what teachers are doing, and have processes for teachers to make suggestions to help us improve the platform. Teachers often suggest solutions, and we are able to go back to them and ask 'well, what problem are you actually trying to solve?'. Then we can work to develop solutions".

This data and feedback from teachers also contributes to an organisational memory which, with teachers leaving the profession in large numbers in English schools, is highly valued.

Philanthropic funding providing crucial early-stage support
HegartyMaths has benefitted from important strategic support from charities and foundations. While still a practising teacher, Colin Hegarty applied to SHINE (an education trust based in Leeds) for grant funding through their 'Let teachers SHINE' programme. 'Let teachers SHINE' is a grant funding programme specifically aimed at practicing teachers with ideas that they would like to pilot in the classroom. Initially HegartyMaths received £15,000 in 2012 (and then further support across the next 2 years) to fund the development of a website to host videos.

This early support was instrumental in building the platform, bridging a gap before the company was able to become sustainable and attract further external investment. Importantly, SHINE was able to do this while also driving HegartyMaths to become a sustainable business. As Colin Hegarty describes,

> "We needed external investment, so SHINE was fantastic. But the money was provided with the explicit intention that we become sustainable, and SHINE were also questioning us on gaps between revenue and costs with a focus on making our own income until we could stand on our own two feet".

Since then, other forms of non-financial support from non-government organisations have helped HegartyMaths to grow. For example, Colin Hegarty was awarded the UK's 'Teacher of the Year Award' in 2014, and shortlisted for the Varkey Foundation 'Global Teacher of the Year' award in 2016. HegartyMaths is a striking example of how strategic support from a small number of organisations can help propel a good idea and well designed product to reach impressive scale in a relatively short period of time.
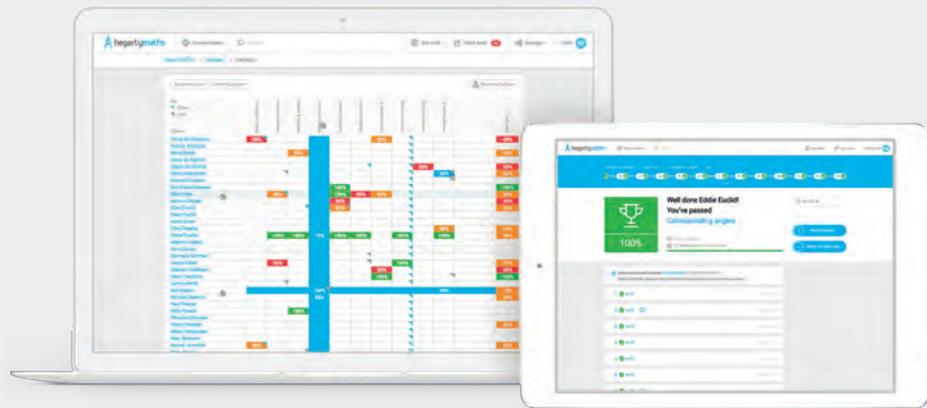
HegartyMaths PC and mobile versions

Prioritising ongoing service alongside a product

HegartyMaths offers a range of services alongside the product itself, all of which are seen as critical components.

1. Schools initially take part in a trial to ensure that the product is appropriate for what a school is trying to achieve and to align expectations.

2. Schools receive training and a five-point plan for initial implementation, delivered by former maths teachers at HegartyMaths. Leaders of the maths faculty are expected to take part in this initial training to ensure senior buy-in during this critical implementation phase.

3. There is ongoing support for teachers and schools through a HegartyMaths helpdesk. As Colin Hegarty commented, "We know that one of the worst things that can happen to a teacher is that technology fails them in a classroom setting. So we have to respond quickly to avoid that".

4. Data reporting to schools and teachers is ongoing. There are options for additional data analysis into specific themes for schools if needed.

8. Manaiakalani
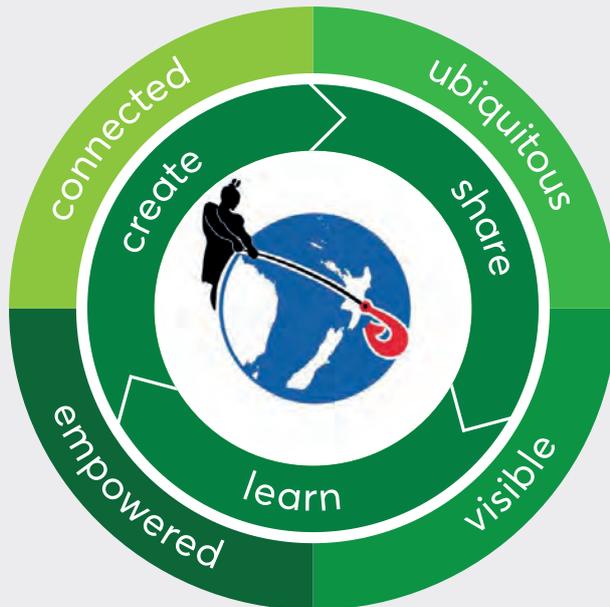
A visual summary of Manaiakalani approach

Having initially been experimented in a cluster of seven schools, the Manaiakalani Programme currently operates in 78 schools in 10 regional clusters across New Zealand[54], particularly in areas with unequal education outcomes within local communities. The project uses technology to enable disadvantaged students to gain 'full digital citizenship', reducing inequalities among pupils at different learning levels and from different socio-cultural backgrounds.

Context

Indigenous communities in New Zealand, specifically the Maori and Pasifika, have lower levels of participation and attainment at school[55]. The Manaiakalani Programme has been firstly experimented within a cluster of seven schools in the suburbs of Auckland, New Zealand, serving a large indigenous community.

New Zealand's school system is characterised by a high level of devolution. Devolved, self-managing schools, governed primarily by parents and competing for students, were expected to foster better teaching and learning, and a higher performing education system. While this has given more autonomy to schools to engage with and develop programmes like Manaiakalani, it also presents difficulties for scaling projects across many schools.

The Manaiakalani programme combines access to digital hardware with a new approach to teaching and teacher training.

Access to hardware is enabled by micro-financing on a lease-to-buy arrangement for all students within the schools involved. Families pay $3.50/week over 3 years to own their child's netbook device. Devices are not provided free of charge with the deliberate aim of fostering parental engagement in learning.

Participating schools adapt their pedagogy based on the framework 'Learn, Create, Share' developed and tested within the programme[56]. This framework emphasises elements that can benefit from the usage of digital devices, specifically: *ubiquity* of learning, *agency* of students, *connectedness* with peers, and *visibility* to teachers, parents and the community. As a result, learning and creativity are enhanced and teachers' 'buy in' in the project reinforced.

Alongside this, a teacher training programme - called the Manaiakalani Digital Teaching Academy (MDTA) - pairs newly qualified teachers with more experienced ones with the aim to share knowledge and experience on how to best use new technologies to improve their teaching. Through the MDTA, technology and the new pedagogical framework are explicitly linked, providing opportunities for teachers to experiment and test both aspects. As part of the programme, teachers have the opportunity to attend a Masters programme at the University of Auckland (a project's evaluation and support partner).
The MDTA is only one of the many different activities offered by the Professional Learning and Development (PLD) programme. Training is seen as fundamental to enable teachers to deliver the 'Learn Create Share' pedagogy at its full potential, accelerating student achievement outcomes.

Generating buy-in from families and harnessing local communities
As the programme was partly a response to low attendance and engagement with schools in some communities, increasing parental engagement in schooling was a deliberate aim. Parents were asked to fund the purchase of the devices with a contribution of $3.50/week over 3 years.

Costs are kept low through strategic partnerships and innovative finance arrangements. As Pat Snedden, Chair of the Manaiakalani Education Trust described,
> "It is typically assumed that poor families are unable to pay the price of the required digital support for their children. The Manaiakalani model shows this need not be the case."

Evaluation driving expansion
A further success factor of the project was the decision to create a network of partners responsible for assessing the projects' results, building evidence that could be disseminated among policymakers and other schools across the country.
Five percent of the project budget has been allocated to research and evaluation in order to monitor and measure impact.

The research was initially conducted internally by Colleen Gleeson and Dorothy Burt, respectively Researcher and Programme Lead at Manaiakalani (2007-2011) and then carried out in partnership with the Woolf Fisher Research Centre at the University of Auckland (2012-2014).

As Prof. Stuart McNaughton, Director of the Woolf Fisher Research Centre and Chief Education Scientific Advisor for the New Zealand Ministry of Education, pointed out:

> "If a child was continuously present in a Manaiakalani school, that is they got the full 'dosage', the rate of gain in writing was twice that expected nationally. This means that these students on average made one more year's progress above the expected rate per year if they were there for three years[57]."

Research has shown how improvements in learning outcomes were possible thanks to the introduction of a new learning pedagogy, which changes the school experience of students from years 1 to 13. The analysis has also shown a higher level of parental engagement and an increased affordability of 1 : 1 digital devices for all students aged 4 to 13. A correlation between a better provision of fast internet to all students and positive learning outcomes have also been noticed[58].

In 2015, as a result of evidence-based student achievement acceleration, the Manaiakalani Outreach Programme (MOP) was established. The goal of the initiative was to share the Manaiakalani methodology with other low socio-economic and challenged school communities, significantly expanding the reach of the Manaiakalani approach. Growing from a cluster of seven schools, the model has now been spread across in 78 schools in New Zealand. The MOP has been implemented thanks to a partnership with the Ministry of Education, Samsung and three foundations (Foundation North, Next Foundation and Spark Foundation).

Classroom of Ruapotaka Primary School, Point England, Auckland

9. The Lemann Foundation and Khan Academy

Meduneckas School - Barueri, Sao Paulo, Brazil - March 2018, © by Khan Academy

Khan Academy provides an online platform with exercises, videos, and a learning platform for pupils to study at their own pace, without the need to be physically present at school. Since 2012, the Lemann Foundation has been working with Khan Academy to translate the platform into Portuguese for teachers and students in Brazil. Between 2012 and 2017, 2.6 million students in Brazil registered on the Khan Academy platform.

At the heart of this, there is a driving question: How to make the most of the limited amount of time available for teaching in Brazil? Some understanding of Brazil's education system is required to recognise the significance of this challenge.

Context

Brazil has almost 30 million primary and lower secondary school students, placing significant logistical pressure on its school system and infrastructure[59]. In most schools, students attend one of three sessions per day (7am - 12pm, 12pm - 5pm, or 5pm - 10pm), and few students have a

full-day of schooling.
With many students receiving only four hours of instruction a day and with teachers responsible for a large number of students, better ways of supporting pupil progress are essential.

Teacher quality and consistency has also been a major issue, with schools struggling to recruit enough qualified teachers to fill positions.
"math and science provision instruction [...] is complicated in Brazil by a severe shortage of qualified teachers in these areas - virtually every state system currently relies on underqualified temporary teachers to fill the vacancies"[60].

Brazil's Center of Studies on Information and Communication Technologies (CETIC) published its fourth survey of ICT use in Brazilian schools in 2014. In public schools, there is an average of 19.1 computers serving an average of 653 students, meaning 'the number of computers available can be considered a limitation to pedagogical ICT use with students, considering the average class size at each level of education'[61]. Internet is available in almost all public schools, although connection speed remains a problem.

How it works

In 2012, the Lemann Foundation partnered with Khan Academy. The aim of the partnership was threefold:
1. To raise attainment through better quality and consistency of maths teaching provision by promoting the use of Khan Academy in Brazil.
2. To provide teacher training and increase confidence in teaching maths.
3. To provide more granular insights - for teachers and system administrators - into how students are progressing.
At the centre of this programme has been the translation of the Khan Academy platform in Portuguese.

Importantly, this effort has involved the translation of not just the learning resources (videos, sample questions, etc.) but also the content management system and analytical tools within the platform. By translating the entire platform, not just its resources, the project aims to gain understanding of how students are progressing in classrooms. This provides those overseeing schools, teachers and students with valuable insights that can help to compensate for some of the challenges of the Brazilian school system.

Meduneckas School - Barueri, Sao Paulo, Brazil - March 2018, © by Khan Academy.

About Khan Academy and the Lemann Foundation

Khan Academy

Founded by Salman Khan in 2006, Khan Academy is an online platform that offers practice exercises, instructional videos, and a learning dashboard that enables learners to study at their own pace, in and outside of the classroom.

When students first interact with Khan Academy, they take an initial test to understand their current level of knowledge. This enables the platform to provide suitable content and make recommendations. Users are incentivised to keep using the platform through gamification and the reward of points and medals.

The platform has been used in several contexts to provide access to quality learning resources in math, science, computer programming, history, art history, economics, and more. The mission is to guide learners to activities which are more personalised and help teachers to benefit from insights about their students generated by the platform. Khan Academy partnered with institutions like NASA, The Museum of Modern Art, The California Academy of Sciences and MIT to offer specialised content.

Lemann Foundation

The Lemann Foundation is a philanthropic organisation founded by Jorge Lemann. Its mission is to ensure that all Brazilian children have quality public education and to create a network of talented people dedicated to solving social problems in Brazil[62]. At the heart of the foundation's strategy is the ambition to reach scale. Over 40 million people have used EdTech solutions supported by the foundation.

Evaluation of the programme suggests positive impact. Schools that took part in the programme saw increased maths attainment among pupils when compared to those that did not. Fifth grade students scored, on average, four points higher in Prova Brasil 2015 (the national standardised exam set by the Brazilian Ministry). This four point improvement represents 30 percent of the expected learning of a school year in elementary school[63].

Training as an incentive to engage

A 2013 survey of ICT use in education in Brazil found that most professional development related to technology use only takes place if it is instigated by teachers themselves[64]. Alongside the translation of the platform, the Lemann Foundation also prioritised training programmes for teachers. Not only was teacher training seen as a way to improve impact of Khan Academy usage, it was also a way to instigate teacher engagement and use of the platform. Teacher training is delivered through a programme called "Inovação nas Ecolas" (Innovation in Schools), providing four-hour face-to-face training for teachers.

Even if teacher training had sparked interest and enthusiasm for the programme, making sure that this was extended beyond initial training was difficult and required a time and resource-intensive effort on the part of the Lemann Foundation. This support included both technical and pedagogical advice to prevent teachers from quickly becoming frustrated when the reality of real-time use presented challenges. The Lemann Foundation monitored use of the platform on a day-by-day basis to track early uptake and usage to ensure maximum support for schools in their first weeks and months using the platform. Engagement and peer assistance was also supported by Informal networks of teachers on Facebook.

Flexibility vs prescription

Analysis of usage patterns of the platform in Brazil reveal that there are many ways in which teachers use the platform[65]. Rather than prescribe how teachers should teach in the classroom, the programme (through provision of the platform and training) enables teachers to make their own decisions about how to incorporate Khan Academy into their teaching and classrooms. This flexibility was cited by teachers as an important factor in prolonged use.

Scaling despite lack of infrastructure

From the outset, this collaboration was seen as a project with ambitions to scale across Brazil. In a country with hugely varying contexts - from remote villages to mega cities - this is particularly challenging.

The success and scalability of Khan Academy in Brazil was limited by the digital infrastructure (particularly internet speed) and hardware provision in the country. As well as a minimum internet speed requirement, the 'adaptive' elements of Khan Academy (the platform's ability to tailor provision to a student's level of knowledge) is dependent on one device per pupil. The programme's impact report notes that, *'Several schools received a lesser impact on Khan Academy because there were not enough computers available in informatics labs for every student'*[66].

The design of computer labs was also a factor. Many are small, poorly ventilated and do not have the required number of computers for a class. As the use of mobile devices increases, there are opportunities to rethink school design and the relevance of computer labs.

Issues were also raised around data privacy and sharing. While data sharing is commonly discussed, this is usually in an abstract way and there are few practical programmes that have tested the ability of individuals, schools and organisations to understand and make decisions about data in real time on the ground. Leonardo Correia, Project Coordinator at the Lemann Foundation, observes that 'formal data sharing frameworks and agreed procedures that have been tested in practice will be essential for future large-scale programmes'.

Cost: Starting at the deep end

Translating the entire Khan plaftorm required a huge monetary investment, however given the size of the Brazil's school system, scaling was always an essential part of the programme's success. This informed the initial rollout of the project.

Rather than pilot the project in the easiest conditions (with fast wifi, multiple devices and in the most successful schools) the Lemann Foundation opted to pilot in some of the most challenging conditions. As Mike Trucano, The World Bank's Global Lead for Innovation in Education, argues:

> "If you want to go to scale with your educational technology initiative, first start down and out [in the most challenging conditions] before you move up and in [to lesser challenging conditions]. Your learning curve will be steeper in the short run. The 'model' you end up with may have more modest goals when compared with what can be achieved in some of the most privileged and advantaged school and communities. But it just might work everywhere."[67]

Interestingly, the process of translating the platform into Portuguese has provided a number of insights that have reduced the difficulty and cost of translating Khan Academy into other languages, such as Turkish.

Conclusion

This report provides inspiration for those who want to improve our schools. The examples we have encountered show the wide range of outcomes that effective use of technology and data can help to achieve - from raising attainment or increasing parental engagement, to widening access to quality learning or supporting teachers to develop their practice.

These examples also provide us with insights. This report draws together these lessons to help us make the most of technology at scale, improving whole school systems. We provide specific recommendations for how different stakeholders in our school systems - governments, philanthropic foundations, technology companies and school leaders - can each play a vital role in maximising the potential of technology.

Most strikingly, we see that investment in technology alone is not enough. Successful efforts to improve schools rely on considering much more, from pedagogy and teacher training to motivation and school context. While this certainly presents challenges, it also highlights the need for all those involved in our school systems - from those in the classroom to those in government - to play a part in making the most of technology.

Appendix:
Long-List of Case Studies

This is the long-list of case studies surfaced through this research and from which those featured in this report were selected.

Case Study Name	Country	Short Description and Links
High Tech High	USA	High Tech High (HTH) is an integrated network or coalition of 12 schools in San Diego, California. More can be found here: https://bit.ly/2QuyWZC
iZONE 360	USA	The iZone programme involves a blended learning programme in which online content complements in-class teaching, giving students more control over where they learn. More can be found here: https://bit.ly/2I3U0Cj
Basecamp Project by Summit Public Schools	USA	The Basecamp Project combines Summit's education know-how with the skills of engineers from Facebook, aiming at helping hundreds and potentially thousands of public schools to implement personalised learning successfully. More can be found here: https://bit.ly/2VHhS3o
Clever	USA	Clever powers learning technology in 60,000 schools across the US. Clever use learning applications in real-time and give students and teachers an easy-to-use, personalised, one-login experience. More can be found here: https://bit.ly/238EiwF
Hewlett Packard Deeper Learning	USA	IT-based schools experimentation on deeper learning for underserved communities fostered by the American multinational corporation Hewlett Packard More can be found here: https://bit.ly/2Es9AXE
ICT-Ed, KwaZulu-Natal	South Africa	ICT in Education is a South Africa national policy for cabling and networking in each classroom; installation and supply of ICT equipment at each school. More can be found here: https://bit.ly/2VHFHNq

SPARK	South Africa	SPARK is a low-cost private schools network in South Africa combining traditional learning with adaptive softwares experimentation. More can be found here: https://bit.ly/2z2Yfcf
Siyavula	South Africa	Siyavula is a platform for low-cost adaptive learning tools and resources tailored specifically for high school mathematics, physics, and chemistry. More can be found here: https://bit.ly/2HoiMOp
Liikkeelle!	Finland	"On the Move!" is an initiative to take secondary school students (age 13 to 19) and teachers out of the classrooms to study and evaluate their local environment. More can be found here: https://bit.ly/2Hnep6m
xEdu	Finland	xEdu is a business accelerator for EdTech startups willing to create innovative learning tools and resources to achieve pedagogical impacts. More can be found here: https://bit.ly/2jWwcU6
Ceibel Ingles	Uruguay	The project complements the Plan Ceibel project (which provided every child in Uruguay with a computer) with innovative teaching techniques in English. More can be found here: https://bit.ly/2JpEbJq
Innova Schools Network	Peru	The Innova Schools Network is made up of 41 new schools in Peru combining teacher-led, project-based learning in small groups with self-directed time using digital learning tools. More can be found here: https://bit.ly/2IfIbvr
Jordan Education Initiative (JEI)	Jordan	Jordan Education Initiative (JEI) couple the power of technology with proven modern teaching strategies fit for the technology-driven 21st century. More can be found here: https://bit.ly/2TjI98F
Malaysia Smart Schools	Malaysia	The Malaysian Smart School is an education support institution for the innovation of teaching-learning practices and school management. More can be found here: https://bit.ly/2wxVYFD
BRCK Education	Sub Saharan Africa	BRCK Education provides hardware, software and connectivity tools to turn any classroom into a digital classroom (reaching thousands of children in over 100 locations across 12 countries). More can be found here: https://bit.ly/2Wa2ReX

Endless OS	Africa & Latin America	Endless OS is an operating system designed for people in areas with poor internet connectivity to access education services. More can be found here: https://prn.to/2VPDdNm
Omar Dengo Foundation	Costa Rica	Omar Dengo Foundation activities aims at improving the quality and equity of learning opportunities through pedagogical innovations that focus on people and the use of ITC. More can be found here: https://bit.ly/2WgSiGR
Tusome (National Tablet Programme)	Kenya	To improve literacy outcomes in primary schools, Kenya is implementing the Tusome National Tablet Programme, which is the first national scale implementation of an ICT programme supporting improved instructional feedback in Sub-Saharan Africa. More can be found here: https://bit.ly/2DZ0KPM
Hybrid Learning	India	The Hybrid Learning programme is a tablet based digital intervention for children. In its current form, it is used by community based groups of children in three rural locations in Maharashtra, Uttar Pradesh and Rajasthan. More can be found here: https://bit.ly/2JqffBC
Learn with Vodafone Pratham	India	The Learn with Vodafone programme provides teachers with access to technology and digital content as well as methodologies for ensuring participative and productive classroom sessions. More can be found here: https://bit.ly/2VvTe5T
Onderwijs & ICT	Netherlands	'Platform Onderwijs2032' set out a vision in which personalised learning platforms are embedded in every school in The Netherlands, providing personalised learning pathways for digital literacy skills. More can be found here: https://bit.ly/2wb0KbX
Escuela 2.0 and Agrega	Spain	Escuela 2.0 is an initiative of the Spanish Government to equip every student in Spain with a digital device. Alongside the Escuela 2.0 project, the Government launched Agrega, a digital learning repository used by 19 educational authorities in Spain. More can be found here: https://bit.ly/2WPl2UI
Escola Nova 21	Spain	Escola Nova 21 is a Spanish network of schools and other public and civil society bodies exchanging practices and information for an advanced education system. More can be found: https://bit.ly/2KZvMwR
Avanguardie educative	Italy	Avanguardie Educative is an innovation movement that systematizes and gathers together the most significant Italian experiences that have been successfully innovating and transforming school management and teaching. More can be found here: https://bit.ly/2JraYh3

Palestre dell'innovazione	Italy	Palestre dell'innovazione is a multifunctional EdTech fablab space based in Rome, open to and used by citizens, schools, social enterprises and universities. More can be found here: https://bit.ly/2W9ZFjl
Reggio Children	Italy	The Reggio Emilia Approach is a global educational project, which is implemented in the Municipal Infant-toddler Centers and Preschools of Reggio Emilia, Italy, and has inspired other schools all over the world. More can be found here: https://bit.ly/1pHGOkF
EEF Research Schools Network	UK	The Research Schools Network is a collaboration between the EEF and the Institute for Effective Education (IEE) to fund a network of schools which supports the use of evidence to improve teaching practice. More can be found here: https://bit.ly/2YKqvfH
Becta	UK	Becta (British Educational Communications and Technology Agency) was a non-departmental public body funded by the Department for Education in the United Kingdom. More can be found here: https://bit.ly/2YGRjxe
Future Classroom Lab	Belgium	The Future Classroom Lab (FCL) is a laboratory for inspirational teaching and learning environments in Brussels, challenging the visitors to reimagine the intertwined roles of pedagogy, technology and design in classrooms. More can be found here: https://bit.ly/2Hu9nF2
KERIS 한국교육학술정보원	South Korea	KERIS (Korea Education & Research Information Service) is a governmental organisation under the South Korean Ministry of Education, Science and Technology that develops, proposes, and advises on current and future government policies and initiatives regarding education in South Korea. More can be found here: https://bit.ly/2WmsBEM
Enlaces	Chile	Enlaces is a Chilean educational programme designed to create structural change in Chilean education in order to prepare Chilean students and families to participate in the emergent society of knowledge, and to generate networks of communication that can help them to reach information globally. More can be found here: https://bit.ly/2RfTfKG
National Center for Education Technology (NCET)	Armenia	NCET is the Armenian government body to introduce ICT in general schools in Armenia and to ensure their further availability. More can be found here: https://bit.ly/2wRrA9H
eTwinning	Europe	eTwinning offers a platform for staff (teachers, headteachers, librarians, etc.), working in a school in one of the European countries involved, to communicate, collaborate, develop projects, share and to be part of the most exciting learning community in Europe. More can be found here: https://bit.ly/1YQGFQ4

Endnotes

1. Baker, T., Smith, L. with Anissa N. "Educ-AI-tion Rebooted? Exploring the future of artificial intelligence in schools and colleges", *Nesta*, Feb. 2019.
https://media.nesta.org.uk/documents/Future_of_AI_and_education_v5_WEB.pdf

2. Stroud, Forrest. "Infrastructure." *What Is Infrastructure? Webopedia Definition*.
www.webopedia.com/TERM/I/infrastructure.html

3. "Goal 4 .:. Sustainable Development Knowledge Platform." *United Nations*, United Nations, 2018. sustainabledevelopment.un.org/sdg4

4. Bleiker, Carla. "UNESCO: 264 Million Children Don't Go to School | DW | 24.10.2017." *DW.COM*, 24 Oct. 2017.
www.dw.com/en/unesco-264-million-children-dont-go-to-school/a-41084932

5. Bamfield, Louise. "Rebalancing the UK's Education and Skills System - RSA." *RSA 21st Century Enlightenment*, 1 Sept. 2013.
www.thersa.org/discover/publications-and-articles/reports/rebalancing-the-uks-education-and-skills-system

6. Hannon, Valerie. "Ile Strand 3: Innovation, Systems And System Leadership", *OECD*.
http://www.oecd.org/education/ceri/Hannon%20paper_ILE%20strand%203.pdf

7. Adkins, Sam S. "The 2017 Global Learning Technology Investment Patterns", *METAARI*, Jan. 2018.
http://users.neo.registeredsite.com/9/8/1/17460189/assets/Metaari_s-Analysis-of-the-2017-Global-Learning-Technology-Investment-Pat27238.pdf

8. Weale, Sally. "Ofsted Warns Teachers against 'Gimmicks' Such as Brain Gym." *The Guardian*, Guardian News and Media, 4 Dec. 2018.
www.theguardian.com/education/2018/dec/04/ofsted-teachers-gimmicks-brain-gym-schools

9. Nataf, Emmanuel. "Education Technology Is a Global Opportunity – TechCrunch." *TechCrunch*, TechCrunch, 19 Jan. 2018.
techcrunch.com/2018/01/19/education-technology-is-a-global-opportunity/

10. "EdTech Strategy Marks 'New Era' for Schools." *GOV.UK*, Department of Education , 3 Apr. 2019.
www.gov.uk/government/news/edtech-strategy-marks-new-era-for-schools

11. Bamfield, Louise. "Rebalancing the UK's Education and Skills System - RSA." *RSA 21st Century Enlightenment*, 1 Sept. 2013. www.thersa.org/discover/publications-and-articles/reports/rebalancing-the-uks-education-and-skills-system

12. Hallgarten, J., Hannon, V., and Beresford, T. "Creative Public Leadership: How School System Leaders Can Create the Conditions for System-wide Innovation", *WISE - World Innovation Summit for Education, Innovation Unit, RSA.* https://www.innovationunit.org/wp-content/uploads/2017/04/Creative-Public-Leadership-How-School-System-Leaders-Can-Create-the-Conditions-for-System-wide-Innovation.pdf

13. Hallgarten, J., Hannon, V. and Beresford, T. "Creative Public Leadership: How School System Leaders Can Create the Conditions for System-wide Innovation", *WISE - World Innovation Summit for Education, Innovation Unit, RSA.* https://www.innovationunit.org/wp-content/uploads/2017/04/Creative-Public-Leadership-How-School-System-Leaders-Can-Create-the-Conditions-for-System-wide-Innovation.pdf

14. Fullan, M., "Change theory A force for school improvement", *Centre for Strategic Education Seminar Series Paper No. 157*, Nov. 2006. http://michaelfullan.ca/wp-content/uploads/2016/06/13396072630.pdf

15. "Scaling Access & Impact: Realizing the Power of EdTech | Omidyar Network." *Omidyar Network RSS*, 24 Mar. 2019. www.omidyar.com/insights/scaling-access-impact-realizing-power-edtech

16. Vaata Maailma sihtasutus. http://www.vaatamaailma.ee/en

17. SHINE. https://www.shinetrust.org.uk/

18. Barber, M., Donnelly, K., and Rizvi, S., "Oceans of Innovation: the Atlantic, the Pacific, Global Leadership and the Future of Education", IPPR, Aug. 2012. https://www.ippr.org/files/images/media/files/publication/2012/08/oceans-of-innovation_Aug2012_9543.pdf?noredirect=1

19. Batty, R., Wong, A., Florescu, A., and Sharples, M., "EdTech Testbed: Models for improving evidence", *Nesta*, May 2019. https://media.nesta.org.uk/documents/EDTech_testbeds_PUBLISH_17.05.2019.pdf

20. MindCET - Changing Education Mindset. https://www.mindcet.org/en/

21. Digital Promise - Accelerating Innovation in Education. https://digitalpromise.org/

22. NYD Department of Education - InfoHub, iZone. https://infohub.nyced.org/resources/school-programs/izone

23. SV[e]F, Silicon Valley Education Foundation. https://svefoundation.org/

24. "Scuola Digitale, Un Quadro In Chiaroscuro." *Scuola Digitale, Un Quadro In Chiaroscuro*, Politecnico Milano, 13 Mar. 2017. www.osservatori.net/it_it/osservatori/comunicati-stampa/scuola-digitale-un-quadro-in-chiaroscuro

25. "Le Sfide Della Scuola Nell'era Digitale." *Link Campus University*, 12 Apr. 2018. www.unilink.it/le-sfide-della-scuola-nellera-digitale/

26. Compagnia di San Paolo. https://www.compagniadisanpaolo.it/

27. Scuole Dada. https://www.scuoledada.it/

28. Cangemi, L. and Fattorini, O., "Il Modello DADA (Didattiche per Ambienti Di Apprendimento), un incubatore di innovazioni", *Convegno internazionale Didattiche, Scegliere, prendere posizione, agire*, Rimini (Italy), 12-13 Oct. 2018.
http://dip38.psi.uniroma1.it/sites/default/files/persone/fattorinio/cv/Fattorini_Cangemi%20-%20Il%20DADA_erickson_ok.pdf

29. Sergiovanni, T. J., "Organizations or communities? Changing the metaphor changes the theory.", *Educational administration quarterly*, 30(2), 214-226, 1994.

30. Cangemi, L. and Fattorini, O., "Il Modello DADA (Didattiche per Ambienti Di Apprendimento), un incubatore di innovazioni", *Convegno internazionale Didattiche, Scegliere, prendere posizione, agire*, Rimini (Italy), 12-13 Oct. 2018.
http://dip38.psi.uniroma1.it/sites/default/files/persone/fattorinio/cv/Fattorini_Cangemi%20-%20Il%20DADA_erickson_ok.pdf

31. Text of Decree-Law 18 Oct, 2012, n. 179 (published on the ordinary supplement no. 194/L of the Gazzetta Ufficiale 19 Oct. 2012, no. 245).
https://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2012-12-18&atto.codiceRedazionale=12A13277

32. Piano Nazionale Scuola Digitale, Ministero dell'Istruzione, dell'Università e della Ricerca, 2015.
http://www.istruzione.it/scuola_digitale/allegati/Materiali/pnsd-layout-30.10-WEB.pdf

33. At the beginning of its activities, Book in progress was born as a movement of "self-production" of books, mostly paper ones; relieving families expense from school books, converting them into technology purchases. To learn more, look here: Landi, S., "Il mondo della scuola e le nuove tecnologie tra realtà e futuro", *Adiconsum*.
https://www.ilsole24ore.com/pdf2010/SoleOnLine5/_Oggetti_Correlati/Documenti/Notizie/2010/09/Adiconsum-scuola-nuove-tecnologie.pdf?uuid=05c0dd9e-c184-11df-9dbf-1fc67cab6050

34. "Book in Progress: Come Risparmiare Sui Libri Di Testo." La Stampa, 14 May 2010.
www.lastampa.it/2010/05/14/cultura/book-in-progress-come-risparmiare-sui-libri-di-testo-nt3R0NKcIIeFIffw4h21FP/pagina.html

35. Tundo, Andrea. "Scuola, a Brindisi i Testi Li Scrivono i Docenti (in Formato Digitale). Addio Al Caro Libri." Il Fatto Quotidiano, 7 Sept. 2014.
www.ilfattoquotidiano.it/2014/09/07/scuola-a-brindisi-i-testi-li-scrivono-i-docenti-addio-al-caro-libri/1112937/

36. Heath, Nick. "How Estonia Became an e-Government Powerhouse." *TechRepublic*, 19 Feb. 2019.
www.techrepublic.com/article/how-estonia-became-an-e-government-powerhouse/

37. Hammersley, Ben. "Concerned about Brexit? Why Not Become an e-Resident of Estonia." WIRED UK, 29 Sept. 2017.
www.wired.co.uk/article/estonia-e-resident

38. e-estonia. "Tax - e-Estonia".
e-estonia.com/solutions/business-and-finance/e-tax/

39. e-residency. "Residency Benefits | Digital Nomad, Freelancer, Startup Company".
e-resident.gov.ee/become-an-e-resident/?gclid=EAIaIQobChMI8rbVuf-z4gIVwuF3Ch2-LwPTEAAYASAAEgJQYvD_BwE

40. e-estonia. "Estonian Education Information System" - *e-Estonia*.
e-estonia.com/solutions/education/estonian-education-information-system

41. Look@World Foundation. "About Us." *Look@World Foundation*.
www.vaatamaailma.ee/about-us

42. eKool. "Index." *EKool Index*. ekool.eu/index_en.html

43. Welsh Government. "List of Digital Pioneer Schools."
https://gweddill.gov.wales/docs/cabinetstatements/2015/151105pioneerschoolsen.pdf

44. Welsh Government "Education in Wales: Our national mission".
https://gov.wales/sites/default/files/publications/2018-03/education-in-wales-our-national-mission.pdf

45. Welsh Government "A new curriculum for Wales".
https://www.youtube.com/watch?v=mH_vqCvC3DE

46. Welsh Government. "Digital Competence Framework." *Learning Wales*, Welsh Government, 13 May 2019.
learning.gov.wales/resources/browse-all/digital-competence-framework/?lang=en

47. Welsh Government. "News." *Hwb*, 3 May 2019.
hwb.gov.wales/news/article/4e119639-7b75-4649-a4bb-9f85b2687b6d

48. United Nations. "United Nations Sustainable Development Goals." *The Sustainable Development Agenda*, United Nations.
www.un.org/sustainabledevelopment/development-agenda/

49. Bleiker, Carla. "UNESCO: 264 Million Children Don't Go to School | DW | 24.10.2017." *DW.COM*, 24 Oct. 2017. p.dw.com/p/2mO4C.

50. The Education Commission. "the Learning Generation Investing in education for a changing world". Sept. 2019.
https://report.educationcommission.org/wp-content/uploads/2016/09/Learning_Generation_Full_Report.pdf

51. Bridge International Academies. *Bridge Open Letter: Response to Global Initiative for ESCR*. 18 Dec. 2018.
www.bridgeinternationalacademies.com/bridge-open-letter-response-to-global-initiative-for-escr/

52. World Bank Group, IFC. "Bridge International Academies ." *Ifc.org*, 2016.
www.ifc.org/wps/wcm/connect/0c4132e1-836c-4f0a-89f3-fffc58ec4af7/Bridge_Builtforchangereport.pdf?MOD=AJPERES.

53. NASUWT. "Big Question Survey Report". 14 Jan. 2019.
https://www.nasuwt.org.uk/article-listing/big-question-survey-report-2017.html

54. This information has been collected thanks to the interview with the project leader. Data are available upon request

55. New Zealand Government Ministry of Education. "Maori Participation & Performance in Education: A Literature Review and Research Programme", May 1997.
https://www.educationcounts.govt.nz/__data/assets/pdf_file/0017/7505/else-maori-summary.pdf

56. Manaiakalani Education Trust. "Learn, Create, Share."
www.manaiakalani.org/our-story/learn-create-share

57. Manaiakalani Education Trust. "Research Evaluation."
http://www.manaiakalani.org/our-story/research-evaluation

58. Manaiakalani Education Trust. "Research Evaluation."
http://www.manaiakalani.org/our-story/research-evaluation

59. OECD. "Education Policy Outlook: Brazil", Nov. 2015.
http://www.oecd.org/education/Brazil-country-profile.pdf

60. Bruns, B., Evans, D., Luque, J. *Achieving world-class education in Brazil: The next agenda.* The World Bank, 2011. http://documents.worldbank.org/curated/en/993851468014439962/pdf/656590REPLACEM0hieving0World0Class0.pdf

61. Tic educação 2013. Pesquisa sobre o uso das tecnologias de informação e comunicação nas escolas brasileiras. São Paulo: Comite Gestor da Internet no Brasil, 2014.
https://www.cetic.br/media/docs/publicacoes/2/tic-educacao-2013.pdf

62. Fundação Lemman. "Homepage." *Fundação Lemman*.
https://fundacaolemann.org.br/en

63. Fundação Lemman. "Five years of Khan Academy in Brazil, impact and lessons learned", Apr. 2018.
https://fundacaolemann.org.br/storage materials/8iY9oeab86DD4WedYutwMsmMJcdqISXZRaeFM4eM.pdf

64. Tic educação 2013. Pesquisa sobre o uso das tecnologias de informação e comunicação nas escolas brasileiras. São Paulo: Comite Gestor da Internet no Brasil, 2014.
https://www.cetic.br/media/docs/publicacoes/2/tic-educacao-2013.pdf

65. Trucano, Michael. "How Brazil Is Improving Education." *World Economic Forum*, 5 Jan. 2019.
www.weforum.org/agenda/2015/01/how-brazil-is-improving-education/

66. Fundação Lemman. "Five years of Khan Academy in Brazil, impact and lessons learned", Apr. 2018.
https://fundacaolemann.org.br/storage/materials/8iY9oeab86DD4WedYutwMsmMJcdqISXZRaeFM4eM.pdf

67. Trucano, Micheal. "A Different Approach to Scaling up Educational Technology Initiatives." *World Bank Blogs*, 31 May 2013.
blogs.worldbank.org/edutech/scaling-up.

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