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Innovative use of technology in education

Winning projects of UNESCO's King Hamad Bin Isa Al-Khalifa Prize

Education 2030

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The Global Education 2030 Agenda

UNESCO, as the United Nations' specialized agency for education, is entrusted to lead and coordinate the Education 2030 Agenda, which is part of a global movement to eradicate poverty through 17 Sustainable Development Goals by 2030. Education, essential to achieve all of these goals, has its own dedicated Goal 4, which aims to ***"ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."*** The Education 2030 Framework for Action provides guidance for the implementation of this ambitious goal and commitments.

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Education 2030

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SHORT SUMMARY

Prize-winning projects showcase good practices of digital learning

Since 2006 the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education has been playing a unique role in identifying grassroots practices that drive the use of digital technologies as a common good in education.

This publication synthesizes and analyses the 24 winning projects from 19 countries from the first two cycles of the Prize. It unveils how the Prize-winning projects defined key educational challenges and prioritized the most marginalized groups; showcases how digital solutions were adopted or invented to serve the common good; and demonstrates how technology, digital content and pedagogical methodologies were integrated to enable effective digital learning.

Based on an analysis of the modes of delivery across winning projects from 2006 to 2020, the publication presents insights into trends in the digital transformation of education with a specific focus on leveraging technologies to build inclusive, resilient learning systems.

The publication offers evidence-based best practices in using digital technology for educational development and facilitates peer learning among policy-makers, practionners and all education actors interested in digital learning and educational innovation.

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"Since wars begin in the minds of men and women it is in the minds of men and women that the defences of peace must be constructed"

Innovative use of technology in education

Winning projects of UNESCO's King Hamad Bin Isa Al-Khalifa Prize

Foreword

Over time, every new technology has held the promise of expanding access to learning opportunities and led to educational transformations. The digital revolution has accelerated this trend globally, unlocking innovations to step up progress towards SDG4 - inclusive and equitable quality education and lifelong learning opportunities. The COVID-19 pandemic dramatically increased reliance on digital technologies to ensure learning continuity, revealing the urgent need for partnership to address inequalities, bridge the digital divide and share successful and well-tested practices.

UNESCO promotes digital technology as a part of the global commons. It advocates for a humanistic approach to the use of digital technologies in education that is guided by inclusion, equity, gender equality and digital well-being. To this end, UNESCO has been reinforcing its observatory role combining knowledge on top-down national policies and bottom-up best practices.

The UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of Information and Communication Technologies in Education, supported by the Kingdom of Bahrain, provides a rich catalogue of practices across different countries and settings. Since 2006, it has rewarded 24 innovative projects and activities from a diverse range of individuals and organizations. Two projects are selected from a pool of more than 100 entries every year, following a rigorous selection process and nominations by governments and NGOs in partnership with UNESCO.

An external review of the Prize conducted in 2020 found that it is fully aligned with UNESCO's mandates on promoting universal access to information and knowledge, expanding learning opportunities through digital technology in education, and promoting equitable and quality education for all. The review noted that among multiple awards relevant to digital technologies and education, this Prize is the only one that is global in scope, covers all levels of learning, and has an open application policy.

This publication describes how the term 'common good' translates in concrete terms at the grassroots to address the educational needs of marginalized groups in different contexts; and how digital technology, learning content, and pedagogy are integrated to deliver effective learning. Leveraging technologies to transform the modes of educational provision and build inclusive and resilient digital learning systems is needed more than ever in the aftermath of the COVID-19 pandemic and in the face of more frequent crises and conflict. Drawing on an in-depth analysis of the 24 innovative projects stretching across 15 years, the publication aims to provide insights into the development and delivery of integrated solutions for effective digital learning and the transformation of provision.

Moreover, it provides examples of grassroots practices to complement UNESCO's three guidance documents on digital learning: *Guidelines for ICT in Education Policies and Masterplans*; *Guidelines on the Development of Open Educational Resources Policies*; and *AI and Education: Guidance for Policy-Makers*.

UNESCO is committed, alongside its Member States, to the inclusive and equitable use of advanced technologies, including AI, to support the achievement of SDG 4. We must ensure that the digital transformation bridges divides, strengthens inclusion and leaves no one behind. This is the vision UNESCO shares with the Kingdom of Bahrain, to whom UNESCO is deeply grateful.

Stefania Giannini
UNESCO Assistant Director-General for Education

Acknowledgements

The publication has been produced by UNESCO's Unit for Technology and Artificial Intelligence in Education, situated within the Futures of Learning and Innovation Team. It draws on best practices and lessons learned from the 24 projects that have won the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of Information and Communication Technology in Education during its first two cycles.

Fengchun Miao, Chief of the Unit for Technology and AI in Education, conceptualized, provided the overall guidance for, and authored some sections of the text. JET Education Services co-authored the publication with the drafting by Kelly Shiohira along with the support of Carol Lunga, Lindsay McCay, Andrew Patterson and Zaahedah Vally. Iaroslava Kharkova from the Unit collected data and contributed to the drafting and review of the text. Appreciation is also due to Glen Hertelendy and Xianglei Zheng, fellow team members of the Unit who helped to produce the required material and bring this publication to fruition.

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Acronyms and abbreviations

Concepts and technologies

a2i	Access to information
AI	Artificial intelligence
AISBL	Association Internationale Sans But Lucratif (International Non-Profit Association)
ATM	Learning with Mobile Technologies
CC-BY	Creative commons attribution licence
CEE	Development of Entrepreneurial and Employability Capacities
CMS	Content management system
EdTech	Educational technology
EJSS	Easy Java / JavaScript simulations
GDP	Gross domestic product
ICTs	Information and communication technologies
IT	Information technology
MOOC	Massive open online course
NCF	National Curriculum Framework
NGO	Non-governmental organization
OER	Open educational resource
PISA	Programme for International Student Assessment
PNAT	National Technological Literacy Plan
SDG	Sustainable Development Goal
SSTRF	Senior specialist track research funding
STEM	Science, technology, engineering and mathematics
STEAM	Science, technology, engineering, art and mathematics
TIMSS	Trends in International Mathematics and Science Study
TVET	Technical and vocational education and training
VR	Virtual reality

Organizations and programmes

ATM	Learning with Mobile Technologies
CLA	Centre for Learning Analytics
CLIx	Connected Learning Initiative
CWTL	Can't Wait to Learn
EDUFI	Finnish National Agency for Education
ETD	Educational Technology Division
EU	European Union
FOD	Omar Dengo Foundation
GENIE	Generalization of Information and Communication Technologies in Education and Teaching
IITE	Institute for Information Technologies in Education

IOM	International Organization for Migration
ITU	International Telecommunication Union
JEI	Jordan Education Initiative
JAR	Young Network Administrators
LIE	Educational Informatics Laboratory
MCIT	Ministry of Communications and Information Technology
MENFP	Ministry of National Education and Vocational Training, Higher Education and Scientific Research
MEP	Ministry of Public Education
MIOE	Moscow Institute of Open Education
MIT	Massachusetts Institute of Technology
MOE	Ministry of Education
MOU	Memorandum of understanding
NCTB	National Curriculum and Textbook Board
NIACE	National Institute of Adult Continuing Education
NIE	National Institute of Education
NRF	National Research Foundation
ONUTICE	National Observatory for ICT Usages in Education
OSP	Open Source Physics
OUC	Open University of China
NCEE	National Center on Education and the Economy
PRONIE	Programa Nacional de Informática Educativa [National Programme of Educational Informatics]
STVU	Shanghai TV University
TISS	Tata Institute of Social Sciences
UAS	University of Applied Sciences
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
ViLLE	Virtual Learning Enviroment

Introduction

Leveraging digital technologies for the achievement of SDG 4

Education is a fundamental human right of every woman, man and child. This has been enshrined in the Universal Declaration on Human Rights in 1948 and since then recognized and promoted by states in international accords (UNESCO, 2018). Governments, UN agencies and partners have cooperated to work towards universal primary school enrolment, and were largely successful – by 2015, high enrolment had been achieved by nine of the ten sub-regions monitored, up from just four in 2005 (UN DESA, 2015; UN DESA and DPI, 2005). However, the advantages afforded by this education still differed greatly across regions and countries (Mullis et al., 2015, 2016; Martin et al., 2016). The 17 Sustainable Development Goals (SDGs) of the 2030 Education Agenda were developed as a set of interrelated social, economic and environmental priorities for the period of 2015 to 2030. SDG 4 aims to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all' by 2030, including a new emphasis on pre-primary and secondary education. Its implementation is supported by the Education 2030 Framework for Action developed and coordinated by UNESCO (2016).

While progress towards SDG 4 has been made, there are still significant challenges to the achievement of universal access to inclusive, high-quality education. Prior to the outbreak of COVID-19, in middle-income countries 25 per cent of children aged 15 were out of school. While this represents a welcome decrease from the 50 per cent seen in 2005, there has not been a concurrent improvement in the quality of education, with half of schoolchildren still not mastering the basics of literacy and numeracy. Inclusiveness remains a further challenge, and women and other marginalized groups continue to be excluded in many contexts (UNESCO, 2020).

In recognition of the changing skills requirements of information and knowledge economies and the potential of digital technologies to facilitate access to content and improve the quality of education, many countries have committed themselves to utilizing these technologies in the provision of learning and pedagogical innovation, supported by a series of international accords. The *Qingdao Declaration* (2015) called on countries to recognize that 'to achieve the goal of inclusive and equitable quality education and lifelong learning by 2030, ICT – including mobile learning – must be harnessed to strengthen education systems, knowledge dissemination, information access, quality and effective learning, and more efficient service provision'. For this, the *Qingdao Declaration* emphasized an existing commitment 'to ensure that all girls and boys have access to connected digital devices and a relevant and responsive digital learning environment by 2030, irrespective of their disabilities, social or economic status, or geographic location' (UNESCO, 2015). Many countries have taken this action, and governments have aligned policies to harness the benefits of digital technologies by ensuring the increased provision of and access to them. These technologies have increasingly become pivotal in teaching and learning, both in response to the changing skill requirements for society and in order to take advantage of opportunities for devising new methods and forms of education.

The COVID-19 crisis thwarted this progress towards the achievement of SDG 4. Beginning in February 2020, it created the most severe disruption to global education systems in history with nearly 1.6 billion learners in more than 190 countries affected by the closure of their institutions at the peak of the pandemic. UN Secretary-General António Guterres warned in August

2020 about a resulting 'generational catastrophe' based on the unprecedented education crisis looming over millions of learners across the planet.[1] But COVID-19 also significantly exposed the ability of digital technologies to enable access to distance learning opportunities and maintain human connections and pastoral care, and it therefore accelerated the digitalization of education. These technologies became a social necessity to ensure the continuity and quality of learning: almost all countries combined digital devices with internet connectivity, TV or radio programmes to support this continuity of learning during the school closures. It is noted that countries without well-planned and well-resourced ICT-in-education strategies prior to the pandemic were among those with lower readiness in terms of teachers' digital competences, digital learning resources and national platforms – leaving one-third of students globally without access to distance learning during the better part of a year of school closures (UNESCO, UNICEF and the World Bank, 2020).

Furthermore, the distribution of access and the ability to leverage digital technologies is still uneven, and equity too often is an aspiration but not a feature of education systems. However, there remains a sizable gap in wired broadband and mobile connectivity around the world. Only 37 per cent of people in rural areas, compared with 73 per cent in urban areas, have robust internet access; meanwhile, in the least developed countries, the same figures are only 10 and 25 per cent (ITU and UNESCO, 2020). The potential of digital technologies to enhance learning quality and access can only be unleashed when appropriate methods and tools are designed and implemented. For this to be achieved, it is imperative to identify the base practices in leveraging these technologies to enable innovative and effective pedagogies and inform the planning of policies and programmes for digital learning.

1 The UN Secretary-General warns of educational catastrophe, pointing to UNESCO's estimate of 24 million learners being at risk of dropping out. See https://en.unesco.org/news/secretary-general-warns-education-catastrophe-pointing-unesco-estimate-24-million-learners-risk

The UNESCO King Hamad Bin Isa Al-Khalifa Prize

At the beginning of the new millennium, innovative practices in using digital technology for educational development were emerging, but evidence-based best practices were not shared sufficiently to facilitate peer learning among policy-makers and practitioners. It was in this context that the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education was initiated, in recognition of the potential for ethical, responsive technologies to contribute to more just societies through improved access to quality education. Funded by the Kingdom of Bahrain, the Prize rewards innovative approaches that leverage new technologies to expand such access.

The Prize was established in 2005 by UNESCO's Executive Board (172 EX/Decision 56) and its first phase ran from 2006 to 2011. In 2014, renewed funding allowed the Prize to continue through a second phase from 2015 to 2020 (195 EX/Decision 11). Two prize-winning projects per year are chosen, and this publication covers the 24 from these two phases. In December 2020, the prize was renewed for an additional six years, from 2021 to 2026 (210 EX/16.I), which will generate another 12. Within this new cycle, the Prize will promote UNESCO's vision of an ethical and human-centred approach towards the use of technologies in education, while stimulating innovation and sharing the best practices.

The design of annual themes is based on the developmental trends in digital technologies in education as well as the challenges faced by Member States during a specified time period. Furthermore, the Prize aligns with UNESCO's programme priorities. UNESCO invites the submission of nominations for the Prize from Member States' governments via their national commissions as well as non-governmental organizations (NGOs) that are in partnership with UNESCO. Self-nominations for the prize are not allowed.

Each year, a shortlisting and selection committee of international and intercultural judges examined more than a hundred nominations from countries in five regions: Africa, Arab States, Asia and the Pacific, Europe and North America, and Latin America and the Caribbean. Nominations included national governments, national and international NGOs, academic institutions, community-based organizations, schools, and private-sector organizations.

To permit an assessment of results and proof of success, nominees were required to have been in operation for at least a year, and other criteria for selection included the following:

- the contribution of the project, programme or tool to national and international goals
- its transformation of the education sector
- its collaborative and networking potential
- the evidence of its sustainability for mid- to long-term application;
- the scale or multiplier effect of the project;
- the ability of the nominee to improve the quality of teaching and learning;
- the seamless and purposeful integration of digital technologies into mainstream education;
- the development and dissemination of quality, learner-centred open tools and pedagogies;
- contributions to facilitating access for all to technology, including marginalized, disadvantaged and vulnerable people; and
- the ability of the technology to address major digital and gender divide issues at the local, national or regional level.

Winning projects

The international development goals that the Prize has supported have evolved over the years. From 2006 to 2011, the Prize focused on recognition for innovative school pedagogies and outreach to remote and lifelong learners, and thus promoted both the expansion of access to education and the integration of digital technologies into pedagogy. From 2015, the Prize emphasized equity in the provision of quality education, particularly for disadvantaged and vulnerable groups such as migrants and rural populations in developing countries. In 2019/20, the Prize was awarded to pedagogical innovations using artificial intelligence (AI) and supporting humanistic visions for the use of new technologies, once again aligned to international conversations such as the *Beijing Consensus on Artificial Intelligence in Education* (UNESCO, 2019).

Over its 15 years, the Prize has supported initiatives to expand education, equity and global citizenship through digital technology. The 24 awards recognize innovations that integrate cutting-edge technologies into education systems to increase quality and access (see **Table 1**).

Table 1. Prize-winning projects by year

YEAR OF AWARD	PROGRAMME	COUNTRY
2006	eDegree Programme **Kemi-Tornio University of Applied Sciences**	Finland
	Cyber Home Learning System **Korea Education and Research Information Service**	Republic of Korea
2007	Claroline Connect **Consortium Claroline AISBL**	Belgium, France and Switzerland
	Curriki **Curriki**	United States of America
2008	Shanghai TV University **Shanghai TV University (STVU)**	People's Republic of China
	ICT-in-Education Program **Dr Hoda Baraka, First Deputy to the Minister of Communications and Information Technology**	Egypt
2009	Jordan Education Initiative **Ministry of Information and Communications Technology**	Jordan
	Digital Transformation of General Education **Prof Alexei Semenov, Rector of the Moscow Institute of Open Education**	Russian Federation
2010	National Institute of Adult Continuing Education **National Institute of Adult Continuing Education (NIACE)**	United Kingdom
	Technological Literacy for Older Adults **Infocentro Foundation**	Venezuela (Bolivarian Republic of)
2011	Internet-ABC **Association Internet-ABC**	Germany
	iZ HERO **Infollution ZERO, Dr Yuhyun Park**	Republic of Korea

YEAR OF AWARD	PROGRAMME	COUNTRY
2015	National Program of Educational Informatics **Omar Dengo Foundation**	Costa Rica
	Open Source Physics @ Singapore **Ministry of Education**	Singapore
2016	Digital Schools **JAAGO Foundation**	Bangladesh
	Kiron Campus **Kiron Open Higher Education**	Germany
2017	GENIE **Ministry of National Education and Vocational Training, Higher Education and Scientific Research**	Morocco
	Connected Learning Initiative **Tata Institute of Social Sciences**	India
2018	ThingLink Visual Learning Technology **ThingLink**	Finland
	Can't Wait to Learn **War Child Holland**	The Netherlands
2019	Letrus Writing Skills Program **Letrus**	Brazil
	Dytective **Change Dyslexia**	Spain
2020	One College Student Per Village **The Open University of China**	People's Republic of China
	ViLLE **Centre for Learning Analytics, University of Turku**	Finland

The innovation adoption lifecycle (Rogers, 2003) classifies adopters into categories based in large part on the timeline of their involvement. The early adopters are the select few with the resources and risk profiles necessary to integrate new technologies or other innovations into their practices. The Prize provides not only an incentive but also a showcase for these early adopters in the realm of education, enabling others to learn from not only the innovations but also the process of integration and implementation of new technologies in education. The value of this publication is in demonstrating successes and summarizing the lessons learned by early adopters in order to inform the future planning of policies and the rollout of programmes.

It is divided into three parts: case studies, snapshots, and lessons learned. The first part consists of 12 case studies from the second Prize cycle from 2015 to 2020, which document the challenges that needed to be addressed, the design and planning of the digital solutions, and the development of resources and innovative practices. The second part includes snapshots of the winners from the first cycle of the Prize, from 2005 to 2011, and provides a brief description of technological tools and programmes that were produced and mainstreamed in the 2000s. As technology and access have evolved over time, these earlier projects have been integrated into new initiatives or discontinued, so full case studies on them were not possible. But the snapshots capture the essence of what

they achieved during their implementation. Together, these case studies and snapshots trace the evolution of the innovative uses of technology to address a wide array of educational challenges, from facilitating access to digital technologies and quality education for marginalized groups to the use of AI to improve teaching and learning. The third and final section of this publication outlines the significant common features of the winning projects and the main lessons learned, including the need for further iterations of humanistic principles in thematic focuses; greater attention to digital empowerment for girls and women as well as linguistic and cultural diversities; the integration of digital platforms, content and skills to create resilient learning systems; and most especially, support for pedagogical innovations that drive the digital transformation by placing human interaction and collaboration between teachers and learners at the core of education.

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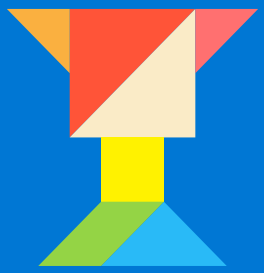

Winners
from 2015 to 2020

2015	National Program of Educational Informatics Open Source Physics @ Singapore
2016	Digital Schools Kiron Campus
2017	GENIE Connected Learning Initiative
2018	ThingLink Visual Learning Technology Can't Wait to Learn
2019	Letrus Writing Skills Program Dytective
2020	One College Student Per Village ViLLE

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National Program of Educational Informatics

2015

Omar Dengo Foundation

Digital technologies as resources for creative learning and problem-solving capacities

Theme
Pedagogical innovation in using ICT in teaching and learning

Location
Costa Rica

Date started
1988

Beneficiaries
8,674,521 students since 1988

Target population
Primary and secondary school learners in rural and urban settings

Digital solution
Developing digital and cognitive skills through the provision of digital infrastructure and innovative education programmes

Summary

The *Programa Nacional de Informática Educativa* (National Program of Educational Informatics, or PRONIE) has been implemented since 1988 through a public-private partnership between Costa Rica's *Ministerio de Educación Pública* (Ministry of Public Education, or MEP) and the *Fundación Omar Dengo* (Omar Dengo Foundation, or FOD). Known as PRONIE MEP-FOD, the initiative was awarded the 2015 UNESCO King Hamad Bin Isa Al-Khalifa Prize for integrating digital technologies and innovative pedagogical approaches to foster the development of creativity and problem-solving skills among primary and secondary school teachers.

As one of the longest-running educational development initiatives in Latin America, the programme has raised quality and narrowed gaps in equity and digital access by applying evidence-based learning experiences through the public education system and the project's resource-rich online presence.

PRONIE MEP-FOD encourages students to interact with real-world problems and daily life situations through project-based learning approaches applied in school computer labs. Students learn through their experience and become accountable for their own development and collaboration with others. The programme also focuses on teachers' continuous training and monitoring to improve their skills and capabilities in using educational informatics.

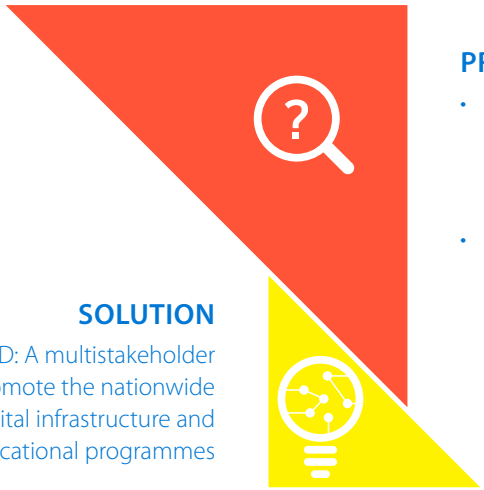
Since 1988, a total of 8,674,521 students have benefited from the programme in pre-schools as well as primary, secondary and TVET schools. PRONIE MEP-FOD has developed a comprehensive and systematic approach to enhance students' capacities while also giving priority to marginalized children and youth in rural and urban areas. It supports the creation of an educated and skilled labour force which will stimulate the economy and equip citizens for the future.

Why selected

PRONIE MEP-FOD was selected for the Prize because of the following features:

- Excellent partnerships between the FOD, MEP, and educational institutions.
- Implementation of a problem-based learning approach validated by Educational Informatics Laboratory (LIE) standards.
- Systematic approach in building student capacity for ubiquitous learning and developing digital technology products.
- Strong emphasis on teachers' training and monitoring for improved informatics-based pedagogy (UNESCO, 2015).

Programme



PROBLEM

- Lack of innovative educational models supported by digital technologies that can help to prepare future generations for active participation in digitalized societies and economies
- Lack of equitable access to digital technologies and resources, especially in rural and marginalized areas

SOLUTION

PRONIE MEP-FOD: A multistakeholder partnership to promote the nationwide provision of digital infrastructure and innovative educational programmes

BENEFICIARIES

- 738,138 primary and secondary student beneficiaries in rural and urban areas (in 2019)
- 2,973 teachers received face-to-face training, while 3,805 received a combination of face-to-face and virtual training (FOD, 2019)

FEATURES

- Diversified provision of digital technologies based on contextual factors such as the size and location of schools
- Centred on innovative pedagogical approaches which leverage technology
- Innovates as new technologies and tools become available
- Leverages the value of public-private and public-NGO partnerships
- Uses continuous monitoring and evaluation that informs programme design revisions

RESULTS

- Supports the creation of an educated and skilled labour force
- Equips students and teachers for a digital future
- Encourages citizens to engage with and work in the digital technologies sector

CHALLENGES

- The digital infrastructure is still incomplete, affecting about 10 per cent of schools
- Connectivity remains patchy, especially for remote rural areas
- Teachers' difficulties with timetabling and project implementation, and limited aptitude for teaching programming

Profile: Omar Dengo Foundation

The FOD is a private, non-profit organization established in 1988 that has designed and implemented national and regional projects that optimize the use of digital technologies for educational innovation and human development in Costa Rica.

Its vision is to lead in creating opportunities for children and youth and their social and productive inclusion in the creation of knowledge. Its three-part mission is to contribute to improving the quality and equity of learning opportunities; to support individual development through innovative, people-focused educational models and initiatives; and to enable people to leverage digital technologies (FOD, 2020). The organization fulfils this mission through stimulating learning processes, creativity and innovation, and contributing to educational access, especially for children from marginalized populations. Teachers' skills and thinking are developed through high-quality software and training.

Context

Costa Rica is a Central American country with a population of just over 5 million and coastlines on both the Atlantic and Pacific Oceans (UNSD, n.d.). Indigenous people comprise 2.4 per cent of its population and live on relatively inaccessible terrain (IWGIA, 2021).

In the late 1980s, the Government of Costa Rica advocated for a new modality that could strengthen the development of skills, creativity and innovation and facilitate a transition into a more modern economy. This thinking led to the establishment of the FOD in 1988. To advance economic growth and per-capita income, Costa Rica focused public policy on achieving higher productivity across all sectors, especially knowledge-intensive industries (Cecchini and Uthoff, 2008).

By 2010, the country's economy had transformed into one based on manufacturing and services, requiring new skill sets (Monge-González, 2016). Its digital sector grew quickly between 2003 and 2008 (CAMTIC, 2017), and by 2018, software and services had created more than 42,000 jobs (PROCOMER, 2019). With an increased demand for skilled labour in the digital sector, Costa Rica has incorporated a green economic policy, the National Strategy for Information and Communication Technologies: Green and Intelligent 2.0. The policy is designed to advance a robust digital ecosystem and promote the digital technologies sector while simultaneously protecting natural resources and the environment.

A combination of political stability, a social contract and steady growth in Costa Rica has resulted in one of the lowest poverty rates in Latin America and the Caribbean. In 2019, the rate was 21 per cent (AFP, 2019; World Bank, 2020*b*). However, the unemployment rate had increased to 12.4 per cent by the end of 2019, among the highest in the region, and youth unemployment has remained even more problematic at 22 per cent. Also of concern for policy-makers is the gender gap in labour market participation, where female engagement in the world of work requires concerted support (AFP 2019, 2020).

Turning to education, the country's system has four levels: early childhood education and care, general basic education, diversified education, and tertiary education (OECD, 2018). Compulsory and free-of-charge education is available from pre-school to the end of upper-secondary school (ages 4 to 18). Primary school enrolment reached 100 per cent in the late 1980s and has remained high since the turn of the century, while secondary school enrolment rose from 50 per cent in 1998 to over 100 per cent in 2010. Gross enrolment rates are now over 125 per cent (TheGlobalEconomy.com, n.d.). Access to primary and secondary schooling is increasing, even for learners whose parents have low levels of education (OECD, 2017*a*).

The educational challenges that persist in Costa Rica include the gaps in learning outcomes and attainment between urban and rural youth, between private and public education, and between different socio-economic groups (OECD, 2017*b*). Of particular concern is the number of young people with incomplete education. There were 57,625 out-of-school children in 2016 (World Bank, 2020*a*), and the number of non-literate people aged 15 and older with less than five years of formal schooling was 84,024. Furthermore, the percentage of people aged 12 to 36 who do not work or go to school was 11.6 per cent in 2018 (CONARE, 2019).

Digital Solution

The PRONIE MEP-FOD initiative is a multisectoral partnership that has successfully introduced educational technology into public schools in Costa Rica and continues to innovate digital technologies for learning and for the empowerment of citizens. This partnership has resulted in a sustainable and comprehensive approach to learning in rural and urban settings across the nation. The initiative leverages digital technologies to engage students and teachers by prioritizing problem-solving, investigation, productivity, citizenship and communication. It is delivered through five prominent programmes: Education Informatics Laboratories (*Laboratorios de Informática Educativa*, or LIE), Learning with Mobile Technologies (*Aprendizaje con Tecnologías Móviles*, or ATM), the Development of Entrepreneurial and Employability Capacities (*Capacidades de Emprendimiento y Empleabilidad*, or CEE), Labor@ Enterprises, and a professional development programme for teachers.

Schools and classrooms are equipped with LIE and related teacher training. The updated programme LIE++: Think, Create, Code encourages students to integrate digital and coding skills into real-life problem-solving. In addition to supporting digital literacy and educational outcomes, LIE also supports youth enrichment programmes such as pedagogical robotics, a problem-solving capacity building programme, and environmental advocacy, among other skills building initiatives that use digital devices.

ATM is another programme that integrates the use of technologies into the classroom in public pre-primary, primary and secondary schools. ATM is guided by three principles. The first is to promote innovative teaching models enabled by mobile technologies in order to develop students' digital competencies. The second is to adopt a progressive, constructive approach to change, and the third is to secure equity while adapting to the changing needs and expectations of society in its different contexts. ATM is offered at pre-school, primary and secondary levels and at Costa Rica's indigenous education centres (FOD, 2021).

PRONIE MEP-FOD also drives initiatives that can benefit aspiring entrepreneurs, institutions and companies that require knowledge and skills to leverage technology. The CEE programme involves youth in entrepreneurship and innovation, building capacities that will enable them to integrate into the labour market. For example, Young Network Administrators (*Jóvenes Administradores de Redes*, or JAR), a partnership between the MEP, FOD and technology company Cisco Systems, offers a programme for 11th and 12th grade informatics students at public vocational high schools to prepare them for employability in the technology field. Students complete four training modules, leading to Cisco certification (FOD, 2019).

Labor@ Enterprises is another programme that focuses on employability in secondary schools. Students learn how to start and manage a company through a simulation program, in the process using digital technologies and developing interpersonal and leadership skills. Its focus on entrepreneurial business may assist young people facing unemployment to find local self-employment. By design, these approaches benefit children in rural communities who might not have been reached by other technology projects (Iglesias, 2016, p. 1).[1]

Finally, PRONIE MEP-FOD features a professional development programme that provides multiple training opportunities for teachers on integrating digital technologies into their teaching. The programme features multiple face-to-face, online and hybrid training activities supported by e-learning and virtual resources and platforms capable of supporting thousands of teachers.

1 Except where otherwise noted, information from this section is drawn from FOD (2015).

Implementation

The project undertook a phased approach to scale up and integrate digitally enabled pedagogies in schools. Beginning in 1988, computers and laboratories were first introduced in primary education, with expansion to secondary after 2002. FOD´s leadership after 2002 has allowed the programmes at both levels to thrive and grow in a coordinated manner. Schools were selected for participation based on the following criteria: parents' interest, school size, students' socio-economic status, geographic location, and the community's willingness to invest in the infrastructure (FOD, 2002). Subsequently, PRONIE MEP-FOD expanded to pre-schools, special education centres, evening schools, and publicly subsidized private primary and secondary schools. Later in the project, increased emphasis was placed on raising the levels of the inclusion of marginalized schools and learner communities. In building the critical mass of participants in the project, it was highly important to secure buy-in and engagement from the local community and to guarantee sustainability and ownership.

The LIE programme for primary level is deployed mainly in schools with 90 or more students. Although the cost-learner ratios for this in smaller schools are prohibitive, they are still reached by PRONIE through its second programme, ATM. The curriculum used in LIE is based on project-based learning, which allows for learners to become active in their development as they answer complex questions. The inquiry process is informed by learning performance standards, while digital technologies are used as creative resources as well as for capacity-building. Content is age-adjusted for learners, and teachers are supported with standards-driven teaching guides to ensure knowledgeable and optimal use of the technology. Teachers allocate about 85 per cent of the session time to activities in which students create, build and/or generate knowledge. The remaining 15 per cent is allocated to teacher facilitation or direct instruction.

As noted, the second programme, ATM, is implemented in small, mostly rural schools with 90 or fewer students at both primary and secondary level. Ordinary classrooms are equipped with computers and other digital tools, and different configurations or options are available depending on learner and teacher numbers.

ATM also provides services through one or two mobile units available to the primary and secondary schools that are involved in PRONIE MEP-FOD. This includes the MobiLabs initiative, which integrates mobile technologies into urban and peri-urban schools in order to develop science competencies in grades 1 to 6 and promote mathematics and Spanish in grades 7 to 9. Mobile carts store, move and carry up to 30 laptop computers each, for use by teachers of these subjects in their classrooms.

Other programmes include the REM@ programme, which focuses on developing intellectual, entrepreneurial and personal capabilities in students from rural secondary schools. Implemented since 2011, REM@ is based on providing one laptop computer per student, to be used inside and outside of the classroom (UN, 2012).

Accommodation is also made for learners who cannot attend school due to illness through the Recuper@ (recover) programme which provides laptops for students in long-term hospitalization.

Finally, PRONIE MEP-FOD launched two online platforms. Open the Door to Knowledge (*Upe – La puerta al conocimiento*) is its virtual campus. This resource for teachers offers courses, peer networking, and other interactions between special technology and software interest groups. The website is also used for the in-service training of educational informatics teachers. Secondly, PRONIE MEP-FOD set up the Connected Generations (*Generaciones Connectadas,* GECO) platform to facilitate the convergence of different generations of people involved in the public educational system of Costa Rica.

Partnerships

The partnership between the MEP and FOD was a key enabler in the success of the initiative. Through this partnership, the government provided a mandate, designed an aligned curriculum and gave the project a large scale, while the status of the FOD as an NGO created opportunities to source corporate and donor funding from a wider array of multisectoral partners and local and international agencies. For example, from the inception of PRONIE MEP-FOD, agreements and affiliations with international stakeholders like the United States Agency for International Development (USAID) and United Nations Development Programme (UNDP) were in place and have been vital to its implementation.

The government has reinforced investment in the initiative through tax incentives for business donors and supported its sustainability through an annual, publicly funded contribution. The mobilization of these investments in turn facilitated R&D that would otherwise not have been possible. A final benefit of the government-NGO partnership is that it fostered a degree of isolation from changes within the government, which has contributed to the longevity of the initiative (Iglesias, 2016).

The MEP and FOD had to be collaborative due to their interlinked roles. The core roles of the MEP were to develop the educational and curriculum offerings and secure the participation of public schools, advisors and educational informatics teachers. Alongside this, the core roles of the FOD were to manage the programme, train and monitor educators and conduct research and monitoring and evaluation.

Monitoring and evaluation

Ongoing research, monitoring and evaluation have contributed to the evolving nature of PRONIE MEP-FOD. Early research found that its teaching methodology was not implemented consistently despite a well-defined set of learning objectives and the provision of teacher training. Out of this observation, a set of teaching guides were introduced in 2010, and the initiative coordinators standardized the integration of digital technologies in classrooms and created frameworks for monitoring and evaluation. In the same period, an evaluation of the learning situation of students in computer laboratories identified differences among learners and teachers in their understandings of key concepts such as 'project' and 'digital product'. This was addressed through the development and refinement of the project-based learning approach and LIE standards. In recent years, LIE monitoring processes have collected information on the condition of technological equipment (operation and technical support), training modules for teachers and teaching strategies used in the labs.

PRONIE MEP-FOD utilizes both internal and external monitoring and evaluation. Internally, learning outcomes are assessed in three ways. First, a formative evaluation is conducted by the teacher using a tutorial guide that contains assessment tools. Second, monitoring of student engagement and progress is conducted by teachers and by the LIE advisors during school visits when they collect data and answer teachers' questions. Additional monitoring is conducted by the FOD evaluation unit when a teacher wants to implement a pilot programme or a new technology-enabled initiative. The last method is an assessment of learning outcomes by examination, which is also conducted by the FOD evaluation unit. External evaluations including randomized controlled trials have also been carried out.

The FOD seeks to contribute to the scientific and technological development of Costa Rica and other Latin American and Caribbean countries that can benefit from its experience. Sharing of research and monitoring and evaluation is a useful way of benefiting from lessons learned.

Results

The initiative has bridged the digital divide and developed learners' personal self-efficacy, professional skills, and 21st century competencies (Brenes et al., 2014). By 2020, its programmes were accessible to 92.2 per cent of pre-school to 9th grade national public school students, which is an increase of over 12 per cent from 2015 and means that education in Costa Rica is approaching digital ubiquity in the classroom. As of 2019, PRONIE MEP-FOD had supported more than 3,897 public education centres benefiting 738,138 students. Also, 16,786 secondary students enhanced their entrepreneurial and employability opportunities through the Labor@ Enterprises and JAR programmes (FOD, 2020).

Students participating in LIE++, which explicitly addresses computational thinking through programming and physical computing projects, obtained better results compared with those in the LIE-Guides programme, which includes only learning with digital technologies (Picardo-Arce et al., 2021).

During his childhood, Alexander Rojas studied at one of the first schools that benefited from PRONIE MEP-FOD: the Juan Chaves Rojas School located in the town of Ciudad Quesada in the province of Alajuela. For Alexander, his involvement with technology from such an early age through the initiative was key to his realization that computing was his field of interest and that programming was something he was passionate about.

Today, Alexander is a software engineer with a master's degree in artificial intelligence from MIT. He is the founder and director of Coral, a digital marketing agency and e-commerce solution provider. Also, he founded the IT Innovation Group, Central America's first consortium for nearshore IT services. Regarding PRONIE MEP-FOD, he said:

'I remember when the Omar Dengo Foundation came to my school and started an educational programme with digital technologies for students at that time. I was very fortunate to have received that first impact with technology within a rural context. In my case, my profession is oriented towards digital technologies, and most definitely that experience was the seed that created a change in my life and made me choose this professional area.'

Source: FOD (2019). Available at: https://youtu.be/rMCrURZudpM (Accessed 12 October 2022.)

Challenges

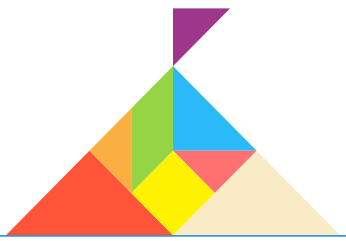
The difficulties encountered during the project can be categorized as pedagogical challenges and connectivity limitations. In 2015, before receiving the Prize, the FOD detailed four main pedagogical challenges or constraints in rolling out PRONIE MEP-FOD that related to teachers' problems with allocating time, trouble implementing projects, resistance to the new assessment protocols, and difficulties in teaching programming (UNESCO, 2015).

First, insufficient time was spent on developing the study projects in schools, evidenced by the fact that students and teachers deviated from the time allocations for projects. Second, teachers followed the didactic guides too closely as 'recipes'. As a result, they failed to make the necessary planning and facilitation decisions to meet the needs of each group of students. The third challenge involved teachers' opposition towards the assessment protocols and instruments that they felt were too detailed and involved too much extra work. Fourth, teachers experienced difficulties in finding effective methods and techniques for teaching programming skills. Even teachers with skills in this area struggled to develop effective ways to teach them to their students. Although some teachers had had some exposure to computers in their pre-service training, it was clear that they needed more knowledge and support to effectively use the digital resources. The FOD initially provided training according to the trickle-down method, where small groups of teachers who received training in turn trained their local colleagues. As the project grew, teacher training was augmented and redesigned in a blended format, with online support and resources.[2]

More recent reports show that the greatest challenge is to build teachers' capacity and motivation to use the technological skills needed for effective teaching in classrooms. To incentivize this engagement, public recognition of outstanding efforts by teachers has been instituted (FOD, 2019).

Connectivity also remains problematic for remote contexts across the world, and organizations like the UN's Broadband Commission continue to aid countries in the development of their digital networks. Similarly, the FOD sees connectivity as a challenge to their mission and vision for rural and marginalized communities. According to the Presidency of the Republic of Costa Rica (2018), of the 4,659 education centres in the country, 511 or 10.9 per cent were without internet connectivity. Of the 4,148 schools and colleges that had internet access, 67 per cent were limited by connection speeds of less than 10 Mbps. Fortunately, the country's Ministry of Education has been expanding higher-speed broadband to primary schools, high schools, and administration centres throughout the country (USTDA, 2020).

2 See https://teachonline.ca/pockets-innovation/international/nation-wide-teaching-training-initiative-focused-enhanced-student-learning-led-fundacion-omar-dengo



Further developments

Since receiving the Prize in 2015, PRONIE MEP-FOD has made further substantial advances. In 2016, its Mobile Technologies in Indigenous Territories project was launched to reach the most vulnerable communities in Costa Rica. The project's primary objective is to close the quality-of-learning gap and digital divide by focusing resources on schools and education centres in indigenous territories and implementing contextualized and appropriate mobile technologies (FOD, 2019). In 2017, the FOD supplied 21 indigenous education centres with solar panels and extended its Mobilab project to secondary night schools (IWGIA, 2021).[3]

In 2018, the FOD committed to supporting the Costa Rican Government in the design and execution of the Bicentennial Educative Network (*Red Educativa Bicentenario*) (Presidency of the Republic of Costa Rica, 2018). The network aims to extend connectivity to all of the country's schools and foster collaborative networks as platforms for expanding and deepening an intelligent, educative community where students can create a digital identity and develop their connective capabilities (Navarro, 2020). The 2020/21 phase aims to reach 2,120 education centres, with more than 700,000 students, 53,000 teachers and 15,000 other employees. The network will offer high quality broadband speeds of at least 15 Mbps and up to 100 Mbps, in accordance with local needs (Presidency of the Republic of Costa Rica, 2020).

Aligned with the objectives of the SDGs, future initiatives by the FOD will have a strong emphasis on sustainability, climate justice, accountability and ensuring inclusive, equitable quality education and the promotion of lifelong learning opportunities for all people. Currently, PRONIE MEP-FOD is exploring AI-focused technologies that may enable the development of problem-solving skills, which could then be incorporated into LIE++ educational offerings.[4]

3 Government night schools or *colegio nocturno* are provided to enable working adults to complete their secondary schooling. Grants are available for transport expenses.

4 Except where otherwise noted, information for this section is drawn from FOD (2020).

Impact of the Prize

The 2015 Prize acknowledged and celebrated the educational achievements of the partnership between the Omar Dengo Foundation and Ministry of Public Education. It validated decades of work, allowed the PRONIE MEP-FOD partnership to impact the fabric of Costa Rican society, and brought international recognition and networking benefits. With the resources provided by the award, the FOD aimed to accelerate two initiatives: further support of teacher training and capacity building, and improvement of the learning process for students in the classroom. As a result of the award, additional funding was received from the MEP to extend operations and reach many more students and teachers in public schools. Leda Muñoz, Executive Director of the FOD, stressed the importance of the Prize as:

> a very important incentive to complete and accelerate a rigorous process of renewing and upgrading our pedagogical model for educational informatics. The new programme is allowing all students, regardless of their geographical location or socio-economic status, to learn and experience critical topics for the fourth industrial revolution, such as robotics, big data, and the fundamental concepts of computational thinking.[5]

PRONIE MEP-FOD has provided a set of services in the field of educational informatics that form a cutting-edge offering to promote the strategic capabilities required for the nation's development. Nevertheless, the impact that was initially expected in terms of the transformation of the education system has proven difficult to attain as it requires a comprehensive, multidimensional approach. However, PRONIE MEP-FOD has established a new and more favourable scenario from which to advocate for the educational visions required to achieve national goals.

5 For more information, see https://en.unesco.org/news/interview-improving-quality-education-through-digital-technologies

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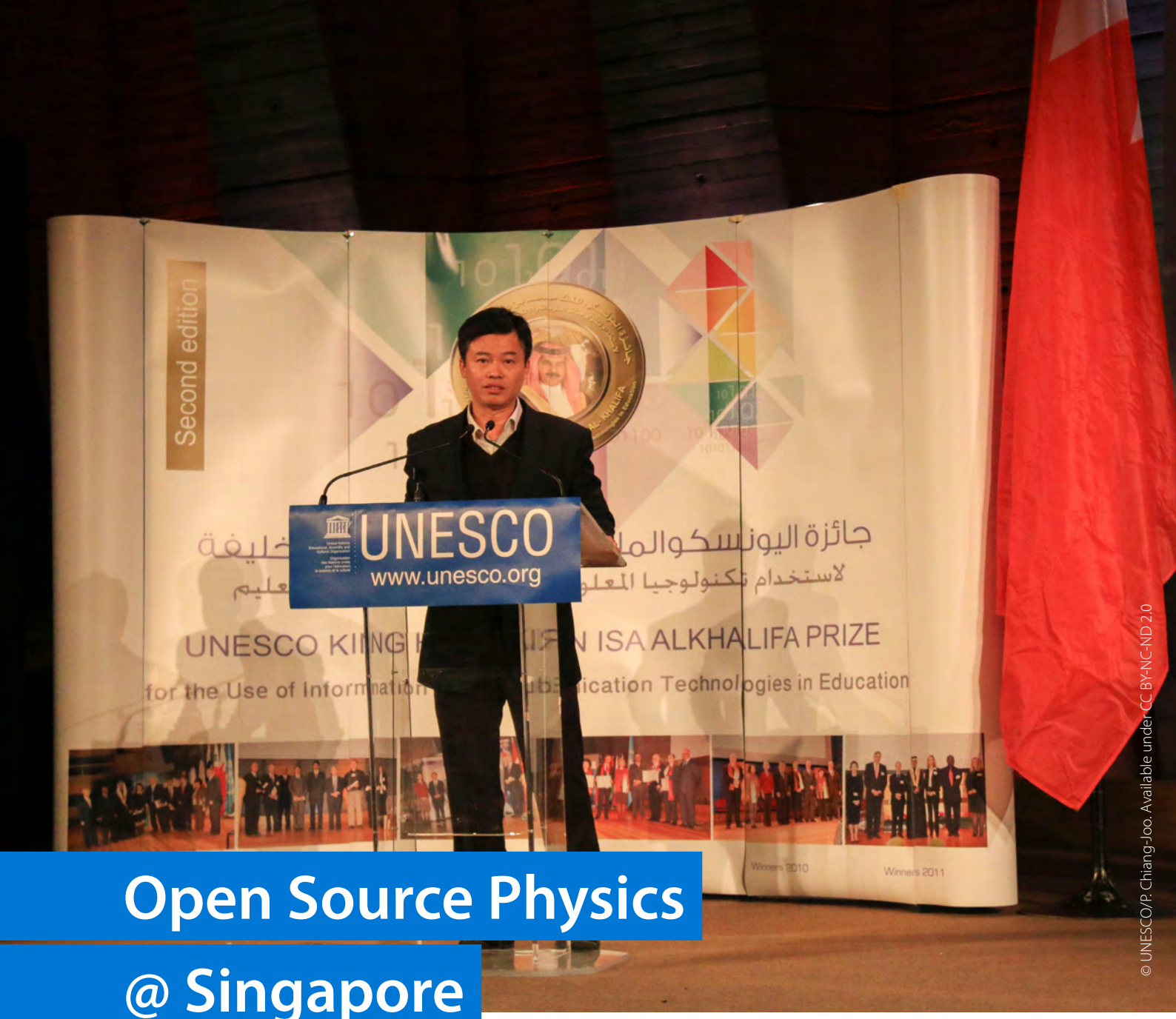

Open Source Physics @ Singapore

2015

Ministry of Education, Singapore

Free global ICT tools for the interactive teaching and learning of physics, mathematics and more

Theme
Pedagogical innovation in using ICT in teaching and learning

Location
Singapore

Date started
2012

Beneficiaries
9,800 students

Target population
Students in grades 3 to 12

Digital solution
Teaching and learning mostly physics and mathematics through simulations on a free, open-source and user-adaptable platform

Summary

Open Source Physics @ Singapore (OSP@SG)[1] is a national government-run programme to give learners the experience of visualization and experimentation, mostly in physics and mathematics courses. It was awarded the 2015 Prize in recognition of its innovation, sustainability and positive impact in the provision of teaching and learning opportunities via tools plugged into the programme platform (the Easy JavaScript Simulation toolkit[2] and Tracker video analysis and modelling tool).[3] Moreover, OSP@SG was included in UNESCO's (2016) *Directory of Free Educational Resources for Teachers: Science*.

The emphasis on learning in the mainstream Singaporean school context is focused on close adherence to fostering success in examinations. However, this method does not necessarily facilitate deep understanding of concepts. OSP@SG is an innovative method to provide more learner-directed concept acquisition while also allowing greater flexibility and adaptation in teaching. The open-source tools utilized by OSP@SG are freely available and customizable. This enables sharing and iterative improvements in the digital tools themselves, along with continuous innovation, efficient delivery, sustainability, and even greater impact.

OSP@SG partners with individuals as well as academics to power the variety of software tools catalogued on the Joomla content management system. The creative commons licence CC-BY-NC-SA[4] permits the creation of model simulations and visualizations by anyone, but most are provided courtesy of the teams behind Open Source Physics (OSP) and Easy Java / JavaScript Simulations (EJSS), Tracker video analysis and modelling and open source code available for adjusting the simulation and video models. While there is no formal agreement between OSP and OSP@SG, the open educational resource (OER) and creative commons licensing enables reciprocal use of resources developed by the respective OSP members for world-wide benefits.

Why selected

OSP@SG was selected for the Prize because of the following features:

- It is an innovative OER tool for learning physics and other subjects including mathematics and science, using an open platform, open-source code and open content.
- The platform works in a collaborative way so that students and teachers can provide adaptable resources for better teaching and learning.
- It strengthens the flow of ideas from teachers to classrooms and fosters collaboration between schools, government and industry.
- It is easily scalable to the global community, as the tools and content are available worldwide.

1 See https://iwant2study.org/ospsg
2 See https://gitlab.com/ejsS/JavaScriptEditor/release
3 See https://physlets.org/tracker
4 See https://creativecommons.org/licenses/by-nc-sa/2.0

Programme

PROBLEM

While computer simulations are used in a wide range of fields and can augment traditional physics and mathematics lessons to improve students' understanding, most other freely available simulations are made for universities and other more specialized educational contexts rather than schools. Thus, even if these simulations are used in lessons at primary and secondary level, the resulting learning experience may not be very coherent.

SOLUTION

Free resources and simulation software allow students to experiment with model-building and testing of hypotheses to improve their learning and understanding. Access requires only a device (mobile, computer, or tablet) and internet access. Offline access is possible via the 'download model' option on the OSP@SG website.

BENEFICIARIES

- Approximately 9,800 learners and 300 teachers in Singapore
- 360,000 installations of the app globally

RESULTS

- Students report deeper learning.
- Schools report positive impacts on classroom practice.
- More than 800 OERs have been created by the OSP@SG community.
- Teachers have created 18 educational games.
- Computer simulation and video modelling were integrated into the national curriculum teaching guide for advanced-level physics.

CHALLENGES

- Some teachers struggle to recognize the value in adopting the computer simulation and video modelling style of teaching promoted by OSP@SG as it does not follow the customary exam-preparation format.
- The resources that are created sometimes need further revision after being presented in the classroom.
- Not all students have the prerequisite knowledge needed to make optimal use of computer simulation programs and video analysis and modelling.

Profile: Implementing agency

The Ministry of Education (MOE)[5] directs and controls educational policy in government and government-assisted schools and colleges in Singapore. The Educational Technology Division (ETD) within the MOE is responsible for the strategic plan for ICT in 21st century learning, alongside the integration and deeper use of digital technologies. In addition, the ETD oversees the ICT Masterplan in Education. With funding from the National Research Foundation (NRF)[6] and the Prime Minister's Office, the ETD ran the EduLab Programme, which piloted the creation of scalable resources for use nationwide.

5 See https://www.moe.gov.sg/about-us

6 See https://www.nrf.gov.sg/programmes/strategic-research-programmes

With advances in technology and its ubiquitous availability, education is positioned to reap the benefits of open-source creations. At the same time, meeting the needs of learners while providing requisite skills development for the 21st century is a challenge which must be addressed. OSP@SG tackles this challenge through the use of OERs to introduce students to physics concepts through computer simulation (EJSS) and video modelling (Tracker).

OSP@SG provides teacher training, lesson planning and additional resources for the use of computer simulation models in science and mathematics. Teachers introduce concepts using both physical laboratory and computer models, and students in small groups then have the opportunity to manipulate various parameters such as weight, distance or time in the simulation and observe changes to outcomes based on these shifts. The results that they produce are aggregated through Google Form inputs to display curves or other graphical representations of changes.

The use of OSP@SG creates efficiencies and allows for deeper curriculum coverage. Teachers spend less time preparing real-life physical setups of different scenarios to demonstrate effects, and due to the aggregation of data, trends emerge with fewer iterations of the experiment per student group. Further, encouraging learners to create hypotheses and then build and test models to prove them deepens their learning experience.

Interview with OSP@SG representative
Source: Open Source Physics @ Singapore (2021)

Context

With a 99.8 per cent total net enrolment rate at primary school level and 99.95 per cent for upper secondary, Singapore does not face significant challenges in terms of access to education. Students in Singapore consistently outperform their counterparts in OECD countries in various international benchmarking tests such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) (NCEE, n.d.).

The public school system in Singapore consists of six years of compulsory primary schooling, four to six years of secondary school, and one to three years of post-secondary education delivered at junior colleges. The secondary level, which is diversified into both academic streams and technical and vocational courses, is competed by 96.7 per cent of students. With five streams, multiple pathways of advancement, and durations that vary between one and six years, Singapore post-primary education system can be described as complex, flexible and highly articulated.[7] All levels of education are primarily supported by the state, which plays a leading role in developing and implementing the system (NCEE, n.d.).

Under the mandates of the National and MOE ICT Masterplans, schools are provided with digital devices and internet access. This includes at least three computer laboratories per school, with each lab receiving about 40 computers. Increasingly, schools have also utilized government funding to purchase tablets. Teachers are also given laptops and a budget to purchase personalized digital devices, and students from low-income families can borrow devices through a government loan programme or receive subsidies for devices and connectivity.

Therefore, it is unsurprising that both massive open and online courses (MOOCs) and OERs have gained popularity in Singapore, with governmental and higher education institutions investing in making resources more widely accessible through these formats (Lim et al., 2017).

Educational challenges

The rate at which students graduate from first degree programmes in tertiary education is high, but has incrementally decreased from 58.8 per cent in 2016 to 53.8 per cent in 2018. The percentage of university students graduating from science, technology, engineering and mathematics (STEM) programmes also decreased from 34.9 per cent in 2017 to 33.5 per cent in 2018 (UIS, 2021). As a result, there is a particular shortage of both human capital and cross-functional skills in the electronics and electrical engineering sectors – the largest component of Singapore's manufacturing base (EDB Singapore, 2021).

At the same time as indicators of technical skill levels in Singapore show such decreases, there is a worldwide recognition that the demands of the labour market are shifting towards higher skills. This is due in large part to the role of technological innovation, and education has a key role to play in reducing skills gaps and upskilling both current and future workforces to meet demand (Liao et al., 2018; Shiohira and Dale-Jones, 2019). In Singapore, the introduction of computer simulations is one way of addressing the skills shortage and acts as a mechanism for future-proofing the workforce and economy.

7 Articulation refers to the ability of learners to move between degrees and educational offerings. Highly articulated means that there are many pathways between different levels of education.

The role of computer simulations

According to Winsberg (2019), a computer simulation can be narrowly defined as a program run on a digital device to explore a mathematical model. More broadly, it can be seen as a process for studying systems, comprised of 'choosing a model; finding a way of implementing that model in a form that can be run on a computer; calculating the output of the algorithm; and visualizing and studying the resultant data'.

This technique emerged after World War II as a way to study nuclear physics, and was quickly taken up by other disciplines such as meteorology, where it is used for weather forecasting and climate modelling (Giere, 2009). Today, the fields which exploit computer simulation models also include many branches of physics, biology, engineering, economics, medicine and sociology (Winsberg, 2019). These simulations allow researchers to replicate and project real-world events without having to physically create the necessary conditions, which could be costly, dangerous, slow, illegal and/or impossible (de Freitas, 2007). For example, computer modelling can be used to study the results of climate change, the spread of contagions, and the effects of motor-vehicle accidents under different conditions (e.g. speed, angle of impact). Given this widespread use, Christian et al. (2011, p. 1077) ask a critical question: 'Why does computer-based modelling remain absent from many educational programmes?'

> …with the [OSP@SG] simulation, you get to learn instantly compared to reading the lecture notes again just to visualize what the tutor is trying to convey… It does shorten the amount of time [needed] to comprehend a new concept.
>
> **Student voice**
>
> *Source*: Open Source Physics @ Singapore (2015)

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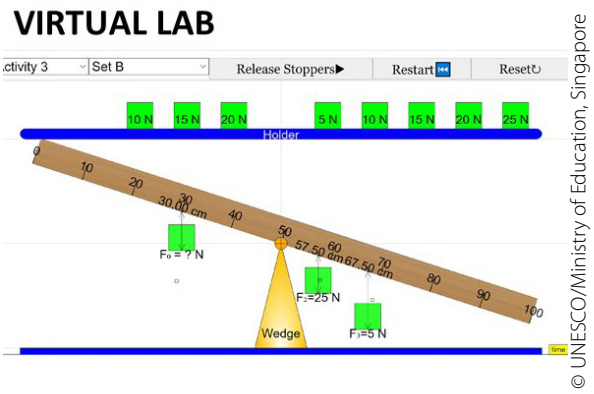
Digital Solution

In OSP@SG, computer simulations are created via an inquiry-directed teaching methodology that allows students to experiment with building models and testing hypotheses (Kwan and Wee, 2015). Learners discover the application of model-building through iteration, finding close-fit mathematical equations and improving their ability to match simulated or real-world data. Visualizations of real-life experiments aligned to the simulations further support their understanding.

The use of computer simulations creates efficiencies by allowing teachers and learners to explore multiple permutations of a phenomenon (e.g. What if there are three weights on one side? What if one of the weights is moved?) without the time-consuming process of setting up different iterations of a live model (see **Figure 1** and **Figure 2**).

Figure 1. Simulation of the effects of forces through a virtual lab



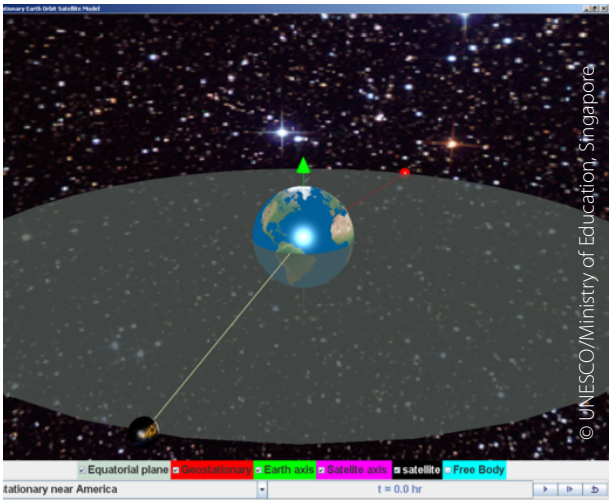
© UNESCO/Ministry of Education, Singapore

Figure 2. Studying the effects of forces using a physical model

© UNESCO/Ministry of Education, Singapore

The results achieved by different groups of students can be aggregated in a collaborative online form, creating larger datasets which are used for data visualizations such as trend lines that illustrate the relationships between variables. Additionally, simulations allow students to explore phenomena that cannot be contained in a classroom, for example, elliptical orbits (see **Figure 3**).

Figure 3. Simulation of an elliptical orbit



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OSP@SG seeks to enable teachers and students to become co-designers and owners of customized digital resources, rather than passive receivers of digital content. They can explore and edit tools and use models to visualize physics concepts such as projectile motion (e.g. the trajectory of a ball thrown into the air). These allow students to form and test hypotheses and juxtapose their models against live videos of the same phenomenon on the platform (Wee et al., 2012). Researchers and education specialists can also access the platform, driving partnerships that encourage the further development and dissemination of OERs and helping to maintain the high quality and relevance of the resources available.

Implementation

OSP@SG is based on the National Science Curriculum of Singapore, and is designed for use by students in grades 3 to 12, including TVET learners in grades 7 to 12, who are studying science and physics. It covers key topics such as energy, kinematics, circular motion and dynamics. OSP@SG is used during normal curriculum hours, with learner-to-teacher ratios of 20:1 for grades 3 to 10 and 25:2 for grades 11 and 12. With the support of teachers, learners investigate questions, record data sets, analyse information, interpret results and communicate findings. The platform is accessible on most devices to any teacher or student at any location with an internet connection.

As an open and web-based platform, OSP@SG accommodates informal learning spaces such as computer laboratories, lecture theatres, homes or even buses and trains. Learning can take place via internet chat groups as well.

OSP@SG utilizes four components contributed by academics who are also software entrepreneurs:

01 Open Source Physics (OSP) created by Wolfgang Christian (Davidson College, United States) under the sponsorship of the National Science Foundation. The OSP project collection contains curriculum resources for physics, computation and computer modelling.

02 Easy Java / JavaScript Simulations (EJSS), created by Francisco Esquembre (University of Murcia, Spain), which allows users to create Java programs with minimal programming knowledge.

03 Tracker, created by Douglas Brown (Cabrillo College, United States). Based on the OSP Java code library, it is an image and video analysis package and modelling tool that allows for object tracking with position, velocity and acceleration overlays and graphs.[8]

04 The NTNU Virtual Laboratory, created by Fu-Kwun Hwang (National Taiwan Normal University, Taiwan Province, China). It has a collection of more than 1,000 Java simulations of physics-related topics.[9]

OSP@SG further supports the embedding of simulations into any learning platform, and a catalogue of simulations and Tracker resources uses Joomla!, a free and open-source content management system.[10] Through a creative commons attribution licence, all materials including the source codes are publicly accessible and adaptable. This allows for both customization required to meet a specific teacher's needs and adjustments to fit the prescribed curriculum.

Teachers are supported through annual workshops which provide training on both using and contributing to OSP@SG. They learn to generate simulations and use pedagogical practices involving collaborative science inquiry, including guided inquiry, modelling, visualization and collaborative discussion (Kwan and Wee, 2015). These can supplement regular classroom instruction for deeper understanding. Through the platform, teachers have access to a collaborative network of active users worldwide and can access resources such as learner-centred worksheets and Google sharing sites. As part of this community, teachers may upload their own customized OERs and thus improve their own competencies and skills by developing original, relevant teaching material.

8 For more information on OSP, EJSS and Tracker, see https://www.compadre.org/osp

9 See http://www.phy.ntnu.edu.tw/ntnujava/index.php

10 For more information, see https://www.joomla.org

Collaborators

The programme leverages government support, school leadership, and international scholars focused on simulations, to ensure strong delivery. It draws from the work of a broader OSP community, with the aforementioned experts Francisco Esquembre, Fu-Kwun Hwang, Wolfgang Christian and Douglas Brown involved in developing the platform's components. The Singapore MOE employs a lead specialist whose extensive knowledge sustains the programme. Additional experts and teachers are deployed to create, share and update materials and resources.

OSP@SG also leverages government policy, particularly the ICT Masterplans, under which Singapore's MOE contributes hardware and internet connectivity to all schools. Furthermore, OSP@SG was one of the EduLab programmes funded by the NRF. These focused on giving teachers, researchers and MOE officials resources to develop digital technologies that could be adopted across the Singaporean school system.[11] Some teacher training was delivered at Edulab workshops run by the Academy of Singapore Teachers, which concentrated on basic digital capacity as well as using the simulation software. With EduLab funding concluded, OSP@SG is now financed via the MOE's 'senior specialist track research funding' (SSTRF) grants. However, other related EduLab projects continue to contribute to OSP@SG, including the following:

- Java Simulation Design for Teaching and Learning,[12] which focuses on using simulation modelling in classrooms and is currently being adapted into JavaScript HTML5 so that it is able to run on any mobile or computer browser;
- the modelling-inquiry-enabled Interactive Textbook,[13] which is used in schools and available on iBook, Playbook and Kindle Store for junior college students, and allows students to conduct inquiry experiments and mathematical modelling using simulated data; and
- Becoming Scientists through Video Analysis (2014-15),[14] which is being used in schools for performance tasks and computer lab activities.

Support from school leadership is critical for successful engagement in the required professional development and teaching strategies used in the OSP@SG programme. Opportunities for the pilot were created by school leaders who set aside the time required, created a common vision in schools and provided strategic direction to build the capacity of teachers.

Monitoring and evaluation

Learning outcomes are assessed through pre and post-tests using Google Forms. Other feedback is gathered through surveys of users and face-to-face interviews with students. These include reflection surveys with which teachers and students indicate areas of the platform and/or content that need improvement.

Because OSP@SG was one of the EduLab programmes, its implementation was monitored by structures within the MOE and ETD as well as by the EduLab Programme Office, who held quarterly meetings to monitor its progress. The MOE provided guidance and tracked the development of OSP@SG. Within the ETD, a Deputy Director and Assistant Director together with a design team evaluated the programme's inputs, activities, outputs and outcomes/impacts. In addition, the EduLab Programme Office received yearly reports which reflected on the achievements, experiences and insights from the project delivery. An EduLab steering committee, consisting of senior management from the MOE and experts from the National Institute of Education (NIE), evaluated the project's funding, progress and final report.

When funding for EduLab ended in 2019, OSP@SG was integrated into the portfolio of a lead specialist in the ETD and no longer has a formalized monitoring or tracking mechanism. However, OSP@SG outputs are currently monitored, as it is one of the funded projects of the SSTRF.

11 See https://www.nie.edu.sg/research/apply-for-grants/edulab-funding-programmex

12 See https://iwant2study.org/ospsg/index.php/projects/335-nrf2011-edu001-el001-java-simulation

13 See https://weelookang.blogspot.com/2015/05/edulab-cfp-2015-submission-modelling.html

14 See https://iwant2study.org/ospsg/index.php/projects/336-nrf2013-edu001-el017-becoming-scientists-through-video-analysis

Results

While there has not been a large-scale controlled study on OSP@SG, its monitoring reports, pre- and post-tests, and expanding implementation suggest positive results.

The use of OSP@SG has consistently grown since its launch in 2012 at five schools. By 2015, it was being used in 12 Singaporean schools by approximately 9,800 learners and 100 teachers. As of 2020, nearly 800 OERs had been created through OSP@SG, and the website attracted an average of 30,000 visitors per month from around the world. The work of OSP@SG was recognized yearly at the national level with awards for best innovation and excellent service from 2011 to 2020. A summary by the NRF (Wee, 2015) reported that the initiative generated the following findings:

01 Teachers were more effective in their teaching of difficult concepts.

02 Through variations in implementation, teachers were able to customize the programme to fit different school contexts and curriculum needs.

03 Sustainable practices were established as the OERs were used across different EduLab projects and were not confined to OSP@SG.

04 The roles of teachers and students with regard to technology shifted so teachers moved towards facilitation and students increased their agency.

05 Through mentorship by teachers, students learned more about the scientific process and developed inquiry skills.

06 Interviews conducted with students (Open Source Physics EJSS Tracker, 2013), suggest that OSP@SG made a deep and sustainable impact on students' learning experiences.

In addition, OSP@SG research has generated 10 peer-reviewed articles. Their findings demonstrate that using OSP@SG to teach multiple subjects can strengthen students' conceptual knowledge in relevant curriculum topics (see for example, Wee et al., 2012; Wee et al., 2015).

Challenges

The NRF found that one of the challenges in terms of implementing the programme was a lack of guidance for teachers, insufficient resource testing, and limitations in prerequisite knowledge. Firstly, discussions indicated that not all teachers were comfortable using computers and Tracker software, and some felt they needed more development to conduct the planned lessons well (Wee, 2015). Additionally, the modeling skills advanced by OSP@SG are difficult to showcase in a school culture focused on examinations. As a result, it is challenging to get teachers to recognize the value of adopting the OSP@SG style of teaching and learning.

Secondly, the resources created on OSP@SG such as worksheets and models often go through a development trajectory in which they are tested by creators, but the first actual trial of the lessons occurs in the classroom. This can result in difficulties surfacing while the resources are already being used by the students (Wee et al., 2015). Lastly, some tools related to Easy JavaScript Simulation modelling remain a challenge for students, and are used more by teachers to make their own interactive games or simulations, rather than in classroom practice.

Further developments

Since winning the Prize in 2015, OSP@SG has evolved to include game creation, mobile-ready apps and the use of analytics. Existing simulations on the platform can now be modified by teachers to create games for students, and simulations have been repackaged as hybrid apps[15] for use with iOS and Android mobile devices. Since 2017, there have been 360,000 installations of the OSP@SG app across Android and iOS platforms, and 200 teachers per year attend sharing sessions. A Moodle Learning Management System plugin was developed to allow teachers to monitor and analyse students' use of the simulations in real time.

The OSP@SG programme has influenced the national syllabus and teaching guide for advanced physics, which now includes video analysis and modelling and encourages the use of Tracker software. The simulation library has expanded to include subjects such as biology, chemistry, Chinese, English, art, physical sciences and civic education.[16] In addition, 28 source codes in Easy JavaScript Simulation were prototyped and submitted to the Partnership for Integrating Computation into Undergraduate Physics in the United States, through which educators can examine the differences between, and value of, various computing languages (including Python, Glowscript and Spreadsheets) in developing computational thinking. A total of 15 primary-level mathematics interactives were also prototyped. Lessons and prototypes were co-developed with teachers for use in the Singapore Student Learning Space, an online platform that contains curriculum-aligned resources and tools,[17] and 28 simulations were created for two interactive textbook chapters. The team is currently pursuing expansion across languages, potentially by utilizing Google Translate to change languages based on user choice or location.

Furthermore, 10 Easy JavaScript Simulations were adapted from a European project called MOSEM for use in Singapore's A-level physics classrooms. At university level, 42 simulations from the book *Learning and Teaching Mathematics using Simulations – Plus 2000 Examples from Physics* (Röss, 2011) were modernized so as to run on mobile platforms.

The user base has expanded to 300 teachers, some of whom have also formed an informal group of EJSS game developers and Tracker video modellers who contribute to the open-source physics repository. To support this type of initiative, a hackathon was organized by the MOE in 2019 and provided a space for teachers to modify existing simulations as part of game creation. This resulted in 18 educational games being produced by teachers. The professional development of teachers has been fostered through resource sharing in workshops and work attachments,[18] and an annual four-day event held in collaboration with the developers of the Easy Java / JavaScript Simulation tool and OSP creator Wolfgang Christian.[19]

15 Hybrid apps are built using a combination of platform-specific technology (such as Swift for iOS) and web technologies such as HTML or Javascript. Their purpose is to allow a mobile app to display web content like a website.

16 Resources can be accessed at: https://iwant2study.org/ospsg/index.php/interactive-resources

17 See https://vle.learning.moe.edu.sg/login

18 See https://academyofsingaporeteachers.moe.edu.sg/programmes-publications/professional-development-programmes/teacher-work-attachment-programme-twa

19 Information in this section is drawn from OSP@SG's submissions to UNESCO in 2019.

Impact of the Prize

The UNESCO King Hamad Bin Isa Al-Khalifa Prize contributed to the development of new content and digital resources, including adapting OSP@SG for mobile apps, introducing gamification and adding learning analytics. Winning the prize also increased the building of capacity among teachers, educators and community members using the platform, resulting in an informal resource development group and sessions organized by the MOE. Teachers are also now more willing to use simulations and plan experiences around them, supporting the effective learning of mathematics and physics while also fostering enjoyment of these subjects.

Receiving the prize further assisted with disseminating the MOE and ETD's work on and support for OSP@SG to a wider audience. Coverage and promotion by UNESCO and local news media provided a boost for the project. This in turn fostered goodwill locally, encouraging teachers to be more willing to access OSP@SG and use the platform's simulations and worksheets.

Since being given the Prize, OSP@SG has received a number of further awards:[20]

- the Gold Innergy Award in 2016, 2017, and 2019;
- the Bronze Innergy Award in 2019; and
- the Excellence in Physics Education Award from the American Physical Society in 2020.[21]

20 For details, see https://iwant2study.org/ospsg/index.php/awards

21 Information in this section and the Implementation section is drawn from OSP@SG's (2015) application to the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education, and its response to UNESCO's follow-up survey from 2019.

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Digital Schools

2016

JAAGO Foundation

A Simple Online Teaching Solution in Rural Bangladesh

Theme
The use of ICT in education for disadvantaged groups

Location
Bangladesh

Date started
2011

Beneficiaries
3,500 learners

Target population
Disadvantaged rural primary school learners

Digital solution
Teachers deliver quality lessons via video conferencing technology to poorly-resourced rural areas

Summary

JAAGO Foundation won the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of Information and Communication Technology (ICT) in Education in 2016 for its Digital Schools innovation, a promising development towards quality education for all implemented in rural Bangladesh.

While Bangladesh has made great strides toward high participation in education by school-aged children, there remains a need to focus on the quality of education delivered, which varies by location. Schools in rural areas face a number of challenges including intermittent electricity access, a lack of digital technology infrastructure such as computers and internet access, poor resourcing, a shortage of qualified and trained teachers and high poverty.

Since 2011 Digital Schools have offered an opportunity for rural disadvantaged learners to access quality teaching despite these challenges. In partnership with telecommunications networks, Digital Schools connect qualified and trained central teachers to remote primary school classrooms through simple video conferencing software, bringing quality instruction in English, Bangla and Mathematics. Learners are supported on-site by trained facilitators to complete activities and classwork.

Conducted research has shown that Digital Schools learners achieve similar learning outcomes to peers in comparison schools, even though Digital School learners face higher poverty and have parents with lower educational attainment than their peers. JAAGO Digital Schools learners have also achieved a 100 per cent pass rate on all national examinations they have taken part in.

The Digital Schools model requires only an internet connection, hardware and video conferencing software, and as such, offers huge opportunities for disadvantaged learners as a model that can be replicated across the country using existing skills within communities.

More information: https://www.jaago.com.bd

Why selected

- JAAGO has introduced the first free-of-cost quality education using digital classrooms exclusively for underprivileged children in Bangladesh;
- The practical use of digital technology enables synchronous learning which helps with bridging the quality gap between urban and rural schools in Bangladesh;
- Despite constraints such as limited electricity and internet access and a lack of qualified teachers in rural areas, JAAGO Foundation developed a strong solution to deliver quality education by maximizing the potential of common technology.

Programme

PROBLEM

Poor quality education in rural areas, driven by a lack of qualified and quality teachers outside of urban areas.

SOLUTION

JAAGO Foundation's Digital Schools provide access to quality instruction delivered remotely by central teachers supported by on-site facilitators.

BENEFICIARIES

3,500 disadvantaged rural learners

RESOURCES REQUIRED

- **Infrastructure and software**: Multimedia classroom application with a webcam and speakers; Internet access; Electricity (including alternative sources for outages)
- **Human Capital**: Trained central teachers and local facilitators
- **Content**: Adapted curriculum content; PowerPoint; YouTube
- **Systems**: Administrative; Quality assurance; Monitoring and Evaluation

RESULTS

- Good performance of children in English and Mathematics
- High attendance and a drop-out rate of 0 per cent

CHALLENGES

- Poor digital technology and electric infrastructure
- Sustainable/guaranteed funding
- Pedagogical content knowledge of central teachers and facilitators

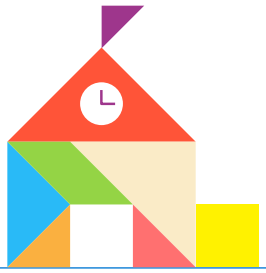
Profile: Implementing agency

JAAGO Foundation is a civil society organization established in 2007 focused on poverty alleviation and social mobilization through education in Bangladesh. It aims to develop skilled human resources through the provision of quality education and growing the confidence and communication skills of learners in a global context. The Foundation runs education, youth development and Rohingya refugee programmes.

The education programme offers no-cost quality education to 3,500 underprivileged children in 12 schools. Nine of these are Digital Schools, in which Dhaka-based teachers deliver virtual lessons in digital technology-enabled classrooms, supported by two on-site facilitators. The programme also includes projects to ensure the physical and emotional well-being of the children such as delivering hygiene products to students, a school feeding programme to ensure adequate nutrition, regular health check-ups and provision of necessary medications (JAAGO Foundation, 2016).

JAAGO Foundation operates related projects with similar developmental goals in Bangladesh, for example, the Volunteer for Bangladesh project that builds youth volunteer networks to tackle social challenges. Volunteer groups independently run their own projects under supervision of local district boards, promoting self-reliance and personal growth in more than 35,000 youth in 32 districts in Bangladesh. The programme seeks to give youth in Bangladesh a voice and a platform to address issues such as children's rights to education, responsible water consumption, promoting a green environment and promoting non-violence, tolerance and peace.

JAAGO Foundation also supports marginalized people through the Rohingya Refugee project that seeks to aid the more than 1.2 million Rohingya refugees who have fled to Bangladesh from Myanmar, sixty percent of whom are children (UNICEF, 2019). The programme leverages the digital content of the education programme as well as providing a safe shelter and therapy for refugee children.



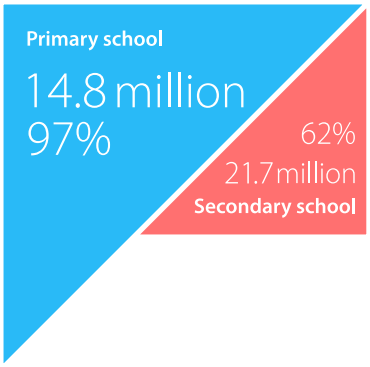
Context

Bangladesh is a coastal country bordering India and Myanmar. The country has a population of 164 million and a particularly high population density of 1,253 per square kilometre (UN, 2019). Bangladesh has experienced strong economic growth of about 6.5 per cent over the last decade; however, the benefits of this are unevenly distributed along an urban-rural divide. While the country has made strides in reducing poverty, about 24 million Bangladeshi (14.3 per cent of the population) still live below the poverty line. Sixty three percent of the population live in areas which are classified as rural (World Bank, 2019), and large portions of the country are low-lying, contributing to a high risk of flooding and rising sea levels (UNDDR, 2020).

Compulsory education in Bangladesh lasts twelve years, spanning primary and secondary school, and is delivered through a complex mix of public and private educational institutions, both secular and religious (GPE, 2020). Enrolment is partially supported by a Primary Education Stipend Programme that serves 13 million primary students and 4.5 million secondary and tertiary students and a school feeding programme that serves 31 million students (Centre for Research and Information, 2018).

Education in Bangladesh is gender-equitable through secondary school, with more girls enrolled in secondary education than boys (UNESCO, 2020). However, post-secondary school environments are not as conducive to female education, resulting in lower enrolment of women. This contributes to a large Not in Education, Earning or Training (NEET) population of around 12 million that is largely female and largely located in more rural areas of the country (World Bank, 2019).

Figure 1.
Primary and secondary school enrolment in Bangladesh, 2018



Data Source: UIS (2020). Accessed 8 September 2021

Access to quality education lies at the heart of all development. However, despite its potential and adequate human resources, Bangladesh still faces huge challenges in its education sector. While the literacy rate has increased over the years, providing quality education to all is still a dream. Among school-aged children, one in every five is out of school. Nearly 30 per cent of enrolled children leave school before completing the full course of primary education. A lack of qualified teachers and poor school facilities contribute to poor outcomes, particularly in remote areas, and challenges of physical distance are exacerbated by additional barriers for many groups: people living in extreme poverty; street children; persons with disabilities; ethnic minorities; children working in factories, in jails or in brothels; and those involved in crime. For these marginalized populations, JAAGO's Digital Schools Programme has brought rays of hope by using ICT to overcome the barriers to education that many experience.

Source: JAAGO Foundation (2020)

Engagement with digital technology

Bangladesh embarked on a national 'Digital Bangladesh Strategy' from 2008 that seeks to leverage digital technology to achieve the goal of becoming a middle-income country by 2021.

The implementation of the strategy included investments in infrastructure and connectivity, including the establishment of more than 5,000 Access to Information (a2i) centres in rural areas that provide both connectivity and access to services ranging from birth registrations to vocational training (Chowdhury, 2015).

The government has invested in equipping 35,000 classrooms with laptops and multimedia projectors, putting 3,000 digital labs in high schools, developing 300 electronic textbooks and establishing 125 digital technology training and resource centres and has trained 61,000 teachers in digital technology and content development (Centre for Research and Information, 2018).

However, the Master Plan for ICT in Education in Bangladesh (2012-2021) still faces persistent challenges including lack of awareness of the strategy and available resources, lack of digital technology knowledge among teachers and communities and poor maintenance of digital technology equipment (Ministry of Education, 2019).

Four Pillars of the Digital Bangladesh Strategy:

- human resource development with a focus on STEM and digital learning content;
- connecting citizens;
- digital government for pro-poor services; and
- IT industry promotion, including e-commerce and, the development of digital technology and related services as an export industry (Government of Bangladesh, 2011).

Education challenges

According to UNICEF (2016), education quality remains of concern in the country. Despite high primary enrolment, only 67 per cent of children qualify for secondary education. Only a quarter of Grade 5 students demonstrate the required skills in Mathematics, and functional literacy rates of primary school graduates are lower than 50 per cent for boys and just 33 per cent for girls. Dropout rates remain high, with 20 per cent of students having left primary school in 2016, and a dropout rate of 38 per cent at the lower secondary level. More than a quarter of children are out of school, with higher rates in rural areas.

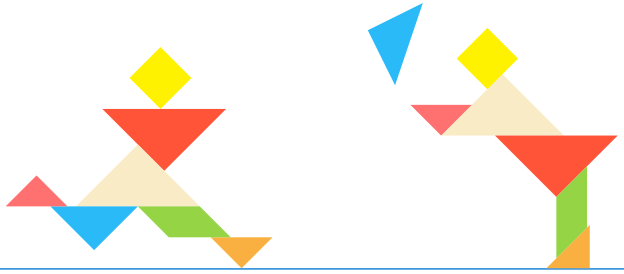
Social challenges such as poverty and child marriage as well as poor teacher training, inadequate infrastructure and overcrowding in classrooms contribute substantially to lower educational attainment (UNICEF, 2016). JAAGO Foundation (2020) identifies these and other challenges still facing the education system, notably:

> …poverty and rising inequality, widening disparities in education opportunities and facilities, poor class-attendance and alarming dropout-rates, [a] lack of skilled teachers, [a] lack of [a] scientific curriculum, [the] high cost of school-education, [and the] imposition of newer systems of education without proper teachers-training programs.

JAAGO Foundation (2020) frames the issue of the urban-rural divide in terms of learning outcomes, stating:

> In recent years the stark contrast between the knowledge of urban and rural students has been a major issue of discussion for the education policy makers of Bangladesh. The students from rural areas are falling behind in terms of quality education, knowledge and fierce competition in the job market. The major reason behind this is the lack of quality teaching in the schools of remote areas.

Furthermore, *the Master Plan for ICT in Education in Bangladesh (2012-2021): Progress Review Report* (Ministry of Education, 2019) asserts that schools in semi-urban and rural areas are limited by poor infrastructure and a lack of electricity and connectivity.



Digital Solution

JAAGO Foundation originally began its operations in Dhaka's Rayer Bazar slum area in 2007, seeking to provide quality English language medium instruction to underprivileged children. However, the Foundation soon realized a far greater need for such provision existed in more rural areas outside Dhaka. In response, JAAGO sought to expand its reach to rural areas of the country. However, the Foundation soon found itself hampered by a lack of qualified and quality teachers in rural areas, while the more qualified teachers in Dhaka could not be persuaded by higher salary and benefits packages to leave the comforts of the city.

In order to solve this challenge without compromising the quality of its programmes, in 2011 JAAGO Foundation identified, developed and launched their Digital Schools model, an innovative and cost effective digital learning solution. JAAGO Digital Schools use video conferencing technology to connect qualified teachers to rural areas of Bangladesh, leveraging digital technology to overcome both the geographical gap between students and qualified teachers and the knowledge gap between urban and rural areas of Bangladesh. The model requires only an internet connection, input and output devices and simple video conferencing software and can be implemented by existing skills within communities.

Implementation

JAAGO Digital Schools education programme involves three components: an digital technology-based digital schooling system; a pool of skilled and qualified teachers; and a modern, creative curriculum and digital content designed by in-house experts. Due to the high socio-emotional needs of children growing up in poverty, the programme additionally emphasizes a holistic approach to education. The programme serves rural disadvantaged children as well as ethnic minorities.

The digital technology-based digital school system uses Webex software, a multi-party interactive professional video conferencing software. The program contains an interactive whiteboard, facilities for desktop, document, slide-sharing, video-sharing and a sketch board making it sufficiently versatile for an education setting. Online teachers based in Dhaka deliver the lecture and an interactive session with students through this technology. The teachers are supported onsite in the remote classroom by two facilitators who assist the children with classwork and maintain a disciplined and productive classroom environment.

After selection, remote teachers are trained on subject content, online delivery and classroom management. As online learning is not commonly included in teacher education programmes, JAAGO Foundation designed a training curriculum based on their own experience and skill set, including elements such as how to use the software for lesson delivery, common challenges faced in delivering online lessons and remote classroom management. Training includes case studies drawn from real life scenarios and the experiences of staff.

Digital Schools follow the National Curriculum and Textbook Board (NCTB), the government-approved national curriculum. The NCTB mandate is to maintain relevance and unity between textbooks and national curricula. The functions of the NCTB include testing and evaluating the effectiveness of curricula, syllabi and textbooks.

Digital Schools teach English, Bengali and Mathematics from the reception year to Grade 2. In Grade 3 and 4, Science and Social Science are added to the three core subjects. Lessons last for 45 minutes per subject and are delivered to classes of 35 children. As there are two on-site facilitators in each class, the facilitator-student ratio is 1:18, while the remote teacher-student ratio is 1:35.

Enablers and supports

The Digital Schools Programme was launched in partnership with Grameenphone Limited and Agni Systems Limited.

JAAGO Foundation employs 176 staff to support the Digital Schools. These include both employees working in teaching roles and central office staff who work in two divisions, Central Administration and Academic Administration. The Central Administration performs essential functions such as yearly financial audits of schools, while the Academic Administration monitors schools' performance and is involved in strategic decision making.

Employees working in teaching related roles include: teachers who plan and deliver remote lessons; facilitators who provide on-site support to learners; and Education Coordinators. Education Coordinators are professionals with relevant education degrees who fulfil critical functions such as quality assurance of materials for online lessons and observation of teachers. Education Coordinators are an essential bridge between the centralised Academic Administration and Digital Schools distributed in rural areas.

Monitoring and evaluation

In the Digital Schools, expected outcomes are aligned with the curriculum expectations of the NCTB. Formative assessments, ongoing evaluations based on classwork, homework and project work are all conducted on-site by facilitators. Oral examinations are conducted by Dhaka-based teachers via video conferencing with each individual student. The Dhaka-based instructors are therefore able to monitor and moderate onsite facilitators' assessments of learners, individually and as class groups.

Monitoring of teaching quality is systematic. In addition, students write two major examinations each year, a half-yearly and a final examination. The results of both formative assessments and major examinations feed into four report cards which provide parents and students with information on students' performance.

Dhaka-based teachers are evaluated and monitored by school management based on professionalism, commitment and contribution to the vision of the organization. In addition to evaluating lesson plans, classroom observation is also conducted by JAAGO Foundation staff to ensure lesson plans are followed and an appropriate learning environment is created and maintained by onsite facilitators.

The programme was evaluated in 2015 by BASE Ltd. using a matched-pair evaluation of five JAAGO Foundation Digital Schools and five nearby control schools. The assessment sought to analyse the processes (including pedagogy) in the Digital Schools Programme in comparison with traditional schools systems as well as understand perceptions, materials and challenges of the programme. The study included student testing and qualitative methods such as classroom observation and interviews with teachers. The results were published in *Grameenphone's Online School Assessment Report* (Salam and Ahmed, 2015).

Results

The evaluation by Salam and Ahmed (2015) found that students from JAAGO Foundation Digital Schools performed comparably to students from control schools in the key subjects of English and Mathematics, while the performance of students in Bangla was higher in control schools. However, the evaluation noted that the educational qualifications of parents of children in Digital Schools were significantly lower than qualifications of parents of children in the comparison group. In total, 83.6 per cent of mothers and 87.4 per cent of fathers of students in Digital Schools had attained only a primary education or less, compared to 1.7 per cent of mothers and 3.8 per cent of fathers in control schools. Additionally, infrastructure in Digital Schools was found to be lacking in comparison with control schools. The combination of low parental education levels and poorer school resourcing, both key factors in educational outcomes, led the evaluators to conclude that 'in comparison with other indicators of education, surprisingly, the achievements of the Digital schools are better than that of the national level schools' (Salam and Ahmed, 2015, p. 9). These findings suggest that Digital Schools benefit from high levels of commitment from parents and children. Indeed, the evaluation found parents and learners to be invested in and appreciative of the Digital Schools model, particularly the quality of English instruction.

The evaluation further found evidence of good pedagogical practices in Digital Schools such as the use of digital/real life teaching aids, quality teaching and learning materials and participatory teaching approaches.

It was noted that variation in content and the number of learning aids were below expectation and that while most of the central teachers had Bachelors and Masters Degrees, only 8.7 per cent of facilitators had an academic background in education. This lack of formal pedagogical knowledge among facilitators was identified as a constraint.

More recently, as of 2020 JAAGO Digital Schools students took part in national examinations including four Primary Education Certificate examinations (administered at the end of five years of schooling), two Junior School Certificate examinations (administered at the end of eight years of schooling) and one Secondary School Certificate examination (administered at the end of ten years of schooling). JAAGO students achieved 100 per cent pass rates on these examinations (JAAGO Foundation, 2020).

Challenges

To ensure the success of a Digital School in a given area, prior to implementation a needs assessment is conducted that examines both the suitability and feasibility of the intervention. Digital Schools are established in areas in which there is a demonstrated need for quality teachers and which have conducive locations, internet access and electricity. Despite this, challenges in infrastructure were noted by both JAAGO Foundation and the external evaluation and included concerns about available space, furniture, play equipment and the number and diversity of learning aids as well as infrastructure aspects related to the delivery model such as low bandwidth, connectivity interruptions, flawed sound systems and small screen sizes offering limited visibility to all students.

JAAGO Foundation notes that electricity remains a periodic issue in farming locations, particularly during the months of April to September when authorities re-direct electricity resources towards irrigation. This can result in power outages for more than an hour during learning time. To mitigate this challenge, schools are equipped with backup power supplies that can supply enough power to run functions such as multimedia tools.

Of central concern for the JAAGO Foundation is a limited supply of qualified education professionals. JAAGO Foundation has responded by opening teaching positions to graduates who do not have an education specialization.

A study conducted in 2015 indicated that the shortage of teachers and facilitators with an academic background in education may have contributed to gaps in pedagogy observed by the external evaluation such as a lack of pair or group work activities as part of lesson design as well as difficulties with cooperation between central teachers and facilitators (Salam & Ahmed, 2015). The study advised that more initial and ongoing teacher professional development opportunities need to be created throughout the organization to address these gaps and proposed joint training of central teachers and facilitators to foster collaboration. JAAGO Foundation is in the process of developing materials to deliver additional training on content and pedagogy through digital platforms to existing teachers (JAAGO Foundation, 2020).

An additional challenge identified by the organization is delivering traditional textbook and curriculum content through a digital platform as an engaging lesson. To create engaging and effective lessons, the NCTB curriculum and textbooks are augmented with resources such as YouTube videos as well as materials created by JAAGO Foundation staff such as PowerPoint presentations. PowerPoint presentations in particular are developed based on NCTB lessons and plans, which are used as a basis for engagement in the digital schools. Before the delivery of each lesson, presentations and materials are evaluated by JAAGO Foundation staff to ensure the lessons adhere to curriculum expectations, with peer collaboration as an additional element to improve quality (JAAGO Foundation, 2016).

Gender equality was another challenge initially. In 2016 the JAAGO Foundation reported a learner demographic in Digital Schools that was 85 per cent male (JAAGO Foundation, 2016); however, in 2020 52 per cent of learners are female (JAAGO Foundation, 2020). JAAGO Foundation (2020) notes that female students face additional social and economic pressures, which make them more prone to drop-out, and notes the importance of creating a safe and gender-neutral environment for female students. The JAAGO Foundation has engaged in deep communication and involvement between schools and parents to establish a sense of trust and security for female students.

In terms of financial sustainability, Digital Schools rely on corporate social responsibility funding and individual sponsors who contribute BDT 2,000 per month to bear all the educational expenses for one student. However, if not all children are sponsored, the financial burden is carried by the organization, posing a potential risk to the model. This situation contributes to anxiety on the part of parents regarding the sustainability of the JAAGO schools (Salam and Ahmed, 2015).

Finally, while the pilot began operations in 2011, obtaining government approval of the JAAGO Digital Schools was one of the outstanding issues reported in Salam and Ahmed (2015). This has since been resolved, but the JAAGO Foundation (2020) notes that partnerships with the government are still an ongoing focus of the organization.

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Further developments

While the main programme components have remained consistent, since 2016 the JAAGO Foundation has substantially expanded its offering in both scope and scale.

JAAGO is continuing its work towards partnering with the Government of Bangladesh, particularly the Ministry of ICT Education and the Ministry of Education. The Digital Bangladesh government strategy has already taken steps towards the provision of multimedia classrooms and related teacher training. These initiatives offer an opportunity for JAAGO to scale up the Digital Schools model across Bangladesh in collaboration with the government.

Towards this goal, JAAGO is now active in an additional ten Government of Bangladesh primary schools on Moheshkhali Island in the Cox's Bazar District, providing teacher training and delivery of English language teaching through distance education to 9,000 children through its Distance Learning Project. Accordingly, the number of online classes offered by the JAAGO Foundation increased between 2016 and 2020 from 27 to 50, while the number of online teachers increased from 38 to 57, and the number of facilitators increased from 60 to 106. The Distance Learning Project is currently focused on providing high-speed internet network service in all ten schools as well as equipping multimedia classrooms and building local capacity in the use of online tools.

JAAGO has also expanded its teacher training activities. The organization developed an online course for teacher training on classroom management techniques using Muktopaath, an open and free eLearning platform. The training is delivered free of cost through a2i centres,[1] a positive development in collaboration between non-governmental organization and national government initiatives. JAAGO plans to add more online courses in order to strengthen the subject and pedagogical knowledge of teachers.

In terms of scope, the organization has added a component of training and empowerment of parents in income generation activities, with the goal of assisting Digital Schools families to become better educated and more financially stable.

JAAGO students from Grades 5 and 7 were also taught basic coding through a program designed and executed by Kids Go Coding, an initiative in Bangladesh which seeks to empower 15 million children living in poverty with the knowledge of computer programming.

Additionally, JAAGO Foundation is experimenting with using its platform and resources in new ways. A partnership with Level UP Village (LUV) allows students to connect with peers in other countries through the exchange of video letters and work collaboratively on Science, Technology, Engineering, Art and Maths (STEAM) projects.[2] This partnership is a first step towards a new goal of the JAAGO Foundation to use the Digital Schools model and resources to enable cross-cultural exchanges.

1 See the context and country overview for more information on a2i and the Digital Bangladesh strategy.

2 For more information, see the Level Up Village website: https://www.levelupvillage.com

3 Except where otherwise noted, information for this section is drawn from JAAGO Foundation, 2020.

Impact of the Prize

JAAGO Foundation credits the award of the UNESCO King Hamad Bin Isa Al-Khalifa Prize with creating international recognition for their programme and Digital Schools and building a crucial link with the International Organization for Migration (IOM). Local media covered the award extensively, contributing to JAAGO's national profile and awareness of the organization's activities. The prize also contributed to long-awaited recognition by and creation of links to the Government of Bangladesh.

Following the awarding of the prize, Mr. Nasrul Hamid (MP Honourable State Minister, Ministry of Power, Energy & Mineral Resources) and Zunaid Ahmed Palak (Former Minister of State for the ICT Division) visited JAAGO's school in Rayer Bazar. The award further helped JAAGO to attract attention from the Ministry of Primary Education and the ICT Ministry, which also contributed to the JAAGO Foundation's Distance Learning Project taking place in the Government of Bangladesh primary schools.

JAAGO Foundation hopes to develop and leverage more international partnerships to improve its technology and capacity and enable scale-up within Bangladesh and abroad.

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Kiron Campus

2016

Kiron Open Higher Education

Harnessing the power of MOOCs to unleash refugee potential

Theme
The use of ICT in education for disadvantaged groups

Location
International

Date started
2015

Beneficiaries
More than 11,000 learners

Target population
Refugees, asylum seekers, and internally displaced people and underserved communities in the Middle East

Digital solution
Free flexible online learning opportunities, skills and certifications for displaced people

Summary

More than 70 million refugees and displaced people have fled their homes to avoid violence, poverty, conflict and persecution. These people undergo physical and mental strain both during their migration and while trying to adapt and pursue integration, education and work opportunities in an unfamiliar host community. Refugees, asylum-seekers and other displaced people often face legal, linguistic, educational and financial barriers to pursuing their goals.

Kiron Open Higher Education has a mission to provide access to learning opportunities for vulnerable populations. Kiron harnesses the potential of Massive Open Online Courses (MOOCs) as enablers and supporters of high quality education, designing curricula and certifications through aggregating and curating of Open Educational Resources. Kiron's goal is to ensure equitable access to quality education for refugees, asylum seekers and internally displaced people through all stages of resettlement, as well as underserved communities in the MENA region.

Through partnerships with government and academic institutions, MOOC providers, foundations, third-sector organizations and volunteers, Kiron is able to offer tailored academic and support programmes to help underserved communities achieve their educational and life goals, as well as support stronger integration into host communities.

Kiron students study for free through the Kiron Campus education online platform and are supported by volunteers, academics, industry mentors and online tools. The platform can be accessed from any device with an internet connection. The Kiron education model provides support through language courses, an online community and mentoring, and opportunities to interact with host community students. While the initial mission of the organization was to help students to access higher education and transfer to partner Universities, over the years Kiron has expanded its education programmes to focus on skill-based courses in order to connect students to career opportunities.

More information at: https://kiron.ngo

Why selected

- Kiron supports the integration of a disadvantaged population into the higher education system and the labour market by addressing the barriers often faced by refugees, asylum seekers and internally displaced people.
- Kiron has established a strong programme and support network for vulnerable people through partnerships with academic institutions, MOOC platforms, international agencies and volunteers, which enables Kiron to address both psycho-social and academic needs of students.
- Kiron's education programmes have promising outcomes that can empower refugees and internally displaced people.

Programme


PROBLEM
Refugees and migrants face social, legal, educational, financial and geographic barriers to higher education opportunities in host countries and communities.
SOLUTION
Technology, academic partnerships, student supports
Phase 1 Platform training
Phase 2 University and/or employment and/or entrepreneurship
BENEFICIARIES
Refugee students in the European Union, Jordan and Lebanon
RESOURCES REQUIRED
• Strong partnerships with government, funding, academic and third sector organizations
• Agile teams comprised of education and subject experts, developers, data analysts and designers
• Existing MOOC courses/resources
• University curricula
• Funding procured from donor organizations and relief aid
• Support structures:
› Study Hubs
› University application guidance
› Skill Booster programmes for employment and workplace-relevant skills training
RESULTS
• Average course completion rates of 34.6 per cent, more than triple international averages
• 132 known successful transfers to a university
CHALLENGES
• Specific targeting of female refugees and simplified registration requiring less data boosted female enrolment
• Refugee needs are broader than academic university access and include specific skills training such as language training, entrepreneurship, etc.
• Exact data on transfers to universities is difficult to ascertain due to reliance on self-reporting

Profile: Implementing agency

Kiron Campus and its model are implemented by Kiron Open Higher Education, an international NGO founded in 2015 that operates out of Germany. In 2019, Kiron Open Higher Education had offices in Germany, Lebanon and Jordan, as well as partnerships with 58 universities in 8 countries (Kiron, 2019*a*).

The organization started with the mission to provide access to higher education for refugee populations. Currently, Kiron Open Higher Education provides high-quality learning opportunities, including skills booster programmes, to vulnerable populations and underserved communities in the Middle East. In addition to digital offerings, the organization supports students in Lebanon and Jordan through blended learning opportunities and works closely with partners from higher education institutions to advance non-formal credit recognition. In support of this Kiron Open Higher Education has developed quality assurance principles in alignment with international standards.

Kiron's team consists of more than 50 employees. Besides project and partnerships management, operations and finance teams, Kiron's largest team is the Ed-tech department. This team continually optimizes Kiron's platform and includes curriculum developers, researchers, specialists in quality assurance and student support, software engineers and developers.

Kiron Open Higher Education operates from an understanding of the barriers to meaningful participation in higher education faced by refugees. Kiron's mission is to remove these barriers, contributing not only to the welfare of refugees but also addressing skills shortages, contributing positively to the economies of host countries and fostering intercultural understanding between refugee and host communities.

Context

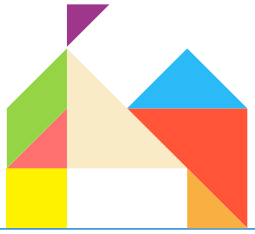
The world is facing an unprecedented number of displaced persons, with 37,000 people per day forced to flee their homes due to conflict or persecution. By the end of 2019, there were a total of 79.5 million displaced individuals, including 29.6 million refugees and 4.2 million asylum-seekers (UNHCR, 2020).

While the largest number of refugees live in developing countries, UNCHR data reports that from 2015–2019 1.86 million refugees arrived in Europe, fleeing conflict, violence, insecurity and lack of opportunity in their home countries. These refugees come from regions as diverse as the Middle East, South Asia, East Africa and West Africa (UNICEF, 2018), and a high proportion of these are protracted or long-term displacements. For example, many refugees from Afghanistan have been displaced for more than three decades (European Commission, 2016).

Migration itself creates mental and physical stress, resulting in challenges in the provision of medical care (Schilling et al., 2017). Migrants also face challenges in gaining entry to the European Union and are at times subjected to mistreatment by police and border guards, gender-based violence in reception centres and long wait times in poor reception conditions in many host countries (FRA, 2018). Once accepted into a host country, limited contact between refugee and host communities, racism, hate speech and politically-motivated attacks are further concerns facing migrants (FRA, 2016).

In contrast, the European Commission's aspirational call is to provide development opportunities to refugees laid out in Lives in Dignity: From Aid-dependence to Self-reliance (2016). The document provides a policy framework for applying a development-oriented approach to refugee resettlement that will gradually end dependence on humanitarian assistance, foster self-reliance and enable displaced persons to 'live in dignity as contributors to their host societies' (p. 2). The framework seeks to 'harness the productive capacities of refugees and IDPs [internally displaced persons] by helping them to access education, housing, land, productive assets, livelihoods and services, and by supporting interaction between them and their host community' (p. 5).

However, UNHCR (2019) asserts that only 3 per cent of refugees globally have access to higher education. According to Kiron (2016), legal and financial obstacles, language barriers and college capacity prevent around 5 million people from living up to their potential, which leads to high integration costs for host countries.



Digital Solution

To respond to the needs of both host communities and refugee populations, the Kiron Open Education model seeks to improve the socio-economic situation of refugee populations through offering free access to learning opportunities in order to improve preparation for university programmes and employability.

Kiron uses digital technology and quality curricula linked to academic and professional quality standards to enable access to quality and inclusive education and training. The programme also aims to validate refugees' prior learning and promote language acquisition, participation in social and civic life in host countries, intercultural exchanges and access to job markets. Language acquisition is central for student empowerment, since 90 per cent of migrants on arrival in Germany have no prior knowledge of the German language (IIE, 2020).

Students enrolling in the programme attend online courses via a learning platform called the Kiron Campus. The Kiron Campus platform leverages more than 500 existing Massive Open Online Courses (MOOCs) and Open Educational Resources (OERs) from various providers that feed into four study tracks (Business and Economics, Engineering, Computer Science and Social Science). Kiron students are able to study outcome-based curricula free of charge, regardless of asylum status, from any geographical location with an internet connection. Enrolment is provided on an ongoing basis, so students can begin studying at any time without administrative delays.

The Kiron model in Jordan and Lebanon is based on the concept of Blended Learning, which incorporates emerging web technologies such as platforms, with instructor-based learning (UN, 2020). In these two countries, to support students Kiron also set up Study Hubs, centres designed to provide students with the best possible learning environment, to facilitate links between Kiron students and other students from local universities and to provide students with additional access to training and educational support. A major added value of Study Hubs is that they provide a physical place for students to meet and support each other, thereby creating an active Kiron community.

The Kiron community has evolved with the goal of connecting students worldwide and fostering a productive learning environment. The current online community encourages Kiron students to present and share their experiences, exchange information on courses and support each other online.

At the time of the award, coursework was supplemented by holistic student support services including counseling services for those who encountered traumatic experiences before or while fleeing their home countries; a mentoring programme that connected students with professionals to assist in preparing for their studies through vocational orientation and internship opportunities; and a Buddy Programme which linked Kiron students to local students in the new country of residence.

The early model linked students to higher education. Once refugee students had satisfactorily completed the Kiron curricula they were eligible to enter regular Bachelor's degree programmes at accredited partner universities as second or third-year students, having already completed one or two years of study through Kiron Campus. This was intended to lower the costs involved in higher education provision and provide time for partner higher education institutions to plan for refugee student intake. While this remains one pathway, Kiron Campus has since expanded to include alternative pathways and short courses (see the section on Further developments for more information).

Implementation

Kiron students are refugees and asylum-seekers with diverse academic backgrounds spanning fields including business, journalism, art, engineering, social sciences, law, medicine and computer science. Kiron has a global footprint: in 2019, more than 6,000 students had access to the Kiron platform of whom 77.7 per cent were male. Their main countries of origin were Syria (49 per cent), Afghanistan (7 per cent), Türkiye (7 per cent), Somalia (4 per cent) and Jordan (4 per cent). Of the 2019 cohort, 48.6 per cent were residing in Europe, 34.7 per cent in the Middle East, 6.5 per cent in Asia, 4.8 per cent in East Africa and 1.3 per cent in North Africa.

A majority of Kiron Campus instruction is in English, and students are required to demonstrate an English language proficiency level sufficient to follow the MOOCs, though Kiron also offers language learning courses. Students must have a document proving they are a refugee, asylum speaker or displaced person, and access to a device and the internet.[1]

The Kiron Campus platform can be accessed via any connected laptop, tablet or smartphone. In 2016 Kiron partnered with NetHope, sponsored by Google, which provided Kiron with 500 Chromebooks placed in the German Study Hubs.

In every study track, students follow a core curriculum organized into different modules. A module is a self-contained study unit on a specific topic with expected learning outcomes. The modules included are decided by the content of an average partner university's first and second-year coursework. MOOC certificates are allocated for successful completion of each module which in combination are designed to be equivalent to the first year of a three-year Bachelor's degree. After a successful application to a partner university, the general credits gained at Kiron can be transformed into ECTS points,[2] which allows students to transfer directly into a higher year of the university programmes.

Most of Kiron's study track coursework components are selected from the existing MOOC offerings of international universities. Kiron further partners with institutions such as RWTH Aachen and Fachhochschule Lübeck in order to produce its own MOOCs which complement the core curriculum. Kiron France[3] has worked towards the development of French language MOOCs to fill potential gaps for francophone universities through a partnership with France's Université Numérique.

Kiron staff communicate with students through the Kiron Campus platform, on social media and through a centralized online helpdesk. Kiron also offers a Mentoring Programme that links volunteer 'study guides' from corporates with students to help them structure their studies, define their goals and document their progress. Mentors assist students to identify necessary study actions and potential opportunities for students such as language courses and scholarship applications. Reflections on goals also form part of each student's learning portfolio.

1 See https://support.kiron.ngo/hc/en-us/articles/360008402939-What-are-the-requirements-to-study-with-Kiron-3

2 ECTS points refer to the workload required to complete a study programme, or a module of a study programme, under the European Credit Transfer Scheme, which enables higher education courses to be more comparable across borders. For more information, see https://www.study.eu/article/what-is-the-ects-european-credit-transfer-and-accumulation-system

3 From 2018, Kiron France decided to continue with a revised model as Universités & Réfugié.e.s.

Enablers and supports

Legislative frameworks

The Convention on the Recognition of Qualifications concerning Higher Education in the European Region (commonly known as the Lisbon Recognition Convention) provides an important framework for the operation of the Kiron Campus model, as it allows for education credits to transfer between participating countries, including most of Europe. This means that similar qualifications achieved in one country or institution can be leveraged in other participating education and labour systems to access further education opportunities or employment. The Convention also prohibits discrimination based on culture, ethnicity, race, gender, colour, disability, language, religion, political opinion, national origin, etc. (Council of Europe, 1997).

Funding

Since Kiron's content is delivered online, the costs per student are low and are covered via a combination of funding, investments and donations. Kiron draws from a wide range of organizations to provide financial and service support, including corporations such as BASF, Volkswagen Foundations, Schöpflin Stiftung and the H&M Foundation.

Kiron also receives support from public institutions. The German Federal Ministry of Education and Research (BMBF) provided financial and institutional support, and Kiron also received financial support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) for project development in Jordan. In 2017, Kiron was also able to leverage funding from UK Aid/Spheir as part of the Padileia project to expand offerings in Jordan and provide services in Lebanon (Kiron, 2019*a*).

Partnerships

University partnerships are key to the success of the model. While Kiron had to revise the model of these partnerships, it still collaborates with academic institutions to create quality-assured, non-formal MOOC-based learning modules. For example, in 2018, Kiron published a Quality Handbook Curriculum,[4] which describes the processes for curriculum development and partnerships with higher education institutions.

In 2016 Kiron also cooperated with Workeer, an online labour market exchange platform which connected more than 10,000 registered users with over 4,500 employers. Workeer enabled Kiron to create internships and jobs for students.

Additionally, Kiron has been able to leverage the recognition of public figures such as Angela Merkel (current Chancellor of Germany), Andrea Nahles (former German Federal Minister of Labour and Social Affairs) and John B. Emerson (former US Ambassador to Germany). In France, Kiron benefitted from administrative support and recognition from the Higher Education State Secretary Thierry Mandon, and the former Minister of Foreign Affairs, Jean-Marc Ayrault.

Since 2016, Kiron has also partnered with the French Ministry of Higher Education, the European University Association (EUA), UNHCR, Singa and SPARK. These organizations share common goals of improving the life chances of refugees, and have been leveraged by Kiron for advice, advocacy and in shared projects.

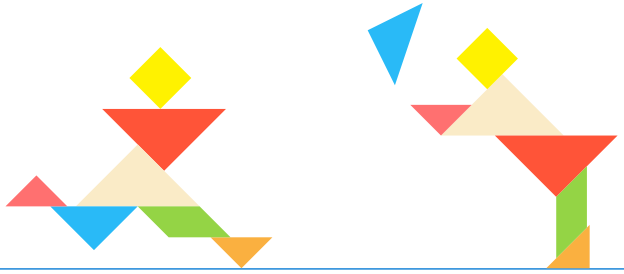
Organizational structure

Kiron has a team of more than 50 employees based in four offices in three countries: Germany, Lebanon and Jordan. Staff roles include project and partnerships management, operations, communications and finance teams, a technology team and a curriculum team. The technology team develops and maintains the Kiron Campus e-learning platform, which was purposefully designed to be data-light and accessible. The curriculum team comprises education and training professionals, and professionals with backgrounds in one or more study track or supported skills area. This team is responsible for selecting available MOOCs and OERs to fit the academic quality standards in various tracks, and for creating new MOOCs.

Prior to adopting a new strategy focused on skills development courses and the provision of mentoring programmes, Kiron staff also included Direct Academics in order to support higher participation and success rates. These were teacher/facilitators who engaged with students regarding their needs and additional coursework in topics such as German for Intermediate Learners, Academic English, Academic Writing and Current Politics. The ratio of Direct Academics to students was around 1:60.

Kiron additionally leverages the expertise of a global network of corporate leaders, professors and entrepreneurs. Academic partners offer credibility and support the recognition of online courses and enrolment of refugees in universities. Corporate leaders participate in an online mentoring programme to advise and support Kiron students.

4 See https://kiron.ngo/community/kirons-quality-handbook-2018



Monitoring and evaluation

A survey of new Kiron Campus students collects information on topics such as their support needs, psychosocial health, employment history, communication channels and digital technology usage. The survey informs changes to the platform interface and programmes to ensure the needs of students are met by both the platform and the holistic ecosystem created to support them. The content of the platform is also reviewed according to student feedback and the relevance of the MOOCs. Courses are continually updated to reflect both user preference and university and professional needs.

Student progress is evaluated through online continuous assessment and periodic examinations recorded on the Kiron Campus platform, including video conference examinations. Students also answer periodic surveys and can submit unsolicited feedback through the platform.

External evaluations have also been set up in partnership with academic institutions. The Behavior and Inequality Research Institute (briq) affiliated with the University of Bonn conducted a randomized control trial to evaluate dimensions of the project such as completed MOOCs, the transition period to regular partner universities, qualifications obtained, labour market integration, asylum status and social aspects such as life satisfaction, stress and mental status.

Additionally, in 2016 the BMBF provided support to Kiron to further engage in data collection regarding the usage of digital technology for social inclusion of refugees, and in 2017 Kiron launched a three-year research project on success and dropout rates in cooperation with the University of Mainz, Munich University and RWTH Aachen University.

Results

While the results of external evaluations are not yet available to the public, Kiron internal monitoring indicates that 84 per cent of students complete their first course and continue to a second course (Kiron, 2016). Course completion rates are at 34.6 per cent, more than triple the reported global averages of 2-10 per cent. As of 2019, 132 known students had successfully transferred to universities (Kiron, 2019*a*).

Students give positive feedback on being able to study flexibly from home and on the interactive features of the platform. Students report that they have improved their ability to study online, their technological skills and their language ability, as well as gained in their general knowledge (Kiron, 2019*b*).

Additionally, in 2017 Kiron organized examinations with the TH Lübeck for some computer science modules. The success of students on these examinations showed that Kiron students were able to study online successfully to gain the skills required by a German higher education institution, and that Kiron can produce curricula through MOOCs which are comparable to German university educational quality standards.

Meet Tooba: Kiron student

Tooba is a refugee from Pakistan currently living in Germany. Her dream is to become a doctor and open a free-of-charge hospital for African refugees in Africa.

'The biggest challenge is that I am a refugee and I wasn't born in Germany. I'm also a Muslim woman with a job. That is also a challenge,' she says. But through Kiron, she is studying social work and reaching towards her goal.

Studying online allows Tooba to manage her time and meeting other Kiron students and staff members keeps her motivated in pursuit of her chosen career path.

'The main support that's needed right now is education support. We need to know what other options are available for us,' Tooba says.

Source: Kiron (2019*b*)

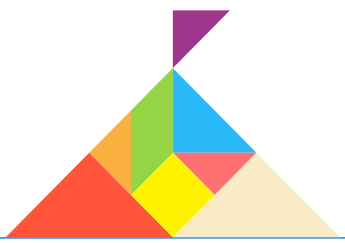
Challenges

Existing data acknowledges that MOOCs success rates are quite low, which is why Kiron developed an online student support community and system to secure much higher success rates, and opportunities to prepare for the job market or university.

Refugees and asylum seekers face constraints around critical infrastructure, including housing and internet access. The scope of Kiron's operation does not allow it a high degree of influence on public policy or the provision of these critical infrastructure supports. However, Kiron does try to reduce the barriers to access its online platform. Kiron Campus evolved into a much more multifaceted service offering and reduced the bandwidth required. Kiron also launched their own low-data Android App, which made learning materials more accessible in low-connectivity environments and has drastically increased student retention rates.

Additionally, the Kiron Campus student population was heavily weighted towards male participation in 2016, with 85 per cent of students in Germany and 80 per cent of students worldwide were male. Noting the gender discrepancy in enrolment and the vulnerability of young female refugees due to both gender-based violence and higher rates of social exclusion, Kiron identified female refugees as an important target beneficiary group. From this point, Kiron conducted research to determine the inhibiting factors preventing women's participation in the institution. Hesitance to provide personal data and the long registration process were discovered to be key inhibitors. Following adaptations such as reduced data requirements and time needed for registration and female-targeted social media campaigns, the female student population increased to 43 per cent.

Finally, while the Kiron model can be utilized effectively for the subjects and tracks currently provided, and likely others, there are some study tracks and subjects such as law and medicine which are not suitable for the online learning platform because of factors such as the specific requirements of individual countries, practical requirements and examination processes.



Further developments

From 2016 to 2020, Kiron has grown from 1,400 to 6,500 students annually, and now has over 11,000 active students.

At the time of winning the prize in 2016, Kiron was in its second year of operation and had yet to demonstrate proof of concept. One of the challenges which emerged was achieving Kiron student transfer to partner universities. In response, the Kiron model added additional preparatory courses and increased language offerings. Kiron also developed an online tool to help guide students through the university application process which provides information on the German, Jordanian and Lebanese higher education landscapes and assists students with personalized information in preparing to transfer to a university. To add further value, Kiron now allows university entrants to retain their Kiron accounts in order to access the additional support provided on the platform and through Kiron's support services.

The organization has also added 'Skill Booster' courses, which are more directly targeted to the labour market in response to identified student needs, particularly the fact that not all Kiron Campus users were interested in transferring to universities. Skill Booster Programmes are short-term certificate programmes that provide skills such as language learning, web design, programming languages, entrepreneurship and teaching online. Skill Booster courses are matched with corporate partners to support students with practical work opportunities and improve their employability in their chosen fields.

The Kiron platform was relaunched in 2019 with adjustments in response to student surveys and needs as well as to increase efficiencies. Many of the support services which were offered by staff or volunteers have been built into the Kiron Campus platform in a more scalable and sustainable fashion. For example, the Kiron Campus now features an overview of different learning and study categories, a success page and a learner page, and each student begins the learning process by choosing their study courses. Students can now access the university application checklist as well as study tracks and mentoring on the platform. Kiron also invested in its help centre, digitizing much of the information previously distributed by staff.

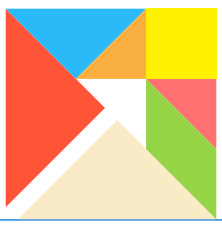
To create an online student community with more peer-to-peer interaction, the platform added local and content-specific message boards and new feedback tools. Student communication has also been improved through the use of notifications which assist to build and reinforce learning habits, inform students of new offerings and provide encouragement.

Kiron has also adjusted its organizational structure from thematic-driven units such as a technology and an education team to cross-functional teams of education and curricula specialists, developers, data analysts and designers which engage in agile project management[5] for the development and delivery of content.

Kiron also wants to help impact-driven institutions go further with online education and has broadened its portfolio as a social business and Software as a Service (SaaS) provider to scale digital education through innovative solutions and collective action. Thanks to the longstanding expertise as a digital learning platform, Kiron will apply these skills to new target groups to help them develop digital competencies for a more resilient future.

Finally, while the focus is currently on refugees, Kiron recognizes that this is only one of many disadvantaged groups, which may be unable to access higher education due to factors such as cost, location and disability. A further evolution of the programme that is currently underway in Jordan and Lebanon provides wide-spread access to more affordable educational opportunities for a wider range of students. Kiron will continue working towards its goals to be a leading provider of refugee education through digital technology and, more broadly, to overcome inequality in access to knowledge and employment worldwide.

5 Agile management is a process originally used by software development teams which incorporates an incremental and iterative approach to projects/products. For a brief overview of agile management, see the Association for Project Management definition and principals at: https://www.apm.org.uk/resources/find-a-resource/agile-project-management



Impact of the Prize

Receiving the award has supported Kiron's continued evolution and development, and its ability to better serve refugees internationally.

Kiron used the prize money from the UNESCO King Hamad Bin Isa Al-Khalifa Prize to develop new content and digital resources. The Prize supported the development of Arabic platform content, capacity building of educators in online teaching with digital content, advocacy initiatives, improvement of the management and administration system, investment in monitoring and evaluation and upgrading software.

Kiron also leveraged the UNESCO King Hamad Bin Isa Al-Khalifa Prize to unlock additional funding from the British Council as part of the Partnership for Digital Learning and Increased Access (PADILEIA), which was formed to increase access to higher education for refugee and underserved host communities in Jordan and Lebanon through new online and blended learning programmes. This allowed the further expansion of Kiron's impact within Jordan and its expansion into Lebanon. Following the Kiron model, students in these two areas can work towards micro-credentials online, and are supported by tailored student services and affordable pathways to local formal academic qualifications.

Kiron further credits the prize with increased visibility and partnerships in 2017, including a visit from Chancellor Angela Merkel of Germany and the establishment of new partnerships with 50 universities in eight countries. In the same year, Kiron appeared in 300 articles in 11 countries and achieved an average of 15,000 unique visitors per month to its website.

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GENIE

2017

Ministry of National Education and Vocational Training, Higher Education and Scientific Research, Morocco

Integration of digital technologies In the Moroccan education system

Theme
The use of ICTs to increase access to quality education

Location
Morocco

Date started
2005

Beneficiaries
10,000+ schools across the country; more than 6 million primary and secondary school learners; 300,000+ educators/teachers and school administrators

Target population
National primary and secondary education, including teachers and learners

Digital solution
An open national platform which provides digital resources and training opportunities for learners and teachers

Summary

Launched in Morocco by His Majesty King Mohamed VI in 2005, the *Programme de Généralisation des Technologies de l´Information et de la Communication pour l´Enseignement* (Generalization of Information and Communication Technologies in Education and Teaching, or GENIE) is implemented by the Ministry of National Education and Vocational Training, Higher Education and Scientific Research.

It aims to integrate digital technologies universally into primary and secondary schooling in order to improve the quality of, and access to, education. The programme covers all aspects of the national curriculum, but is especially focused on STEM subjects in four languages, namely Arabic, Amazigh, French and English.

GENIE is built around four complementary objectives to:

- equip all schools and training centres with multimedia environments, and connect them to the internet;
- provide all schools with digital pedagogical resources in line with national curricula;
- train school directors, inspectors and teachers; and
- improve the utilization of digital technologies by Moroccan educational stakeholders through awareness, information, support, monitoring and evaluation.

GENIE was initiated in pursuit of outcomes such as educational access, equity and lifelong learning for all students and teachers at all levels within the public school system through the use of digital technologies. Through the implementation of these far-reaching reforms, the Moroccan Government seeks to lay a foundation for economic and social progress, and to progressively realize the construction of a knowledge society.

Why selected

GENIE was selected for the Prize because of the following features:

- It involves a large-scale national policy for digital technologies with the potential to promote significant changes in the educational system in Morocco.
- It provides a national online platform[1] with multilingual digital educational resources.
- The programme is transformative, changing the role of teachers and learners in the classroom, and demonstrates sound implementation strategies, including multistakeholder partnerships and a focus on teachers and initial teacher training.

1 See http://www.taalimtice.ma

Programme

PROBLEM

With school enrolment rates rising rapidly, the Government of Morocco faced the challenge of improving and extending educational outcomes in the digital era, and increasing the quality of teaching and learning as well as equity across rural and urban settings.

SOLUTION

The GENIE programme is a systemic educational intervention to equip all learners with 21st century skills through the provision of safe internet access and digital content for all subjects; the training and certification of teachers in using digital technologies for teaching and learning; and open access to a digital platform with learning software and resources for learners, teachers and administrators.

BENEFICIARIES

Primary and secondary school learners in approximately 11,000 schools

RESOURCES REQUIRED

- Government collaboration and political will
- Efficient and well-serviced digital systems with secure and reliable internet connectivity
- Initial and continuing teacher training to enhance pedagogy through the integration of digital technology into the classroom
- Engaging and up-to-date digital curriculum resources for all subjects
- Buy-in and motivation to use the system among teachers and learners

RESULTS

- 2,838 schools and 173 training centres equipped with multimedia classrooms and internet
- 230,000 digital resource kits distributed
- 5,000 educators received a certificate recognizing their professional development in the use of digital technologies for education
- Approximately 7 million students subscribed to the national teaching and learning portal
- 8,973 OERs distributed
- Improved awareness of internet safety and a positive impact on the national digital culture

CHALLENGES

- Difficulties with infrastructure, equipment maintenance and connectivity, especially in remote rural areas
- The need to provide greater access to digital technologies in communities, including individual devices for teachers and access outside of school time for students
- The challenge of increasing teachers' pedagogical motivation to keep up to date with developments

Profile: Implementing agency

Morocco's Ministry of National Education and Vocational Training, Higher Education and Scientific Research (*Ministère de l'Education Nationale de la Formation Professionnelle, de l'Enseignement Supérieur et de la Recherche Scientifique*, MENFP) is the implementing agency of the GENIE programme. In terms of its governance and shared accountability, MENFP is managed collaboratively by different parts of the government. The GENIE steering committee is chaired by the head of government and includes the Ministries of Education, Finance, the Digital Economy and the National Telecommunications Regulatory Agency. The programme is funded through the Telecommunications Department and its universal service fund.

Context

In 2019, the population of Morocco stood at 36.47 million people, with 26.97 per cent aged 15 and under, and 62.99 per cent located in urban areas (UN DESA, 2020). As a lower-middle-income country, Morocco has made remarkable progress in extending equitable access to basic services. Access to electricity was available to 97.4 per cent of the population in 2012 and to 99 per cent of senior secondary schools by 2018 (UIS, 2020, p. 3).

However, the schooling system is affected by social challenges such as poverty, exclusion and isolation. In 2013, 4.8 per cent of the population was living below the national poverty line (World Bank, 2020). Likewise, societal inequality is reflected through gender imbalances in the schools. Though gender parity outcomes within Morocco are improving (UNDP, 2019), female students are traditionally under-represented in a number of career pathways (ILO, 2020; UNESCO-UNEVOC, 2019), and over-represented in informal jobs and the care sector (IBCR, 2007).

Between 1990 and 2010, Morocco showed a strong commitment to ensuring access to schools and increasing literacy rates. Net school enrolment rates in rural areas increased from 36 per cent in 1990 to 95 per cent in 2003, while the literacy rate for youth improved from 58 per cent in 1994 to about 80 in 2009. Much of the latter is attributed to better literacy among females.

Nonetheless, Morocco's education system continues to face challenges. In 2018, 7.4 per cent of students dropped out of public schools without obtaining a certificate (INE/CSEFRS, 2019), and illiteracy remains a national problem. Progressive increases in state spending since 1990 reflect the Moroccan Government's commitment to providing access to quality education for all, and to using digital technologies in schools to open up possibilities for youth in the world of work by developing their skills and competencies, especially in the STEM subjects.

Digital Solution

The GENIE programme's digital solution consists of a comprehensive and enabling architecture to support the distribution, use and integration of digital technologies and resources in the public school system.

First, a diversified range of equipment was supplied to schools, tailored according to the type of establishment. Options include multimedia classrooms, interactive white boards, and tablets. Schools are connected to the internet through 3G, ADSL and Wimas, and in rural areas, satellite connections are utilized.

Second, an open national platform[2] was established for general usage throughout the Moroccan education system. The portal houses digital resources that are categorized through the Drupal open-source content management system (CMS). On the platform, free reusable units or modules are available to teachers and learners for use in the classroom.

The portal also has five principal spaces to support digital innovation, integration within schools, and the other key functional areas of the GENIE programme, particularly skills and knowledge acquisition by students and teachers:

- The first space focuses on the diffusion of national, regional and international news items related to the use of digital technologys for teaching and learning.
- The second space contains more than 1,000 online resources acquired by MENFP and developed by educational actors through various competitions to innovate and showcase the use of digital technologies for subjects within the national curriculum. This space is curated by the National Laboratory for Digital Resources.
- The third space is dedicated to reinforcing learning outside of the classroom through the TelmidTICE[3] project, which includes game-based applications targeted to all grade levels.
- The fourth space holds training modules on the use of digital technologies for education. Two types of training are supported with distance modules and courses accessible through the GENIE MOOC. The courses and applications are open-source and developed using CMS solutions such as Moodle and Canvas.
- The fifth space is for collaboration, communication, and sharing and exchanging ideas on topics related to the use of digital technologies in education and best practices in pedagogy.

2 See www.taalimtice.ma

3 See www.taalimtice/telmidtice.ma

Implementation

The implementation of GENIE has taken place in three phases, shaped by both strategic policy decisions and the evaluation of outcomes. The themes of each phase are shown in **Table 1**.

The first phase, initiated in 2005, was rolled out to six million students and aimed to introduce digital technologys into all public schools with an emphasis on infrastructure, training and pedagogical content (CSEF, 1999). After an external evaluation, GENIE was repositioned in 2008 to inform the second phase, in which a roadmap charted the way to integrate digital technologies into several key areas. These included training, open digital resources, content creation, and the development of infrastructure. Professional training and certification in digital technologies for educational purposes was rolled out to 300,000 teachers, principals and inspectors. In the third phase of implementation, the strategy was updated to promote the country's broader Strategic Reform Vision 2015–2030 (CSEFRS, 2015), which is aligned to the Qingdao Declaration (UNESCO, 2015). In this phase, infrastructure in schools was further augmented through contracts with 'agile' service providers to widen access for establishments without internet coverage, including those in remote areas.

Table 1. Timeline of GENIE phases

PHASE	PHASE 1:	PHASE 2:	PHASE 3:
PERIOD	2005–2008	2009–2013	2014–2030
MAIN FOCUS	Introduce digital technologies into all public schools	The government's urgent plan of action for education reform	National vision 2015–2030 for education, training and scientific research reform
THEMES	• Infrastructure • Training • Pedagogical content	• Teachers' learning and professionalism • Appropriation of digital technologies by learners • Connectivity • Sustainable budgeting	• Quality education for all • Equity and equal opportunity • Promotion of the individual and society • Efficient leadership

Data Sources: Llorent-Bedmar (2014); UNESCO-UNEVOC (2019); WEF (2018)

Teacher training

For in-service training organized close to schools, the GENIE programme uses a cascade model that mobilizes 900 master trainers and 6,000 facilitators. Progressively, this model has evolved to include blended training with both face-to-face and distance provision over five days. Additional support for teachers is offered through standard-setting and sharing workshops which reinforce training and offer extension opportunities, including competitive examinations for career progression and recruitment. Specific modules with certification of digital competencies are also available, such as how to use interactive whiteboards, video clips and other multimedia; the Microsoft Office Specialist certificate for teachers; and the Microsoft Certified Educator online course. Initial teacher training in GENIE also emphasizes the pedagogical applications of digital technologies, and aims to reduce reticence and encourage the innovation and development of digital content that can be shared with other teachers on the portal as part of a broader, connected community of learning.

Since 2009, pedagogical change has been supported through communication, awareness-raising, the sharing of good practice, and monitoring and evaluation. The National Observatory for ICT Usages in Education (*Observatoire National des Usages des TICE*, or ONUTICE) is responsible for developing indicators and tracking progress through data collection, workshops, debates and competitions. Various competitions in which teachers create digital applications also lead to certification and professional recognition.

Digital content

Digital content was developed to give all public schools access to pedagogic virtual resources that support the national curriculum across all phases and disciplines, but especially the STEM subjects. This was achieved through setting up the TICE portal. Teachers are able to use the available resources to resolve teaching and learning challenges, conduct diagnostic tests, and make use of didactic simulations. The National Laboratory for Digital Resources was established within the programme in 2010 as an implementing arm for this approach.

Important interventions to deepen the value of the curriculum include the development of materials in all four national languages, including Amazigh, so any child would be able to access content in their language (IBCR, 2007). A new learning pathway was generated to include computer science as an option for study upon exit from senior high school, in recognition of the central role that graduates play in the production and sustainability of digital technology systems. Given the need to involve girls in this field, strategies for digital inclusion within the programme are gaining traction (Essabban, 2019) and girls are increasingly encouraged to pursue computer science and coding. In addition, new initiatives have been developed for the 5th and 6th years of primary school to introduce younger learners to programming.

Human resources and partnerships

Digital technology units are responsible for the close co-ordination, monitoring, communication and evaluation of GENIE at the regional, provincial, local and school levels. The programme links together a network of 2,660 inspectors, 900 master trainers, 11,000 digital technology trainers and coaches, and 6,000 digital technology facilitators. Each school has one digital technology teacher or coach (MORCHID TICE).

GENIE leverages not only intra-government partnerships but also international credentials and engagements. Face-to-face information-sharing workshops within regional academies are important for the transfer of competencies to schools and to ensure the concrete enactment of the GENIE programme through digital technology units at the provincial level. Further certification of teachers in the use of digital technologies for education is assured by the Korean-Moroccan Centre for Training. Other partnerships with the Telecom provider Orange and Devoxx4kids have resulted in coding workshops for 12,900 learners, and training in robotics, respectively.

Finally, GENIE has been enabled by an active and deliberative policy and implementation environment and a strong political will at the highest levels. For example, following the adoption of a new constitution in 2011, reforms for sustainable development and global competitiveness were operationalized, with 30 per cent of the state budget directed towards social spending (including education) (WEF, 2018). The steering committee is chaired by the head of government and plays an important role in driving the strategic vision as well as monitoring progress.

Monitoring and evaluation

The GENIE programme leverages both internal and external monitoring and evaluation. Internally, information on the processes and results of using and integrating digital technologies in the classroom are regularly collected from teachers, principals, students and other educational stakeholders by ONUTICE through questionnaires and surveys. In this way, feedback on progress and any gaps in the use of digital technologies in pedagogical practice is actively obtained on a continuous basis.

Moreover, an information management system was established as part of the Regional Programme for the Integration of ICTs in Education, with indicators on digital infrastructure; pedagogical applications of digital technologies; governance and co-ordination; training and professional development; and the creation of open, inclusive digital resources. Externally, an evaluation identified a resistance among teachers to taking up new technologies and changing their practice in the scientific subjects (Al Akhawayn University, 2009).

Results

Following a phased approach to equip schools with digital infrastructure, by 2017 a total of 10,928 institutions were connected to the internet and 87 per cent had basic multimedia environments for teaching, learning and training purposes. In 2020, training centres and schools that were not yet equipped with infrastructure and connectivity received through a new finance law an allocation of MAD 121 million (approximately US$13 million) to remedy these gaps.

By 2019, approximately 230,000 kits with DVDs containing digital resources and information were distributed by ONUTICE to teachers, and regular updates and additions were subsequently posted to the TICE portal. Six hundred inspectors were trained to use the digital resources that had been developed and/or acquired to support their monitoring role. Due to the MENFP's training strategy, 100 per cent of teachers had achieved the minimum qualification necessary to teach at their respective levels, and 5,000 educators had received the professional development certificate through the TICE platform.

With respect to OERs and content, by 2019 the digital material available for learners on the open platform was fully compliant with the national curriculum for all subjects. At the time of writing, there are approximately 7 million students subscribed to the national teaching and learning portal.

The 2009 study by Al Akhawayn University found that the provision of equipment and connectivity alone was insufficient for guaranteeing the effective and optimal use of technologies in the classroom because this does not address teachers' motivation and understanding of the value of the technologies for different subject areas. To shift pedagogical practice in the right direction, it is necessary for teachers to see themselves as lifelong learners and classroom facilitators. Communication and collaboration through online forums and email groups emerged as a useful practice to help teachers make this transition. The study also found that learners were generally more open than teachers to the introduction of new technologies, and highly motivated to use them, especially when time for play and exploration was allowed. A consequence of their increased interest and participation was a reduction in school absenteeism and stronger outcomes in the sciences.

Challenges

The two main challenges faced by GENIE have been difficulty in ensuring regular and equitable access to digital technologies, and problems addressing reluctance among teachers to buy into the programme.

Firstly, given that 40 per cent of the approximately 11,000 schools in the country are in rural areas, access to equipment, repairs and connectivity is often limited. In 2018, only 79 per cent of primary schools had internet connectivity, compared to 91 per cent of senior secondary schools. Primary learners sometimes only have access to infrastructure if they go to larger central schools or if equipment is moved to their schools. In addition, the fact that many parents and family members do not have access to new technologies means that learners are not able to build their competencies in the home environment (UIS, 2020). A lack of individual access to devices also constrains teachers from fully developing their digital competencies, and some have been frustrated by technical barriers (El Mouden and El Oafa, 2019; Ismaili, 2020; Omar and Benjelloun, 2013; Zyad, 2016).

Secondly, while GENIE aims to counter resistance among the different actors and encourage their widespread involvement and commitment, some have been reluctant to engage with and adopt the mechanisms of the programme. To mitigate these effects, plans within GENIE, called TICE 2030, have been set out to provide access to connected personal devices for teaching staff, virtual classes for both teachers and learners, and more digital tools for communities. At the same time, the broadcast of learning content through radio and television channels helps to bridge divides, especially in rural settings.

Further developments

At its core, GENIE is aligned to the country's *2015–2030 Education Vision* to create 'a school and pedagogic model that is innovative, equipped, connected and integrated into the knowledge society' (CSEFRS, 2015, p. 38). Within this framework, the programme has evolved in several dimensions since being awarded the Prize.

For example, a digital tutoring initiative was developed as part of the TelmidTICE project[4] to provide online remedial support to help learners them prepare for examinations. It allows for self-paced and flexible learning, self-testing and diagnostics. Areas of difficulty for learners are addressed with appropriate extension activities via face-to-face and/or distance learning. GENIE has also leveraged Africa Code Week[5] to deepen learners' competencies in developing software. In 2019, two million youth engaged in this event. Such initiatives position students as both users and creators of new technologies in real-life contexts.

Additionally, the programme has responded to intensifying risks in the cyber world, for instance through a campaign to raise awareness of cyber-crime, and a range of age-appropriate cyber-security guides for learners, as well as one for teachers and one for parents.

To further support teachers, three regional centres were established in cooperation with Samsung to promote training in computer science, coding and robotics. In 2019, they trained high school teachers to use Arduino[6] and RUR Python[7] software. This is also an example of how GENIE has collaborated on development projects through international partnerships and with the private sector.

Impact of the Prize

The Prize served to confirm for GENIE's partners and equipment providers the quality of the programme and its impact on digital culture. As such, the programme was able to exploit continued support for, and interest in, its objectives both locally and internationally. This recognition has also led to material and technical assistance being given to GENIE by a number of organizations, including Samsung, SAP, Devoxx4kids, the French Institute of Morocco, and several telecom providers.

Likewise, the Prize had a positive impact on teachers within the Moroccan school system,[8] which was evident in 2018, when they responded enthusiastically to an invitation to submit the digital resources that they had created during their classroom practice over the years.

4 See http://soutiensco.men.gov.ma

5 Supported by SAP: https://africacodeweek.org/tag/SAP

6 An open-source electronic platform. See https://www.arduino.cc

7 A python learning environment. For a summary, see http://rur-ple.sourceforge.net/en/help.htm; to download see https://sourceforge.net/projects/rur-ple

8 See https://en.unesco.org/news/how-genie-programme-morocco-doing-receiving-2017-unesco-ict-education-prize

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Connected Learning Initiative

2017

Tata Institute of Social Sciences

A holistic digital ecosystem for quality learning experiences

Theme
The use of ICTs to increase access to quality education

Location
India

Date started
2015

Beneficiaries
76,226 learners and 3,509 teachers

Target population
Disadvantaged secondary school learners and teachers

Digital solution
Leveraging a digital technology platform and mobile communications to benefit learners and teachers in underserved communities

Summary

The Connected Learning Initiative (CLIx) was developed through a collaboration between Tata Trusts Mumbai, the Massachusetts Institute of Technology (MIT), and the Tata Institute of Social Sciences (TISS), with a commitment to serve marginalized communities in India to overcome poverty, deprivation and unemployment through quality learning and teaching.

CLIx leverages local, national and international partners and open resources to create an ecosystem that supports the integration of technologies, classrooms, laboratories and assessment activities. CLIx modules are available in three of India's national languages and cater for high school learners in underserved communities, leading to improved outcomes in mathematics, science, English, digital literacy and other 21st century skills. The initiative leverages government provision mandates on digital technologies and adds value through instructing students and teachers in how to maintain and support these technologies.

The initiative concentrates on platform-based, blended-learning and interactive technologies for secondary school learners and for teachers. The TISSx teacher platform offers courses for professional development. Its OERs are accessed through three modalities: an online platform, a local server-based platform with opportunistic use of the internet, and an offline 'unplatform' that can be installed on devices. These options enable CLIx to reach even the most underserved and under-resourced areas. CLIx further creates communities of practice where teachers can interact with subject and curriculum experts as well as courses which culminate in a blended learning credential. The project has been deployed in urban and rural contexts, and was rapidly and successfully replicated in four states in India.[1]

Why selected

The CLIx project was selected because of the following features:

- Formation of a multistakeholder partnership of universities, foundations and local governments to tackle the challenge of improving the quality of education.
- Focus on innovative teaching and learning processes, with an emphasis on transforming traditional educational practices, even when the infrastructure is not ideal.
- Attention to teachers' engagement and professional development, with blended learning strategies designed to promote content knowledge and better teaching practices.
- Development of quality, open-source digital educational materials.
- Production and use of data to track the results of the project and promote evidence-based decision-making for national and local governments.

1 The information in this section is drawn from https://www.tissx.tiss.edu and https://clixoer.tiss.edu

Programme

PROBLEM

Despite high levels of enrolment in India's large school system, the education is generally of low quality, particularly in rural areas.

SOLUTION

The Connected Learning Initiative (CLIx), a holistic digital-technology-integration programme including infrastructure maintenance support and four tools for engagement:

1. The CLIx platform for students
2. The TISSx online learning platform for teachers
3. The Telegram messaging app, which creates a community of practice for teachers and stakeholders
4. Design Labs for teachers, which support quality materials and practice

BENEFICIARIES

76,226 learners and 3,509 teachers

RESOURCES REQUIRED

- Basic hardware infrastructure
- Teacher and administrator buy-in
- Government and local partnerships
- International open-source learning platform (Open edX)

RESULTS

- 548 schools were served
- Students taught by CLIx-trained teachers performed significantly better than a control group in targeted subjects
- All students, including those from traditionally marginalized groups, significantly increased their technological skills

CHALLENGES

- Maintaining computer equipment and training students to support this
- Some teachers' perceptions of digital learning as passive
- Reluctance of some teachers to engage with learning through technology

Profile: Implementing agency

The Tata Institute of Social Sciences (TISS) in India is a centrally funded public university with over 4,500 students that aims to produce passionate, knowledgeable professionals who enable people to overcome poverty, deprivation and unemployment. As a result of its historical commitment to national development, TISS works closely with state governments and almost all central ministries, and plays a strategic role through those collaborations.

TISS is focused on new and enhanced ways of achieving inclusive, sustainable development through extensive teaching, research, policy support and field action programmes. At any given point in time, the TISS faculty is working on around 500 research initiatives. TISS also has collaborative research and student exchange programmes with over 100 universities and institutions across the world, in addition to being a member of various university networks.[2]

2 Information in this section is drawn from CLIx's (2017) application to the UNESCO-King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education.

CLIx might not quickly affect the standard of the students
but will eventually uplift the conceptual understanding of the students.
Now, the students only reproduce the knowledge taught by the teachers like a parrot.
But using CLIx, the education system will change the perspective of the students.

Mr Lalthawmmawia, Ex-Director, Directorate of School Education

Source: CLIx (2020*b*)

Context

India has a population of about 1.3 billion (UIS, 2022), with a density of 455 people per square kilometre. It is a rapidly developing country with an average GDP growth of 7.4 per cent from 2008 to 2018 (World Bank Group, 2019). The country achieved a remarkable 33 per cent reduction in poverty levels between 1995 and 2015; however, 176 million people remain in poverty (World Bank, 2019), and the benefits of development remain unevenly distributed along a rural-urban divide (Deb, 2018).

India's school system is the second largest in the world, with 260 million students in more than 1.5 million private and free state schools (British Council, 2019; Government of India, 2020). Compulsory education in India lasts 8 years, from ages 6 to 13 (UIS, 2022).

Table 1. India's school enrolment and completion

Indicator	Perfomance
Primary school enrolment ratio	113%
Primary school completion	91%
High school attendance	75% overall 70% for rural/low-income students*
Female-to-male enrolment ratio	50:51 for high school 100:107 for tertiary education

Data Sources: UIS (2022) and *the British Council (2019)

Education Chanllenges

Teacher-to-pupil ratios in India generally reach as high as 1:40 (Kumar, 2019), and the country also faces challenges such as multi-grade classrooms, a lack of basic infrastructure and underqualified teachers. The issue of low-quality education is further perpetuated by high rates of teacher absenteeism and non-teaching activities (Muralidharan et al., 2017).[3]

An authoritative longitudinal study, the Young Lives Initiative, offers insights into factors affecting the grade 5 mathematics outcomes of Indian students. The study found no significant impact from teachers' length of service, gender, or subject knowledge. However, other characteristics such as their attitudes, level of education, residence relative to school, and use of corrective feedback were found to have significant impacts on student outcomes (Singh and Sarkar, 2012). Since most of these characteristics are influenced by teacher training, professional development is recognized as essential for improving performance and learning outcomes.

Finally, India has significant language diversity, with 22 official languages. In response to the complex linguistic situation, the government's policy is for students to study two indigenous languages along with English (British Council, 2019). However, there is a serious dearth of high-quality resources in many of these indigenous languages.

3 Non-teaching activities can include administration, planning, clubs, sports, events and so forth.

Engagement with digital technologies

An important driver of achieving universal digital literacy is India's National Policy on ICT in School Education. In pursuit of the national goals laid out in this policy, the ICT@schools scheme partners with state governments to provide high schools with software, hardware and teacher training related to digital technologies. Each school is provided with personal computers and equipment such as data projectors and printers, and schools are connected to broadband. The scheme also provides secure storage facilities and generators or solar equipment in regions where access to electricity is unreliable (Department of School Education and Literacy, 2017). In reality however, state governments struggle to sustain access and quality, and teachers are ill-prepared to infuse digital technology into learning processes in schools.

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Digital Solution

To address these challenges, CLIx offers a scalable model with global relevance for quality teaching and learning. It makes use of modern technology and the established success of MOOCs in higher education to improve the academic prospects of high school students from underserved communities. CLIx is a holistic model which includes teacher training and support; computer maintenance provided through national policies; and the construction of interactive or game-based modules for high school students in three national languages, Hindi, Telugu and English.

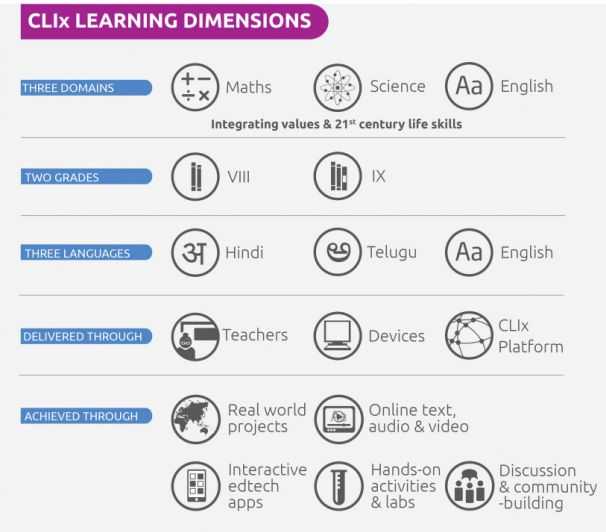
The three core facets of the CLIx ecosystem are:

01 The CLIx platform for students which is integrated with the school curriculum to encourage digital and non-digital learning.

02 The TISSx platform for teachers, which focuses on professional development.

03 The Telegram messaging app, which creates a community of practice among teachers and other stakeholders within the project.

Figure 1. The dimensions of learning in the CLIx programme



The CLIx platform houses core learning modules aligned with the National Curriculum Framework, including 10 STEM modules, five digital literacy modules, and 40 hours of communicative English and life skills, as well as 16 types of open assessments. The modules include a combination of digital and non-digital tools, with four pillars of delivery: classroom activities; lab activities; technology-enabled activities; and review and assessment.[4] The CLIx modules use low-cost and locally available materials and tools, and external learning applications can be added over and above the pre-existing modules.

The platform also features applications that broaden collaboration between learners such as discussion boards and Buddy Login, which allows groups to log into the platform. A maximum computer-to-student ratio of 1:3 ensures high levels of access, peer collaboration and interactive experiences with the technology.

The platform works both online and offline, with the offline version referred to as the 'unplatform'. The online version uses a cloud-based model of anytime, anywhere access, while the offline version is modelled as an 'internet in a box'.[5]

4 See https://www.thehindubusinessline.com/news/variety/how-tiss-tata-trusts-are-making-mits-teaching-programme-clix-with-students-in-rural-india/article23384818.ece

5 See http://clix.tiss.edu/our-clix-software-platform-which-way-to-go

Implementation

The programme operates in three states: Chhattisgarh, Mizoram and Telengana. Participating schools are required to have certain basic digital infrastructure, and so schools which are beneficiaries of the ICT@schools initiative and have established computer labs are targeted.

The CLIx implementation design is guided by a vision of making the programme cost-effective and locally sustainable. It emphasizes partnerships between multiple stakeholders including state departments and local implementation partners. The scope of work in each state is jointly decided by CLIx and government representatives. To ensure school-level adoption, academic institutions such as Colleges of Teacher Education and State Boards of Secondary Education provide feedback on the design of CLIx modules, and CLIx subject groups produce resources and conduct professional development activities for teachers.

As for institutional planning, the CLIx implementation team works with teachers and principals to check that the infrastructure is sufficient and prepare timetables and the arrangement of student groups. Provision is made for regular monitoring and evaluation to ensure adoption.

Module development

The design of the materials is undertaken using an iterative approach that guarantees their relevance and quality. Key pedagogic principles deployed to enhance quality include collaboration, relevant authentic content, and learning from mistakes within safe spaces. The modules accentuate the process more than the outcomes and thereby introduce students to lifelong learning practices. To this end, modules are designed to enable agency and autonomy in students, who start at a basic level and progress at their own pace to more advanced levels, even as collaboration and interaction between peers are systematically integrated into the learning process.

Internal reviews of ideas at weekly meetings involving the whole team allow the sharing of critical feedback among people in the different subject domains and fields on aspects of content, implementation, relevance and sustainability. Curriculum design workshops are convened with subject experts and teachers to present and review each module idea in detail, with feedback incorporated into the material. After the first round of material development, prototypes are prepared and piloted with students in laboratory and field settings.

CLIx modules have helped my students to overcome the fear of computers. These students who have never been exposed to computer education before are actually handling both technical issues and also academic content on their own.

This kind of self-learning is important to both teachers and students, as [the] CLIx team has trained us teachers with content and students with technical skills. I felt that teachers and students should learn from each other, which is possible because of CLIx in my classroom. We would like to thank CLIx for giving us this opportunity.

Anil Kumar, School Assistant, English (State Resource Group), Zilla Parishad High School, Kukatpally

Source: CLIx (2018)

Formative assessments are built into the modules using digital technology. A number of different types have been developed for this purpose through open educational assessment tools. Apart from the traditional multiple-choice questions, descriptive answers and gap-fill varieties, these include innovative types of assessment activities such as sandboxes,[6] image sequencing, file uploads, audio recordings and drag-and-drop tasks. Following the pedagogy of assessment for learning, these activities provide individualized scaffolding using audio, visual and textual feedback loops to foster positive attitudes toward learning from mistakes.

The modules are inclusive in terms of gender and socio-economic background and incorporate thoughtful considerations in an attempt to promote equality and break stereotypical perceptions, for example, showing girls at their best in mathematics and technology. Collaborative learning environments also ensure that girls and boys support each other in learning content together.

Teachers' professional development

The professional development of teachers, a core element of CLIx, uses technology to change classroom practice through the Postgraduate Certificate in Reflective Teaching in ICT (PGC RTICT) offered by TISS. This certificate offers blended, practice-based courses that run partly on the TISSx platform using Open edX,[7] which provides opportunities for interactivity, discussions, peer feedback and assessment. These courses are complemented by in-person workshops that allow teachers to gain extensive experience in facilitating the CLIx student modules.

Initial 3-day workshops for teachers are held with two facilitators for groups of 50 teachers, followed by ongoing support through mobile phone platforms. This includes tech support from field-based personnel and subject support from the domain leads which serves to ensure that queries are efficiently dealt with and secures continued interest among the teachers. CLIx has also developed course books for teachers to help them deeply engage with the modules and plan blended teaching effectively.

Finally, CLIx forms communities of practice in which expert faculty interact with teachers in discussions about domain-specific pedagogy and technology. Such engagements happen through instant-messaging apps like Telegram and WhatsApp. State and subject groups on pedagogy, content, practice, and innovation are also formed for in-depth conversations among teachers and TISS field mentors.

6 Sandboxes are learning environments in which students interact directly with content independently of facilitation by the teacher or third-party intermediaries. When sandboxes are digital, a range of data is produced incidentally which can be captured (e.g., where learners click, which activities they pursue, time to completion, strategies used, etc).

7 Open edX is an online learning platform founded by Harvard and MIT in 2012. It provides course hosting and a learning management system and is both non-profit and open source. For more information, visit: https://open.edx.org

Design Labs

CLIx has evolved a powerful and accessible analytic process that is used to conceptualize and produce workable tools and products for supporting and improving active learning. This structured process is facilitated by CLIx staff in 'Design Labs'. In these design thinking workshops, participants locate and identify a pedagogical problem within a context, design creative solutions that integrate technology to address the problem and create a prototype of the tool or product for testing. Thereafter an iteration process of refining the tool or product is undertaken. Through these engagements, teachers and education curriculum teams build their capacity to design and develop new OERs.

Design Thinking methodology helps teachers to find ways of exploring, creating and curating digital tools and resources for teaching and to identify and analyse opportunities and limitations for active learning inherent in a particular resource.

Source: CLIx (2020*a*)

Organizational structure and partnerships

A project of this magnitude requires a sound structure and the management of CLIx therefore comprises three functional teams: the core team deals with leadership, project management, technology, communications, research, curriculum production, and implementation. The curriculum team addresses core subjects: English, mathematics, science, and values and life skills, as well as the 'i2C' (invitation to CLIx) digital literacy component and teachers' professional development. The implementation team is active in rolling out the programme in Chhattisgarh, Mizoram and Telangana.

CLIx works to build capacity at various levels, such as through developing technology resource groups and teacher educator groups. The former are comprised of selected teachers and management information system coordinators from every district, and provide technical support to ensure that the labs remain functional. The latter consist of teachers and faculty members from state academic institutions who are responsible for fostering district-level teachers' professional development, managing communities of practice, and organizing mentoring.

The initiative is also characterized by strong partnerships that are facilitated through project structures. First, the partnership between TISS and MIT covers curriculum planning, design principles, production planning and logistics, communication and documentation, and overall coordination.

Curriculum development partnerships, especially with respect to the integration of digital technologies, include the following organizations:

- The Ekalavya Foundation, which played a role in developing subject-specific material for science;
- The Tata Institute of Fundamental Research's National Centre, and the Homi Bhabha Centre for Science Education, which both supported the CLIx technology team through the design, development, integration and deployment of the platform, while the latter also was instrumental in creating the 'i2C' digital literacy component of the CLIx course;
- Tata ClassEdge, which provided the online learning platform that CLIx teachers use, called 'Multiple Learning Experiences'. It broadly promotes critical thinking, creativity, teamwork, research-orientation and communication skills.

Research and higher education institutions that play a fundamentally important role as implementation partners at the state level and include the Center for Education Research and Practice in Chhattisgarh State, the University of Mizoram in Mizoram State, and the Telangana State Council of Educational Research and Training in Telangana State.

Finally, a performance assessment and scalability scoping exercise was undertaken by IBM under their corporate-social-responsibility initiative Corporate Service Corps. This exercise examined CLIx and gave insights into approaches for expanding its outreach such as seeking enhanced support from the government, modifying the criteria for school selections, deploying field personnel in a more targeted way for various activities, and improving applications of technology when planning scalability.

In terms of enabling the programme to be successful, buy-in and support from headteachers has also been essential. They have done the following:

- Overseen the activation of their school's computer lab and used school funds for repairs when needed;
- Allowed teachers time off to attend workshops;
- Facilitated the use of the lab and CLIx resources through adjusting the school timetable;
- Dealt with the batching of learners and related logistics for the use of the lab; and
- Negotiated with service providers regarding the regular maintenance of the labs.

Funding

Tata Trusts is the primary funder of CLIx and also took the initiative to build and implement the project at scale. State governments bolster the programme through infrastructure procurement and supporting teachers' attendance at workshops, the printing of resources and workbooks, and headteachers' orientation meetings.

Certain core elements of the intervention have been integrated into existing government schemes and activities to ensure financial sustainability. Lab maintenance is sustainable through budget allocations from states for new digital infrastructure, repairs and upgrades. Professional development for teaching staff is continuously funded by state grants, and its sustainability has been further boosted by a fee-based model that meets roughly 60 per cent of the maintenance costs.

Monitoring and evaluation

Design-based research and ongoing monitoring and evaluation are fundamental components of the programme. CLIx uses four main methodologies to inform stakeholders on how particular participant groups and functions are performing in the various phases of implementation, and has developed a set of forms to gather data about progress in different project contexts. These approaches, which enable CLIx to tap into the experiences of key players such as teachers and monitor project developments downstream, are as follows:

- Innovation-diffusion process documentation, which involves documenting and analysing the unfolding intervention in the field and the evolution of the concerns, roles and expectations of external and internal stakeholders across macro, meso and micro levels of the programme;
- The concern-based adoption model, which is a framework used to identify and address concerns as experienced by the teachers as they engage in the programme;
- Baseline, midline and endline studies, which provide information about changes in the knowledge, attitudes and practices of students, teachers and school managers. Prior to the intervention, a detailed baseline study was conducted on a sample of intervention and control schools to establish the initial conditions and develop an understanding of the digital technologies and networks available, as well as the access and usage characteristics of the student and teacher groups; and finally
- The learning outcome study, which evaluates achievements in science, mathematics and communicative English to determine the impact that the CLIx modules have on learning and achievement. Research-based studies are conducted by an independent team within the larger CLIx organization.

Data for evidence-based decision-making

The CLIx platform also hosts a dashboard that offers opportunities to explore state-level data and visuals of granular data points., This data is updated monthly, while school-level data is updated daily and its dashboard is password-protected. The dashboard facility on CLIx has the potential to encourage decision-makers at all levels to consult and analyse data and incorporate it into their policies.

Results

The CLIx programme has achieved substantial scale, currently offering over 15 modules in mathematics, science, English and digital literacy in three languages to 548 schools equipped with labs. The programme involves 3,509 teachers and serves 76,226 students in grades 8 and 9.

The baseline study was conducted in the 2016/17 academic year with a sample set of 165 CLIx and 55 control schools across 4 states. The endline study was conducted in 2018/19 (CLIx, 2019), and showed that:

- Groups taught by teachers who received higher levels of CLIx professional development performed significantly better in English, science and mathematics than the external control group.
- All students including those from scheduled castes, tribes and classes[8] made gains in basic and intermediate technical skills and application-based technological skills.
- Students from marginalized communities in CLIx schools performed better than their counterparts in non-CLIx schools in all three states.
- Teachers demonstrated engagement and participation in online subject groups, and improved their digital skills and beliefs about technology in education.
- Students displayed enhanced skills in collaboration and autonomy and improved their conceptual understanding in the CLIx subject areas.

8 Scheduled castes, tribes and other classes are Hindu sub-communities who have previously experienced oppression and social isolation due to negative perceptions of their status as per the varna system of Hinduism (Gopinath, 2018).

A journey of transformation from a government school into a digitally enabled CLIx school

Our case-study school is located in Paidipally, a small hamlet in Parkal Mandal in the Warangal District of Telangana State. The school has enthusiastic teachers, but constant technical glitches hampered the rollout of the CLIx modules. The school's computer laboratory was mainly engaged for administrative purposes, and teachers were reluctant to use it for its main purpose, as a learning centre.

In 2018/19, Paidipally School was chosen to participate in the programme because of the motivation of one of its mathematics teachers, Mr Venkateshwarulu, and his students, who were keen to learn computer skills. The CLIx Field Resource Coordinator clarified teachers' misconceptions about the project's teaching-learning processes and provided continuous technical support to teachers as well as guidance on various aspects of its aims and methodology. This improved teachers' motivation levels, and students' curiosity about the programme.

Although the implementation was frustrated by technical difficulties, Mr Venkateshwarulu was able to resolve many of them with online help through video calls and troubleshooting techniques. He worked together with the Field Resource Coordinator to train students in handling minor technical issues in the computer lab, to ensure sustainability and reduce students' reliance on the teacher. The students supported these troubleshooting processes which meant that the teachers could concentrate on facilitating the subject learning and modules. The CLIx team's consistent collaboration enabled the school's use of digital technologies as well as its blending of virtual education with classroom teaching.

Several sustainable activities have taken root relating to the collaborative learning of teachers. Following their mathematics colleagues, other subject teachers in the school learned to implement the CLIx approach in their classrooms, leading to more student exposure to using digital technologies for active learning in different subjects. Mr Venkateshwarulu noted, 'Over time a sense of confidence was developed among the students [through] using computers for their subject learning'.

Source: CLIx (2020*b*)

Challenges

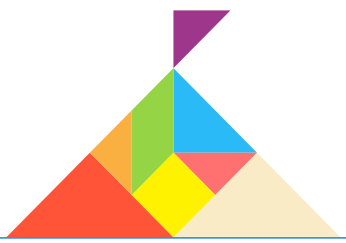
The main two challenges were insufficient infrastructure and lab readiness, and perceptions among teachers that digital technologies are associated with passive learning. The CLIx modules are accessed by students in the school labs established through the government's ICT@schools scheme. Improving and sustaining the quality and usage of these labs is a major challenge. Difficulties include limited numbers of computers; a lack of upgrading and peripherals; and insufficient random-access memory (RAM). Some labs are controlled by service providers or vendors whose resources are not integrated into the core curriculum, which leads to low teacher usage levels. Building the capacity of schools to maintain labs and manage and schedule user access requires diligent follow-up and support For connected learning experiences, it is critical to ensure that schools have internet connectivity, OERs, and easy ways to update content and retrieve data.

Secondly, in contrast to the use of digital technologies to design interactive learning, there is a widespread tendency to view them simply as mechanisms for presenting videos of lessons that students watch passively. Their association with the digitalizing of textbooks, which is now commonplace, reinforces a passive model of learning in which knowledge is merely transferred.

This mindset has to be counteracted through investing in professional development that inspires teachers to actuate learners' participation and collaboration through digital technologies. However, in the Indian context, professional development is only weakly linked to career advancement pathways, and thus teachers lack incentives and motivation to participate in it. The intervention has therefore encountered obstacles when relying on the personal motivation of teachers to engage rigorously with the model offered by CLIx.

Overall, the key lessons that have emerged from the experience of implementing CLIx are as follows:

- It is desirable to have at least 20 computers with headphones in a lab.
- Approximately 15 to 20 per cent of the curriculum can be delivered using computers in the present lab conditions.
- Technical glitches on the platform hamper implementation at the school level, making it imperative to carry out sufficient testing and eliminate bugs.
- The training of teachers who cannot access functional computer labs is unproductive.
- About 70 to 80 per cent of teachers require continuous support to feel confident about using computers for teaching and learning.
- According to a survey of teachers, most see blended courses as useful, but find it difficult to engage with online courses, primarily due to time constraints.
- Completion of an online certificate course should be recognized as part of teachers' professional development requirements.



Further developments

The holistic CLIx model continues to be embedded in Telangana, Mizoram and Chhattisgarh with support from district project teams. For example, in Mizoram 70 new schools across four districts have been added to the programme along with 170 teachers, 70 headteachers, and 8 technicians to maintain the labs.

Online educational courses are provided to teachers, teacher educators and students using the TISSx MOOC platform. Participants can receive certificates from CLIx through the web version or mobile app.

To share the innovations of CLIx more widely, its materials, modules and tools are being prepared for release into the public domain as OERs. The intention is not just to share the resources as packages but also to make the design and development processes underlying them available so that the wider educational community has opportunities to shape the materials and tools for their own specific needs.[9]

9 Except where otherwise noted, information for this case study is drawn from CLIx (2017) and a follow-up survey administered by UNESCO in 2019 (CLIx 2020*a*, 2020*b*).

Impact of the Prize

Being a recipient of the UNESCO King Hamad Bin Isa Al-Khalifa Prize has helped CLIx to access additional funding from the Indian Government's Scheme for the Promotion of Academic and Research Collaboration. It has also led to increased support and interest from public bodies, and the funds from the Prize have helped CLIx to intensify advocacy and awareness-raising through 11 national and 20 regional print publications across the 4 CLIx partner states and 9 online portals. Since winning the Prize, the programme has attracted further international interest and was selected as a leading 'Open Collaboration' initiative in 2019 by the Open Education Consortium in the United States.

Moreover, the Prize has generated greater recognition within the EdTech industry which will strengthen collaboration with enterprises in the sector.

In addition, it has enabled CLIx to gear the platform more towards supporting teachers. Impetus for this comes through the CLIx Annual Design Thinking Workshop. Finally, the Prize allowed the project team to develop handbooks and implement an innovation-diffusion study in order to gather information on how to share this innovative practice widely, as this is the spirit underlying the resource design and development in CLIx.

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ThingLink

Visual Learning Technology

2018

ThingLink

An immersive learning tool for accessible quality education

Theme
The use of innovative ICTto ensure education for the most vulnerable groups

Location
Founded in Finland; operates worldwide.

Date started
2011

Beneficiaries
7 million registered content creators; 30 million monthly learners active students

Target population
School and tertiary level students and teachers

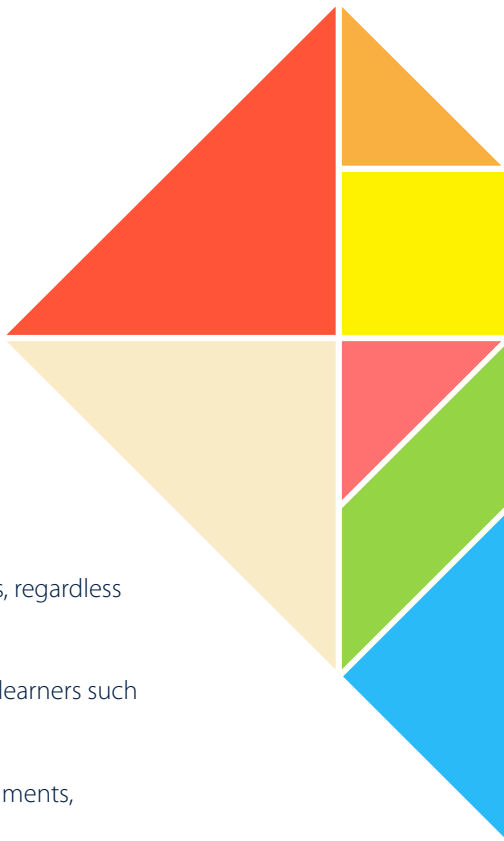
Digital solution
A multi-media publishing solution and content-creation platform for school and workplace learning

Summary

ThingLink, a Finish technology company, was awarded the 2018 UNESCO King Hamad Bin Isa Al-Khalifa Prize for its cloud-based software solution which lets users easily enrich images, videos and 360 degree media with additional information, notes, sounds, narration, video or links.

This innovative software has multiple learning applications including improving digital literacy and the quality of school and post-school curricula and learning. Through this online tool, learners can virtually access environments beyond their physical reach to develop cultural awareness and engage in experiential learning. ThingLink further empowers learners to create and document their own learning and allows educators to customize lessons to support students with different learning skills. The tool allows teachers to create virtual tutorials for their lessons and share them in ThingLink's global image database. Through this database and an engaged community of teachers, ThingLink's web service offers a resource base to support and expand access to quality learning.

More information at: https://www.thinglink.com



Why selected

ThingLink was selected as a Prize-winning project due to its:

- intuitive software, which is flexible and able to support users' learning experiences, regardless of educational level,
- support of learners' virtual mobility and offering a creative space for marginalized learners such as those with disabilities or limited ability for expression,
- accessibility to educators across formal, informal and community learning environments,
- capacity to support interaction between teachers and students who can become producers of openly accessible resources for the ThingLink database (UNESCO, 2018).

Programme

PROBLEM

• Students of all ages have limited access to experiential learning opportunities outside of their immediate context, creating challenges in teaching for deep and cross-cultural understanding

• Access to learning opportunities remains a challenge for some students, such as those with disabilities or those who speak minority languages

SOLUTION

ThingLink's quality interactive visual media software empowers teachers and students with tools to easily build multi-sensory learning experiences in the cloud

FEATURES

• Innovative, user-friendly software which allows users to create and share immersive multimedia learning experience

• Digital materials, such as interactive images, videos, drawings and audio files available in open access

• Teachers and communities of teachers trained to use the tool and share their lessons

• Partnerships with educational and TVET institutions, private sector and governments

BENEFICIARIES

Over 7 million content creators and 30 million learners in 190 countries

RESOURCES REQUIRED

• mobile devices

• internet connection

RESULTS

• Students learn new skills using multiple forms of media

• increased virtual collaboration among students and teachers

CHALLENGES

• Lack of technology resources and connectivity

• Shortage of trained teachers

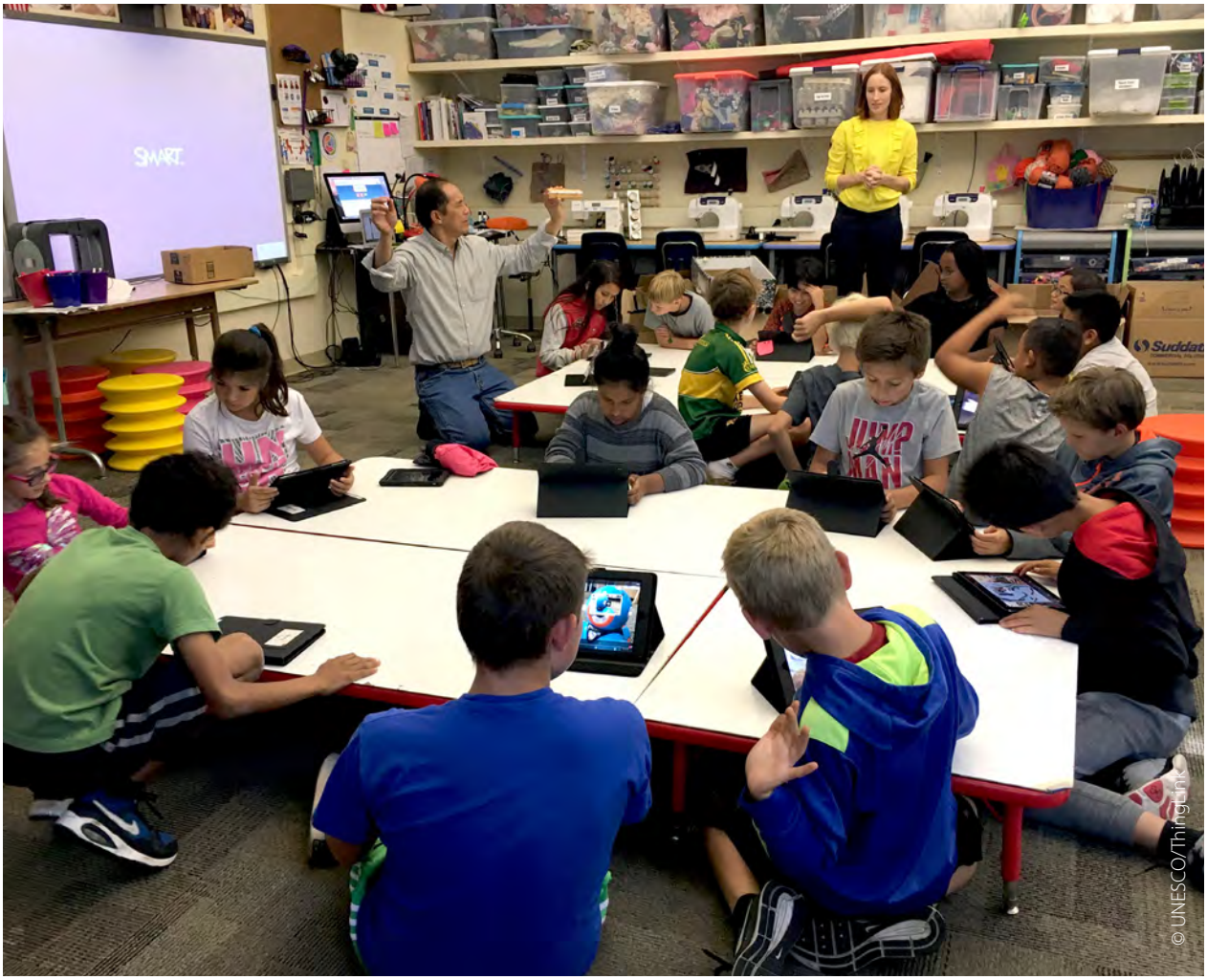
• Localization

• Language(s) of educational content

Profile: Implementing agency

ThingLink was established in Helsinki, Finland in 2010, born from a desire of the founder and CEO, Ulla-Maaria Koivula, to develop a tool whereby she could integrate information and links directly in images. As a Ph.D. student at the University of Helsinki in Finland in 2005, her passion for art and culture and her interest in technology gave her the idea 'about connecting culturally or personally meaningful physical artefacts with digital information about them' (UNESO, 2019). Five years later Ulla-Maaria Koivula, together with her friend Janne Jalkanen, gathered a team of engineers to make this idea come to life, resulting in the ThingLink tool. ThingLink's primary focus is education and workforce development, and the company offers tiered services to education and private sector consumers.

The company has maintained its innovative status by being the first company to launch a regular interactive image editor for education (2011) as well as the first company to launch a 360° image editor for education (2016).



Context

ThingLink focuses its efforts on educational solutions for schooling and workforce development, and offers software solutions to unlock creativity and allow experiential learning remotely. This section addresses only a few of the contexts with potential applications of such software.

Increased access to schooling

There is a global need for improved access to a physical school and to learning materials. As of 2018, approximately 250 million children and youth were out of school (UIS, 2019). Significant contributors to this phenomenon include poverty, region, disability, gender, conflict, and children from ethnic minorities (UNICEF, 2020). A particular challenge is education for children who speak minority languages – UNESCO's Global Education Monitoring Report (2016*a*) indicated that up to 40 per cent of the world's population is educated in a language they do not understand. Multilingual groups remain a challenge to the provision of quality education.

Additionally, exclusion from schooling or education opportunities as a consequence of disabilities or illiteracy are prevalent in many national contexts. While the Education 2030 Agenda and the Convention on the Rights of the Child both emphasize the importance of the inclusion of groups with disabilities, children with learning or other disabilities often face exclusion due to discrimination and a lack of facilities to accommodate them (UNESCO, 2016*b*).

Intercultural education

Article 26 of The Universal Declaration of Human Rights (UN General Assembly, 1948) dedicates the practice of education to 'the full development of human personality' and notes the importance of education which 'promote[s] understanding, tolerance and friendship among all nations, racial and religious groups', which brings the issue of intercultural exchange and learning to the forefront of educational purposes. According to the UNESCO Guidelines on Intercultural Education, intercultural education should be embedded within all aspects of a learning environment, including 'inclusive curricula that contain learning about the languages, histories and cultures of non-dominant groups in society' (UNESCO, 2006, p. 19).

Workforce development

The continuous change in workforce skills demands (see Frontier Economics, 2018; Manyika et al., 2017; Pew Research Center, 2016) has led to the reimagining of the traditional 'corporate ladder' career progression into a 'corporate lattice' in which movement is undertaken vertically, but also laterally (Benko and Anderson, 2010). Lateral career movement would often require the acquisition of new skills, and a reality of the current labour economy is that workers in many fields must undertake periodic or continuous skills development or face irrelevance in their sectors. Just one example of large-scale workforce development is the talent overhaul undertaken by the US company AT&T, which, beginning in 2016, has invested in large-scale restructuring and workforce training to adapt to the changing demands of the telecommunications sector (Donovan and Benko, 2016). In this context, the achievement of Sustainable Development Goal 4, inclusive and equitable quality education and the promotion lifelong learning opportunities for all rests partially upon access to affordable quality Technical and Vocational Education and Training (TVET) that offers development linked to the skills needed for employment, decent work and lifelong learning (UNESCO, 2016*b*).

Digital education initiatives have enabled access to learning opportunities that can expand the choice, quality and experiences of curricula and generate flexible access for rural, isolated or otherwise marginalized learners.

Digital Solution

> ThingLink is not just a tool. It is a supportive community designed to provide teachers with rich, interactive experiences that engage learners and immerses them into worlds they may not possibly be able to experience otherwise.
>
> **Laura Moore, classroom teacher**
>
> *Source:* ThingLink (2018*b*)

ThingLink has developed a user-friendly digital tool which enables users to enrich online visual media such as images, videos and 360° virtual reality content with additional information in the form of text, sound or voice notes, images and videos. Using this technology, teachers, trainers and students can create multisensory learning experiences that both contain and collect data. Because ThingLink is a cloud-based image-tagging tool, these resources can then be distributed across the internet.

With ThingLink, students can learn in a real-world context without being physically present. As a result, ThingLink's interactive image technology can include and engage displaced, vulnerable and even illiterate students in education and learning communities. Over 5.5 million educators, students and professionals in 190 countries use ThingLink to document projects, products, lessons, cultures and communities, creating advanced opportunities for cross-cultural information-sharing.

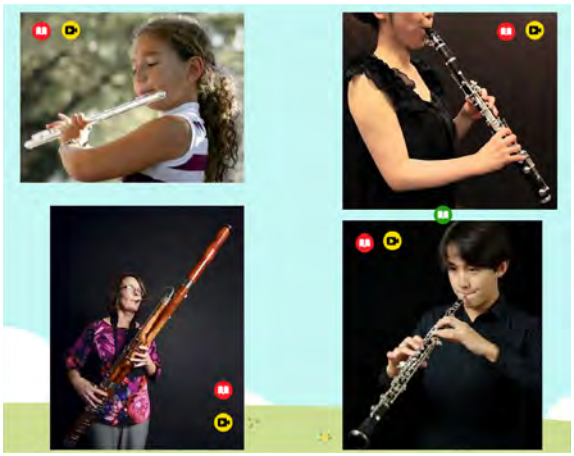
Learning materials created with ThingLink can be integrated with most Learning Management Systems and shared on platforms such as Microsoft Teams. This opens opportunities for both wide viewership and advanced monitoring of learning achievement.

Examples of ThingLink products

The ThingLink tool has extensive applicability across a wide range of institutional environments, including educational institutions at all levels, media, businesses and governments. ThingLink has been used for classroom learning at schools and universities, e-learning corporate training, editorial and marketing functions, paid online courses and online publishing (ThingLink, 2018*a*). This section shares a few examples of the ways in which users have engaged ThingLink.

The 'woodwind collage' in **Figure 1** shows the viewer a selection of woodwind musical instruments being played.The viewer can click the icons in the image to

Figure 1. Woodwind collage, a ThingLink project



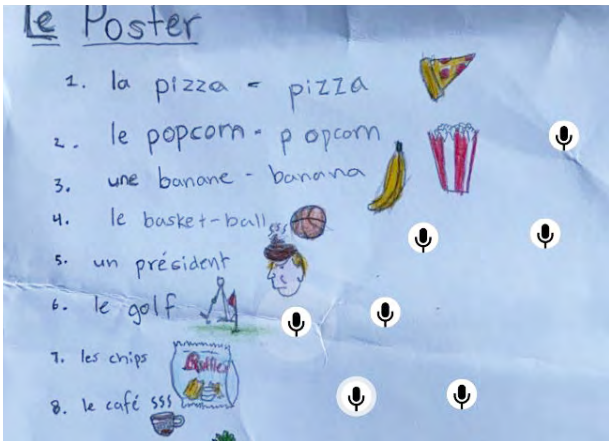
© UNESCO/ThingLink

> ThingLink provides us an easy and cost-efficient way to produce media-rich learning materials. As the usage grows, we are going to see various kinds of new use cases from different disciplines. It is great that we can now also offer the tool for students.
>
> Sari Koski-Kotiranta, Head of Educational Services, University of Helsinki[1]

launch additional information: The red 'book' icon links to textual information and the yellow 'camera' icon links to a video performance. Viewers are thus given visual, textual and auditory information on one page.

In **Figure 2**, a primary school student has combined a digital image of her hand-drawn poster of foreign language words and microphone links to the correct pronunciation of each word. In this process, she has reflected her interdisciplinary learning using ThingLink, demonstrating her own physical drawing skills, digital skills and knowledge of the foreign language.

Figure 2. Foreign language practice, a ThingLink project



© UNESCO/ThingLink

Activities such as these are suitable for school or home and can also be developed in collaborative groups working from different locations. For example, 5th grade students of Romea Canini took turns and used their own voices to tell the legend of the Republic of San Marino, the oldest and the smallest independent state in the world.[2]

Teachers also use ThingLink to create narrated introductions to subjects across grade levels. In just one example, Professor Annamaria Bove from the Instituto Comprensivo Nocera Inferiore turned the UN infographic on the Sustainable Development Goals into an interactive resource, explaining each goal in detail and linking to more information (see **Figure 3**).

Figure 3. Sustainable Development Goals interactive infographic, a ThingLink teaching resource

© UNESCO/ThingLink

ThingLink has also been used to introduce working environments3 and safety drills,[4] and created a virtual tour of the Finnish education system in collaboration with the Finnish National Agency of Education.[5]

1 See https://blog.thinglink.com/marketing/thinglink-and-university-of-helsinki-announce-partnership

2 The result can be viewed at: https://www.thinglink.com/mediacard/1193230132706279426?fbclid=IwAR16qec3ysWEHUbtLoHpP9hcog0fv

3 An example is available at: https://www.thinglink.com/mediacard/1172877973385117697

4 An example is available at: https://www.thinglink.com/mediacard/1184044991484264449

5 The tour can be viewed at: https://www.ccefinland.org/finland-education-tour

Implementation

Teachers can publish an unlimited number of images, videos and 360° images using limited features through a free account. A premium classroom plan allows a single teacher to manage over 60 student accounts, create products, assign lessons and review students' work. Accounts are also available for schools and districts and provide additional options for offline access, unlimited views, onboarding and professional development of teachers and integration into learning management systems.[6]

Teachers have the option to make their images and example lessons accessible and searchable for all the other users on ThingLink. Through the contributions of teachers around the world, ThingLink's global image database contains millions of interactive images and lessons. Users can copy shared database images to their own accounts and add information, notes, music or other media to that image. In this way, ThingLink's community of teachers take forward and enrich the resources available, and virtual lessons or key learning elements of a lesson drawn can scale to millions of students through tablets, laptops or smart phones with an internet connection.

ThingLink provides resources and free professional development options for teachers through the 'Creating Visual Learning Materials' introductory course, available on the Microsoft Education Centre. The course focuses on helping educators overcome the practical challenges related to blended learning environments, the need to rethink current approaches to learning methods including use of learning materials and enhancing the online connection between teachers and students. About 1,000 teachers per month take this course, and teachers who complete the requirements are awarded a certification and badge on the Microsoft Education Centre.[7]

How ThingLink can support cultural exchange

Preserving and digitalizing items of cultural heritage has so far relied on locally built databases and servers, which make them extremely vulnerable to the impact of a physical disaster. Image annotation provides cultural organizations a possible way to digitalize images with rich metadata that is searchable, not only locally, but via the cloud. This makes archives safer and allows benefits such as research collaboration.

Imagine: A small local museum in Africa labels images with titles and descriptive text, and a local archaeologist records brief audio clips with observations of each item. Through the ThingLink cloudbased image and video database system, the museum can now make parts of its archives available to remote colleagues, researchers in other countries – or even the public.

6 See https://www.thinglink.com/edu-options

7 The course can be found at: https://education.microsoft.com/en-us/course/052154c4/overview

Enablers and supports

ThingLink is enabled by partnerships and advocacy, particularly the buy-in of educators, education leaders and administrators across the education and training sector, inclusive of lifelong learning and workforce development. The motivation of school, university and district leaders provides an important point of entry for ThingLink to impact education. Consultants who assess and train employees in transitions, changing working conditions, skills requirements and protocols are also important collaborators in the use of ThingLink.

Part of ThingLink's strategy has been to increase capacity in order to engage with city, municipal and state governments, and the company has embarked on partnerships with leading platform providers to enable delivery and relevant features for this scale of engagement.[8]

To improve advocacy, ThingLink employs social media and blogs to strengthen the community of educators as users on Facebook and Twitter and utilizes the ThingLink Blog and a YouTube channel to propagate ideas for integrating ThingLink into schools, colleges, universities and workplaces.

In addition, ThingLink has provided demonstrations at conferences, including the UNESCO-UNEVOC Innovation in Technical and Vocational Education conference held in Bonn, Germany in 2019, which introduced ThingLink to officials and influencers in over 100 countries.

8 See 'Further development' for more details.

'The COVID-19 epidemic significantly increased the need for remote learning solutions including video production tools and other interactive solutions that support connecting remotely.'

Mikko Halonen, Educational Technology Coordinator at the University of Helsinki

'ThingLink has allowed my students to become the experts by sharing their knowledge with their peers and other classrooms around the world.'

Leilani Sills, classroom teacher

'ThingLink has provided us with a tool for our students to be creators of authentic and interactive Virtual Reality content!'

Brian and Jennifer Cauthers, science teachers

Source: ThingLink (2018*b*)

Monitoring and evaluation

ThingLink is able to measure how many teachers have participated in its professional development and continuously monitors and evaluates participation, content usage, content creation and engagement with its tools on a daily basis.

ThingLink program data reflects ongoing growth in numbers of users. As of 2020, there are 30 million unique views of ThingLink images per month, with 70 per cent of views from mobile devices, smartphones or tablets. Users now span 190 countries, with 7 million registered content creators and 30 million monthly learners. ThingLink users create 250,000 new interactive image experiences used by over 100,000 teachers and students for learning projects every month.

In addition to the ability to integrate with Learning Management Systems, ThingLink offers analytics of views, clicks, hovers and time spent on images, which makes it possible to collect data on individual student progress and performance. In addition, when teachers create visual learning materials with ThingLink, they can use existing tools such as Google or Microsoft Forms to add entry and exit tests for students and thus monitor improvement or learning from individual courses or engagements.

As yet, a formal evaluation of ThingLink or the impact of ThingLink on learner achievement among teacher and student users has not been conducted.

Table 1. ThingLink engagement statistics

User statistics	
Weekly visitors on the site	333,025
New weekly registrations of content creators on ThingLink	19,420
Weekly views of interactive images and videos	8,210,000
Weekly virtual tour views	271,000
Total number of content creators	7,102,068
Total number of virtual tour viewers	20,788,689
Interactive images and videos created	10,742,174

Data Source: ThingLink, 2018*b*

Challenges

As a cloud-based solution for use in education, ThingLink faces challenges related to access, teacher training and localization of content:

Users with limited technology resources and connectivity

Lack of access to a mobile device or the internet is a challenge experienced in many communities. A smartphone, tablet, laptop or computer with basic Internet access is required to access ThingLink, one of the greatest challenges to ThingLink's global expansion. Underserved communities such as migrants and those in least developed nations are most likely to lack internet access. According to ITU (2020), while the share of students without internet access at home is below 15 per cent in Western Europe and North America, it can reach as high as 80 per cent in Sub-Saharan Africa.

To assist in reaching these populations, ThingLink offers substantial discounts to non-profit organizations and has modified its technology to better serve these communities.[9] ThingLink works with large technology companies and public institutions such as libraries and governments to provide students with access (ThingLink, 2018*a*).

Global shortage of suitably trained teachers

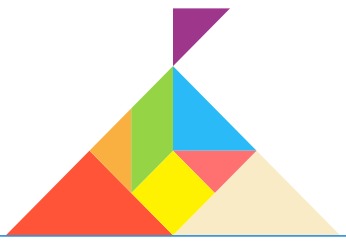
Teachers are the core constituency through whom the benefits of ThingLink infuse into an education system, and the value of ThingLink's offering is dependent on the willingness and motivation of individual teachers to extend their learning and capacity to utilize the tools to the benefit of students.

There is an inequitable distribution of teachers and, moreover, of trained teachers across the globe, which negatively affects the ability of students to benefit from innovative technology such as ThingLink. In response, ThingLink allocates substantial resources to support teachers as primary users as well as offer professional development opportunities.

Language and localization

While the ThingLink application is translated into English, French and Spanish, content can be created in any language. The value of the resources available in each language and on each topic increases with the size of the user base and with the level of awareness and collaboration within particular communities. Ultimately, optimizing the value of ThingLink tools requires partners who can localize materials and teacher training as well as the creation of a core constituency of teachers or communities of practice in each language and subject.

9 See 'Further development' for more details on modifications to the product.



Further developments

On all levels of learning, basic, secondary and adult education, learning environments globally are becoming digital. The home base of learning is in the cloud, not anymore in a physical building. In the absence of a shared physical space, the role of the visual grows in the virtual space. We learn by perceiving and interacting with our environment, this fundamental principle of learning applies to both physical and digital environments.

Ulla-Maaria Koivula

Source: ThingLink (2018*b*)

In 2019, ThingLink transitioned to serve not only individual educators and schools, but also cities, districts, municipalities and local governments seeking to build digital infrastructure for remote learning. ThingLink established global partnerships with Microsoft, Google Education and ClassVR to better support larger public sector clients and offer enhanced services. ThingLink was selected as an official Microsoft partner in 2018 for supporting creativity in classrooms, and through a partnership with the Google for Education Integrated Solutions Initiative, ThingLink has integrated to support G Suite for Education users through features such as a 'Share to Classroom' function to create tasks in the Google Classroom workflow.[10]

In order to reach communities with poor or intermittent connectivity, ThingLink released an offline access version for Windows and macOS devices in October 2019. The addition of offline access will assist ThingLink in adding value to education in communities where electricity is poor or intermittent, thus reaching a larger share of disadvantaged learners and communities.

Amid the large-scale shifts to remote learning that accompanied the global COVID-19 pandemic, ThingLink allocated development resources to supporting smart solutions for cloud-based course creation and assessment. These included a 'Donate Lesson'[11] feature to help teachers share online learning materials with colleagues and a 'Shared Folders' feature which allows students to collaboratively create interactive products and presentations. ThingLink further invested in integrating Immersive Reader with automatic language translation. This addition has enabled instant accessibility to learning materials in over 80 languages. To further support teachers, ThingLink built its first demo of a virtual course creator with an integrated chatbot.[12] In 2019, the company released a collection of professional 360^0 images of some UNESCO World Heritage Sites and made all images available for reuse and editing under the free ThingLink Teacher account.[13] Finally, ThingLink's social impact programme sponsors cultural institutions that seek to improve access to culture during the pandemic.[14]

10 See https://www.thinglink.com/blog/thinglink-joins-google-for-education-integrated- solutions-initiative

11 See https://www.thinglink.com/articles/thinglink-has-announced-a-new-donate- lesson-feature

12 See https://www.thinglink.com/blog/tvet-in-the-cloud-thinglink-and-oep-showcase- a-virtual-course-creator-with-chatbot

13 See https://thinglinkblog.com/2019/03/28/thinglink-releases-free-360-images- to-unesco-world-heritage-sites-and-invites-teachers-to-create-lessons-in-multiple-languages

14 See https://www.thinglink.com/blog/vermont-art-online-bringing-culture-to-their- communities-in-the-face-of-COVID19

In a further technological advancement, ThingLink educational accounts now include options to embed questions relating to images and videos, making it possible to collect data on individual student progress and performance on ThingLink. This development allows ThingLink to better serve higher education and TVET institutions seeking to create context-based learning modules as it provides a way to assess comprehension and retention in the actual technical environment. ThingLink has increasingly partnered with TVET colleges to build skills assessment and other educational content modules that can be offered to governments looking to engage youth in skills development programmes. ThingLink also partners with other higher education institutions: for example, the University of Helsinki has partnered with ThingLink to include rich media images, interactive video lessons and virtual tours in its courses. ThingLink is focused on leveraging university partnerships to take a more active role in research.

The company has also garnered international recognition as an innovator, winning a number of prizes:

- selected as a HundrED global education innovation (2017);[15]
- the edTechX Rise Award for promoting 360-degree storytelling (2017); and
- recognition from Tutora as one of the 'Hottest EdTech Tools' of 2017 and 2018.

15 See https://youtu.be/tWXJg8E2kO4

Impact of the Prize

Winning the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education generated positive recognition for ThingLink and online education in social media and among existing and new ThingLink users and partners.

Winning the global prize has motivated ThingLink to increase its capacity to contribute to alleviating global education challenges. Since winning the Prize, ThingLink has invested extensively in initiatives and modifications to enable the technology to reach and be used by marginalized populations, such as integration with automatic translation software, investment in the development of offline options, discounted accounts to non-profits and NGOs, and the addition of a 'Donate Lesson' feature.

Funds were also allocated to advocacy and awarenessraising.

> The prize has clarified our mission as a company, and it has become even more clear to us that we want to actively work with international organizations and contribute to solving some of the biggest challenges in global education by building useful technology and tools together with other companies, educators, researchers and education experts around the world. Coming from Finland, we believe strongly in a free, accessible, high quality education system – even if the new home base for this system is in the cloud.
>
> **ThingLink CEO Ulla-Maaria Koivula**
> *Source:* ThingLink (2018*b*)

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Can't Wait to Learn

2018

War Child Holland

Bridging disruption of children's education in conditions of conflict

Theme
The use of ICT to ensure education for the most vulnerable groups

Location
The Netherlands (Headquarters)

Date started
2011

Beneficiaries
20,000+

Target population
Conflict-affected, out-of-school children and youth in marginalized communities needing quality education

Digital solution
Free gamified learning using tablets for children in conflict zones

Summary

War Child Holland's programme Can't Wait to Learn (CWTL) was awarded the 2018 UNESCO King Hamad Bin Isa Al-Khalifa Prize for its innovative EdTech solution that provides quality gamified learning programmes delivered via tablets. The programme helps to mitigate learning losses which arise from lack of access to schooling in times of conflict and civil crises.

War Child Holland delivers its programme across five countries: Chad, Jordan, Lebanon, Sudan and Uganda, with a pilot conducted in Bangladesh. The Can't Wait to Learn system is aligned with local national curricula to provide quality education to children and youth in conflict situations, ensuring that learners can return to formal schooling without being left behind. Rigorous monitoring and evaluation coupled with input from learners guides the curriculum programme which is engaging, highly customizable and locally-focused. Can't Wait to Learn offers the advantages of functioning offline, running on solar power and allowing students to learn independently at their own pace.

The Can't Wait to Learn model currently reaches over 30,000 learners, growing exponentially from an initial trial of 66 learners in 2012. Can't Wait to Learn demonstrates positive impacts not only on learning but also on the psychosocial well-being of children and offers solutions at scale that improve value for money.

More information at: https://www.warchildholland.org/intervention-cwtl

Why selected

- This innovative game-based educational platform increases access to and quality of learning in Education in Emergencies (EiE).
- The programme adapts to local contexts via integration with curricula from local ministries of education and feedback from learners, which allows for continuous improvement and greater contextualization.
- Can't Wait to Learn accounts for self-paced learning and supports teachers and facilitators in guiding learners while conducting monitoring of attendance and performance at a global level for research purposes.
- The proven cost-effectiveness of the Can't Wait to Learn programme, which is provided free of charge to children beneficiaries, furthers its use in any crisis or country conflict setting.

> I really enjoy learning Maths and Arabic.
> I made two friends, and I want to continue coming here.
> I love my teacher, and I want to become one myself in the future.

Quote from Salma, a student in Jordan reflecting hope, community-building and motivation
Source: War Child Holland (2019*b*)

Programme

PROBLEM

Lack of access to and interruption of formal education for children and youth in conflict zones

SOLUTION

Offline access to engaging self-paced quality learning using solar-powered tablets, with the support of teachers or facilitators

BENEFICIARIES

30,000+ across five countries

RESOURCES REQUIRED

- **Infrastructure**: Solar panel charging stations; periodic internet access; tablets with durable protective cases; stationery for drawing (colouring markers, paper, etc.)
- **Human capital**: Teachers and facilitators to guide learners; technical experts in education and project implementation
- **Content**: Digital game-based learning software
- **Systems**: Monitoring and evaluation

RESULTS

- Students show rapid learning, motivation and engagement and positive impact in psychosocial benefits
- Improvements in both numeracy and reading scores regardless of gender
- Programme sustainability and successful replicability to other countries
- Adoption into the formal education system proving practical application outside the intended initial scope

CHALLENGES

- Availability of teachers, education practitioners, mentors and facilitators not guaranteed
- Security in conflict zones is unstable and a threat to programme continuity
- Lack of funding for a proven innovation on its way to scale

Profile: Implementing agency

War Child Holland is a non-governmental organization providing psychosocial support, education and protection to children and youth affected by violence and armed conflict. Founded in 1994, the organization runs activities in 17 countries designed to support children living through war and/or humanitarian crisis. Through building resilience and facilitating empowerment, the organization works to improve the psychosocial well-being of children and youth – supporting them to create a better future for themselves and their communities.

War Child Holland is part of the wider War Child family with affiliated organizations in Australia, Canada, Germany, the Netherlands, Sweden, the United Kingdom and United States. The Netherlands unit fulfils its mission through activating interactive and creative activity programmes created for and by children as well as through partnerships with institutions such as Save the Children and Sheffield Hallam University.

War Child Holland has a portfolio of five projects that involve children and youth drawing on sport, leadership, drama, music and learning technology activities that are customized to encourage engagement. Participants gain confidence that fosters positive personal impact and development in the short- and medium-term.

01 **Back to the Future**[1] is a project in collaboration with AVSI (Association of Volunteers in International Service) and Terre des Hommes Italy, funded by the EU Regional Madad Fund and the Elma Relief Foundation. The project assists Syrian child refugees in Jordan and Lebanon to access basic education.

02 **TeamUp**[2] focuses on sport and movement activities with psychosocial support to help refugee children and youth in Colombia, the Netherlands, Palestine, Sri Lanka and Uganda. At asylum reception centres and schools, volunteers use proven methods to bring about a decreased sense of isolation, increased emotional stability and improved resilience in participants.

03 The **Sports and Humanitarian Assistance** (SAHA 2)[3] project in Lebanon nurtures goals through football. Participants play in a safe environment and the team-based interaction generates inclusion with female participation above 40 per cent and improves their sense of resilience.

04 **I-DEAL**[4] is a project developed to make use of the arts through music, drawing, painting, role play in workshops, performances to encourage better coping, and emotional expression of child and youth cohorts, but extends also to adults through community building and learning life skills.

05 The **Can't Wait to Learn (CWTL)** programme exploits the capabilities of digital technologies to offer quality learning opportunities for children who are denied access to schooling, as a result of armed conflict, the disintegration of formal schooling systems, or having taken refugee status.

There are strong synergies across these projects, all of which affirm the importance of inclusion, humanity, caring, learning and resilience through interaction with individuals and communities affected by armed conflict. War Child Holland brings cross-cutting knowledge, experience and systems into play in operations of each specific project.

1 See https://www.warchildholland.org/projects/back-future
2 See https://www.warchildholland.org/projects/teamup
3 See https://www.warchildholland.org/projects/football-unites-us
4 See https://www.warchildholland.org/projects/i-deal

Context

Conflicts are globally a major cause of forcibly displaced populations, which currently amount to 82.4 million people, of whom 48 million people are internally displaced within a country. Refugees globally number 26.4 million people about half of whom are under 18 years of age (UNHCR, 2021). In this context, host countries have obligations to provide for and support refugees, and a number of countries are facing challenges associated with large population migrations due to internal crises or conflicts in neighbouring countries. Jordan and Lebanon for example, have borne some of the repercussions of civil war in adjacent Syrian Arab Republic as large numbers of citizens seek refuge in neighbouring countries.

In areas of protracted conflict such as civil war and international armed confrontation, the burden of violence and trauma falls often invisibly on children and youth. An estimated 149 million children live in conflict-affected zones (Save the Children, 2020). During conflict and in cases of migration, children and youth can be deprived of access to schooling as formal education systems are particularly vulnerable when confronted by social conflict, and more so armed conflict. This fragility brings major negative sequelae for education quality and access to local populations in the short, medium- and long-term (Sinclair, 2001). Contexts of immediate localized military conflict, regional uncertainty regarding emerging conflicts and fears of individual safety can lead to a deterioration of state education systems, which manifest in decreased learner attendance, poor teacher motivation, lack of management and supervision of schools and disruption of operations, resulting in a lack of coherence in education service offerings. Teachers may consider moving to other contexts away from conflict zones.

Interruption of studies leads to learning losses that can have long term impacts. Disruptions can last an indefinite length of time, leaving children vulnerable to missed learning opportunities at critical periods and leading to irrecoverable developmental impairment. Students are affected by uncertainty and impact on their social networks and can be impacted by depression, anxiety and alienation, and out-of-school youth may be disinclined to reintegrate into formal schooling. Linkages between schooling and work are attenuated, leading to the impoverishment of youth and their households. In these conditions, education in emergencies is essential to mitigate disruption of formal education, isolation, poverty and poor future job prospects associated with refugee and asylum status or neglect of migrant children (War Child Holland, 2020).

Substantial challenges are experienced in refugee environments. Access to schooling is seldom offered on a comprehensive basis unless refugees are permitted by the host state to attend school with local resident communities. Refugee children have a wide range of learning needs across age groups. Schools that are in operation tend to suffer serious shortages of key resources, including teachers who are appropriately qualified, lack of materials and lack of basic facilities, including classrooms and services such as water provision.

One advantage to those invested in improving the educational opportunities of vulnerable populations such as refugees is digital technology, which has been noted as a conduit that can link education access to internally displaced people (IDPs) and refugees (Mastercard Foundation, 2020). Additionally, by using software solutions curricula can be tailored to meet unique needs in different environments while taking into account differences in language and culture (Kamal and Diksha, 2019).

Digital Solution

Can't Wait to Learn (CWTL) is a digital learning solution that consists of an innovative game-based mathematics and reading curricula, delivered through a flexible model designed to support learning in areas where state and private formal education institutions and practices are either non-functional, over-burdened or inaccessible. Can't Wait to Learn is adaptable across countries to take into account different national, cultural and linguistic characteristics, and is resilient enough to survive uncertainty and crisis through reduced dependence on the typical inputs required by formal schooling. Can't Wait to Learn can therefore address the learning needs of children who don't have access to conventional schooling opportunities as a consequence of conflict or war conditions, isolation or resource deprivation, and can also be used as a complement to formal teaching methods.

Children and youth engage Can't Wait to Learn through offline tablets pre-loaded with numeracy and reading game-based software. Since the software curriculum environment on the tablet is self-contained, learning is also not dependent on the availability of a typical classroom environment and compensates for situations where teachers are not available, as the software enables learners to progress at their own pace.

Figure 1. Can't Wait to Learn's reading game in Sudan: rapid recognition sentence

Figure 2. Reading Game World in Lebanon from War Child Holland's educational programme Can't Wait to Learn (CWTL)

To pique learner interest and engagement, the educational content and concepts are presented in the form of a series of mini-games that encourage learners to progress through different difficulty levels and thereby to master the underlying content and skills. The self-paced games are co-designed with children to reflect their context and aligned to the national curricula, providing children with the opportunity to transition to formal schooling. The software developers specifically invite learners to provide feedback in the design process and integrate learners' stories and drawings into the software. As a result, the co-created software design and appearance reflect the children's lived local context, which improves their connection with the learning scenarios and raises learning propensity.

Implementation

The Can't Wait to Learn model is implemented in very different national contexts (**Table 1**) which require adaptability to highly urbanized and predominantly rural settings, as well as to different levels of access to the internet.

In response to these varying contextual requirements, the programme model is designed to be low-resource and with flexible implementation requirements. Can't Wait to Learn can be used by children at home, in education centres or in addition to formal teaching methods at school, for accelerated learning or to follow the formal education cycle. Implementation is based on simple equipment and hardware requirements with low maintenance demands, and the ability to connect and operate with disparate electrical and Internet infrastructures. Tablets are encased in a durable protective cover to increase longevity, and solar panels reduce dependency on electricity and operating costs. The tablets require safe storage in an accessible location.

Given the context of Can't Wait to Learn operations, levels of real or perceived personal safety and security cannot be taken for granted. These factors are known to have strong impacts on the inclination and capacity of young children and youth to achieve age-appropriate developmental and learning goals. Further, even as formal school systems and classroom environments can differ, this is equally if not more the case in unpredictable environments where children are living.

To ensure the highest possible degree of confidence and personal safety, portable tablets are taken to safe and comfortable spaces when students meet as a group. In countries where Can't Wait to Learn reaches out-of-school children, the Can't Wait to Learn implementing teams select a central village location, thus enabling children without access to existing schools to participate without having to leave their communities.

Learners connect to a tablet using headphones. If necessary, a tablet may be shared by two or three learners. A majority of participating learners are of school age, between six and fourteen years old, with 62 per cent of learners in the 10- to 14-year age group. The Can't Wait to Learn programme also includes Accelerated Learning Programming, which targets youth above the age of 14.

Table 1.
Characteristics of host countries where Can't Wait to Learn projects are/have been in operation

	Bangladesh	Chad	Jordan	Lebanon	Sudan	Uganda
Refugee population 2020 (million)	0.854	0.443	0.693	0.916	1.100	1.400
Refugee numbers of country population (per cent)	0.5	2.9	6.9	13.5	22.9	3.3
Country population 2019 (million)	161.4	15.5 (2018)	10.0	6.8 (2018)	41.8	42.7
Urban population percentage 2018 (per cent)	36.6	23.1	91.0	88.6	34.6	23.8
Population using internet 2017 (per cent)	15.0	6.5	66.7	78.1	30.8	23.7

Data Sources: International Organization for Migration (2020) Migration Data Portal; International Telecommunications Union (2020) The ITU ICT SDG indicators Indicator 17.8.1: Proportion of individuals using the Internet; Pilot conducted in 2019-2020 (Bangladesh)

Each learning element includes instruction and practice modules. Data collection, monitoring and tracking learner activities and attendance are automatically uploaded in the learning management system if the tablets are connected to the internet or a mobile hotspot. Otherwise, this can be done manually.

The flexibility of the modes of Can't Wait to Learn delivery have allowed for mitigation strategies in the context of COVID-19 disruptions, and continue to be adapted to ensure preparedness for future crises.

Development

The curriculum focus is on basic numeracy and reading in Arabic or English, with French mathematics recently developed. The frequency and duration of lessons differ across contexts but the programme is benchmarked for a minimum of 2-3 contact hours per week.

Curriculum designers have taken care to ensure that content is inclusive. Assessment of the programme revealed that boys expressed entrenched gender stereotypes such as that girls should primarily do the work in the household, yet in contrast, girls showed interest in 'typically male' activities such as football. As a result game scenarios have been created to take boys and girls out of their traditional gender roles so that female characters are doctors or taxi drivers. To make game activity attractive to both girls and boys, cooperative and competitive elements are incorporated to elicit equal levels of engagement and progress of participants.

Figure 3.
Can't Wait to Learn's game story in Uganda

Enablers and supports

Partnerships and collaboration

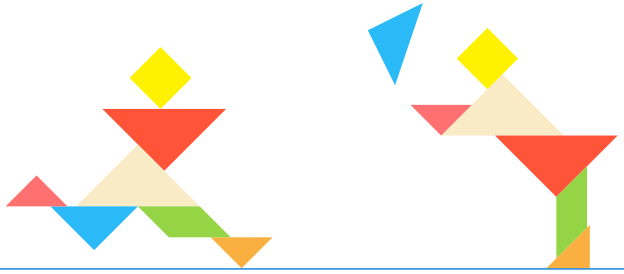
The environment in which Can't Wait to Learn operates depends on well-functioning partnerships with governments, the private sector, local and international NGO/non-profit organizations and local communities. Without such partnerships, the Can't Wait to Learn project might not be able to function. Partners and partnerships vary from country to country, so Can't Wait to Learn must commit substantial resources to securing relationships in each particular country and location of operation to access local networks, technical expertise and local knowledge such as safe venues for learning sessions.

Particular emphasis is placed on establishing and maintaining relationships and high degrees of collaboration with Ministries of Education. The project has obtained signed Memorandums of Understanding (MoUs) with every national government education authority where teaching and learning are taking place. In Lebanon, the level of cooperation and trust has extended to government approval in 2019 to incorporate Can't Wait to Learn in formal schools.

At the international level, Can't Wait to Learn is governed by a partnership coalition including Jesuit Refugee Services, the Norwegian Refugee Council, Finn Church Aid, Windle International, Save the Children, Butterfly Works and Ranj and Sheffield Hallam University among others, with funding and implementation support from the Cisco Foundation, EU Civil Protection and Humanitarian Aid, Google.org, Humanitarian Education Accelerator, the IKEA Foundation, the Dutch National Postcode Lottery, UKAid, and USAID (War Child Holland, 2019*a*). Can't Wait to Learn also collaborates with multilateral agencies such as UNICEF and UNHCR.

Teachers and mentors

Though the model does not require the constant presence of teachers and mentors, professional or trained educators assist depending on their availability in the conflict zone, and teachers and mentors can carry the responsibility of connecting the offline tablets to the internet for monitoring data uploads and software downloads. Teacher training remains a priority, and Can't Wait to Learn provides training to members of the community who can take up this role. Typically, where Can't Wait to Learn operates in non-formal settings, the programme makes use of local facilitators, whereas when Can't Wait to Learn is implemented in formal schooling or for the Accelerated Education Programme, the programme makes use of existing teachers.

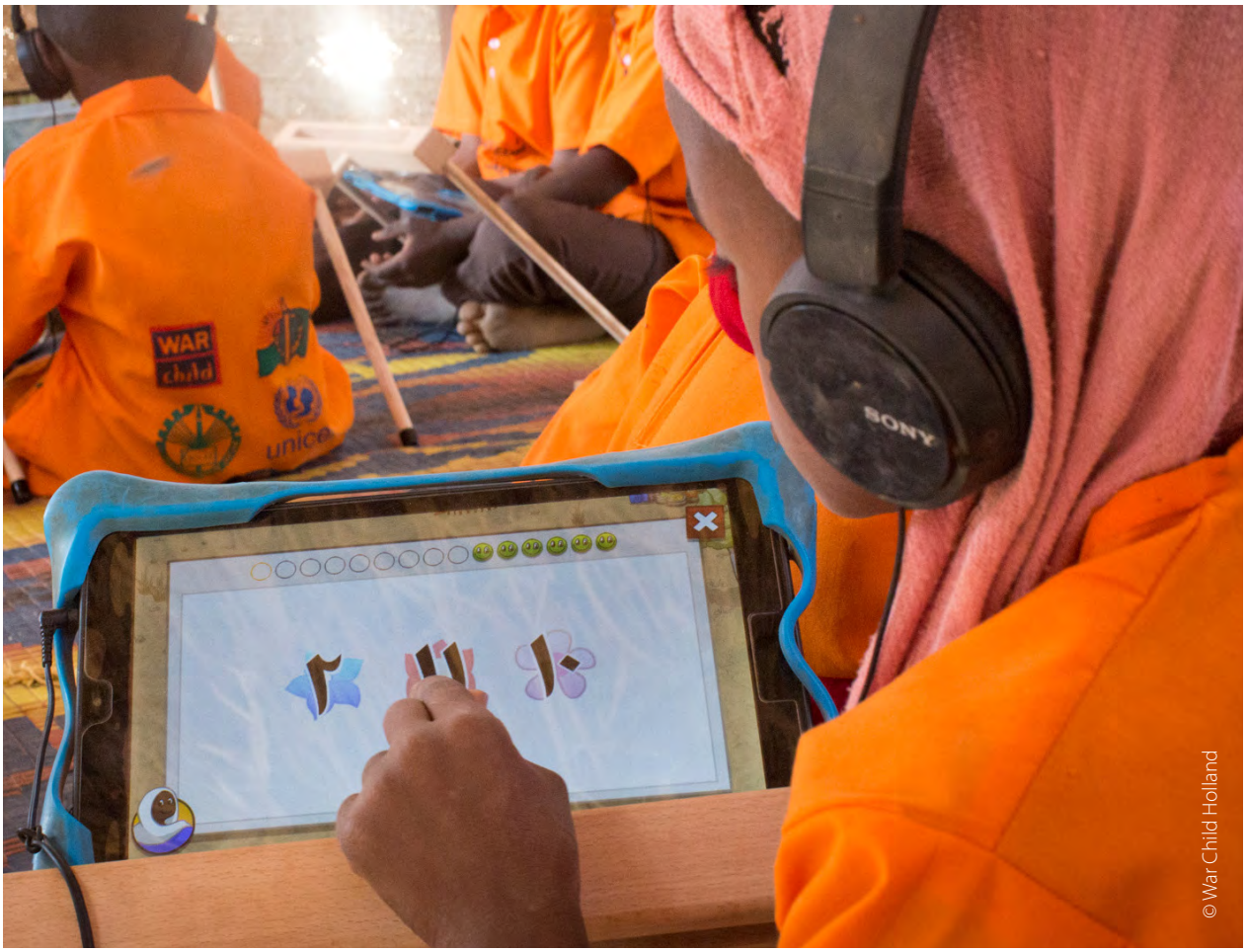


Monitoring and evaluation

Recognized international child well-being and psychological distress scales are used for measurement, along with numeracy and reading tests developed by War Child Holland and internationally recognized assessments such as Early Grade Mathematics Assessment (EGMA), the Early Grade Reading Assessment (EGRA) and the International Common Assessment of Numeracy (ICAN).

In addition, monitoring data related to children's progress is uploaded into the data management system. This includes data on the amount of time played, how many mini-games children completed and which level they reached in the game. Data retrieved from the game is analysed and used to update and revise the games and exercises to further enhance the learning process.

Improvements to the monitoring and evaluation framework are also carefully implemented to take into account differences in the programme quality in the different countries as experienced by learners. This is an important and complex process involving linguistic, intercultural and child development aspects. Accordingly, curriculum teams streamline and update the tutorials and implementation manuals regularly.



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Results

The Can't Wait to Learn model has proved to be replicable, with the scope of the programme extended from an initial trial of 66 learners in 2012 to reach 30,000 children by the end of 2020. Also as of 2019, Can't Wait to Learn was delivered in six countries despite contextual challenges such as infrastructural and human capacity resource constraints. Currently (2021), the programme is implemented in five countries. The programme has managed to control costs through a sound evidence base and rigorous coordination to support operational logistical and cost decisions, seeking to achieve a substantial decrease in per-learner costs through economies of scale.

In terms of learning outcomes, research demonstrates learning achievements by Can't Wait to Learn students. In Lebanon, over a 12-week period, learners achieved a 7 per cent improvement on average in mathematics scores. In Sudan, when compared to learning through traditional approaches, children using the Can't Wait to Learn method achieved nearly twice the learning gains in mathematics, and nearly three times the learning gains in reading. The same group also outperformed government alternative learning programmes, achieving milestones at roughly twice the rate of children in these programmes (Topham, 2019).

Table 2.
Can't Wait to Learn in-country achievements and scaling up journeys

	Jordan	Lebanon	Sudan	Uganda	Chad[7]	Bangladesh[8]
Exploration	2015	2015/16	2011	2017	2019	2019
Proof of concept	2018	2018	2012	2020	-	2019
MoU signed with MoE	2017	2016	2017	2017	-	2019/20[9]
First implementation	2017	2017	2014	2018	2020	2019
Research conducted	2018	2017/18	2014 & 2018	2019	2020	2019/20[10]
Age of beneficiaries	6-12	10-14	7-9	10-14	8-9	-
Total beneficiaries	3,904	20,730	4,127	5,039	1,147	261
Enrolment goal 2020	5,000	9,000	10,000	8,000	2,000	-
Cost per child per year, 2019 enrolment (€)	444	253	-	297	-	-
Cost per child per year, enrolment at scale (€)	55	74	37	74	-	-

Data Source: War Child Holland, 2019*b*

7 Launched February 2020. Enrolment and cost statistics were not available at the time of publication

8 Enrolment and cost statistics were not available at the time of publication

9 MoU signed by the Education Consortium

10 Research conducted by the International Rescue Committee (IRC)

Challenges

Can't Wait to Learn has responded to certain challenges encountered in delivering its programmes, which must operate in fluid environments.

Availability of teachers

Ensuring the availability of teachers and support for teachers in a taxing environment is of fundamental importance. War Child Holland has developed a professional development programme - CORE for teachers - for those in teacher/facilitator roles to meet academic and social and emotional needs of children. This includes teaching methodology and also enhanced personal well-being and social and emotional competencies of teachers for the interactions with children in their care. Country Coaches also provide extended ongoing and specific coaching for teachers.

Development and implementation costs

Implementation costs are country-dependent and can substantially differ. Additionally, working internationally in varied country environments with different currency and operating cost profiles requires substantial financial and project management expertise. A key consideration is to monitor measures of economy, efficiency, effectiveness and equity, the programme withstood rigorous assessments confirming low and decreasing average cost per child per year among other metrics.

The cost of local customization of the software for each new country can be substantial. However, adapting the software to ensure it is locally relevant is critical to the programme's scalability, which is essential to make savings in per-user costs. Additionally, local adaptation and integration of national curriculum content and goals into the game's content also helps to obtain government approval. To respond to this challenge, Can't Wait to Learn has made use of templates, for example using generic mathematics content upon which contextual elements are adapted. Recently, the programme has seen substantial cost reductions in the development process, as existing game code and content can be re-used.

Bridging Innovation and Scale

Can't Wait to Learn is in a pivotal phase, between innovation and scale. It is in - what is known as - 'The Missing Middle': the demand for the programme is high, but funding is limited. Continuous investment is essential to overcome key challenges and scale exponentially. Subsequently, Can't Wait to Learn's Knowledge & Innovation Hub has developed a new scaling strategy, one that leverages on its 10 years experience, expertise and learnings; and strengthens the existing building blocks towards a sustainable scalable programme. This strategy provides pathways that help bridge the programme from innovation to full scale up. This strategy explores a spectrum of strategic partnership approaches, with different business models to help generate funds for scaling; and ensure the continuous improvement of Can't Wait to Learn's value proposition. Ultimately, it will enable greater adoption of the programme in the sector and potentially reach millions of children affected by war and conflict, in need of access to quality education.

Maintaining partnerships

In each country, Can't Wait to Learn must develop sustainable relationships with organizations that can be relied upon as partners in implementation and logistical support. Can't Wait to Learn notes that partnership maintenance is not merely a function at the inception of the project but constitutes an ongoing investment of resources and effort due to the pace of change in conflict environments.

Differentiation of learning

Between and within countries Can't Wait to Learn encounters substantial differences between learners in their levels of tech literacy, which in a conventional teacher-driven class environment could be disruptive. This challenge is overcome because the Can't Wait to Learn software profiles individual learner progress, which enables the programme to pace learning appropriately.

Hardware vulnerability

Can't Wait to Learn recognized that the programme was vulnerable to loss of tablets other devices and other digital equipment needed for implementation. This concern was addressed through achieving high trust relationships with local organizations regarding advice, and secondly on developing relationships with communities so that the communities develop a sense of ownership for the equipment which has a joint benefit.

Further developments

Since winning the prize, Can't Wait to Learn has forged partnerships with Jesuit Refugee Services in Chad and Windle International in Uganda, and UNICEF has become a full implementing partner in Sudan. In early 2020, Can't Wait to Learn launched its programme in Chad, which required the adaptation of the mathematics game into Arabic for Sudanese refugee and Chadian host community learners. This was followed by the launch of the mathematics game in French, also in Chad.

Can't Wait to Learn has sought to achieve further development of its systems, processes and results. Some key focus areas for improvement are:

Embedding quality in operations through research. Can't Wait to Learn strategists and managers have sought to define and concretize drivers of optimal coordination to achieve efficient, effective expansion. This includes a commitment to research that informs the creation of manuals, quality assurance frameworks, tool improvement and model-building, and supports fine-tuning systems and processes. In addition, Can't Wait to Learn received a grant by the international research body Knowledge and Innovation Exchange to undertake new research to help improve global education outcomes.

Expansion in new contexts. Can't Wait to Learn plans to expand its curriculum game into urban communities in Middle Eastern country cities, in contrast with the more rural environments served in Sudan. As part of this transition, the gamified curriculum will be customized to meet children's needs in a different cultural and economic context.

Response to the COVID-19 pandemic. To respond to the worldwide pandemic, Can't Wait to Learn was adapted for home-based learning in line with the requirements of each context (infrastructure, capacity on the ground, availability of hardware at home). This included, for example, increased number of available tablets (in Uganda) and distribution of the Can't Wait to Learn Distance Learning & Teaching Package through a downloadable link (in Lebanon). These programmes also increase children's social-emotional well-being. The programme even achieved some spillover effects as some children started teaching their siblings, friends and parents what they learned about numeracy and reading through Can't Wait to Learn, and further supported their parents with the use of mobile phones and technology.

In a further development, War Child is working together with the Lego Foundation, the International Rescue Committee (IRC) and other partners. As part of this initiative, War Child is co-leading a research agenda with the IRC on learning through play called PlayMatters.[11]

11 The LEGO Foundation Awards US$100 Million Grant to the International Rescue Committee to Bring Learning through Play to Children Impacted by Crises in Ethiopia and Uganda. See https://www.legofoundation.com/en/about-us/news/the-lego-foundation-awards-us-100-million-grant-to-the-international-rescue-committee-to-bring-learning-through-play-to-children-impacted-by-crises-in-ethiopia-and-uganda

Impact of the Prize

Winning the UNESCO King Hamad Bin Isa Al-Khalifa Prize has contributed to increased visibility of War Child Holland among organizations whose work focuses on serving the international humanitarian and education sectors. As a result of a broader awareness of their work and capabilities, War Child Holland received invitations to join consortia to jointly seek new funding opportunities important to growth and sustainability.

Funds from the prize were invested in improving the organization's management and administration systems and bolstering its monitoring and evaluation capability. Funds reinforced Can't Wait to Learn's programme implementation and management in Jordan through support for collaboration with the Jordanian Ministry of Education as well as research with the American Institute of Research.

Since receiving the UNESCO award, Can't Wait to Learn has received further recognition that includes:

- Can't Wait to Learn won the Public Award for Best Innovation from the Dutch Coalition for Humanitarian Innovation, in October 2018
- Can't Wait to Learn presented at the prestigious CIES (Comparative & International Education Society) conference in the United States in 2019
- Can't Wait to Learn was featured in 2020 among a set of promising EdTech initiatives by the EdTech Hub which is supported by UK AID, DfID and the World Bank
- In February 2020, the MacArthur Foundation shortlisted War Child's application for scaling Can't Wait to Learn - with partners &ranj, Butterfly Works, Save the Children and Sheffield Hallam University was designated as the Top 100, in its 100&Change competition to help solve one of the world's most critical social challenges.

For some children gaining reading and numeracy skills through Can't Wait to Learn can be their only chance for an education. Take 14-year-old Mahmoud, whose family fled from Syria to Jordan. He has never been to school, and spends most of his time working to support his family. Mahmoud comes to a UNICEF-supported learning centre every morning to use War Child's Can't Wait to Learn tablet-based learning software.

'I have an hour class every day, playing with the tablet. I learnt a lot of new things using the game. I'm enjoying knowing how to calculate. I know how to add and subtract numbers. The teachers guided us in the beginning on how to use the tablet, and now I know how to do everything by myself. I am moving through the game levels quickly.'

Source: War Child Holland (2019*b*)

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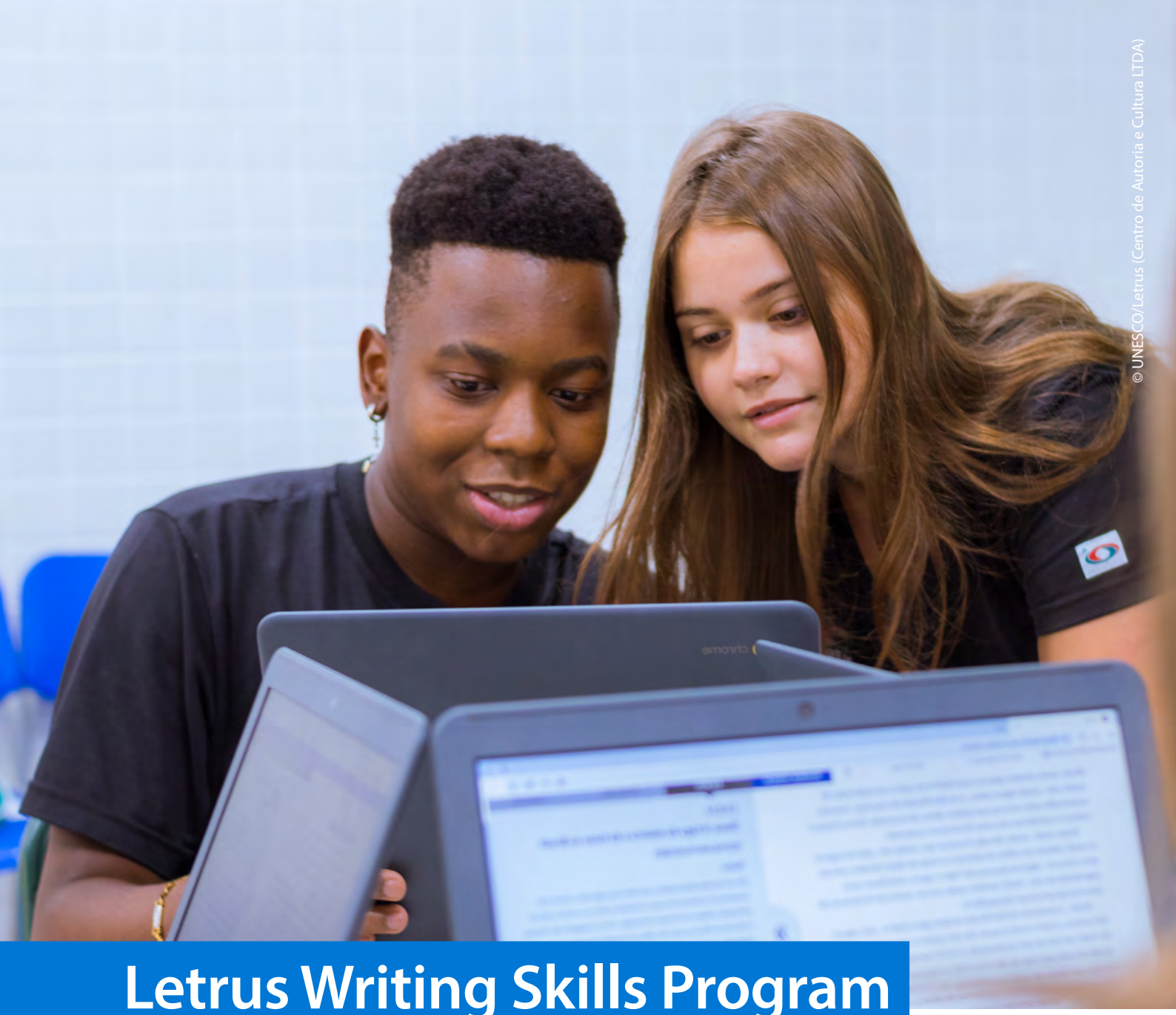

Letrus Writing Skills Program

2019

Letrus (Centro de Autoria e Cultura LTDA)

Improving students' writing skills through using artificial intelligence

Theme
The use of AI to innovate education, teaching and learning

Location
Brazil

Date started
2014

Beneficiaries
116,677

Target population
Primary and High school students

Digital solution
Letrus assists in improving the writing skills of primary and high school students through an adaptive online learning platform

Summary

'The limits of my language are the limits of my world.'
Ludwig Wittgenstein.

Luis Junqueira, Letrus, 2019[1]

While Brazil has made great strides towards eliminating illiteracy, functional literacy is still a challenge for the country, with only 2 per cent of students achieving the highest marks in literacy on the 2018 Programme for International Student Assessment (PISA) (OECD, 2019*a*).

The Letrus Writing Skills Program2 is an innovative technology solution that supports the development of student writing in Portuguese through an Artificial Intelligence (AI) platform built at the intersection of linguistics, pedagogy and computer science. Through its AI and comprehensive programme of support, Letrus provides a dynamic learning method and personalized, extensive essay feedback to students and reduces both teacher workload and the typical response time associated with grading essays.

Students who submit essays on the Letrus platform receive immediate feedback from the Automated Writing Evaluation (AWE) algorithm, which provides them with formative comments on specific areas of strength and weakness such as adherence to the formal written norms of Portuguese or the length of specific paragraphs. Essays are then evaluated by human graders3 who assign additional comments and final grades in alignment with the criteria used for the National High School Exam (*Exame Nacional do Ensino Médio*, or ENEM), the largest college admission examination in Brazil.

At the same time, teachers access class dashboards to view progress on completion, receive feedback on aggregate and individual scores and connect to Letrus support staff. Teachers receive support with implementation and monitoring, interpreting the results on the dashboard and utilizing results for targeted instruction and/or remediation.

More information: https://www.letrus.com.br

1 See https://www.linkedin.com/company/letrus

2 In this text 'program' is used to reference a computer-based application or engagement, while 'programme' refers to a general intervention that includes both human and digital support structures.

3 As of 2020, Letrus also offers an AI-only option. See the 'Results' and 'Further developments' sections for details.

Why selected

The Letrus Writing Skills Program was selected as a Prize-winning project due to its:

- Innovative use of AI to automatically detect features of the essay and to classify five different skills that are aligned with the national standards for language learning in Brazil,
- hybrid AI-human feedback loop of immediate feedback from the AI and more detailed feedback from human graders, leading to more effective practice opportunities for essay writing,
- enabling teachers to follow students' writing progress and view the writing skills of their students and classes in a structured way, as well as provide the students with personalized feedback,
- ability to operate at a large scale, and promising findings demonstrated by initial research that student marks improve as more essays are written on the platform,
- aim to improve functional literacy and promote inclusion by helping students, especially from low socio-economic backgrounds, to access higher education institutions (UNESCO, 2019*b*).

Literacy is the foundation of any healthy and just society,
and the capacity of expressing oneself in written form is fundamental
for the cognitive, human and social development of every student.

Source: Letrus (2019)

Programme

PROBLEM

While Brazil has made great strides towards universal literacy, functional literacy levels remain below the levels necessary for full economic and civic participation

SOLUTION

An adaptive learning platform which combines AI and human elements to provide responsive feedback on writing skills and personalized learning experiences for students

BENEFICIARIES

Teachers and primary and high school students

RESOURCES REQUIRED

Access to a device with internet access

RESULTS

- Reach: 957 schools; 1,327 teachers; 116,677 students
- Average improvement of 10 per cent after writing five essays on the platform
- Proven impact: Experimental evidence shows a significant, positive impact
- Proven impact: Letrus could decrease the public-private achievement gap for specific skills by 20 per cent

CHALLENGES

- Internet access / device accessibility
- Financing the programme, particularly in low-resource and public schools

STRENGTHS

- Builds on existing technologies such as Natural Language Processing resources
- Rigorous interdisciplinary approach leverages linguistics and computer science
- Engagement of academic partnerships
- Teachers remain the pedagogical leaders for students.
- Applications for remote and hybrid learning models

Profile: Implementing agency

Letrus (*Centro de Autoria e Cultura LTDA*) is a private education start-up company launched in December 2014 with headquarters in Sao Paulo, Brazil. Working to achieve universal literacy is Letrus's core mission, and the main goal of its products is to reduce the functional illiteracy rate in Portuguese. To this end, Letrus has developed a programme comprising an online platform, AI tools and a support team to provide semi-automated or fully automated feedback on students' writing. Letrus helps students from various socio-economic backgrounds to access enhanced writing practice opportunities.

The company currently employs 72 staff members and leverages principal investors United States funds Canary and Potencia Ventures, which focuses on education and health impact initiatives. To date, Letrus has partnered with 957 schools in 26 states across Brazil, serving over 116,677 students.[4]

4 As of December, 2020.

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Context

Brazil is a country with an estimated 210 million people and a population density of 25 people per square kilometer. About 13 per cent of Brazil's population is rural, with a poverty rate of 4.8 per cent[5] (UIS, 2020).

Brazil serves nearly 40 million students (UIS, 2020), with optional pre-primary education and compulsory education for children between the ages of 6 and 17, both provided by a mix of public and private institutions. The compulsory education system is divided into primary school (*ensino fundamental*) and high school (*ensino médio*). Primary school consists of level one in years 1 to 5 and level two in years 6 to 9, and high school consists of a further three years (*Presidência da República Casa Civil Subchefia para Assuntos Jurídicos*, 1996). Students progress after passing end of year examinations in each grade (Ministry of Education, Brazil, 2009).

In the final year of high school, students participate in the National High School Exam (*Exame Nacional do Ensino Médio*, or ENEM), the largest college admission examination in Brazil and the second-largest college admission examination in the world. The ENEM covers language, social sciences, natural sciences and mathematics, and includes multiple choice questions and a composition.[6]

Engagement with digital technology

Digital technology in education policies in Brazil have been active for more than a decade and seek to attain three main objectives: digital literacy training for teachers and students; transforming classrooms into dynamic environments; and helping students build autonomy and authoring skills. National implementation of digital technologiess in education is outlined in a National Development Plan and focuses on delivering digital technologies infrastructure, training teachers and developing open educational resources (OERs).

By the end of 2010, Brazil had established digital technology access for 25 million of its 40 million students, trained over 300,000 teachers in digital technology and invested in the development of multimedia resources and a teacher portal for accessing them (Ministry of Education, Brazil, 2010). However, a review of technology use by Souza et al. (2017) identified slow growth of digital technology prevalence in schools as well as persistent limitations such as low connectivity, low ratios of devices to students and a need for further teacher training.

Education challenges

As of 2016, the Brazilian government invested 6.3 per cent of its gross domestic product (GDP) into education (Ministry of Education, Brazil, 2016), well above the OECD average of 3.2 per cent. According to the 2019 Global Education Monitoring Report (UNESCO, 2019*a*, pp. 310-311), education spending accounted for 16.2 per cent of total government expenditure. However, due to Brazil's low GDP, the monetary investment per student as well as teacher compensation is lower than the OECD average, both in terms of absolute value and purchasing power (OECD, 2019*b*).

Brazil has achieved increasing literacy rates since 1980. As of 2018, 93.2 per cent of the population aged 15

5 Poverty is determined as subsisting on an income of less than US$1.90 per day.

6 See https://www.gov.br/inep/pt-br/acesso-a-informacao/perguntas-frequentes (in Portuguese)

and older was considered literate, though Brazil was still home to roughly 11 million illiterate adults (UIS, 2020), and only 71 per cent of people surveyed were functionally literate.[7] In addition, only about 16.5 per cent of adults in Brazil attain a tertiary education (PNAD Educação, 2019), and while young women are 42 per cent more likely to attain tertiary education than young men, they are less likely to be employed. While over 80 per cent of primary and secondary education students are enrolled in public education institutions, over 75 per cent of tertiary students enroll in private universities (OECD, 2019*b*).

At the high school level, Brazil participates in the Programme for International Student Assessment (PISA) examination, an internationally normed assessment which measures the scholastic achievement of 15 year olds in mathematics, science and literacy. In 2018, Brazil performed below the OECD average in all three subjects, with the largest difference of more than 100 points in mathematics. The percentage of low performers in all three subjects was 43.2 per cent, one of the highest among participating countries, and only 2 per cent of students attained marks demonstrating high proficiency in literacy. In addition, data submitted regarding education context showed that Brazil had one of the highest student:teacher ratios (OECD, 2019*a*).

7 Functional literacy here refers to the ability to read and interpret minimal levels of text, e.g. news articles. For more information see Statista Research Department (2020).

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Digital Solution

The Letrus Writing Skills Program seeks to contribute towards building a fully educated country, a more qualified workforce and citizens with critical thinking able to exercise citizenship through the development of writing skills.[8] Letrus uses a combination of Artificial Intelligence (AI) and human feedback to reduce the time between submission and feedback to students, provide extensive and meaningful positive as well as corrective feedback, and reduce teacher workload. The platform enables personalized learning and responsive feedback for both students and teachers and further empowers the learning process through providing the information necessary for teachers to target pedagogy towards addressing student errors. An added benefit is that Letrus provides a practical solution to large class sizes by automating parts of the essay-grading process.

Students in participating high schools write freely in response to writing prompts on the Letrus platform and are able to keep track of their word count and time remaining. The platform also automatically saves essays periodically. As a student writes, the Letrus Automated Writing Evaluation (AWE) algorithm analyses the text, and once the essay is submitted, the student receives instantaneous feedback on performance related to writing norms and composition structure, together with comments to guide improvement.

Following this initial feedback, the essay can be evaluated by human graders who have access to the essay and the results of the AWE algorithm.[9] Human graders can assign additional scores, adjust grades and comments and assign the final score to the student within three days. Final scores provide a grade per skill for a maximum of 200 points, aligned to the official grading scale used by the ENEM.

As students are writing, information such as progress towards completion, average scores for structure and skills as evaluated by the AWE algorithm are provided to teachers on a personal class dashboard. Teachers can follow the progress of students on the writing task and monitor if they have logged in, started writing or finished the task, and view real-time feedback in aggregate and for individual students. Information on common errors across the class can be taken up for instruction or remediation, and teachers are able to view and adjust comments made to individual students.

Developing the digital solution technology

To develop Letrus, a minimum viable product was developed which allowed students to submit essays to the Letrus platform following the ENEM model. These essays were assessed by graders trained and experienced in the ENEM criteria, and formed part of a database of 56,644 ENEM and Letrus platform essays that were analysed to identify patterns in the style, content, grammar and structure of excellent essays. This analysis resulted in eight text indicators: words, connectors, spelling mistakes, colloquialism, paragraphs, sentences, social agents and social intervention elements. The iLetrus Index is the AWE algorithm used to interpret the essay through these text indicators to arrive at a score for the text. An additional resource, iLetrus Levels, automatically attributes a level from 1 to 5 for essays submitted.

iLetrus is built using deep neural networks and feature engineering. Deep neural networks are AI programs with multiple layers of processing between the inputs and the outputs (Witten et al., 2017). In this case, the first layer processes individual textual elements (i.e. performs calculations between words and sentences),

8 For more information, see https://www.facebook.com/Letruseducacao (August, 2020).

9 Letrus also developed and tested a fully-automated feedback process. See the 'Results' and 'Further developments' sections for more details on the AI-only program.

and a second layer performs calculations based on these outputs to score the composition (i.e. performs calculations between sentences and the essay in full) (Fonseca et al., 2018). Feature engineering is a way of preparing unique data inputs (or features) to maximize the performance of the algorithm (Rençberoğlu, 2019). In Letrus, 681 feature values are mapped for relevance across the five ENEM skills: 1) adherence to formal written norms of Portuguese; 2) conformity to the argumentative text genre and the topic; 3) selection, organization and interpretation of data and arguments in defense of a point of view; 4) usage of argumentative linguistic structures; and 5) elaboration of a proposal of intervention to solve the problem in question. The feature engineering approach is used to continuously evaluate the essay as it is written, and the deep neural network approach is used when the student completes the essay.

Comments on the platform respond to specific text indicators (e.g. the use of conjunctions, spelling, length of paragraphs, etc.). Essays also receive a general comment and comments on the five specific ENEM skills. Comments are randomly chosen to respond to specific sets of challenges and levels of achievement, and many will provide a model response. For example, an essay with a poor introduction may generate a comment with an example of a good introduction for the student to refer to.

Implementation

The Letrus platform is accessed by students and teachers with a programme of support implemented in schools. The Letrus team involves school management and teachers in the partnership and provides support with setting a writing timetable for the school, on-site registration and training in order to orient teachers to the platform and its capabilities. Letrus also has a dedicated support team, including a pedagogical advisor, who assists teachers and students on their learning pathway.

In addition to assisting with implementation of the programme with students, the Letrus team supports teachers to interpret the results presented on their personalized dashboard to inform pedagogical practices. As the Letrus programme is designed to empower teachers as the curriculum and instruction leads, teachers are the point of contact between Letrus and the school, and are able to contact the Letrus team via a chat function on the platform or directly to query results, request support and give their own feedback. While students are not encouraged to contact Letrus for pedagogical support, they may contact Letrus via a contact form on the Letrus website for technical support such as logging onto the platform or questions about submitting essays.

In the midst of the COVID-19 pandemic, the schools in the Sesi Education Network of Mato Grosso do Sul intensified investments in technology-based education to maintain learning. In preparation for ENEM and other entrance exams in the country, students are improving their writing techniques through the Letrus platform.

'Sesi chose to invest in Letrus because it is a platform with adherence to all the technology that the Sesi schools offer, including artificial intelligence, and also due to the wide initial receptivity we had with students in a pilot phase. Sesi's schools are always aligned with the most modern and advanced tools available in the country and in the world,' said Sesi's superintendent, Bergson Amarilla.

Through AI, the Letrus program allows students to write essays and obtain immediate feedback on the structure of the text, regardless of the chosen theme. Simultaneously, the teacher receives an individualized analysis of the student's work and can create more effective classes to assist students to improve their writing skills. The platform also minimizes the work of the teacher, who would otherwise spend hours correcting students' texts, and enhances the performance of teachers in the classroom.

'Letrus software is able to recognize the spelling and grammar of each student, whether the language is colloquial or formal, the argumentative pattern and whether there is a proposal for social intervention, as required by the ENEM test,' Sesi's education analyst Gláucia Campos explained, adding, 'the teacher's role becomes even more strategic and fundamental. They start to have a basis to reorient teaching practice and manage the classroom.'

Source: Com startup de inteligência artificial, as escolas do Sesi de MS aprimoram a redação dos alunos (original: Português). Fiems (2020). https://www.fiems.com.br

Enablers and supports

Letrus staff

The Letrus team consists of 72 staff members which includes a technology and pedagogical team. As a multi-disciplinary innovation, the technology and pedagogical teams work closely together to develop and refine Letrus products. The technology team is primarily responsible for maintaining, testing and refining the algorithm and other technology tools and developing new products using input from the pedagogical team. The pedagogical team develops content such as comments, supports teachers and trains Letrus graders.

Letrus graders

Letrus graders access an additional platform where they can see essays available for correction and are paid per correction. The number of graders fluctuates based on the demand of schools, and selection processes are periodically conducted for new graders. An initial analysis of work history prioritizes candidates with a history of working with examinations and grading and/or teachers. Stage two of the selection process involves a practical essay grading test. Graders are selected not only based on technical grading accuracy and skill, but also on the language and orientation of their feedback, with a preference for those who use developmental and motivational feedback styles. Selected graders attend a training on the text genres, criteria for grading and structuring developmental comments for students. After training, graders are added to a database of individuals who can access the grading platform.

Technology

A number of existing technologies and technological resources supported the development and support the ongoing delivery of Letrus.

The technologies used in the development of text indicators were a Python Natural Language Toolkit (NLTK) library and NLPNet. NLTK is a platform which supports the development of Python programs that can work with human language data.[10] NLPNet contributed to the analysis through automating processes such as part-of-speech tagging (e.g. labelling a token or word such as 'quickly' with metadata that identifies it as an adverb).[11] Together these technologies supported the initial analysis used to construct a gold standard corpus[12] (in other words, a reliable collection of language data suitable to inform the algorithm training).

iLetrus also makes use of a spell checker to identify words which are outside of the parameters of formal written Portuguese, such as typos, spelling errors and jargon, and provide suggestions for substitutions. The spell checker rules allow developers and facilitators to understand common weak spelling points of students and provide schools, teachers and students with precise feedback which explains mistakes and provides examples to improve understanding. For the development and maintenance of this resource, the main technologies adopted were the Spell Checker algorithm (including handcrafted rules, ElasticSearch[13] and Levenshtein distance),[14] dictionaries, the Letrus corpus and a general Brazilian-Portuguese Language corpus.

In addition, the Letrus platform incorporates plagiarism detection using a resource which identifies the rate of similarity between an essay finished on the platform with other texts in the Letrus plagiarism data bank, which includes the writing prompts and motivation texts presented by the platform to the student as well as texts from the web.[15]

10 For more information, see https://www.nltk.org

11 For more information, see https://pypi.org/project/nlpnet

12 A 'corpus' refers to a collected body of text within set parameters, stored as an electronic database. For more information, see https://courses.helsinki.fi/sites/default/files/course-material/4433684/070916part2.pdf

13 For more information, see https://www.elastic.co

14 The Levenshtein distance equation measures the minimum number of changes (such as adding, subtracting or replacing a single letter) required to transform one word into another (for example, the Levenshtein distance between 'boy' and 'toy' is 1). For more information, see https://dzone.com/articles/the-levenshtein-algorithm-1.

Partnerships

Letrus seeks to build solid partnerships with research centres and organizations that share the programme's orientation to education development. Academic partnerships have been formed to share knowledge with the Institute of Physics at the University of São Paulo and the Pontifical Catholic University of Rio de Janeiro. The former focuses on a textual evaluation automation project, and the latter leverages the research database of Professor Erica Rodrigues to build an algorithm to map students' writing processes. Academic partnerships also informed the expertise in linguistics necessary to build the Letrus AI.

Partnerships have also contributed to the assessment of the programme, including partnerships with the Abdul Latif Jameel Poverty Action Lab (J-PAL), the Lemann Foundation, Espírito Santo State Education Department, the Center of Public Policies and Education Assessment (CAED), and the Sao Paulo School of Economics (FGV - EESP).

15 This similarity index is calculated following the n-gram based containment measure, described by Barrón-Cedeño and Rosso (2009).

Student's voice

'The Letrus platform is a great benefit that the school offers us, because in addition to training for writing an essay, we can find and correct our mistakes. We are increasingly prepared for entrance exams and know how to argue about several current issues.'

Isadora Gotardo, 3rd grade high school student,
Sesi Campo Grande School (*Escola do Sesi de Campo Grande*)

'Letrus has helped me a lot this year. It provides information on how to improve my writing, and has been helping me to develop texts that are increasingly grounded and cohesive.'

Diego Soares Ribeiro, 3rd grade high school student,
Sesi Capital School (*Escola do Sesi de Capital*)

'Using the platform to practice writing has been very good, because, in addition to bringing texts from different themes, it makes notes on what we need to improve our ability. In our writing classes the teacher's partnership with the tool makes us realize how much we are able to write better and better.'

Maitê Louise Falbo Oliveira e Silva, 8th grade primary school student,
Sesi Três Lagoas School (*Escola do Sesi de Três Lagoas*).

Source: Com startup de inteligência artificial, as escolas do Sesi de MS aprimoram a redação dos alunos (original: Português). Fiems (2020). https://www.fiems.com.br

Monitoring and evaluation

The platform includes back-end analytics which monitor the engagement of students and teachers, including the number of written essays per number of registered students in each activity and the number of teachers who access the platform monthly. The platform and its AI algorithms are also monitored for quality over four levels:

01 Outputs are validated periodically to ensure they are accurate (e.g. ensuring that spelling errors identified by the AI are actually spelling errors, etc.). This assists with identifying areas in which the AI algorithm needs to be retrained.

02 Comments are collected by the humans interacting with the program, primarily Letrus graders, teachers and students. Feedback is used to identify additional areas which may need adjustments. Letrus's partnerships with language professionals are also a critical resource at this level.

03 Academic partnerships assist with directed research that validates and improves Letrus technology. This monitoring and evaluation is linked to the development of new functionalities and products.

04 Large-scale partnerships with research organizations and foundations assess impact and contribute to Letrus product development. Evaluations conducted to date have included research to analyze student improvement through the programme and a large-scale randomized control trial.

Results

Reach

At the time of the award, the Letrus Writing Skills Program had been used by over 44,000 students in schools in all 26 states in Brazil, totaling over 200,000 essays made on the platform.

Engagement

In 2019, a partnership with the State Department of Education of Espírito Santo took the use of Letrus to 54 municipalities, reaching 12,000 students and 400 teachers from 110 schools. In this project, the average engagement of students was between 75 per cent and 80 per cent, and 95 per cent for teachers.

Performance

In an analysis of the evolution of students' grades and performance on specific text indicators conducted in 2019 with public schools in Espírito Santo, students using Letrus demonstrated an average of 10 per cent improvement and were found to write 32 per cent more essays than a control group. Ninety per cent of schools improved their grades.

Ferman et al. (2020) engaged in a stratified randomized control trial to determine the impact on student performance of two versions of Letrus, the first incorporating human feedback and the second relying on the AI alone. Each of these treatment groups included 55 schools, with 68 control schools. Data was gathered from the Letrus platform, the 2019 ENEM essay, additional writing samples, and survey questions regarding demographic information and information on school practices and perceptions from teachers and students.

Findings included that both versions of Letrus resulted in significantly improved student essay scores over the control group, and that the inclusion of additional inputs from human graders did not improve the effectiveness of the Letrus program. The research suggests that teachers did not simply delegate tasks to the AI but filled in the gaps in the pure technology solution. As a result of these findings, Letrus dedicated more effort to developing the AI-only option in order to lower costs and increase access.

A further significant finding was that the use of Letrus could mitigate 9 per cent of the public-private achievement gap in ENEM essay scores, with a reduction of 20 per cent in the skill-specific gap (reported nationally to be 80 per cent).

Finally, the research measured control and intervention group performance on writing in the narrative genre, literacy skills and non-literacy skills. Findings indicated that improvements were limited to argumentative essays specifically, without significant spillover effects into other genres or subjects.

Challenges

Letrus is still working to determine both the best model and the best methods to ensure the company is financially sustainable while reaching its largely vulnerable target audience. This is a significant challenge and has resulted in a shifting model as different avenues are explored.

Reaching target beneficiaries

The company originally explored a direct-to-student purchase option, in which individual students could pay for access to the platform and support. In this model, private schools were provided access with no direct cost, but would assist Letrus in selling the program to students as a co-curricular support for use at home.

This model has been discontinued in favor of a direct business-to-business model in which schools pay for the service, or a business-to-government model in which the government will procure services for schools. However, challenges remain. Many of the schools which serve vulnerable students are public institutions and do not have the revenue streams to support Letrus. At the government level, there are both buy-in and logistical challenges to overcome: it will require a high degree of political will to achieve the government investment necessary for national implementation of Letrus.

Municipal governments, which are mainly responsible for access to and funding for primary grades, provide an access point to public schools that may have less bureaucracy and offer an equitable solution at a smaller than national scale. However, fitting into this market requires adjustments to the product.

Affordability

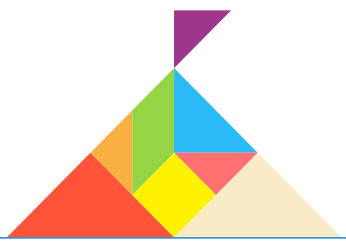
The company is considering a sliding scale model, in which cost is linked to the scale of implementation.

While the implementation and support of the model requires some funding, Letrus is also committed to decreasing the cost of the program as much as possible. To this end, Letrus is exploring different levels and components of support. As of December 2020, Letrus offers both an AI-only option and one which includes a human grader. In either option, a percentage of text is validated to ensure the AI is still appropriate and accurate.

Infrastructure

Both hardware and an internet connection are necessary to run the Letrus platform and program, and one challenge noted is that access is still an issue Brazil is facing as a country.

To make all possible accommodations, the program was built to be lite software which can run on a lower connection speed, as well as on devices such as smartphones. Additionally, while the programme model was designed to be flexible and does not require all students to write simultaneously, participating schools were required to have a computer:student ratio of at least 1:20.



Further developments

Since winning the UNESCO prize in 2019, Letrus has grown to a total of 72 staff members and has expanded its scope to 957 schools, 1,327 teachers and 116,677 students. Over 456,000 essays have been submitted to the portal.[16]

In addition, Letrus has begun testing a version of its software designed for Grades 6 to 9 in order to reach students earlier in their academic careers, as well as adding additional genres such as descriptive, narrative and news articles. This introduces a new set of challenges, as at the high school level a large quantity of essays and specific criteria were available. The Letrus team now faces the challenge (which is also an opportunity) of helping learners develop along a trajectory of skill in the lower grades.

On the technology side, Letrus is working to improve the relevance of platform monitoring. In addition to monitoring general use by teachers, Letrus now monitors how frequently teachers open reports, which will provide more information on how teachers use the platform and how they can be better supported. Letrus also plans to integrate monitoring on the behaviour of writing, such as how often students revise or review their work, and to provide general feedback on the writing process of students as well as their writing performance. In 2020, Letrus also launched an app version of its program for students.

Letrus has a five-year vision to become financially sustainable and access wide education networks and particularly support public schools from elementary to higher education. Letrus plans to expand to other Latin American countries and has a broad goal to increase the scale and quality of their services at a price point accessible to citizens of any age.

Founder's Story

When Letrus co-founder Luis Junqueira was a student at the Institute of Language Studies at the State University of Campinas, he came to realize the impact writing and freedom of expression can have. From his own experience as a teacher, he then launched the First Book Project (*Projeto Primeiro Livro*) to help children and adults publish their own books. Learning from the challenges they encountered led him to create the Letrus Program (UNESCO, 2020).

16 Figures as of December, 2020.

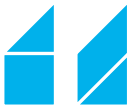
Impact of the Prize

Letrus was awarded the UNESCO-King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education 2019 during the height of the COVID-19 pandemic. During this time, many schools around the world, including in Brazil, closed to contribute to efforts to contain the virus, leading in turn to an anxiety on the part of teachers, parents, governments and international organizations that existing learning divides would widen.

Given this context, Letrus decided to allocate the funding received from the prize to funding the use of Letrus in public schools for a semester to assist in reaching students during quarantine. The Letrus team first provided a lite version of the software for two months to public schools, but when it was understood quarantines would be prolonged and schools would continue to be closed, Letrus shifted this implementation to a six-month programme which included the remote support of its team with chat support and training to help teachers understand the activities and program.

Although Letrus received the prize during a time when the world focus was on the COVID-19 pandemic, receiving the award did lead to increased publicity and a deep sense of pride for the organization. As a result of the award, Letrus has appeared in seven national and international articles and has made a television appearance, and the organization has noted an increase in its social media followers. Letrus has also forged closer ties to UNESCO in Brazil and is exploring opportunities to collaborate both in knowledge-sharing and in UNESCO Associated Schools.

The Letrus team mentions the prize proudly in every presentation to programme participants and partners, and has found the prize to be valuable in enhancing the organization's reputation, both in terms of the award itself and by placing an international focus on using technology to improve education.



'We wanted to offer support for schools in general, a platform to practice and develop writing skills remotely or in the hybrid education model.'

Interview with Letrus, September 2020

'The theme 'Using AI in Classrooms' caught our attention. What we want is to use AI to fulfill students' needs and help them progress, and to support educators in their teaching practice. We were very aligned with what the prize wants to promote.'

Interview with Letrus, September 2020

'The award symbolizes that we are moving in the right direction and that the trail now has more light and possibilities to open new doors in the future.'

Letrus co-Founder Luis Junqueiras, Press Release Point, 2020

Source: Letrus (2020)

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Dytective

2019

Change Dyslexia

Gamified dyslexia risk detection

Theme
The use of AI to innovate education, teaching and learning

Location
International

Date started
2016

Beneficiaries
246,548 users in total (screened)
141,167 accounts formed
(by year 3)

Target population
Students and adults with dyslexia

Digital solution
A detection and cognitive stimulation platform for dyslexia using machine learning and scientific validations in educational settings

Summary

Achieving reading fluency is considered a critical component of empowering individuals to participate meaningfully in society and is a major contributor to improved livelihoods. However, globally up to 250 million children are unable to acquire basic literacy skills.[1] While there are many factors which contribute to poor learning outcomes, one widespread challenge is developmental dyslexia, a reading-specific disability, which, by some estimates, may affect 5 to 10 per cent of the global population (Al-Lamki, 2012; Gibbs and Elliott, 2020). Despite being common and accounting for up to 80 per cent of those diagnosed with learning disabilities (Shaywitz, 1998), developmental dyslexia is still under-diagnosed and often goes untreated. This can result in school failure (Rello et al., 2016), negatively impact workplace performance (Morris and Turnbull, 2007), and reduce social independence.[2]

Change Dyslexia is a Spanish company that has leveraged linguistic knowledge and AI to develop a screening tool for the early detection of dyslexia, and a game-based environment enabling learners with dyslexia to practise important skills. The main aim of the company is to prevent school failure through the timely identification and support of learners with reading difficulties.

Its Dytective screening tool uses AI decision trees to analyse the mistakes users make in a series of timed, gamified language exercises such as selecting the correct spelling of a made-up word or correcting the errors in a passage. In about 15 minutes, the free screening tool is able to predict dyslexia with about 70 per cent accuracy, greatly reducing the time and monetary commitment usually needed to identify reading difficulties. Learners can then subscribe to DytectiveU, a personalized learning platform which provides game-based exercises proven by research to help children overcome reading and writing difficulties.

Why selected

Dytective was selected for the Prize because of the following features:

- The use of AI techniques to analyse types of errors and support the early identification of dyslexia in Spanish, a language with a transparent orthography.
- Attractive games based on empirical analyses of a corpus of linguistic errors, which provide personalized learning to improve reading outcomes.
- The high degree of accurate identification offered by the free AI screening tool, which in tests detected nearly 80 per cent of participants with dyslexia, and its wide reach to over 289,000 people in 55 countries.
- The empowerment of families and therapists with detailed reports about children's cognitive skill development, which can improve the effectiveness of dyslexia therapy.
- The dedication to reducing socio-economic barriers to dyslexia treatment through scholarships for underprivileged students.

1 See https://en.unesco.org/themes/literacy

2 See https://dyslexiaida.org/dyslexia-basics

Programme

PROBLEM

Due in part to the high cost and time commitment required for diagnosis, dyslexia often goes unnoticed or is diagnosed too late for effective intervention.

SOLUTION

- Dytective: An online gamified test underwritten by an AI algorithm, which screens for dyslexia in Spanish;
- DytectiveU: A developmental, platform-based, personalized learning support tool for people with dyslexia.

BENEFICIARIES

Over 289,000 users in 55 countries on 5 continents

RESOURCES REQUIRED

- Online connection
- Digital devices

RESULTS

- Dytective accurately predicts up to 80 per cent of participants with dyslexia.
- Users of DytectiveU demonstrate significant learning gains in only 8 weeks.
- 329 scholarships were awarded to families in need.

CHALLENGES

- The needs and preferences of different user groups require different interfaces and languages, which can be costly to create and adapt.
- It is difficult to ensure added value for all target beneficiaries, children, schools, therapists and families.

Profile: Implementing agency

Change Dyslexia is a social enterprise based in Barcelona with a mission to solve the large-scale problem of reading difficulties through the application of technological solutions. It offers a mix of AI, computer games, linguistic studies and data to identify and support students with reading difficulties broadly and dyslexia in particular. Through these efforts, the organization seeks to reduce the incidence of poor scholastic achievement. Luz Rello is the founder and CEO of Change Dyslexia. Its products integrate her findings from over eight years of research conducted at Pompeu Fabra University in Barcelona.

> Congratulations on this wonderful application! My school children are super motivated and the best of all are the great results they are having.
>
> **Mi Mochila Especial AL (speech and language therapist)**
>
> *Source*: Change Dyslexia (2019)

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Context

In *The Teaching of Reading and Writing* (1969), Gray defined literacy as the 'ability to read an easy passage and to write one's name or a simple message' (p. 20), and functional literacy as the ability to 'engage effectively with all those activities in which literacy is normally assumed in his culture or group' (p. 24). While the definition and scope of those activities have expanded over time to include media literacy, digital literacy, transversal literacy and so on, the development of both literacy and its application to different domains in society has remained a core element of formal education as well as development initiatives (Shiohira, 2019).

The ability to read and write is an unnatural process bolted onto other functions in the human brain. Generally, reading involves processing visual information such as written text, 'translation' between those visual symbols and the sounds they represent, and engagement of the faculties leveraged by the brain in the production of meaningful speech (see for example Coltheart, 1978; Coltheart et al., 2001). While the ability to comprehend and produce oral language has been described as a developmental but innate ability (Chomsky, 1957), written language requires explicit instruction to each new generation.

Wolf (2008) describes stages of literacy learning from oral language development and early literacy concepts such as text direction, through degrees of proficiency related to decoding skills (the ability to connect written letters to the sounds the represent), to fluent comprehension and finally expert reading, the stage at which readers learn from and draw connections between a wide range of text types on various topics from multiple perspectives.

The timeline of this progression is affected by a number of factors including the language of the literacy learner. The writing systems of languages (known as orthographies) range along a scale from 'opaque', meaning there is a notable degree of inconsistency in the way sounds are represented by letters or combinations of letters, to 'transparent', meaning there is very little inconsistency, and the same combinations of letters consistently result in the same sound (Cuetos and Suárez-Coalla, 2009).

According to Démonet et al. (2004), developmental dyslexia is a specific reading disability in which children with normal intelligence and sensory abilities exhibit learning deficits in reading. Essentially, while all the components of the brain used for reading are functioning normally, in people with dyslexia, the required neural connections between letters and sounds are partially or imperfectly formed. People with dyslexia often demonstrate challenges in phonological awareness, or the awareness and manipulation of discrete sounds, and there is some evidence that dyslexia correlates to challenges with visual attention skills. Symptoms of dyslexia include difficulty with accurate and fluent reading, poor recognition of words, and frequent spelling errors. Further, empirical analysis has shown that the errors made by individuals with dyslexia are different from common reading errors among the general population (Rello et al., 2016).

Despite being widespread, dyslexia is still under-diagnosed and often goes untreated. This is the case even in developed countries like the United Kingdom, where only 5 per cent of dyslexic individuals have a diagnosis (Rello et al., 2016). Internationally, 15 to 20 per cent of the population is estimated to be living with dyslexia (International Dyslexia Association, n.d.). There are approximately 3.6 million children with dyslexia in Spain, Argentina, Mexico, Chile and Colombia, the countries in which the company operates (Change Dyslexia, 2019).

In fact, dyslexia has been called a 'hidden disability' (Morris and Turnbull, 2007) due to the difficulty of diagnosing it. It is even more difficult to diagnose in languages with transparent orthographies, as the symptoms of dyslexia are less severe (Rello et al., 2016; Serrano and Defior, 2008).

Dyslexia is related to high rates of school failure (Rello et al., 2016) and can lead to difficulties in work and everyday social interactions as well (International Dyslexia Association, n.d.). In a study conducted by Morris and Turnbull (2007), it was found that dyslexia negatively impacts workplace performance as well as career progression.

However, dyslexia does not affect general intelligence, and people with dyslexia can learn coping strategies to deal with its negative effects. Unfortunately, the most common way for Spanish speakers to learn that they might have dyslexia is through school failure, when it may be too late for effective intervention. Traditional methods of diagnosis and screening require professionals to collect performance measures related to reading and writing via a lengthy in-person test consisting of activities such as reading words, pseudowords and passages, and answering comprehension questions. Performance is measured using indicators such as reading speed (words read per minute), reading errors, writing errors and text comprehension. These methods and their requisite professional oversight are quite costly (Rello et al., 2016).

> We found if we integrate the linguistic patterns we found in the mistakes people with dyslexia make into computer games we can significantly improve the performance of children with dyslexia. We integrated all this research into our platform Dytective so that every child in the world can have access to screening and treatment through play. So these children, if they work, they won't fail, and they will be able to dream.
>
> **Luz Rello, Founder and CEO, Change Dyslexia**
>
> *Source*: Change Dyslexia (2018)

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Digital Solution

The goal of Change Dyslexia is to reduce the incidence of school failure that is caused by dyslexia and associated reading difficulties in Spanish, through a multidisciplinary approach using computer games, linguistics and data mining.

The goal of Change Dyslexia is to reduce the incidence of school failure that is caused by dyslexia and associated reading difficulties in Spanish, through a multidisciplinary approach using computer games, linguistics and data mining.

Change Dyslexia's free online screening service for reading difficulties is the first step in assisting families, schools and caregivers to support students. This service is comprised of an online gamified test called Dytective and an associated predictive machine learning model. The test is designed for ages 7 to 17 and can be completed in about 15 minutes. The accuracy of the screening tool varies with age and medium, but is higher than 70 per cent for most groups (Rello et al., 2020).

While machine learning techniques are broadly used in medical diagnosis, in the case of dyslexia exploration into technology for screening or diagnosis has largely been limited to eye-tracking measures, which use sensors to determine variables such as the length of time spent on each word or the number of times the eye jumps forward or backward while reading a given text. However, Dytective is designed to screen for dyslexia using a gamified online test and associated machine learning algorithm. The design of the test incorporates principles of language acquisition and specific linguistic skill sets related to dyslexia, such as phonological awareness, reading speed, and visual attention skills, and the underlying algorithm uses a Random Forest Classifier model. In this model, a series of decision trees individually divide data into groups based on shared characteristics and issue a prediction (Yiu, 2019). If the majority of the decision trees that make up the 'forest' predict that the user exhibits signs of dyslexia, the screening tool gives this as a likely conclusion. To increase the probability of detection, the exercises were designed using a corpus of real errors committed by individuals with diagnosed dyslexia. A study of 243 children and adults, 95 of whom had diagnosed dyslexia, revealed differences in not only the extent but also the type of errors made by those with and without diagnosed dyslexia (Rello et al., 2014).

The different skills addressed by the tool are structured according to the order in which they are naturally acquired. As a result, the exercises which appear earliest are the easiest for people with dyslexia as well as younger children to complete. Higher difficulty levels include words which are longer, less frequent, appear or sound similar to other words and/or involve elements of complexity such as letter blends (such as the 'str' in the English word 'straight').

Dytective players proceed through a series of timed stages of increasing difficulty, with the goal of solving as many linguistic problems as possible within the time limit. For example, players may need to correct errors in a written passage, or hear a series of made-up words and select the correct spelling from a list of options on the screen. Dytective has 32 linguistic exercises in total. The algorithm presents a likely diagnosis based on the performance of players and the errors they make (Rello et al., 2016). The Dytective tool is notable for the speed at which a diagnosis can be presented, its high degree of accuracy, and the fact that it engages learners who have already achieved a degree of literacy, as similar products often target pre-readers.

DytectiveU, a scientifically validated tool to improve reading performance, forms the second part of the solution. DytectiveU is aimed at the same age range as the test, and contains more than 45,000 exercises targeting 24 different cognitive skills related to dyslexia. Children engage with it for three to six months, during which time they can complete all the challenges of one

'world' of the game. Two more worlds are available for those requiring further training, extending support to over a year.

Based on linguistic research into the errors that dyslexics commonly make, the exercises can be accessed via the Change Dyslexia website or through the Dytective app on Android or iOS. The platform not only targets dyslexia but also highlights the strengths of individual students. As they complete activities, an algorithm compares their various cognitive skills to age-based norms and provides levelled exercises based on their performance. In this way, the games adapt per cognitive skill, so children engage in harder exercises in their areas of higher competence.

DytectiveU also offers detailed reports on cognitive skills for the use of professional therapists, enabling evidence-informed treatment, while families benefit the improved academic performance of their children (see Rello et al., forthcoming). While DytectiveU is available through paid subscriptions, families in need can apply for various scholarships which eliminate 80 to 100 per cent of the cost. These are provided by social services, ministries, and relief agencies such as Caritas,[3] to improve access to DytectiveU for underserved and socio-economically disadvantaged populations.

3 See https://www.caritas.org

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Implementation

As an online screening tool and platform, Dytective and DytectiveU are available in Spanish from any location with an internet connection. Individual as well as bulk licences can be purchased, and Change Dyslexia primarily engages four types of consumers:

- Individual Spanish-speaking families concerned about their children's reading performance;
- Schools that wish to screen for dyslexia among their student population;
- Public education institutions, districts, states or research institutes that wish to screen at a larger scale for dyslexia; and
- Professional therapists who need a screening tool for their clients.

The value proposition of Change Dyslexia is to offer screening and support at a lower cost than traditional interventions,[4] with gamification that allows children to enjoy playing while scientifically improving their reading performance. For therapists, the inclusion of Dytective and DytectiveU can increase the reliability of their services, and the reports generated by the platform provide a record of engagement and/or progress that can be shared with parents. Participating therapists are also included in the Change Dyslexia online directory.[5] Moreover, schools and public institutions can benefit from cost-effective methods for detecting and treating dyslexia at scale, and a reduction in the number of students dropping out.

In addition to being backed by the academic institutions, Change Dyslexia has attracted the support of various international bodies. The company has been financed through short-term personal loans to the founder, a crowdfunding campaign which earned US$30,000 in 2016,[6] and several grants and awards:

- 2018 Cartier Women Initiative Award (US$35,000)
- 2016 Princess of Girona Award for Social Good (€10,000)
- 2016 Social Entrepreneurship Grant from Obra Social 'La Caixa' (€25,000)
- 2015–2018 Ashoka Fellowship (€108,000)
- 2015 Solidarity Talent Award from the Botín Foundation (€10,000)
- 2013 First Prize in the Vodafone Foundation Mobile for Good Europe Awards (€25,000)

Further financing comes through licence sales. Bulk licence packages have been sold to public institutions, including the councils of education in Madrid and the region of Murcia, as well as corporations and over 300 public schools.

Change Dyslexia started with one employee and now has four, along with an advisory board and a scientific board, which are both comprised of research collaborators and mentors. The advisory board assists with networking, strategy and negotiation with larger institutions, and the scientific board provides feedback on fitting the product to market expectations.

4 The cost of a professional diagnosis of dyslexia ranges from €300 to €1,000, with a time commitment ranging from 30 to 40 hours. Dytective offers a screening tool at a much lower cost. However, the tool cannot be considered as a substitute for professional diagnosis.

5 The directory can be accessed at: https://www.changedyslexia.org/directorio-dislexia-terapeuta-logopeda-psicologo-colegio

6 The return for the crowdfunding was licences that enable access to the tool.

Monitoring and evaluation

The monitoring and evaluation focuses on both the platform and the social impact. Platform monitoring includes statistics such as numbers of beneficiaries, numbers of diagnoses, and quantitative improvement in reading skills. Dytective also allows a qualitative feedback loop from families and schools via email or social networks. Data from the prediction model is enriched with research that is based on information from professional therapists.

In terms of evaluation, the validity of the algorithm of Dytective was investigated in a user study with 4,039 Spanish-speaking participants, including 496 with formal diagnoses (11.6 per cent), recruited through dyslexia centres and associations. Participants without dyslexia were recruited through schools. Overall, 103 organizations from Argentina, Chile, Colombia, Spain and the United States participated in the study: 3 universities, 60 primary and secondary schools, 22 specialized centres that support people with dyslexia, and 18 non-profit foundations and associations concerned with dyslexia. In the study, children and adults aged 7 to 70 independently played a 32-question game for 15 minutes. Data collected on each participant included the numbers of clicks, correct answers (hits), and incorrect answers (misses).

At the level of social impact, dropout rates and scholastic performance are being tracked in 100 public schools in collaboration with the Education Council of Madrid to measure the effect of Dytective.[7] Research using data drawn from DytectiveU is also currently being carried out at the Ministry of Education of Murcia by researchers from *Universidad Rey Juan Carlos* and *Centro de Estudios Monetarios y Financieros*.

7 Results will be available from 2024, when the current cohort of learners reaches secondary school.

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Results

Change Dyslexia made Dytective available for the first time in 2017. By 2019, it was the most used dyslexia screener online, with almost 250,000 users in 43 countries accessing the free tool, resulting in 141,167 registrations. That same year, more than 150 schools around Spain used Dytective, and 250 families received free treatment grants from Change Dyslexia. By 2020, a total of 285,188 children had been reached and 329 scholarships awarded.

Research involving more than 3,600 participants found that the Dytective model correctly detected dyslexia over 80 per cent of the time, and another study with over 1,300 participants and age-customized tests resulted in accuracy rates of at least 60 per cent for all age groups. Regarding DytectiveU, significant differences between a control and intervention group were observed after eight weeks of using the platform. It was also found that adherence to the use of the platform is higher when a professional therapist is providing supervision (Rello et al., 2020).

Further developments

Change Dyslexia is developing new products, including tools for English and Catalan. Often, simple translations of the tool are not possible, and thorough research is conducted for each of the languages. At the close of 2020, around 20 per cent of the training exercises (10,000 exercises) per language had been completed.

The tool is used by different target groups, and each one requires a different user experience, interface and language. These needs and preferences have to be unified into one tool, which causes logistical challenges and increased expenses. Efforts are also being made to guarantee that the Change Dyslexia model adds value to all stakeholders, including schools and public institutions as well as therapists and families. During the COVID-19 pandemic in 2020, a special promotion code was created offering a 20 per cent discount, which was used 264 times.

Change Dyslexia also plans to launch a language-independent screener for dyslexia. Research in using visual and musical cues to screen dyslexia was carried out by testing 313 children in German, English and Spanish and yielded a 0.69 prediction rate (see Rauschenberger et al., 2018).

From the Judy Sharp Foundation we want to congratulate Luz Rello and appreciate the collaboration with our foundation through the scholarships offered to some of our students. Thanks a lot!

Fundación Judy Sharp, a pioneering foundation for students who have learning disabilities

Source: Change Dyslexia (2019)

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Impact of the Prize

Change Dyslexia was awarded the UNESCO King Hamad Bin Isa Al-Khalifa Prize in 2020, in the midst of the pandemic. Despite the associated disruptions and shadow of COVID-19, the award still brought greater visibility to Dytective and DytectiveU. It contributed significantly to engagement by public institutions and was instrumental in forging the agreements that increased Dytective's access to public schools. As a result of this, the company was able to offer initiatives for the social good such as universal licences for public schools in the Region of Murcia in Spain, which gave children unlimited access from home during the pandemic.

In the days after the award was announced, visits to the Change Dyslexia website and social networks increased by about 20 per cent. Media outlets that covered the Prize included the newspaper *La Vanguardia* and Aecid. In the nine months following the press release about the award, Change Dyslexia was mentioned in 28 news items in print and on TV and radio.

The company is using the funds from the Prize to create the abovementioned new exercises and content in English and Catalan and to improve the user experience and interfaces of the tool. An updated version of Dytective was released in 2021. Additionally, the money is supporting the development of online content for training teachers to use Dytective and gain a better understanding of dyslexia.

I will not get tired of saying it. My child's improvement (7 years old) has been spectacular. But not only in reading and writing, which is phenomenal, but in his smile, in his eyes, in confidence and self-concept, and that excites me so much! Thank you Luz Rello, Change Dyslexia, DytectiveU and Genoveva (her child's therapist).

Ana Lorenzo Lobo, mother

Source: Change Dyslexia (2019)

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One College Student Per Village

2020

The Open University of China

Using artificial intelligence to enable quality learning
For disadvantaged groups

Theme
Use of AI to enhance the continuity and quality of learning

Location
China

Date started
2004

Beneficiaries
825,827 learners (68.25 per cent male, 31.75 per cent female)

Target population
Young people and marginalized communities

Digital solution
A smart learning platform created for both online and offline learning environments, aimed at learners in rural and remote areas

Summary

In 2004, there were 780 million people living in China's rural and remote areas, accounting for 80 per cent of its total population. In these areas the economy lagged behind, there was a shortage of university resources, and many people had a low level of education. China's Ministry of Education (MOE) launched the 'One College Student Per Village' scheme in order to improve education and alleviate poverty in these areas. The Open University of China (OUC) was entrusted with carrying out the scheme, and adopted digital technology in order to fulfil this mission. In recent years, the integration of smart technologies such as AI and big data has transformed education. The scheme increased the integration of these technologies into its teaching programmes, including agricultural economic management, botany and zoology, with the aim of guaranteeing learning continuity and quality.

In order to ensure that AI was fully applied in the scheme, the OUC enhanced the local educational infrastructure by setting up 538 cloud-based and smart classrooms in high-poverty areas in 31 provinces, municipalities, and autonomous regions. Simultaneously, a smart learning platform and mobile apps for smartphones and tablets were developed to meet learners' needs.[1]

Why selected

The OUC was selected as a Prize-winning organization because of the following features:

- The programme uses AI to provide customized learning plans, select targeted and qualified resources, and give instant and traceable feedback.
- It reduces cost and workload, enabling teachers to concentrate on critical learning needs.
- The programme provides evidence of its outreach and impact in rural areas in China.
- The scheme boosted local economies and enabled more learners to remain in their hometowns.

1 See http://tongshike.multimediapress.cn/video/2020/12/14/20201214160791252298O_6.mp4

Programme

PROBLEM

Inadequate access to quality education for local people resulted in a lack of qualified workers, particularly in more rural areas.

SOLUTION

A smart learning platform created both online and offline learning environments for learners in rural and remote areas.

BENEFICIARIES

825,827 learners, 31.75 per cent female and 68.25 per cent male

RESOURCES REQUIRED

- Mobile devices
- Internet connection

RESULTS

- 529,321 learners have graduated from the scheme
- More than 500,000 village cadres have been trained

CHALLENGES

It was often hard to get a clear picture of what the learners needed, and thus it was difficult for teachers to provide teaching plans that met the needs of learners.

Profile: Implementing agency

Founded in 1979, the OUC makes degree and non-degree education available to all members of society under the direct guidance of the Chinese MOE. One of its most distinctive features is that it is supported by digital technology with the aim of promoting equal access to quality education. Over the past 40 years, the OUC has operated a national system consisting of a headquarters, 45 provincial branches, 14 industrial and corporate colleges, and over 4,000 study centres covering all urban and rural areas in China. As of mid-2020, there had been 15.12 million graduates. Technological advancement in education has served to further the objectives of the university by reaching marginalized communities (Zhang and Li, 2019). In order to assist learners and facilitate educational delivery in rural and remote areas, the OUC has applied technologies like cloud computing, big data, AI and blockchain, helping to realize the UN's 2030 Agenda for Sustainable Development.

Context

China is the most populous country in the world, with 1,447,917,852 people at the time of writing.[2] The country achieved gross enrolment rates of 101.9 per cent in primary schools but only 53.8 per cent in tertiary education in 2019 (OECD, 2020; UNESCO, 2020). Since the 1990s, the Chinese Government has pursued a long-term commitment to balanced development with efforts in infrastructure, policy and programming aimed at reducing these gaps. As a result of these efforts, the number of people living in poverty in China dropped from 689 million in 1990 to 57 million in 2015 (Ministry of Foreign Affairs, China, 2016). However, despite substantial economic growth and poverty reduction, China is not exempt from regional disparities. For instance, coastal regions outperform inland regions, even though coastal regions historically have lower rates of literacy and higher levels of inequality (Fan et al., 2011; Han et al. 2016; Textor, 2020).

Prior to 2004 and the start of the One College Student Per Village scheme, internal migration, particularly towards the coasts, caused additional challenges. Children were not permitted to take college entrance exams in the province where their parents worked, causing many migrant workers to leave their children in their home provinces under the care of grandparents. Local governments in the inland regions therefore bore a heavy burden to educate these children, while their parents worked and paid taxes in more developed regions. Inland regions typically also spent less on education than the coastal regions and many poor families could not afford the cost of meals and boarding, one of the main reasons for students dropping out of secondary schools. Those students who did complete secondary school often did not attend higher education, due to the rigorous entrance examinations and prohibitively high costs (Cai et al., 2002).

The weaknesses of education in rural and remote areas prior to 2004 mainly stemmed from a lack of infrastructure and resources, poor alignment of distance learning initiatives to the needs of learners, inadequate metrics to identify knowledge gaps, and teachers being overloaded with administrative work (OUC, 2020).

2 See https://www.worldometers.info/world-population/china-population

Digital solution

One initiative in which China has long engaged to support development, reduce poverty and improve equality is the establishment of open universities and distance learning in order to promote a culture of lifelong learning among its citizens (Zhang and Li, 2019; Cui, 2018). In this tradition, in 2004 the OUC launched the One College Student Per Village scheme through open and distance education enhanced by digital technology. In 2017, AI technology was integrated into the project in order to create customized learning plans, select targeted and qualified learning resources, provide instant feedback from automated assessments, and decrease the burden of routine administrative work for teachers. As students engage in their coursework and assignments, AI is used to trace each learners' journey. Data is collected on indicators such as professional background, time spent on the platform, clicks on learning resources, message posts, assignment submissions and test scores, and this is then used to analyse their learning habits and needs.

Individualized study plans are developed based on this analysis, and adaptive reminders are used to track and stimulate the pace of learning. Virtual reality (VR) is harnessed in online learning resources to illustrate abstract and complicated content, which is helpful for learners with limited prior education and in remote areas where practical teaching facilities are not available. For example, in the forestry programme, VR can vividly recreate lessons on how to prune fruit trees, just like in the fields.

Learners submit assessments to the smart learning platform, which can give automatic replies to objective questions, while automated essay scoring is used to mark writing assignments. After marking, any relevant knowledge that the learners have not mastered will be provided to them for further study. Teachers can also review the marking results to determine common areas of need and prepare for future teaching sessions.

Finally, a knowledge corpus was set up featuring a smart robot that can answer learners' questions based on spoken or text inputs. This reduces the teachers' workload so they have more time to concentrate on lesson delivery, resource construction, and research.

Implementation

This is both an enjoyable and a rewarding teaching journey for me. As AI robots can help with answering many common questions, I am free from the routine workload…I can spend more time on preparing and reflecting [on] the lectures and conducting academic research. Automated essay scoring is efficient. I don't have to mark these assignments myself, but I can get a clear picture of where learners need help.

Li Guangde, OUC teacher

Source: OUC (2020)

The OUC is a national structure with headquarters in Beijing. Each province in China also has its own open university as well as local centres. The production team and management of the system are centralized at the OUC, which is supported in the delivery of the programme by these provincial open universities and their employees, including full and part time teachers and tutors.

Delivering education at a distance is one of the OUC's greatest advantages. It uses various technologies to supply educational resources to disadvantaged people. For example, over the years it has used audio and video recordings, radio and TV, and the internet. Since the advent of cloud-based classrooms, remote learners can also engage in online face-to-face tutorials. With this programme, the OUC has integrated AI, OERs, MOOCs, small private online courses, flipped classes, online social networking, smart robots and VR. The blended learning models enables disadvantaged groups in rural and remote areas can get access to high quality educational resources.

In order to support national objectives to alleviate poverty, the OUC selected disadvantaged areas in 31 provinces, municipalities and autonomous regions in which to set up county-level study centres and cloud-based and smart classrooms. These areas included Qinghai, Gansu, Inner Mongolia, Xinjiang, Sichuan, Yunnan and Hunan. Currently, there are about 4,000 OUC learning centres nationwide, with 1,513 established in 29 provinces during the One College Student Per Village scheme. The OUC as well as the provincial open universities provided the initial financing and resourcing to equip these local centres with the necessary hardware and software to leverage these technologies. Twenty-nine programmes have been implemented using AI in these 1,513 centres, including 20 degree programmes.

New teachers undergo an orientation that provides training on the scheme, while their more experienced colleagues undergo training biannually, usually during the spring and autumn terms. This training focuses on how to use the smart learning platform, how to upload and download learning resources, how to interact with students, how to conduct tutorials and manage evaluations, and how to analyse students' learning habits and needs using the data collected in order to give customized support and tutorials.

Students are able to access the platform at any time and place via the internet. Their learning profiles are compiled on the platform and analysed so that individual tailor-made plans can be created and their progress can be automatically traced. AI-enhanced robots can also guide learners along different learning paths as a measure to alleviate high teacher-to-learner ratios and reduce workloads.

People in rural and remote areas generally earn a living through agriculture, forestry, fishery or animal husbandry. Therefore, the OUC provides programmes, courses and resources that focus on these industries, with the goal of improving human capital and skills and enabling graduates to run their own businesses or find a job in the local labour market.

Most of the courses are linked to formal qualifications, and students can also apply for professional certificates from industry after studying with the OUC. Some courses such as flower arrangement, folk culture and social etiquette are not linked to formal qualifications but aim to improve quality of life.

With regard to cost, different provinces in the country have different tuition policies and scholarship opportunities. Typically, the tuition fee for a diploma averages US$780 (RMB 5,000). In Hainan Province, the fee is covered jointly by provincial, municipal and county governments, while in Ganzhou Jiangxi Province, it is covered only by the municipal government. In other provinces, the tuition fee is covered jointly by the government and students themselves. For example, in Shenyang City, Liaoning Province, the tuition fee is US$530 (RMB 3,400), of which the government pays US$390 (RMB 2,500) and the balance of US$140 (RMB 900) is covered by the student. In Mianyang Sichuan, the local government pays 80 per cent and the remaining 20 is paid by the student.

Monitoring and evaluation

From 2017 to 2020, the programme monitored the online behaviour of learners studying four subject areas: phytophysiology, agroecology, silviculture, and the prevention and treatment of common animal diseases. The indicators tracked include the number of page views, number of days online and number of posts.

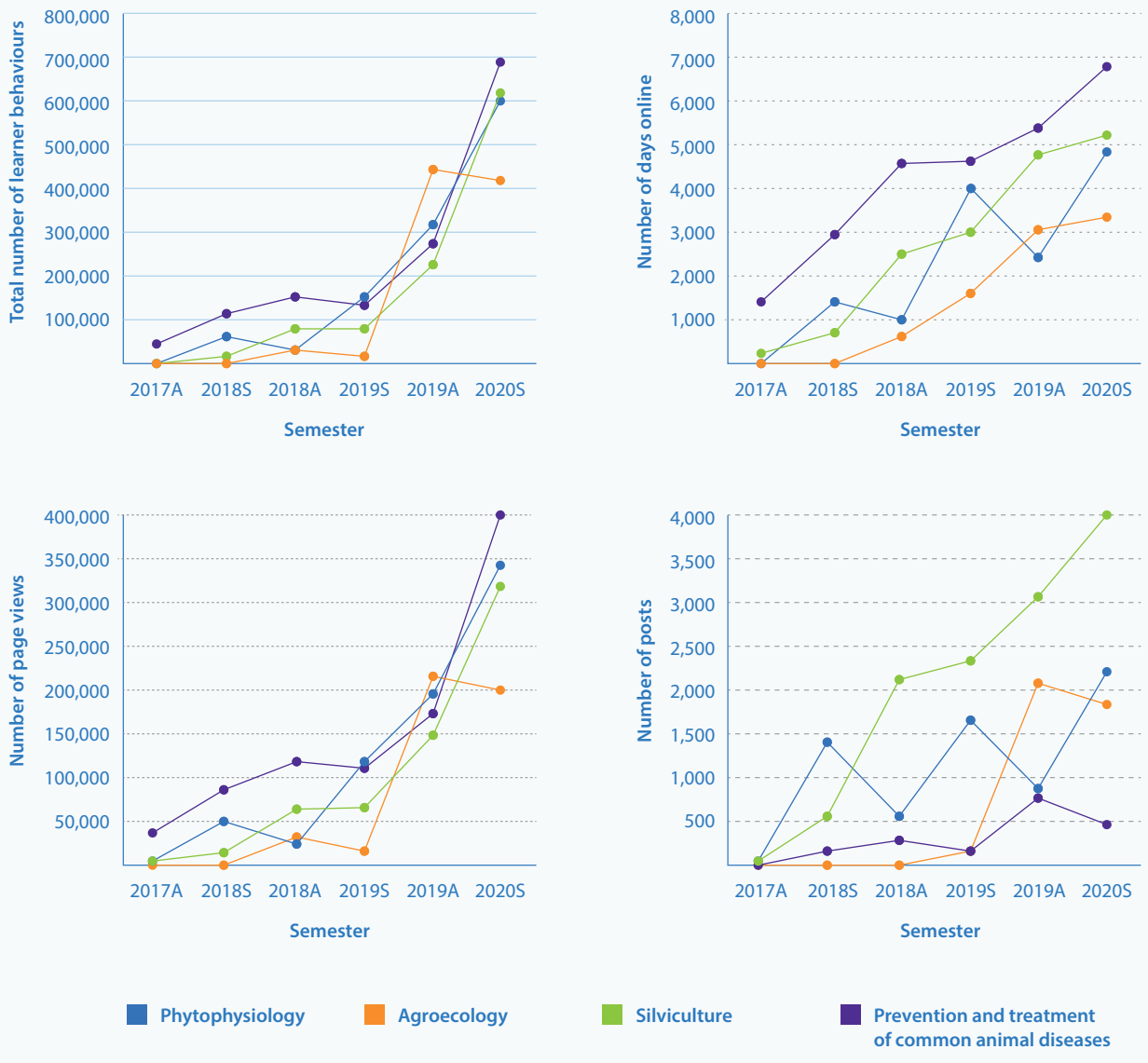
Teachers also routinely monitor and provide feedback on students' messages and posted homework, and students are given opportunities to resubmit based on this feedback and their marks. Students also fill in end-of-course surveys on the usefulness and quality of the learning, which are then reviewed by tutors. Finally, longitudinal surveys are conducted with graduates to determine trends in employment, earnings and related information.

Results

Since 2004, the scheme has been implemented in 1,513 of the OUC's county-level study centres in 31 provinces, municipalities, and autonomous regions, of which 967 (64 per cent) are in underdeveloped central and western regions of China (MOE, 2020). As of December 2020, the scheme had enrolled 836,272 learners and trained more than 500,000 village cadres. A total of 552,685 learners graduated between 2004 and 2020.

The programme's monitoring shows a steady rise in usage until 2019, when a sharper increase occurs for most indicators (see **Figure 1**).

Figure 1. Trends in the online behaviour of learners on four courses, autumn 2017 to spring 2020 (average of aggregate numbers of students)



Data Source: OUC (2021)

The data also suggests that the inclusion of some forms of AI has contributed to improving certain aspects of learning. Since VR was adopted, learners spend more time online, and both their page views and posted messages have increased. The average growth rates for learning behaviours in the four courses tracked from 2017 to 2020 were between 16 and 300 per cent, and formative assessment scores increased by up to 42 per cent for some subjects.

There is also evidence that that the scheme has boosted local economies. OUC research indicates that 90 per cent of learners remain in their hometowns, and graduates who open businesses improve their own economic situation and can provide job opportunities for local villages. A study by Manyin et al. (2019) indicates that by the end of 2016, 33,205 former students had started their own businesses in Zhejiang Province, and that 60 per cent of graduates in Hunan had become local business owners. In one case, a student who participated in the scheme in Hunan helped many rural villagers from Guchong in Zhijiang Dong Autonomous County to improve their agricultural practices, leading to their orange harvests bringing in 80 million yuan (about US$12.4 million).[3]

Finally, there is evidence that the scheme has reduced the administrative workload for teachers, freeing them up to engage in research. A study conducted by the OUC shows that the research output of teachers has increased by 36 per cent since the AI was applied (OUC, 2021).

3 See http://www.gov.cn/xinwen/2021-04/30/content_5604157.htm and https://baijiahao.baidu.com/s?id=1630866194477217489

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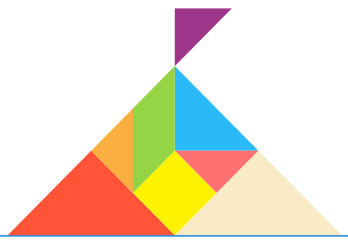
Challenges

The main challenges encountered by the One College Student Per Village scheme have been the limited numbers of teachers available to take it up, restricted financial support in some provinces, and difficulties in meeting the diverse needs of large numbers of learners and ensuring the continuity of their learning. Firstly, while the intention is to improve education and training in rural areas, there are discrepancies in the availability of professional teachers and the uptake of the scheme. While OUC teachers have academic and research backgrounds, there is a lack of professional teachers in some local learning centres. However, through the application of AI technology, some of the pressures on the system caused by an insufficient number of skilled teachers in some areas have been reduced, as learners in all contexts can access relevant and quality training content remotely.

Second, not all local governments have supportive policies and financial aid for the scheme. This can limit student access in some areas. As a result, some provinces have achieved large-scale uptake, while others do not have as many students. Thirdly, one of the major aims that the use of AI has sought to address is to ensure that learner needs are met. When developing the smart learning platform, the OUC came to realize that for its target demographic, the software and interfaces needed to be extremely intuitive to both access and use, ideally without an associated learning curve. However, the scheme covers vast rural areas at different stages of development, and the needs of learners in these regions are also very diverse. In order to create the flexible customization and personalization necessary to meet each student at the level of their aptitude and prior knowledge, the scheme requires further investment.

Continuous improvement centred on the user experience can ensure the sustainability and increasing scale of the scheme. Given the role of the technology, users exist on multiple levels, including students, teachers, local learning centres and OUC headquarters. They each require different data and use it in different ways, and gathering relevant feedback from all of these stakeholders is a key component of an effective system.

Finally, what was demonstrated in 2020 was that AI can contribute to and even enable responses to large-scale public education crises such as the one caused by COVID-19. During the pandemic, many institutions had to suspend classes due to social distancing requirements, and while this affected the learners' offline studying, AI played an active role in guaranteeing their online study. Because of this, 3,345 of them managed to continue their studies despite the lockdown. Moreover, the number of online learning engagements reached 2.6 million and learners posted 8,877 messages on the discussion forum in this period. This demonstrated that the scheme and its technology were able to guarantee the continuity of education.



Further developments

During the pandemic and in order to facilitate learning in the midst of social distancing regulations, virtual experiments were launched in some of the courses. For example, a simulation was incorporated into the Plant Protection course which enabled learners to interact with insects and their body structures, and find targeted control solutions.

In recognition of the importance of online learning, in 2020 the MOE released a comprehensive reform plan for the OUC, which outlines how its technology will be developed into a major platform for lifelong learning and online education, flexible learning and international cooperation. In this expanded platform, more innovative technologies like big data, cloud computing, blockchain, AI and 5G will be adopted for the teaching and learning.

The future goal of the scheme is to broaden its audience from disadvantaged groups in rural and remote areas to all members of society, accommodating 70,000 more online learners annually. It will also extend its provision to include master's level degrees and short-term non-degree programmes, with the aim of meeting the needs of diverse learners. Furthermore, the scheme's training programmes will eventually serve learners in Chinese companies based overseas, and possibly be offered to other developing countries.

The OUC will continue to invest in R&D for AI-enhanced learning. Areas of focus include integrating more learner analytics to drive data-driven teaching processes, providing personalized learning paths and automatic evaluation, creating knowledge maps, automatically generating content, and ensuring accessible support for learners through chatbots. The further development of the smart learning platform to allow it to give automated feedback on objective and subjective questions is of particular interest.[4]

4 Unless otherwise cited, information for this case study was drawn from OUC (2020, 2021) as well as interviews and email communications with OUC staff.

Fang Jifan, a village leader in Anhui Province, has successfully transformed his tea business thanks to the One College Student Per Village programme. Since 1990s, Fang Jifan has been dedicated to promoting Hong King tea, a local product in the Huangshan area, to the outside world. Being a recognized local entrepreneur, Fang never stopped seeking new inspiration to grow his business. In 2007, he enrolled in the Huangshan City branch of Anhui Radio and TV University, a localized OUC centre within the One College Student Per Village framework. Majoring in agricultural economic management, Fang learned a wide range of subjects including branding, managing small and medium-sized enterprises, and organic farming. Upon completing his studies, he managed to integrate the skills and knowledge gained through the programme into his business. His company has since helped to provide job opportunities for local farmers and college graduates, with more than 400 people hired as staff at its height in 2014. Fang, among other graduates of the programme, has demonstrated the value of lifelong learning adapted to personal needs, as well as enhanced practices within the local context, which have proven to be instrumental in unleashing the potential of those who otherwise do not have access to formal education.

Source: OUC (2020)

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ViLLE

2020

Centre for Learning Analytics, University of Turku

Teacher collaboration and artificial intelligence For student success

Theme
The use of AI to enhance the continuity and quality of learning

Location
Finland

Date started
2005

Beneficiaries
350,000 teachers and learners

Target population
Teachers and learners in primary, secondary and tertiary education

Digital solution
A collaborative platform that offers students and teachers detailed information regarding their learning process in the form of immediate feedback and learning analytics

Summary

The Visual Learning Environment (ViLLE) was created in 2005, a time when technology was gaining acceptance in education and mobile technology especially was becoming more sophisticated. Over the years, the platform has kept up with emerging trends in technological innovations. Today, ViLLE presents a comprehensive way of collecting data such as the number of completed exercises, response times, and scores which are used to identify learners' strengths and weaknesses and how they evolve over time. The embedded AI engine detects and highlights students' misconceptions, and algorithms assist educators to provide tailored support and guidance. At the same time, the agency of the users is preserved through the ability of teachers to assign learning levels and learners to select a within-task difficulty. In addition, the visualizations of analyses enable educators to examine and extract important information about their students' actions and progress, which can inform the timely delivery of personalized and adaptive learning tasks. The provision of such features has been linked not only to better learning outcomes and achievements but also to the prevention of learner attrition, as the platform acts as an early warning system.

The utilization of such a tool can address different needs and resolve educational barriers that emerge both in the individual classrooms (e.g. relating to students' progression) and at the national level (e.g. relating to tasks linked to the curriculum).

Why selected

The ViLLE programme was selected for the Prize because of the following features:

- The project uses AI tools to recommend personalized sets of exercises based on students' performance while addressing learning deficiencies.
- The lessons include interactive and gamified exercises with immediate feedback.
- The project seeks to empower teachers with detailed reports on the development of their students, which has the potential to improve educational effectiveness.
- There is evidence of both scale and impact, and adaptability to both basic and higher education contexts.

Programme

PROBLEM

ViLLE is a collaborative platform that offers students and teachers detailed information regarding their learning process in the form of immediate feedback and analytics. A network approach to development synthesizes academic research and teachers' content-creation skills.

BENEFICIARIES

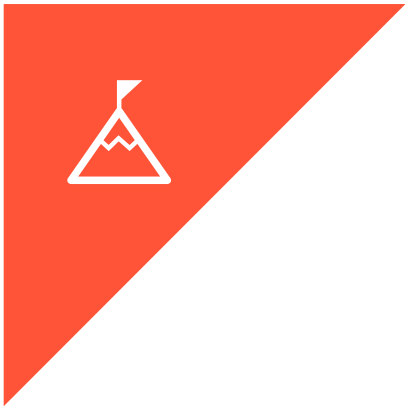
Teachers and learners in primary, secondary and tertiary education

RESOURCES REQUIRED

A device with an internet connection

RESULTS

- Reach: ViLLE is used by 48 per cent of Finnish schools, 300,000 students and more than 14,000 registered teachers.
- Engagement: Students and teachers have collaboratively created more than 4,000 courses and 130,000 exercises via the 'From Teachers to Teachers' initiative.
- Proven impact: Quasi-experimental studies show that students using ViLLE perform statistically better than a control group.



CHALLENGES

- It is difficult to create a system that provides autonomy and benefits to a diverse range of teachers, and to bring the research community, classroom teachers, school administration and policy-makers together to support joint development.
- Technological advances outpace changes in the education system and its culture, and solutions need to consider the pace of both.
- The system and its stakeholders behave differently at scale than they do in smaller controlled studies.

Profile: Implementing agency

The Centre for Learning Analytics (CLA) is a research lab housed at the University of Turku. The Centre strives to improve the quality of teaching and promote digital education using learning analytics in Finland and beyond. As a hybrid research laboratory, the institution works collaboratively with other units in the university, including the Faculty of Education and Department of Mathematics and Statistics. The Centre also works with other universities and organizations to promote learning analytics practices, both in Finland and internationally. The CLA's digital learning platform, called ViLLE, is the most widely used learning management system in Finland. Forty-eight per cent of the country's schools have integrated it as part of their teaching, and multiple cities and municipalities benefit from using it.

In addition, the CLA works in close cooperation with Finnish municipalities to expand the digital education network. In particular, the Centre lends them its expertise in digital assessment in order to assist in national evaluations and help develop digital entrance paths to universities in Finland.

Our goal is to build a nationwide ecosystem of learning to be able to measure the effects and impacts of educational investments and changes, be it investing in new learning materials, additional teachers, implementing new pedagogical ideas, or revisions of the curricula. In other words, we want to make the actual learning visible, in the classrooms, lecture halls and homes. By making this learning visible, we make every student visible. We want to help teachers to see the trees, and not only the forest, and give educational policy-makers a reliable, real-time understanding of the well-being and growth of the forests.

Dr Mikko-Jussi Laakso, Director of the Centre for Learning Analytics

Source: Centre for Learning Analytics (2021)

Context

Based on the results of international comparative studies, Finland has one of the best education systems in the world, with results above the OECD averages including in numeracy and literacy (Crato, 2021; OECD, 2020). Enrolment rates for early childhood education and care have also been increasing.

The Finnish education system is highly decentralized. Most education-related decisions are taken at the municipal and institutional levels, with a strong emphasis on stakeholder participation. Finland spends more on education as a share of national wealth than the OECD average (5.5 per cent compared to 5), with most funds being publicly sourced. Tertiary education is free for most students, with funding allocations to institutions based on performance (OECD, 2020). Teacher training is also exclusively the responsibility of universities in Finland, which has resulted in high teaching standards and produces graduates of exceptional quality (Mikkilä-Erdmann et al., 2019).

Finland is embracing trends in digitalization and the potential of technology to maintain its high educational outcomes, as demonstrated through initiatives such as the online information hub developed by the Finnish National Agency for Education (EDUFI) to guide teachers to adopt good practices and share resources to support virtual education (OECD, 2020).

Digital solution

The ViLLE platform was developed as a programming visualization tool in 2005, and over the years it has been adapted to the local educational context. Today, the platform presents a state-of-the-art personalized and adaptive learning path for primary- and secondary-level pupils, covering subjects related to mathematics and languages. The lessons include over 130,000 interactive and gamified exercises and more than a million individual tasks. Beyond this, the platform engages university-level computer science and engineering students in blended and collaborative learning activities.

Student users are provided with immediate feedback, and teachers receive information on the performance of classes and individual students. ViLLE makes suggestions to teachers so that they can assign learners to the levels suited to their ability. In this way, technology makes a recommendation based on actual performance, and the teacher can consider other contextual and individual factors in order to make a final decision on whether a student will engage at the basic, intermediate or advanced level. Students themselves receive semi-random exercises linked to their learning level, with an algorithm set to increase the frequency of tasks related to errors in their past performance. Students can also set their own difficulty level within each task, and thus enjoy agency over the degree to which they will be challenged on a given day.

Teachers can use materials made by others via the linked 'From Teachers to Teachers' initiative or create exercises for their personal use. In addition, a ready-to-use material bank for teachers provides curriculum-aligned pathways in mathematics and Finnish for primary grades. It also has an introductory-level programming course for junior high school and both introductory and object-oriented programming courses for high school (Kurvinen et al., 2020). Most exercises on the platform are automatically assessed, allowing teachers to spend more of their time supporting students.

ViLLE works in any modern browser with no additional plugins required. While computers are preferred due to the advantages of a large screen and keyboard, all of the features aimed at students can also be accessed via any modern smartphone or tablet. The platform can be accessed at schools or from any location with an internet connection.

Implementation

ViLLE is based on a core concept of continuous learning and assessment. Students complete a vast number of exams and tests during a school year, all targeting different aspects of performance. However, formal assessments and exams measure only a specific set of skills or prior knowledge in a strict timeframe and context. On the other hand, information gathered from digital exercises is consistent and systematic.

Students engage in the digital, interactive lessons on the ViLLE platform weekly and performance information such as time on task, per cent correct and number of submissions is collected. Based on an AI analysis of students' data using techniques such as k-means clustering[1] and Naive Bayes classifiers,[2] visualizations are created and recommendations are made for teachers. AI techniques identify and map the actual knowledge and skill sets that students develop in the context of their daily routines and provide instant feedback to them and their teachers, which includes detailed insights relating to monitoring progress and identifying misconceptions. The system employs a 'red to green' colour-coded grading scale from 1 to 5 in order to group students based on statistical analysis in different learning topics, allowing for an instant mapping of their skills. Teachers are given recommendations on which students should be assigned to which categories, e.g. 'struggling' or 'performing well'. In addition, an exercise recommendation system offers suggestions to teachers on suitable exercises for the different groups of students.

Teachers remain the decision-makers in the educational setting, with the ViLLE system only providing recommendations and analysing results. With this knowledge, students and teachers can pursue targeted remediation or take on additional challenges as appropriate. It becomes fundamentally easier to support students with special educational needs as the teacher can adjust the speed and pace of the learning process.

Finally, by using such sophisticated solutions, educators can reflect on their didactic practices, identify the weaknesses of their current approach, and improve their strategy by introducing alternative interventions.

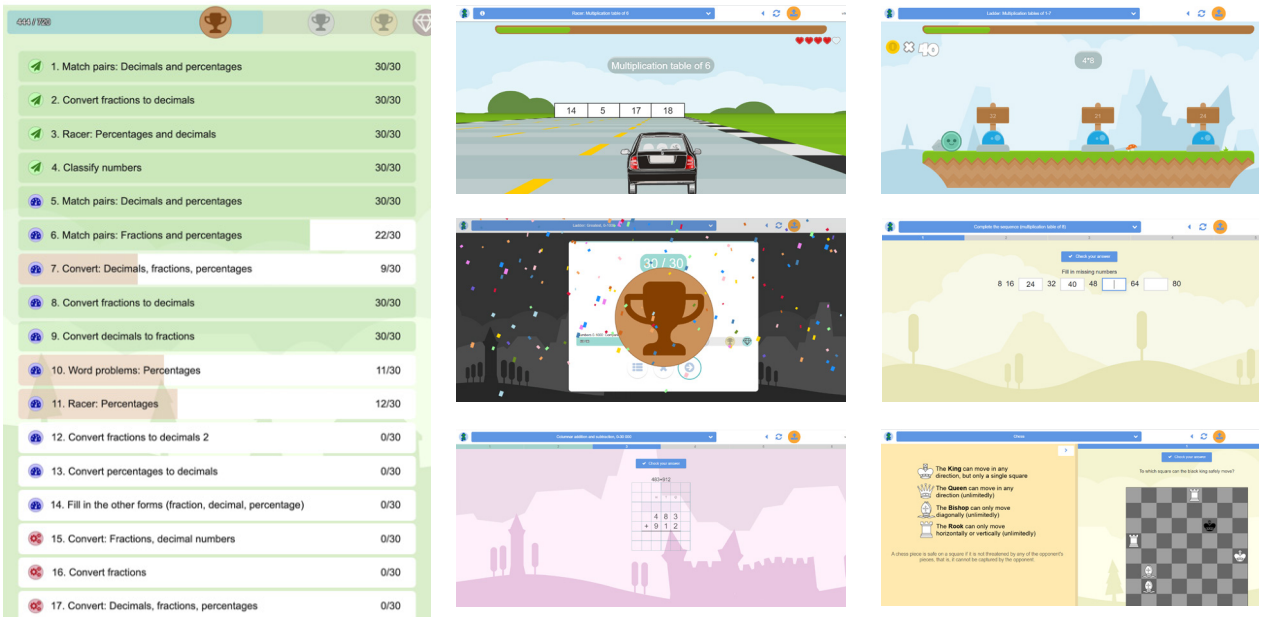
Students engage in various types of tasks (see **Figure 1**), and are additionally motivated through gamification mechanisms such as progress meters and periodic trophy awards. After completing all of the (typically 20 to 25) tasks in an exercise, students are provided with immediate feedback on their performance. They can also determine the level of their engagement on a given day by selecting the difficulty levels of their tasks. As this assignment of levels is only seen by the student and their teacher, and the presentation of exercises is semi-random, students are not stigmatized by choosing lower difficulty levels. Teachers can also create static tasks or tasks which are assigned to all students in the class.

Schools and teachers do not pay for the use of ViLLE, though there are training fees applied to cover costs such as staff time, travel and accommodation.

1 K-means clustering is a popular method of unsupervised learning, one type of AI. Typically, unsupervised learning algorithms rely only on labelled input data, and the algorithm groups outputs based on shared characteristics. For more information, see https://towardsdatascience.com/understanding-k-means-clustering-in-machine-learning-6a6e67336aa1

2 A Naive Bayes classifier is a type of machine-learning model which determines the probability of something happening given the presence, absence or value of at least one other variable. For more information, see https://towardsdatascience.com/naive-bayes-classifier-81d512f50a7c

Figure 1. Screenshots of ViLLE learning activities



From Teachers to Teachers

The ViLLE team creates ready-made lessons for teachers to use, aligned to curricula in different grades and subjects. Its members visit a number of pilot teachers and classrooms weekly throughout the school year in order to co-create and test the content and its efficacy with them and receive their feedback. Research is also conducted with learning games, and only those with an evidence base are included in the final content. The creation of pedagogically sound exercises thus requires one to two years of concentrated effort. However, in this way ViLLE is able to capture the hidden knowledge of classroom teachers alongside research results to ensure quality, effective content that works in practice.

After the first cycle of development, the content is released to the entirety of the ViLLE teacher community and can be utilized by all schools. The material is further improved from feedback received from the broader community.

In addition, any teacher can develop their own content for their individual classroom, and it can be released to the entire community. For example, when Finland's curriculum changed to include the Swedish language from grade 5 instead of grade 7, one teacher developed digital exercises for Swedish in her grade and released a finalized set of lessons for the whole ViLLE teacher community. Teachers can also work collaboratively within a theme or region to generate content. To ensure the quality of the materials, ViLLE organizes theme committees and material improvement events where feedback and suggestions are collected and implemented.

ViLLE has also established a support network among its thousands of teacher users. When a school joins ViLLE, a few interested teachers will sign up and receive some brief initial training. After six months, those teachers can go through additional training to become 'expert teachers', an accolade accompanied by a digital badge. They can then mentor three new teachers per year within the system. In a third step, expert teachers can undertake 20 hours of further training to become ViLLE master trainers. At times, cities and municipalities hire these trainers to provide orientation and support for the system. In practice, these trainers train teachers in their own cities, onboarding new staff, creating new content and developing an ecosystem of practice. As a result of this network of cascaded capacity-building, just one employee on the ViLLE team can support several thousand users.

Enablers and supports

Over the past decade, the number of ViLLE users has expanded from hundreds to hundreds of thousands, enabled by a dedicated core team, innovative methods of teacher training and mentorship, funding partnerships and research collaborations.

The ViLLE team consists of 25 people, including senior researchers, PhD students in education and computer science, pedagogical specialists, teachers, designers and programmers. The platform's user base is growing by approximately 50 per cent per annum, enabled by the training and mentoring system for teachers which allows experienced or advanced users to invite and support newcomers. These peer training and mentoring programmes have proven to be a viable way to increase the rate of adoption while further developing capacity.

Training takes place through various formats, including online, in-person, and blended sessions. There are three levels of ViLLE training for teachers: a basic package which includes orientation and takes between 3 and 8 hours; an expert package which consists of a yearly information packet and linked additional training; and the teacher-trainer package, which includes an initial comprehensive course lasting 20 hours and an additional annual session. There are currently about 20 ViLLE master trainers in Finland.

Development programmes are also available for teachers in the platform itself, covering topics such as flexibility, diagnostic support for students in need, learning analytics for teachers, and the data-driven development of the education system. These courses were developed in collaboration with research and NGO partnerships and seek to develop the overall knowledge and skills of the education sector.

In terms of its funding, ViLLE's 15 years of operation have been driven by research-oriented financing and grants supplied by various stakeholders, including the University of Turku, EDUFI, Finnish Ministry of Education and Cultural Affairs, European Union Committee, and various NGOs. The CLA is participating in R&D projects financed by the EDUFI, European Union, and Strategic Research Council of the Academy of Finland, among others.

The ViLLE project receives approximately €700,000 per year, which covers both operational costs and expansion. This financial security has enabled ViLLE to remain a free service to all Finnish schools and universities. As the platform is well-established in both basic and higher education settings, the annual funding is devoted almost exclusively to R&D.

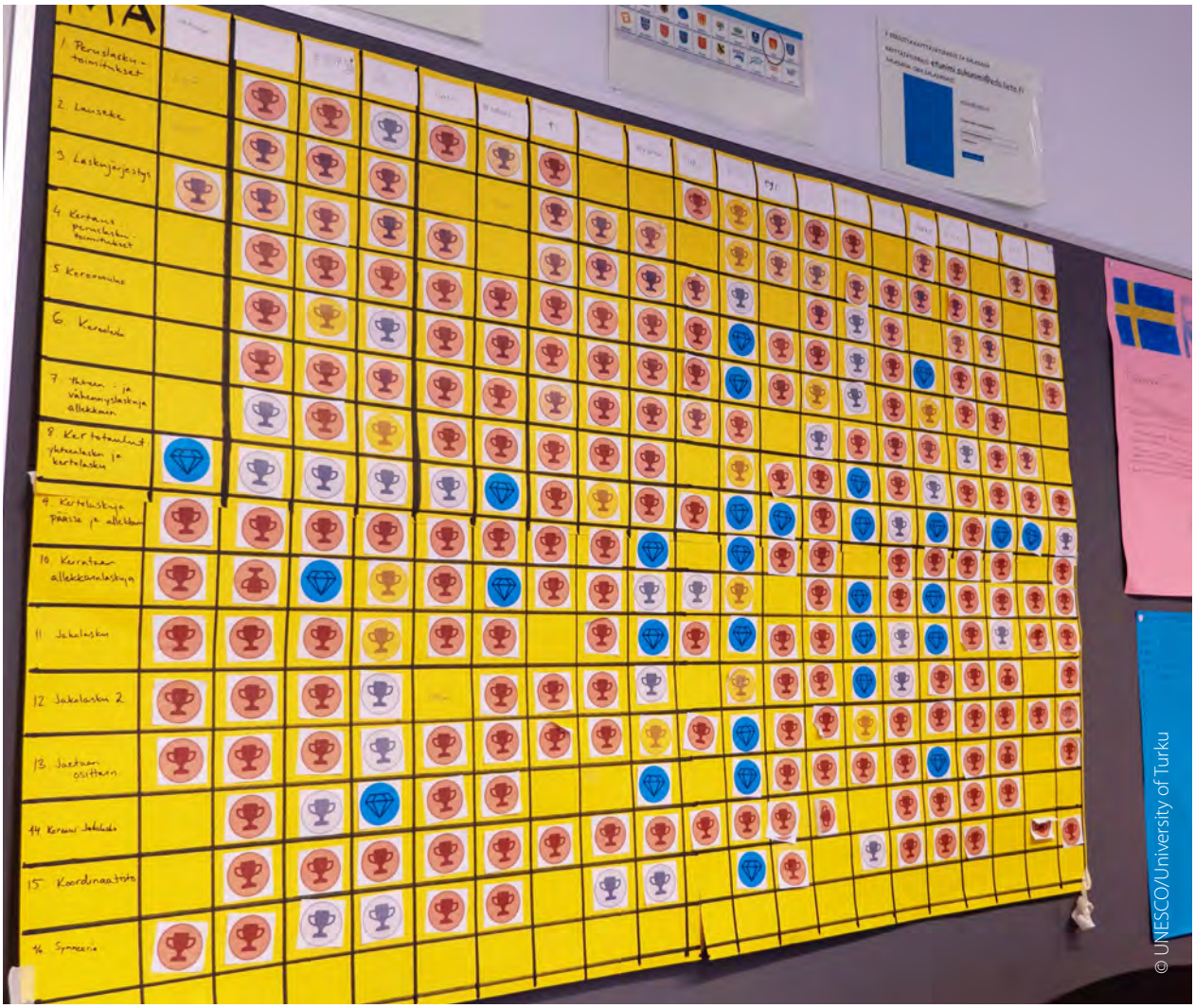
The ViLLE team and CLA also work on research in conjunction with other universities and organizations that have shared goals. For example, a collaboration with the Finnish Education Evaluation Centre, a governmental agency responsible for national assessments, has been in place since 2012. A collaboration with all Finnish universities allows the ViLLE learning analytics system to be used to collect data for different research projects. Collaborations are also undertaken with institutions outside of Finland. For example, a joint project between Aalto University in Finland and Harvard University in the USA leveraged the CLA's tools to assess learning, skills and social interactions in the classroom.

Joint development work on learning and assessment tasks for educational practice has also contributed to the ecosystem as teachers and researchers build evidence-informed tools. For example, a project funded by the Technology Industries of Finland Centennial Foundation and the Finnish Cultural Foundation aims to improve the personalization of math education within inclusive education while supporting teachers' professional development. It brings together multiple research groups from different Finnish universities that focus on game-based learning and associations of teachers devoted to promoting high-quality pedagogical models in mathematics.

Monitoring and evaluation

The ViLLE platform is improved through continuous cycles of feedback and development, beginning with rigorous engagements throughout initial development with pilot teachers. Once the material is released to the broader community, teacher and student feedback is incorporated into annual revisions. Material on the platform can also be evaluated and ranked by individual teachers.

Multifaceted data such as correctness, time on task and numbers of submissions are collected on the platform as students engage. In addition to providing feedback to students and teachers, this data has been utilized for various studies and to improve the understanding of effective pedagogies and learning patterns. The CLA follows the EU data regulations and acts as a focal point for data. When data is used for research purposes, permissions are collected following this strict set of ethical standards.



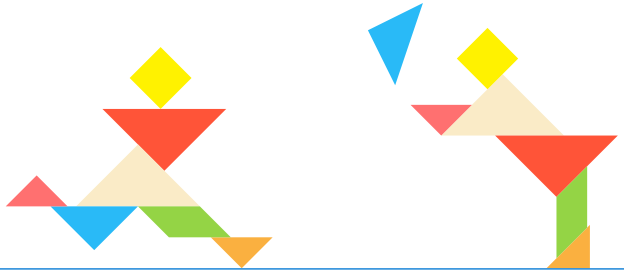
Results

The project has demonstrated an expansion in usage over the last decade. In 2020, learners completed more than 20 million gamified tasks per month. Approximately 300,000 students and 14,000 registered teachers have collaboratively created more than 4,000 courses and 130,000 exercises via the 'From Teachers to Teachers' initiative.

Over the lifespan of this project, results have been published from various short- and long-term studies, conducted in Finland and international contexts. A one-lesson pilot with third-graders (Kurvinen et al., 2012), a 10-week study on first-graders (Kurvinen et al., 2014), and an 18-week study with both first- and third-graders (Kurvinen et al., 2015, 2016) showed that computer-assisted learning had a positive effect on pupils and their outcomes. As a whole, the team has published in more than 50 peer-reviewed scientific journals (see Laakso et al., 2018; Kurvinen et al., 2018) and conference proceedings. Four PhDs related to ViLLE have also been completed.

A quasi-experimental difference-in-difference design accounting for an even longer time frame looked at the mathematics performance of two second-grade classes that had used ViLLE for one and a half to two school years and compared it with that of three second-grade classes from the same municipality who had not used ViLLE or any other computer-assisted method regularly. Results showed statistically significant differences, with the ViLLE classes outperforming the others on all topics (Kurvinen et al., 2020). In another study of third-graders, it was found that the control group made on average three times more errors than the intervention group (Kurvinen et al., 2018).

Research also demonstrates that university students using the platform to learn computer science and engineering through blended and collaborative activities achieve 20 per cent higher scores than those studying through traditional didactic approaches, and have lower dropout rates. On average, the models developed with formative assessment tasks were valuable for the computer science and engineering instructors as they could predict students who were at risk of failure as early as two weeks after the course initiation (Veerasamy, 2020).



Challenges

The four most significant challenges facing the programme have been meeting teachers' and students' needs in varying contexts, building the network, achieving scalability, and deploying AI in a purpose-driven and ethical manner.

Learners are taught in classes of various sizes and by teachers with a range of different skills, attitudes, interests and views about pedagogical practices. It has therefore been challenging to enable personalization for each student in a way that does not increase the workload of teachers and also preserves the decision-making autonomy of teachers and students.

The iterative development and deployment of ViLLE across more than a decade has culminated in a system in which the technology makes recommendations, the teacher forms decisions about learner levels, and students themselves exercise their own preferences within tasks. The ability of ViLLE to save teachers time while delivering quality pedagogy with demonstrated results is a critical factor for the success of the system.

Bringing the research community, classroom teachers, school administration and educational policy-makers together for a collaborative development process was also challenging. The initiative has built on a coalition of actors with shared interests and goals, and the innovative approach of integrating a development pathway to create master trainers has enabled the wide reach of the programme and broad investment from the teaching community. The inclusion of teachers' organizations has also supported the uptake of the project.

Due to the decentralization of the Finnish system, teachers enjoy full autonomy when deciding what educational methods or tools to use. Therefore, the task for ViLLE has been to show the effectiveness and usefulness of the system to each individual teacher. In a more centrally organized educational culture, this might not be as necessary, and the adoption of the system may be faster. But the challenge of winning users over one by one has forced the ViLLE team to work in close collaboration with the teachers, ultimately creating a more useful and user-centred platform.

Scalability is always a challenge for projects that aim to build data-driven and evidence-informed solutions. While a controlled study may be done with small samples and well-planned steps, on a large scale the degree of control and the consistency of application are decreased. It requires a number of steps to move from laboratory conditions to the classroom, as well as respect for the knowledge of teachers and their individual contexts. The extended consultation processes with teachers in different contexts supports the scalability of the materials, and the platform collects constant feedback to ensure that the system offers scalable tools and methods.

When integrating AI into education, the rationale matters a great deal and consideration must be given to the kind of data used and its purpose. AI has a place in education as a decision-making support tool that can aid in creating personalized learning experiences, preventing learning gaps, identifying struggling students, and providing tailored support and guidance to the learners. However, there is a need to give appropriate attention to data storage, security, privacy, and the potential risks of data loss, theft or exposure. The ethical use of data and learning analytics for the good of students, schools and societies must be pursued and robust practices put in place to ensure that personal data is not accessed or utilized for unethical or unrelated purposes, and that ultimately the uses of the data are approved by the learners themselves.

The respect of the rights of all parties, including workers, teachers, students, families and researchers in the joint effort to build a comprehensive learning ecosystem has been the key element of the progress and successful implementation of ViLLE in Finnish schools.

Further developments

ViLLE won the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education in 2020, the first year of the COVID-19 pandemic. In this context ViLLE provided a digital solution which was taken up by a number of new teachers in Finland as the education system shifted entirely towards remote learning. Two weeks after the start of the crisis, training had been provided to an additional 1,000 teachers and the number of tasks completed on the platform had jumped to 60 million per month. Together with teachers, the ViLLE team developed new visualizations to compensate for the lack of classroom interaction and mitigate to some extent the stress of isolation.

Within Finland, the team has developed an interdisciplinary, research-driven teaching and learning ecosystem of experts, teachers and researchers, which will continue to grow and seek to maximize the potential of every learner.

Winning the Prize has also brought possibilities for global collaboration that can help take ViLLE to a new level and contribute to the learning of hundreds of millions of learners. The ViLLE team at the CLA remains invested in its mission to bring about quality education for all, and will seek opportunities internationally in support of this goal.

3 Except where otherwise noted, information included in this case study is drawn from the Centre for Learning Analytics (2020, 2021) and interviews with ViLLE practitioners.

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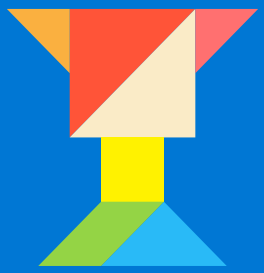


Winners
from 2006 to 2011

2006	eDegree Programme Cyber Home Learning System
2007	Curriki Claroline Connect
2008	Shanghai TV University ICT-in-Education Programme
2009	Digital Transformation of General Education Jordan Education Initiative
2010	National Institute of Adult Continuing Education Technological Literacy for Older Adults
2011	iZ HERO Internet-ABC

eDegree Programme

2006

Kemi-Tornio University of Applied Sciences

Opening a door to opportunities in rural Finland

Theme
Enhancing teaching and learning

Location
Finland

Date started
2003

Target Beneficiaries
Working and unemployed adults in Finland, including underserved rural and remote demographics

Problem Statement
Lapland, the largest province in Finland, is largely rural and sparsely populated. This has a major impact on the local services available. Schools and libraries in particular are difficult to access, and educational needs are a primary driver of migration from the area.

Digital solution
Blended-learning degree programmes for rural adult learners in higher education

Significance
The Kemi-Tornio University of Applied Sciences was the first higher education institution in Finland to offer a complete bachelor's degree programme online. This was also the first programme to combine asynchronous learning activities in the university's virtual environment with synchronous learning in an adopted virtual classroom. This approach has since been widely adopted across Finland.

Profile: Implementing agency

Kemi-Tornio Polytechnic was established in 1992, and evolved into the Kemi-Tornio University of Applied Sciences (UAS) in 2006. The mission of UAS was to develop the Lapland region and promote education, research, innovation and development.

Approximately 195 staff members served 2,400 full-time students in three units: business and culture, social studies and health care, and technology. The UAS supported and collaborated with local enterprises and the public sector, and had a strong impact on regional development in addition to being on the forefront of e-learning developments in Finland since 1999.

In 2014, Kemi-Tornio UAS was merged into Lapland University of Applied Sciences, which continues to offer a variety of e-learning options using a mix of synchronous and asynchronous provision through Moodle and a virtual classroom environment.

The digital solution

In response to the needs of working life in Lapland and based on rich experiences with eLearning acquired in previous distance-education projects, the Unit of Business and Culture at Kemi-Tornio UAS developed a Bachelor of Business Administration degree programme.

The degree was supported by the university's E-Learning Centre, which was established in 2000 to support teaching and learning in virtual environments as well as engaging in distance education research and development. The Centre also produced digital materials and oversaw the university's virtual education strategy. From 2006 onward the degree programme also leveraged Moodle, an open-source learning management system designed to help people create and manage online courses. Moodle offers tools for displaying learning materials, and conducting discussions, quizzes and individual and group work. Students can build e-portfolios in Mahara,[1] and study programmes also utilize a variety of social media applications such as wikis and blogs.

The online learning comprised 25 per cent synchronous time and 75 per cent asynchronous, with some blocks including seminar days. In addition to their scheduled classes, students could enrol in the online electives of regular degree courses. The programme could be completed in three and a half years, ending in a bachelor's thesis also submitted online.

While the original programme was targeted at students living near the UAS, the programme soon expanded nationally. By 2007, only 40 per cent of students came from the Lapland area. An international E-Degree at the master's level was also offered. The content production initiated by the E-Learning Center was later organized by the Finnish Virtual Polytechnic and used to create a material bank which is now shared by all polytechnics in Finland.

The E-Degree approach has now been applied to many degrees across Finland, and bachelor programmes often have parallel online and face-to-face modalities. This enabled a seamless transition to fully remote learning during the COVID-19 pandemic in 2020.

1 See https://mahara.org

Cyber Home Learning System

2006

Korea Education and Research Information Service (KERIS)

Reducing education expenditure and boosting performance in the Republic of Korea

Theme
Enhancing teaching and learning

Location
Republic of Korea

Date started
1999

Target Beneficiaries
Students

Problem Statement
Students in the Republic of Korea faced challenges including high private tutoring expenses and unequal opportunities for quality supplementary learning, particularly for students in remote areas and lower-income families.

Digital solution
The Cyber Home Learning System provides alternative tutoring options through digital technology to students nationwide.

Significance
The KERIS Cyber Home Learning System was one of the first large-scale government-led digital educational interventions targeted for home use to address learning gaps. The system also reduced tutoring expenditure across the country.

Profile: Implementing agency

KERIS was established in 1999 as a national institution to promote the effective use of digital technologies in education. The vision of the organization is to create an open, lifelong learning environment for citizens to enhance the quality of teaching and learning in the knowledge-based information society.

In addition to maintaining the Cyber Home Learning System, KERIS is involved in a number of ICT-in-education initiatives both within the Republic of Korea and abroad. These include Korea Open CourseWare,[2] an initiative which provides free university courses over the internet; EDUNET, the Republic of Korea's national teaching and learning centre; and the Research Information Service System, which is designed to enhance the sharing of quality academic research.

In 2018, the project changed its name to E-Learning Systems following research by the MOE on how to improve the services provided. The new platform is cloud-based and still operated by KERIS.

2 For details, see http://www.kocw.net

The digital solution

The Cyber Home Learning System is an internet-based free service for supplemental learning. It provides systematically structured levels of learning content, and a flexible way for students to study at their own pace and level. They can evaluate their own achievement, and the system monitors attendance, academic progress and results through a learning management system.

The Cyber Home Learning System is aligned with the Republic of Korea's national curriculum requirements and has two models, a class type and a self-study option. In the class type, students register for classes and are assigned cyber-teachers to encourage them to study regularly, answer their queries and provide discussion or assignment activities. The self-study option allows students to plan and proceed with learning at their own pace without the help of cyber-teachers or registration. In both models, services such as video lectures, self-evaluation and blogs are provided, and students can use avatars or other optional services with mileage that they earn through their achievements.

The system had attracted widespread use by 2006, with nearly 65 per cent of students utilizing the system more than three times a week. It was considered a contributing factor in reducing private tutoring expenses and narrowing educational gaps between regions and family income levels. In 2006, 14 per cent of students surveyed had cancelled their private tutoring as a result of the system, leading to an annual reduction in education-related expenditure. The system received international acclaim and was further considered as an influential component in the Republic of Korea's top performance in digital literacy in the 2011 OECD PISA survey.[3]

Challenges were encountered when an analysis by Shin and Albers in 2015 found that the Cyber Home Learning System was an effective second-language-learning tool only for those students in higher achievement brackets who had demonstrated abilities of self-initiated study. But in 2019, a year after it was redesigned into a cloud-based e-learning system, it was being used in about 30 per cent of the Republic of Korea's elementary and middle schools by 300,000 students and teachers, for 'flipped' blended learning classes and micro-learning units.

3 See http://www.oecd.org/newsroom/educationkoreatopsnewoecdpisasurveyofdigitalliteracy.htm

Curriki

2007

Curriki

The global open resource education and learning community

Theme
Open education

Location
United States origin, international reach

Date started
2004

Target Beneficiaries
Teachers, students and education experts

Problem Statement
Education is characterized by a lack of collaboration between and among institutions and teachers, contributing to persistent inequities in the system.

Digital solution
An online collaborative community for accessing, modifying and sharing open-source curricula

Significance
Curriki became a leader in the OER movement by bringing together a unique and powerful set of partners including for-profits, local authorities, non-profits and NGOs, all dedicated to a mission of eliminating the education divide by making high-quality learning materials freely available to educators around the world.

Profile: Implementing agency

Curriki is a non-profit social enterprise dedicated to improving education by empowering teachers, students and parents with universal access to free and open-source curricula. Curriki was founded by Sun Microsystems in March 2004 and became an independent non-profit in 2006.

The digital solution

Curriki maintains an online collaborative environment for educators, learners and committed education experts to work together in creating educational materials. Drawing on the social network model, Curriki advances a culture of learning and sharing in a networked environment. Facilitated by digital tools and publishing templates, groups and individuals can access and modify learning materials for specific contexts. Curriki also provides hosting for development and localization efforts, including the support of curricula in multiple languages.

This interactive and open repository and community empowers educators globally to teach and to learn through three main functions:

- Find – Build a repository of OERs.
  Curriki's repository offers easy access to online materials that can be localized by ministries and departments of education. The quality of materials is assured by ratings and comments provided by Curriki staff and users.
- Contribute – Engage a global community.
  The website supports and simplifies community content creation by providing scaffolding such as curriculum guidelines and publishing tools to insert metatags and align content to curriculum frameworks or standards. Group tools promote collaboration by allowing members to systematically work together on curriculum development.
- Connect – Build a community of educators.
  Curriki attracts individual educators who want to contribute open-source curricula by providing unique online tools that streamline the development process. Curriki also works to secure collaborative agreements and partnerships with policy-makers, ministries of education, regional departments of education, graduate and undergraduate schools of education, and organizations for teachers, parents and schools.

Educators from over 180 countries have accessed the Curriki website, and more than 2,000 new members join the community each month. Curriki is working with partners in the USA, India, Republic of Korea and Argentina to develop content in multiple languages and create sites that support local learning objectives.

In a further development, Curriki conducted local teacher-training workshops in Indonesia on developing OERs. Participants included 'master teachers' responsible for teacher training and curriculum development for primary and secondary education, as well as lecturers from post-secondary-level teaching courses. The website also promotes 'CurrikiOne Events', training webinars presented by members of the Curriki community, and a publishing resource 'CurrikiGo', which connects created content to micro-websites and learning management systems.

In 2020, CurrikiStudio was launched to provide a free full-service site for authoring learning content. It aims to give educators the tools to create engaging, immersive online content for learners without any coding knowledge required.[4]

4 See https://www.curriki.org/about

Claroline Connect

2007

Consortium Claroline AISBL

An open-source content management system for elearning

Theme
Open education

Location
Belgium, France and Switzerland

Date started
2001

Target Beneficiaries
Learners and teachers

Problem Statement
E-learning creates the potential for instructional shift towards student-driven, asynchronous, collaborative and lifelong learning, but these ideals are rarely realized in practice.

Digital solution
A student-centred, open-source content and learning management system, Claroline Connect.

Significance
Claroline Connect brought a learning solution proven to shift pedagogical practices towards constructivist, student-centred learning activities through providing a wide range of collaborative features and tools.

Profile: Implementing agency

Consortium Claroline is a non-profit organization located in Ottignies-Louvain-la-Neuve, Walloon Brabant, Belgium, and is part of the digital technology services industry. It was initiated in 2001 by the Catholic University of Louvain within the *Institut de Pédagogie Universitaire et des Multimédias.*

The digital solution

Claroline Connect is an open-source course management system that provides tools for student-centred online pedagogy and collaborative and remote learning. It is based on pedagogical principles that emphasize conviviality, flexibility and stability, and place the learner at the heart of their learning. The platform provides flexible offerings that accommodate all subjects, levels and languages of instruction, including continuing education. Continuous exchanges between users and developers allow the tool to evolve in form and function in accordance with the needs of the knowledge and skills society.

In each course space, trainers can access tools related to the course agenda or announcements; provide documents, links and exercises for students; design a 'pedagogical path' or complete sequence of learning activities; and create tasks for students to complete independently or in groups in a workspace. The platform is associated with learning analytics such as attendance and exercise/course completion.

Research into the platform between 2004 and 2007 found that teachers evolved in their practices towards more innovative or active learning methods, and that a significant proportion of students observed pedagogical changes, including an increase in their peer interactions and active engagement, and the identification of learning as a research process. At the height of its use, the platform was distributed to over 5,000 institutions in around 100 countries.

In 2015, a new version of Claroline Connect was established to develop and extend the possibilities of the project, and make the platform available to businesses as well as educational organizations. This allowed smaller entities to more easily benefit from the project. In 2018, version 12 of the platform was released.

Shanghai TV University

2008

Shanghai TV University (STVU)

Turning the digital divide into digital opportunity

Theme
Digital lifelong learning

Location
Shanghai, China

Date started
1994–2009

Target Beneficiaries
Shanghai residents, adult learners and migrant workers

Problem Statement
In the 1990s, Shanghai experienced rapid economic development. However, due to a lack of basic training, most adults were not competent enough in digital skills to apply them to their daily work. In addition, computer specialists were in short supply.

Digital solution
In order to meet the economic and social demands of the 21st century, a digital lifelong learning system was developed and deployed in the Shanghai Municipality.

Significance
The project helped to popularize computer skills and digital learning, and reduced the inequality in educational opportunities among working adults and the general public.

Profile: Implementing agency

Shanghai TV University (STVU) was founded in 1960 and funded by the Shanghai Municipal Government. STVU is committed to building a lifelong learning system aimed at education for all and bridging the digital divide in Shanghai. In 2012, with the approval of China's MOE, STVU was renamed Shanghai Open University.

The digital solution

The digital lifelong learning system developed by STVU provides educational services and learning materials not only to senior citizens and working adults, but also to students in primary, secondary and tertiary schools in Shanghai as well as rural areas of China. STVU promotes the wide application of digital technology and skills, providing non-degree training to around 50,000 people per year. STVU awarded 2.1 million certificates in computer application competency, a credential which is recognized by the Shanghai Municipal Government and thus provides career advancement opportunities. In addition, 6.2 million individuals benefited from distance-learning programmes delivered via television and online.

The accomplishments of STVU include:

- The establishment of a metropolitan area network, encompassing the municipality, 19 districts and counties, and 230 community learning centres. The network reaches all communities in Shanghai, providing an hour a day of educational broadcasts.
- A lifelong learning system comprised of eight specialized platforms with guidance and services for a range of subjects and target beneficiaries. This system encompasses municipal services through STVU, district-level services at community colleges, and guidance through neighbourhood schools in villages and towns.
- The Shanghai Education Resource Centre, which offers digital learning resources for all levels, including community and continuing education. It has nearly 200,000 registered visitors.
- Diversified training programmes, ranging from elementary and intermediate levels of computer skills to office automation and digital applications.
- 50 kinds of textbooks and learning materials, six million of which resources were distributed to trainees.
- The development of a special training programme for migrant workers in Shanghai, including aspects of culture and skills, delivered via multimedia resources and STVU networks.

Outside of Shanghai, an extension service helped Yunnan Province, a rural area in southern China, by delivering computer training services to 1,700 teachers working in primary and secondary schools.

Finally, a series of international training workshops and several international conferences were sponsored by STVU and organized by the UNESCO Chair on Open Distance Learning. In cooperation with the UNESCO offices in Paris, Bangkok and Beijing, developing countries such as Mongolia and the Republic of Korea shared their experiences and expertise related to digital technology in schools and distance education, with 206 delegates participating from more than 30 countries.

From 2012, work on digitally based education has continued under the renamed Shanghai Open University. By the end of 2018, the total number of online learners in China had reached 201 million, and 194 million people were accessing education through mobile devices. The focus on workforce development has strengthened as employees require increasing amounts of upskilling to respond to the shifting demands of industries. To this end, learners require diversified, multi-level and individualized study plans.

The university has also benefited from the development of the Shanghai Lifelong Education Credit Bank, which supports credit recognition, accumulation and conversion. From 2012 to 2017, approximately 246,000 people had accumulated credits in this bank.

In addition, a series of international training workshops and high-level conferences have been held, involving nearly 2,000 participants from more than 40 countries. More than 60 open-access research papers and presentations have been created, and 11 publications have been released.

ICT-in-Education Programme

2008

Dr Hoda Baraka, First Deputy to the Minister of Communications and Information Technology

Towards a ubiquitous reach to all learners in Egypt

Theme
Digital lifelong learning

Location
Egypt

Date started
2007

Target Beneficiaries
People in formal, informal and non-formal education streams.

Problem Statement
A high prevalence of digital illiteracy among students, staff and administrators in formal education settings, as well as among children and adults in underserved, remote and minority communities leads to unequal education and work opportunities.

Digital solution
The ICT-in-Education Programme, which is designed to meet Egypt's strategic objectives for increasing competitiveness and employability among its workforce through the eradication of digital illiteracy and the utilization of digital tools and applications for new models of learning.

Significance
The programme had a demonstrated and widespread impact on the capacity of students and teachers to utilize technology for self-directed learning, project-based education and teamwork.

Profile: Implementing agency

Dr Baraka was appointed as the First Deputy to the Ministry of Communications and Information Technology (MCIT) and led the implementation of the ICT-in-Education Programme. The Ministry is the caretaker of the 'Digital Egypt' strategy, described as 'an all-encompassing vision and plan, laying the foundations for the transformation of Egypt into a digital society'. MCIT is focused on digital transformation and inclusion, human and industry development, and innovation through AI. MCIT offers a range of initiatives, including training opportunities and courses for students and industry, improving services through the use of digital technologies and supporting national development goals through telecommunications infrastructure.[5]

5 See https://www.mcit.gov.eg

The digital solution

The ICT-in-Education Programme sought to provide tailored, contextually appropriate mechanisms to impact communities through formal, informal and non-formal education streams. Implementation was achieved through the integration of diverse digital technology projects targeted at different beneficiary groups, such as students, teachers and administrators in formal education settings as well as children and adults in underserved, remote and minority communities. This was underpinned by a partnership model involving the government and local and multinational companies.

The programme was developed in three iterative stages, which enabled MCIT to determine the feasibility of ICT-in-education projects for different audiences as well as lay the necessary foundations of technology, support centres and human capital to facilitate widespread deployment. Ongoing monitoring and evaluation was undertaken following a results-based approach, leading to identification of new areas for experimentation.

The achievements of the ICT-in-Education Programme are notable in both the formal and non-formal streams. Accomplishments in the formal education system include:

- The inclusion of digital competencies in teacher training and for university graduation requirements as well as the incorporation of digital technology courses in the national curriculum for students in grades 7 to 9.
- The training of more than 300,000 teachers on digital technologies and innovation, leading to awards in the Arabian Innovative Teachers' Network Competition.
- 75,000 teachers and staff being trained on digital content development, resulting in the publication of 9,000 preparatory lessons and 60 higher education courses.
- Supporting the establishment of the Higher Education National E-Learning Centre and 18 digital content development labs in all public universities.
- The development of an e-learning diploma to support the industry, and existing online platforms and resources being leveraged to certify 9,650 students in the use of digital technologies.

Accomplishments in the non-formal education system include the establishment of mobile technology units in 24 governorates, serving 126,000 people, and the development of 430 Cisco Network Academies. In total 71,300 lifelong learners were trained. Programmes targeted marginalized individuals such as deaf and hard-of-hearing people, and 2,300 formerly illiterate individuals also received literacy certificates.

The programme contributed to Egypt's Vision 2030,[6] which saw 2,000 schools modernized and equipped with digital solutions. It supported the adoption of a school management system and was a cornerstone in the deployment of digital learning in schools and universities in Egypt. Central to the success of the programme were teacher training and professional development, and a nationwide commitment to providing high-speed connectivity and affordable devices for teachers and students. Building on its success, the programme has been extended to cover 1,600 secondary and 16 vocational schools. Through this and subsequent initiatives, Egypt has positioned digital transformation as a key to achieving quality education.

6 See https://mped.gov.eg/EgyptVision

Digital Transformation of General Education

2009

Professor Alexei L. Semenov, Rector, Moscow Institute of Open Education

Creating educators for the knowledge society

Theme
Teaching, learning and e-pedagogy: professional development of teachers for knowledge societies

Location
Russian Federation

Date started
1993

Target Beneficiaries
Teachers and students

Problem Statement
The changing needs of the 21st century knowledge society required new types of education and pedagogy, in order to serve the needs of all students and Russian society at large.

Digital solution
A range of large-scale and innovative undertakings including textbook and resource development, teacher training, and experimental pedagogies in digital schools.

Significance
The work undertaken had a widespread impact across the education system, and influenced both classroom practices and the policies governing the education sector.

Profile: Implementing agency

The award was granted to Professor Alexei L. Semenov, the Rector (President and CEO, 1993–2013) of the Moscow Institute of Open Education (MIOE), one of Russia's largest teacher-training institutes. Subsequently, he became the Rector of Moscow State University of Education (also known as Lenin Pedagogical University) from 2013 to 2016, where he emphasized the introduction of digital technologies into initial teacher education and to the faculty.

The digital solution

The work of Professor Seminov spans multiple projects with a focus on resources and teacher training. He was the organizer and co-author of the Russian Federation's first computer science and technology textbook for Russian schools, and in 1989 founded the Institute of New Technologies, which engaged in the development and adaptation of educational software and hardware and published hundreds of digital educational resources and books for teachers.

For 16 years, Professor Seminov led the MIOE as it organized dedicated e-pedagogy for 5,000 to 10,000 teachers and introductory modules for 30,000 teachers. These featured extensive web-based content and technologies as part of a process of transforming the educational system to respond to the new priorities of the 21st century knowledge society, with appropriate requirements and methodologies conceptualized in the project entitled 'The Digital Transformation of General Education', which ran from 1983 to 2009.

The project worked to integrate digital technologies into all disciplines and to develop students' competencies through providing exposure to these technologies in schools that mirrored professional practice. This approach enabled them to develop digital literacy and to create their own virtual content, in essence learning by doing and incorporating new ways of thinking, communicating, behaving and learning.

The vision supporting this theory was realized in a school model developed by Professor Semenov based on international experience, which is known as the 'informatization school' or digital school. In these schools, frameworks for future education were created and tested, prioritizing the introduction of e-pedagogy and student-as-researcher pedagogical foundations. Digital schools featured a single Moodle-based learning environment, providing transparency and accountability as well as safety and privacy, and high levels of support, resources and guidance on technology and methodology for teachers who pursued the use of digital technologies in their pedagogy.

The ideas and achievements of this considerable body of work were leveraged into multiple policies and large-scale projects in the Russian Federation, including the Federal Standards for General Education (2004), the Federal Portal for General Education's collection of OERs, the Framework for the Integration of ICTs in the Education Process (2007), and the Digital (Data) Economy of the Russian Federation (2017).

Jordan Education Initiative

2009

Ministry of Information and Communications Technology

A public-private partnership for the innovative use of ICT in education

Theme
Teaching, learning and e-pedagogy: professional development of teachers for knowledge societies

Location
Jordan

Date started
2003

Target Beneficiaries
Teachers and students

Problem Statement
The Jordanian Government sought to leverage technology in educational reform designed to meet the emerging needs of the information society.

Digital solution
The Jordan Education Initiative (JEI), a large-scale public-private partnership dedicated to improving education in Jordan through the use of digital technology, including infrastructure provision, curriculum development and professional training for teachers.

Significance
By the end of phase one (2003–2007), the initiative had managed to foster and maintain partnerships and launched multimillion-dollar projects that had a strong impact on the modernization of education in Jordan, and effectively contributed to the development of the local private sector in the areas of digital technology and professional development.

Profile: Implementing agency

The JEI was launched with the support of their Majesties King Abdullah and Queen Rania as a public-private partnership aiming to improve education in Jordan and create a model of reform for other countries through the effective use of digital technology. The initiative incorporated 17 global corporations, 17 Jordanian entities, and 11 governmental and non-governmental organizations as stakeholders. In 2017, the JEI transitioned from maintenance by King Abdullah II to the Queen Rania Foundation for Education and Development.

The digital solution

The JEI team piloted the programme in 100 'Discovery Schools' which acted as pathfinders to create models of excellence in the public education system. A public-private partnership model was formed to implement three streams of interventions:

01 The development of digital curricula: Curricula for six subjects (3,373 lessons) were generated, including math, science, English, Arabic, ICT and civics. These curricula are designed to be student-centred and promote the interactive use of digital technologies in classrooms.

02 Professional development for teachers in the Discovery Schools, beginning with basic digital literacy programmes. Content developers also created teacher-training programmes based on their products. These initiatives were embedded into the education system by MOE trainers. The JEI ultimately trained 3,000 teachers on digital skills and blended learning approaches.

03 Technical infrastructure: All 100 Discovery Schools were provided with broadband and wireless access points, a minimum of two computer labs, and innovative in-class technology solutions such as laptops, projectors, interactive white boards and Classmate personal computers.

The holistic model that JEI implemented in these schools starts with a baseline assessment of the school's infrastructure capacity and performance. Then the school is supplied with the necessary hardware and networks, and teachers are trained on the six digital curricula. Professional development opportunities are offered to teachers and other school staff to address identified needs. The JEI also deploys change management programmes by working with the principals, teachers and students to leverage the investment made in the school, develop holistic improvement plans, and actualize the changes necessary in the school environment to use technology for a positive impact.

Using the vast experience gained in this undertaking, the JEI rolled out its successful model and services in collaboration with 'Madrasati',[7] a school rejuvenation programme launched in 500 schools by Her Majesty the Queen of Jordan in 2008. The JEI also expanded its public-private partnership model to include universities, technology companies and training organizations. In addition, the JEI participated in global outreach and as part of the Global Education Alliance offered support to the Government of Rwanda to develop its ICT-in-education policy.

7 Madrasati means 'my school' in Arabic.

National Institute of Adult Continuing Education

2010

National Institute of Adult Continuing Education (NIACE)

Provision of ICT-empowered adult learning in the United Kingdom

Theme
Teaching, learning and e-pedagogy: professional development of teachers for knowledge societies

Location
United Kingdom

Date started
2006

Target Beneficiaries
Adult learners

Problem Statement
While ICT offered new ways to engage in lifelong learning, a lack of basic digital skills prevented many adults from accessing these opportunities. At the time of the award, there were nine million adults in the United Kingdom who did not use the internet.

Digital solution
NIACE promoted adult learning in digital literacy through training and advocacy, and an e-learning platform for adults.

Significance
NIACE empowered adult learners on a large scale, with a particular focus on the most vulnerable populations.

Profile: Implementing agency

NIACE was a leading NGO promoting adult learning in England and Wales. The organization traced its roots back to the 1921 British Institute of Adult Education, and focused on research, consulting and advocacy related to adult education and lifelong learning. In 2016 NIACE merged with the Centre for Economic and Social Inclusion to form a new organization, the Learning and Work Institute. This institute describes itself as 'an independent policy, research and development organization dedicated to lifelong learning, full employment and inclusion,' and works in priority areas including the provision of essential life skills and social justice.[8]

8 For more information about the Learning and Work Institute, see https://learningandwork.org.uk/about-us

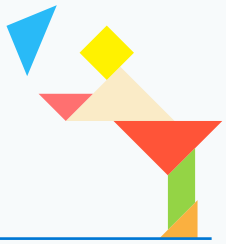
The digital solution

NIACE was awarded the Prize for its overall engagement and contribution to adult learning in and through digital technologies, which included the following:

- NIACE partnered with Digital Unite for the 'Get Digital' project, which established 194 internet centres in sheltered housing units for older people.
- Through the Digital Activists Inclusion Project and in partnership with the Workers Educational Association and the Central England Forum for European Training, NIACE trained over 100 volunteer digital activists to offer first-stage internet experiences in their communities.
- NIACE were contributors to the UNESCO Avicenna project, which set out to develop mechanisms for sharing digital content between Mediterranean universities.
- NIACE advised a government agency (the Learning and Skills Council) on the development of a national plan for digital technology in adult and community learning, adapting the institution-based e-learning model to work in community venues where staff were part time, equipment was moved about and connectivity was limited.
- NIACE designed a strategy to deploy technology for offenders in prison and in the community for the Learning and Skills Council.
- NIACE developed with partners an E-learning Positioning Statement Diagnostic Tool, which enabled providers to benchmark their own position in relation to the use of technology and plan improvements.
- NIACE trained 2,992 people to be digital guides and established national and regional networks to provide training to adults on digital technologies and the internet. The courses regularly recorded satisfaction rates of over 95 per cent.

NIACE worked particularly with marginalized learners, including homeless people, migrants, prisoners, unemployed people, elderly people, individuals living in poverty, and people with learning difficulties and low levels of education.

Technological Literacy for Older Adults



2010

Infocentro Foundation

Technological literacy for all in Venezuela (Bolivarian Republic of)

Theme

Digital Literacy: Preparing Adult Learners for Lifelong Learning and Flexible Employment

Location

Venezuela (Bolivarian Republic of)

Date started

2000

Target Beneficiaries

Low-income demographics in underserved areas of Venezuela (Bolivarian Republic of)

Problem Statement

A lack of access to digital technology facilities for inhabitants of Venezuela (Bolivarian Republic of) in disadvantaged areas, despite a constitutional right to access them.

Digital solution

Infocentros, physical spaces with hardware and free internet access that also provide digital training programmes at no cost.

Significance

Over 950 Infocentros were established across the country, providing opportunities for digital access and training to marginalized and disadvantaged populations at scale, including elderly people, those with special needs, and minority language speakers.

Profile: Implementing agency

The Infocentro programme to democratize the internet started in 2000. In 2007, the Infocentro Foundation was appointed as the governing body for the programme. In February 2010, the management of the Infocentros was transferred from the government to individual communities, which are provided with implementation guidelines. There are more than 950 Infocentres across Venezuela (Bolivarian Republic of), staffed by approximately 1,033 facilitators and administrators.

The digital solution

Infocentros are physical centres with computer equipment that have free internet access and provide digital training programmes at no cost to beneficiaries. They are often linked with social, cultural and political organizations in the various communities as a way of encouraging local development.

The National Technological Literacy Plan (*Plan Nacional de Alfabetización Tecnológica*, PNAT) is implemented through the Infocentros countrywide. PNAT is an initiative which aims to guarantee access to digital technologies for marginalized populations in Venezuela (Bolivarian Republic of) as well as providing training to communities on their use to encourage lifelong learning. The PNAT is built on a belief that digital technology access and associated lifelong learning is instrumental in improving individual circumstances and quality of life, and the programme sought to strengthen community spaces for the social appropriation of digital technologies.

The initiative focuses especially on older adults and visually impaired beneficiaries, although the Infocentros are open to everyone and serve children, adolescents and adults of all ages including people with other disabilities. The Infocentros and their associate programmes are targeted to disadvantaged neighbourhoods. PNAT is available in two indigenous languages of Venezuela (Bolivarian Republic of), Kariña and Wayuú, as a means of protecting and promoting cultural diversity.

The digital literacy programme for older adults aims to train participants in the basic use of computers and allow them to advance to more technical training in areas such as website design. Other components of the programme focus on online government, accessing online media, managing office applications, and using cameras, smartphones and tablets. The topics are often associated with the interests of the user group so as to contextualize and personalize the training, and could include the use of email to keep in touch with family and friends, or accessing the internet to search for information on health care, entertainment, banking or social security.

iZ HERO

2011

Infollution ZERO, Dr Yuhyun Park

Teaching children responsible digital citizenship

Theme
Educating youth for responsible global citizenship

Location
Republic of Korea

Date started
2010

Target Beneficiaries
Children and youth up to 18 years of age, cyber-wellness teachers at primary schools, and parents of primary-age children

Problem Statement
As children are increasingly exposed to digital media content at younger ages, it has become critical to guard them against information pollution (infollution) such as obscene and violent content, cyberbullying, abusive language, sexual predators and technology addiction.

Digital solution
The iZ HERO programme is a research-driven 'edutainment' service for young people that combines online and offline learning tools to improve their awareness of various cyber-risks.

Significance
The programme provides a fun yet informative and interactive platform for young children to engage with and learn how to protect themselves against the harmful effects of information pollution in the digital age. This programme has the potential to induce changes in children's attitudes and interactions with digital media.

Profile: Implementing agency

Infollution ZERO is a non-partisan grassroots advocacy and campaigning organization based in the Republic of Korea, Singapore and the United States. Its principal goals are to raise public awareness of infollution and push for measures to reduce it. Infollution ZERO eventually contributed to DQ World, a movement that began in 2017 to empower children aged 8 to 12 with comprehensive digital citizenship skills through eight-week programmes for both individual children and schools.[9] In 2019, DQ World engaged with more than 100 partner organizations in 80 countries.

9 See https://us.dqworld.net

The digital solution

iZ HERO was a holistic play-and-learn programme for primary school students centred around a web platform, iZHERO.net, that contained interactive multimedia activities for children. iZ HERO Exhibition was designed to teach kids to understand the potential dangers of inappropriate digital media usage and self-regulate their online behaviour, addressing topics such as cyberbullying, game and device addition, identity protection, predators and strangers, discretion in sharing, empathy and kindness, and communication with adults. Through a mobile app, the fun interactions helped to empower children with critical digital leadership skills and values in order to use digital media safely, responsibly and independently, and helped parents set appropriate guidelines for them.

The iZ HERO programme aimed to:

- Increase public knowledge of cyber-risks, including critical awareness about when and how threats may appear in daily life.
- Encourage children to have the discipline to responsibly use digital media.
- Equip children with strong values including respect for themselves and others and empathy to speak up for others.
- Foster healthy communication about digital media between children and parents.
- Encourage children to be positive forces for cultural change online.
- Make the entire learning experience fun.
- Provide a safe digital environment where children can seek support from professional counsellors.

The programme also worked through assembly talks in schools, a roadshow with a mobile digital booth which visited school events, and an interactive exhibition at the Korean National Science Museum, iZ HERO Adventure. Older children were assigned as mentors to younger children for support through the programme. The iZ HERO Challenge was an anti-cyberbullying social campaign using the iZ HERO project content which helped children become true change-makers in their communities.

An evaluation of the iZ HERO Adventure digital exhibition found that the programme was effective in improving students' attitudes towards offline meetings and homework, and increasing their vigilance with respect to cyberbullying, and that children related positively to the programme (Liau et al., 2015).

Internet-ABC

2011

Association Internet-ABC

Promoting safe and knowledgeable internet use for young and old

Theme
Educating youth for responsible global citizenship

Location
Germany

Date started
2001

Target Beneficiaries
Children 5 to 12 years old, parents and educators

Problem Statement
Children and adults alike require education in order to be informed and safe consumers of digital media and to be positive actors in online and networked environments.

Digital solution
Internet-ABC offers material for children and adults to help them acquire core competences and support their safety during first experiences with the Internet.

Significance
This national project provides ICT and print resources for up to a third of German teachers of children in the target age range of 5 to 12, signifying a wide reach in the advancement of media literacy in the country.

Profile: Implementing agency

All German regional media authorities belong to the Internet-ABC non-profit organization, set up in 2003 as a non-partisan association to promote open dialogue on social digital divides and equal access to media education. Internet-ABC is a nationwide project, sponsored and supported by the national media authorities, and was further under the patronage of the German Commission for UNESCO from 2005 to 2015.

Internet-ABC is part of a national network and linked to well-known websites for children, child protection organizations, and educational and government institutions, which enables joint actions and helps to popularize the platform and reach the specific target groups.

The digital solution

Internet-ABC runs a safe, ad-free and no-cost website and produces learning modules and materials to support safe internet skills and practices for all ages. The website is ad-free and barrier-free and provides a safe environment for the discovery of the internet, and audible modules provide easy use for even very young or dyslexic children.

Websites for parents and educators show how the World Wide Web works and offer information, hints and instructions on topics such as social networks, computer games, cost traps and chats. Details on the project and its concepts as well as professionally-drafted teaching materials for the primary school level are provided, and teachers can find helpful resources as well as recommendations for educational software.

Offline teaching materials are also made available. There is a combination package including a CD-ROM and a handbook on media literacy, and a regular Internet-ABC newsletter that addresses topical issues for parents and educators.

For children aged 5 to 12, Internet-ABC offers child-friendly and exciting resources for playing, learning and communicating. Children can use audible 'Know how it works' modules to progressively acquire basic knowledge of internet tools such as search engines or chats, as well as about topics like internet safety, data protection and computer viruses. They can exercise their creativity through completing tasks related to these topics in 'Show how it works' modules, where they are encouraged to take part in discussions, voice their opinions, share their ideas, exchange electronic postcards and take part in writing a never-ending story, thereby actively and creatively engaging in the construction of content and knowledge. These modules motivate children and deepen their understanding of the appropriate use of technology, and allow them to test their knowledge in the game-based 'Web-surfer's test'. According to a survey conducted in 2010, one-third of German children aged 6 to 13 engaged with the Internet-ABC platform and its content.

Internet-ABC also offers children opportunities to question the project's experts and visit curated websites, and thus serves as a guide to entertaining, instructive and responsible internet surfing. In 2019, the booklet 'My First Internet-ABC' was developed for younger pre-literate children to enable them to deal with themes related to the media and internet in an age-appropriate way.

Internet-ABC is available in German and Turkish, and can be accessed freely via PC, iPad, tablet and smartphone. The website, resources and modules are regularly updated to ensure they encompass emerging technologies and topics.

Conclusion

The UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education was established to reward individuals and institutions for the creative use of digital technologies to enhance learning, teaching and overall educational performance with a vision of surfacing excellent models or best practice. Since 2006, the themes of the Prize have been aligned to the goals and normative instruments of the global agenda, including the Education for All goal before 2015, the vision of SDG 4 – Education 2030, which promotes equitable and quality education for all (UN, 2015), the *Qingdao Declaration on ICT in Education* (UNESCO, 2015) and the *Beijing Consensus on AI and Education* (UNESCO, 2019).

In order to draw lessons from the Prize winners, UNESCO has compiled this series of twelve case studies from the second cycle of the Prize, which ran from 2015 to 2021. While less information is available from the first cycle (2006–2011) due to departure of the project managers from their previous positions, snapshots were created that capture the core elements of these Prize-winning initiatives. This conclusion section analyses of the thematic focuses or educational challenges that the technological solutions have been targeting, their construction and rollout, their drivers for advancing the use of digital technologies as a common good, their promotion of gender equality and linguistic diversity, and the locations and modes of their learning delivery.

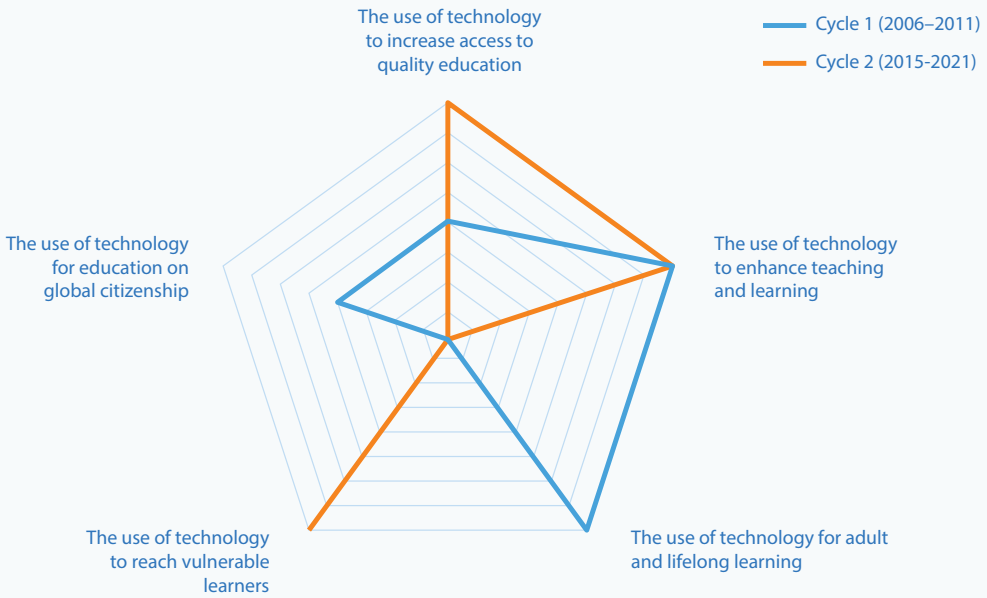
Analysis and key findings

How has the Prize steered the use of digital technologies as a common good for education?

Over the course of the Prize, the annual themes have been designed to steer the innovative use of digital solutions to address the fundamental challenges that countries are facing in achieving the vision of SDG 4 – Education 2030. Five key areas can be categorized based on the annual themes: the use of technology to increase access to quality education; the use of technology to enhance the relevance and quality of teaching and learning; the use of technology for adult and lifelong learning; the use of technology to reach vulnerable learners; and the use of technology for education on global citizenship. **Figure 1** shows the distribution of the key themes across both cycles.

The focus on technology to increase access to quality education intensified in the second cycle, with outreach to vulnerable learners being central. On the other hand, access for adult learners was integrated and guided by lifelong learning as a basic principle. The use of technology to enhance teaching and learning remained a key feature across both cycles.

Figure 1: Number of prize-winning projects by focus area



Assignment of themes to the shared values and global commitments on education

The thematic elements are also generally defined by the broader frameworks and normative instruments developed by global education actors over time.

In 2000, the *United Nations Millennium Declaration* (resolution 55/2) (UN, 2000) and the *Dakar Framework for Action* (UNESCO, 2000) committed to ensuring universal access to primary education for children and learning and life-skilling programmes for youth and adults, as well as reducing adult illiteracy rates by 50 per cent. The first cycle of the Prize reflects the ambitions of these international instruments through the promotion of adult and youth education with themes including 'Digital Lifelong Learning' in 2008 and 'Digital Literacy: Preparing Adult Learners for Lifelong Learning and Flexible Employment' in 2010. Teacher training and pedagogies were emphasized in 2006 with the theme 'Enhancing Teaching and Learning' and in 2009 with the theme 'Teaching, Learning and e-Pedagogy: Professional Development of Teachers for Knowledge Societies'.

In 2015, the UN adopted the *2030 Agenda for Sustainable Development* (UN, 2015), including SDG 4 on universal quality education, improved access to tertiary education, and relevant skills training. Particular provision is given to gender equity, those living with disabilities and other vulnerable populations. The *Qingdao Declaration* states that emerging technologies must be harnessed to strengthen education systems, ensure equitable access to education for all. From 2016 to 2018, the UNESCO King Hamad Bin Isa Al-Khalifa Prize reflected these initiatives with themes related to the use of ICTs to advance equity, quality education and vulnerable populations: 'The Use of ICTs in Education for Disadvantaged Groups' in 2016; 'The Use of ICTs to Increase Access to Quality Education' in 2017, and 'The Use of ICT to Ensure Education for the Most Vulnerable Groups' in 2018. Among the Prize-winning projects during this three-year period were Kiron Open Campus (2016), a tertiary education initiative focused on refugee and migrant populations; and Can't Wait to Learn (2018), which concentrated on providing gamified learning to children in conflict environments.

In 2019, the *Beijing Consensus* on Artificial Intelligence and Education promoted the use of AI to transform educational delivery and pedagogies and give recommendations on planning policies. In line with the Universal Declaration on Human Rights, the *Consensus* emphasizes humanistic principles including the role of education in 'preparing all people with the appropriate values and skills needed for effective human–machine collaboration in life, learning and work, and for sustainable development' (UNESCO, 2019*a*, p. 4). In 2019 and 2020, the Prize focused on the uses of AI in education, with the theme 'The Use of AI to Innovate Education, Teaching and Learning' in 2019 and, in further recognition of the disruption caused by COVID-19, 'The Use of AI to Enhance the Continuity and Quality of Learning' in 2020.

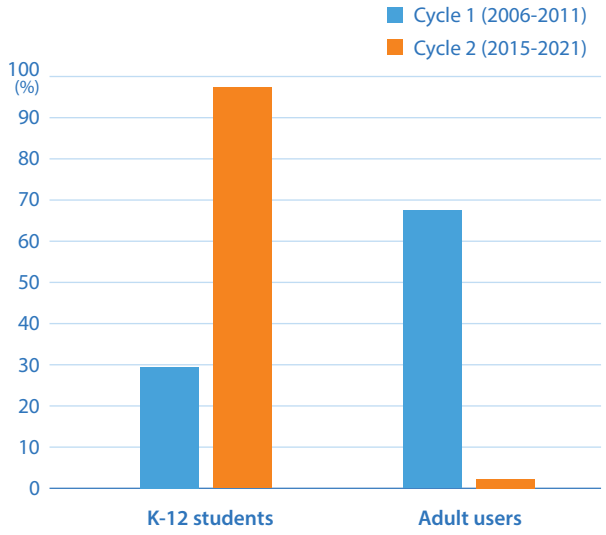
The Prize has been aligned to advocate the use of digital technologies as common good to support the achievement of the shared values and committed goals across time.

Target beneficiaries

As also shown in **Figure 2** on the percentage of beneficiaries by category, the shifts in focus between the first and second cycle are at least in part responding to the evolution of the global challenges, for example the 26 per cent rise in the number of migrants and refugees between 2000 and 2019 (UNESCO, 2018). While access is reflected throughout as a key focus of the technological solutions, a further emphasis on this emerged in the wake of the pandemic with the 2020 theme 'The Use of AI to Enhance the Continuity and Quality of Learning'.

The number of beneficiaries reported by Prize-winning organizations tripled between the first and second cycle, from 12.7 million to 38.5 million. The majority of beneficiaries were adult users in the first cycle, and K-12 students in the second. In fact, the percentage of reported beneficiaries who were K-12 students more than tripled, and they made up more than 90 per cent in the second cycle. Adult learners, on the other hand, saw a drop from representing over 65 per cent of beneficiaries in the first cycle to less than 5 per cent in the second.

Figure 2. Percentages of reported beneficiaries by target group and cycle



Gender equality

Given that UNESCO adopted its strategy on gender equality in 2013 at the 37th session of its Executive Board (UNESCO, 2019*b*), this criterion for selection was only prioritized for the second cycle of the Prize. Consequently, information on gender was only collected during three of the project years, and a majority of the initiatives did not have this information available. Of the six programmes, only one reported a majority of female beneficiaries at the time of the award (Can't Wait to Learn, 55 per cent female), and one, ThingLink, reported equal proportions of male and female beneficiaries. Four programmes indicated that just 15 per cent of their beneficiaries were female, including the Jaago Foundation, Kiron Open Campus, GENIE, and the Connected Learning Initiative. The Open University of China indicated its beneficiaries were 31.75 per cent female.

However, the Jaago Foundation, GENIE and Kiron Open Campus later reported that they were able to significantly improve the percentage of female beneficiaries. In the two years after winning the Prize in 2017, Kiron conducted female-specific awareness campaigns and adapted the registration process due to finding that women were more hesitant to provide personal details. These initiatives successfully increased the proportion of new female students to 43 per cent.

In Bangladesh, the Jaago Foundation Digital Schools reduced the rate of female attrition and improved their enrolment rates from 15 per cent in 2016 to 52 per cent in 2019. This increase was enabled by explicit gender-equality objectives and deep engagement between school administrators and parents to develop trust and ensure that a safe environment for girls is cultivated at the schools. And in Morocco, the government-driven GENIE programme now requires that beneficiaries are 50 per cent female.

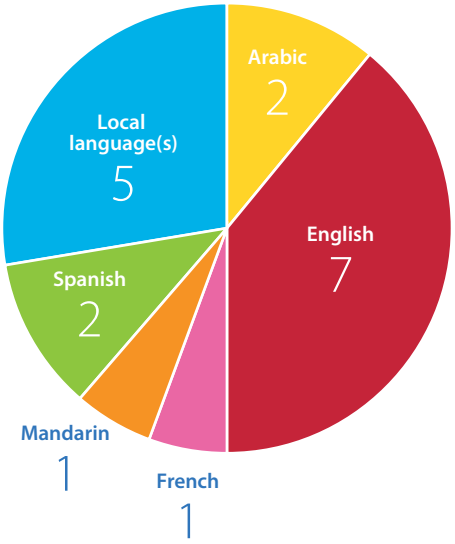
Linguistic diversities

Like gender equality, the encouragement of linguistic diversity was only adopted for the second cycle of the Prize. Therefore, information on the languages used in the technological solutions is not available for the first cycle. The 12 Prize-winning projects in the second cycle produced materials in a total of 12 languages. The largest share, 58 per cent (n = 7), produced materials or products in English (see **Figure 3**). The next most common languages were Arabic and Spanish, each implemented in just under 17 per cent of the projects (n = 2). All other languages, including Amazigh, Bengali, Finnish, French, Hindi, Mandarin, Portuguese, Swedish and Telugu, were implemented in one project each. The five Prize-winning projects that generated materials in local languages are as follows:

- ViLLE, which includes content in Finnish and Swedish;
- Letrus, which operates in Portuguese;
- CLIx, which operates in Hindi and Telugu;
- GENIE, which operates in Amazigh, Arabic and French; and
- Jaago Foundation Digital Schools, which operates in Bengali.

The Prize should continue to promote cultural and linguistic diversities through recognizing projects that engage indigenous groups and other language minority groups in the design of digital solutions for education.

Figure 3. Language use by the 12 Prize-winning projects (n = 12, multiple responses possible)



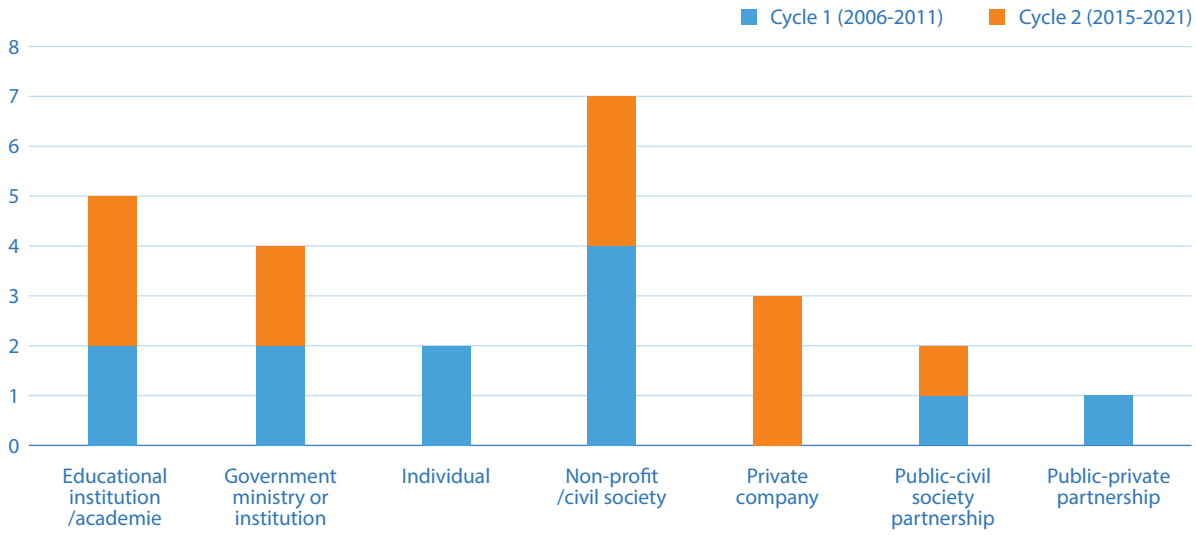
Who are the key actors to drive the use of digital technology as a common good for education?

To steer the use of technological innovation as a common good for education, the Prize has introduced eligibility criteria requiring that the solutions used by the project should be designed completely for public good or for charitable purposes. This means they should not be commercial applications or packages that only offer limited functions free of charge, while requesting users to pay for advanced features. This line of criteria has filtered out technology solutions with explicit or hidden commercial purposes. In this context, the types of Prize-winning organizations can be disaggregated according to the type of actor as shown in **Figure 4**.

NGOs and governments

NGOs and governments are the most active driving forces for using digital technologies as a common good for education. Overall, civil society organizations including NGOs and foundations received the Prize most frequently, with nine awards including two where they partnered with government. Governmental agencies, especially ministries, accounted for a total of eight Prize-winning projects, with four implemented by government alone, two in combination with civil society and one in partnership with the private sector.

Figure 4. Number of prize-winning projects by institutional type (n=24)



In general, important driving forces to ensure digital technologies are used as common good for education are national agencies that apply sustained public funds or government-purchase models, and NGOs that secure a sustainable funding mechanism.

Public-private partnerships

Sustainable public-private partnerships remain limited. The only two Prize-winning projects undertaken by government and civil society jointly were those of Venezuela's Infocentro Foundation which was supported by the country's Ministry of Popular Power for Science and Technology, and Costa Rica's Omar Dengo Foundation, which worked in partnership with the Ministry of Public Education. These also constitute the only winning projects from Central and South America. The Jordan Education Initiative in the first cycle was the only winning project to leverage a public-private partnership. In addition, one of the individual laureates from the first cycle, Dr Hoda Baraka, was the First Deputy to Egypt's Minister of Communications and Information Technology at the time of her award.

Private companies and academic institutions

Private companies and academic institutes are important in leading the early adoption of cutting-edge digital innovations. The number of Prize-winning projects run by civil society and government was slightly lower in the second cycle than the first partly due to the requirement for the use of emerging digital innovations. In the second cycle, three private companies were selected, namely, ThingLink, Letrus and Change Dyslexia, without direct government involvement. In the meantime, the number of individual laureates dropped from two to zero. Letrus and Change Dyslexia are the two Prize-winning organizations of 2019 under the theme of 'The Use of AI to Innovate Education, Teaching and Learning' which required strong technological capacities in supporting the early adoption of cutting-edge digital technologies in education.

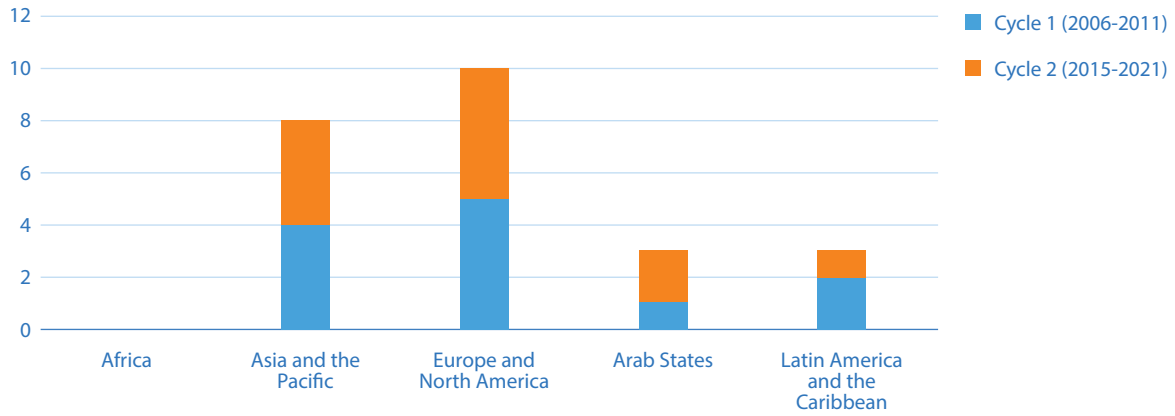
The number of educational institutions or academics receiving awards increased slightly from two in the first cycle to three in the second. The 2020 theme of the Prize necessitated the adoption of AI solutions that are designed for the public good, and this was fulfilled by the two Prize-winning organizations that had an academic background: the Open University of China and the Centre for Learning Analytics at the University of Turku in Finland.

Digital infrastructure

The large-scale and effective use of technologies in education requires a solid digital infrastructure. In terms of the regional distribution of awards (see **Figure 5**), the highest number of Prizes, 10 out of 24 or 41.7 per cent, were received by organizations with headquarters

in Europe and North America, followed by Asia and the Pacific with 8, or 33.3 per cent. Together these regions received three-quarters of all the Prizes, with the remaining six split between the Arab States and Latin America and the Caribbean, which received three each. In the framework of *Global Priority Africa* (UNESCO, 2021), the international selection committee has given a priority to the projects nominated by Sub-Saharan countries. However, over the two cycles there were no projects from the African continent that qualified for the Prize. This reflects the reality that the use of digital technologies in education to generate large-scale and sustainable impact requires a solid digital infrastructure.

Figure 5. Number of awards by region (n=24)



Is ubiquitously accessible digital learning transforming modes of educational provision?

This analysis categorizes the Prize-winning projects by their locations and methods for delivering learning. There are variations of educational contexts among the projects, including schools, community learning centres and mobile locations. Community learning centres are open to the public and can be linked to a specific programme or may be institutions for general use such as libraries. Programmes offered through mobile locations, often distance learning courses, may be accessed from wherever the student chooses.

The three main methods of delivery in the winning projects were: distance learning, blended learning and hybrid learning. The term 'distance learning' may be used synonymously with online learning, e-learning, distance education, correspondence education, flexible learning and MOOCs. Common features of distance learning are: the separation between the teacher and learner in space and/or time, and the use of media and technology to enable communication and exchange during the learning process. This may be achieved through print-based learning materials, one-way broadcasting (TV and radio programmes), or web-based exchange using social media channels or learning platforms. Distance learning tends to require a high level of self-direction and study skills, which must be supported through new guidance strategies (UNESCO, 2020). Blended learning can include models in which distance education, mostly online learning, is used to complement face-to-face instruction, or where technology is integrated into traditional classrooms (UNESCO, 2022). Hybrid learning often refers to a stage at which digital technologies are deployed to transform the delivery of learning or even the modes of provision. Hybrid models can result in increased elements of learner autonomy and control over aspects such as the path and pace of learning (ITU and UNESCO, 2021).

Figure 6 shows the number of winning projects that engaged different locations and modes of educational provision or different types of technology-enabled learning. A majority, 13 out of 24 (54 per cent), engaged students and teachers at schools, with the share growing in the second cycle. A similar number engaged them through mobile learning locations.

As shown in **Figure 7**, a combined total of 17 Prize-winning projects (71 per cent) leveraged either blended or distance learning, with a shift in favour of blended learning in the second cycle, reversing an earlier trend favouring distance over blended. At the same time, two winning projects in the second cycle adopted hybrid learning.

Under the theme on enhanced teaching and learning, in 2006, the winning projects focused on distance learning in higher education in Finland and the technology-based provision of distance learning in the Republic of Korea. In 2009 under the theme 'Teaching, Learning and e-Pedagogy: Professional Development of Teachers for Knowledge Societies', the winning projects from the Russian Federation and Jordan concentrated on teacher training together with the provision of technology in schools. In the Russian Federation, the pedagogical perspective of the student as a researcher was introduced in some pilot schools, but it is not clear if this became widespread practice.

Figure 6. Number of Prize-winning projects by location (n = 24, multiple responses possible)

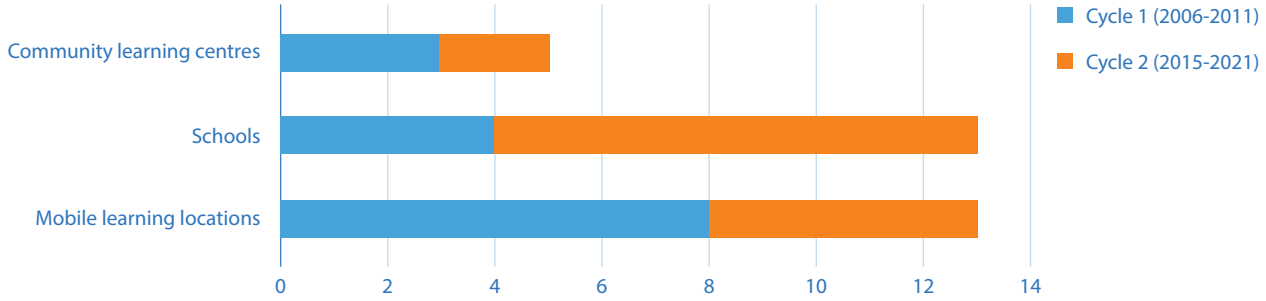
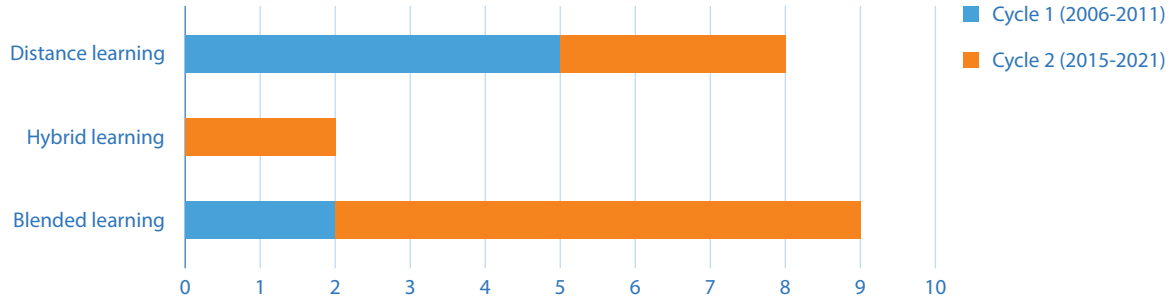


Figure 7. Number of Prize-winning projects by method of delivery (n = 24)



More recently, in 2015 the prize was awarded to the Omar Dengo Foundation in Costa Rica and Singapore's OSP@SG for 'Pedagogical Innovation in the Use of ICTs in Teaching and Learning', and in 2019 Letrus and Dytective won under the theme 'The Use of AI to Innovate Education, Teaching and Learning'. OSP@SG leverages a series of open-source technologies to deliver physics education through computer simulations, which are used as both a mode and a topic of study, reducing the need for preparation time. Similarly, Letrus won the Prize for an extensive effort including natural language processing and AI trained on a national database of student essays to deliver immediate feedback on essay writing, reducing the amount of time spent on marking and waiting to receive corrections. Both of these initiatives focus heavily on the digitalization of traditional classroom experiences and improving the efficiency of existing pedagogies, rather than the creation or implementation of new ones.

The second cycle saw the emergence of hybrid learning, demonstrating emerging efforts towards transforming delivery to facilitate increased student autonomy. Two projects reflected this especially well. The programme in Costa Rica is a longstanding effort of infrastructure and teacher education designed to shift pedagogy towards project-based learning and particularly the creation of digital products. It first began in 1988, and the case study indicates that a long-term commitment to an iterative cycle of implementation, evaluation and revision based on the needs of individual teachers and the system as a whole is a key to the success of shifting pedagogical practice at scale. Finland's ViLLE programme also leverages AI to deliver a platform and learning management system that provides personalized education to students, offering a replacement to classroom 'seat time' and engaging learner autonomy through the choice of difficulty level and 'anytime, anywhere' provision in response to COVID-19.

How can integrated digital learning solutions be constructed and delivered?

The Prize has been calling for nominations of projects that take an integrated approach to the planning and implementation of digital learning solutions. And therefore, the Prize-winning projects should engage the following strategies: (1) teacher training including but much beyond the building of digital skills; (2) technological solutions including the rollout of digital infrastructure, the development or adoption of learning platforms to deliver content, and the development or use of learning management systems to facilitate administration and/or manage student learning pathways; and (3) the provision of content including the curation and delivery of relevant materials and the development of digital resources.

The winning projects engaged these strategies to deliver the integrated solutions to various extents.

Teacher training and support

Training and supporting teachers on the effective pedagogical use of digital technologies was one of the prerequisites for projects to win the Prize. The training methods outlined in the case studies are:

- Direct teacher training, often provided by project staff. This approach is leveraged by all but two of the projects involved in teacher training, including all of the government-driven initiatives as well as Digital Transformation of General Education in Russia, ThingLink, OSP@SG, the National Programme of Educational Informatics (PRONIE), and Jaago Foundation Digital Schools.
- Platform-based teacher training, used for example by CLiX, which leveraged platforms to train teachers on digital pedagogies, and the training culminated in a digital certificate.

- A cascading model based on peer coaching in networks, as deployed by the ViLLE platform in Finland, which used teachers' networks to orientate and coach new participants, creating a system that supported the adoption of the technology and fostered strong pedagogical approaches collectively owned by teachers. The participants received digital credentials for achieving different levels of expertise in the system and for mentoring other teachers.

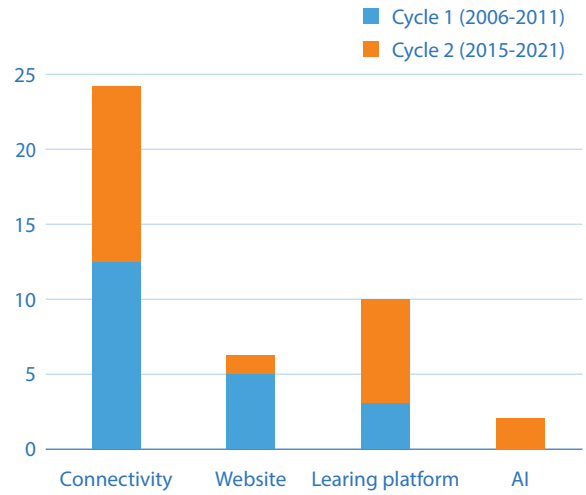
The evolution of the technological solutions

The case studies trace the solutions adopted or developed by the Prize-winning projects from 2006 to 2020. While nearly all of them require devices and connectivity, there has been a notable evolution of technologies over the two cycles (see **Figure 8**).

In the earliest years of the Prize, the projects used personal computers, software (including products such as CD-ROMs) and websites to implement their programmes. Hardware provision did not disappear in the second cycle, but winning projects were more likely to invest in tablets or laptop computers. For those first cycle projects which have continued, such as iZ HERO (now DQ World), CD-ROMs gave way to websites and internet access.

Another significant shift is that although platform technologies were mostly used by universities in the first cycle, in the second cycle they were also widely adopted by NGOs. The second cycle saw the emergence of AI technologies as well, and a reduced emphasis on hardware and connectivity. Websites, a fairly popular medium in the first cycle, were almost non-existent in the second cycle.

Figure 8. Technologies employed (n = 24)



Digital learning platforms

Over 65 per cent of initiatives (n = 16) harnessed direct learning platforms, or platforms which provide content directly to students. There were three main types:

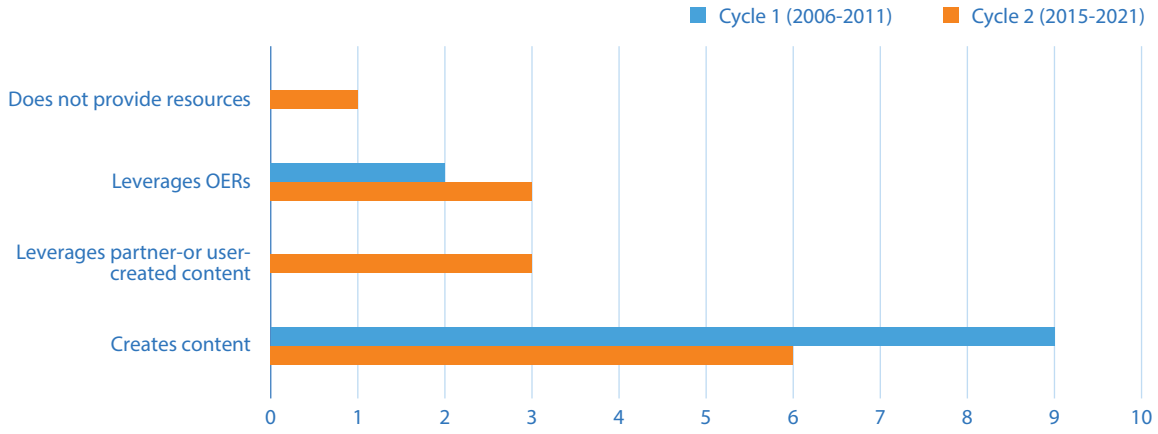
- **Integrated digital learning platforms**: Some Prize-winning projects such as the eDegree Programme in Finland and the smart learning platform of the OUC were developed and managed by higher education institutions to create asynchronous environments to complement synchronous interactions for remote students. These also included Kiron Campus, an open platform serving the needs of refugee populations; the Digital Lifelong Learning System in Shanghai; and the adult learning platform run by NIACE in the United Kingdom.
- **Content management platforms to support home-based learning**: These open platforms provide free supplementary content to support students' learning at home and may focus on curricular materials such as the Republic of Korea's Cyber Home Learning System or on resources that address special needs such as the Dytective platform. Some platforms in this category target extracurricular or interdisciplinary topics, such as iZ HERO and Internet-ABC, which provide learning activities and content linked to global citizenship.
- **Content management platforms to extend or enrich school-based learning**: A quarter of Prize-winning projects applied platforms for the purpose of delivering supplementary content to students in schools, making this the most widely used application. For example, Can't Wait to Learn from the Netherlands targets vulnerable learners such as those in refugee or conflict situations who may not have access to a school or teacher. Other platforms under this category include Claroline Connect in Belgium, Letrus in Brazil, ViLLE in Finland, CLIx in India, and OSP@SG in Singapore.

Strategies for providing digital content

The Prize-winning projects generally employed one of three strategies to supply content: developing content themselves, leveraging content generated by partners or users, or exploiting OERs (see **Figure 9**). Overall, five winning projects stated that they leveraged OERs: CLIx, OSP@SG, and PRONIE FOD-MEP in cycle 2; and Curriki and Claroline Connect in cycle 1. It was only in the second cycle that some projects leveraged partner- or user-created content which was not open to the public: Kiron Campus, which leverages MOOCs from partner universities and platforms; ThingLink, which has a largely closed system of user-created content available to subscribers; and ViLLE, which similarly has content on its platform that is generated by the teacher community it serves.

The majority of the winning projects created their own content. This includes six in the second cycle (Jaago Foundation, GENIE, Can't Wait to Learn, Dytective, the OUC and ViLLE); and nine in the first (the eDegree Programme, Cyber Home Learning System, Digital Lifelong Learning System, ICT-in-Education Programme, Jordan Education Initiative, NIACE, Technological Literacy Programme for Older Adults, iZ HERO Project and Internet-ABC). Only one programme, Letrus, did not have a focus on providing content.

Figure 9. Digital content sources (n = 23, multiple responses possible)



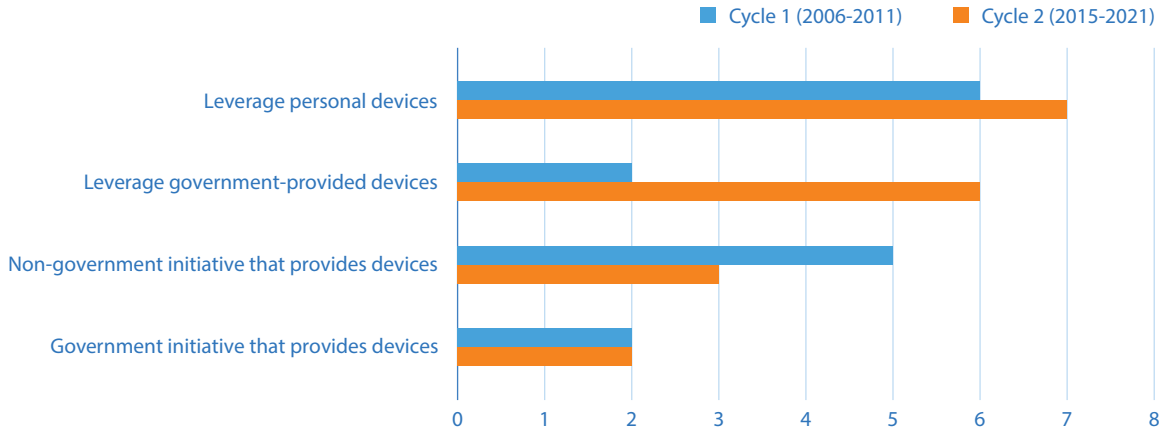
Strategies for providing digital devices

Basic or inclusive access to digital devices for the most disadvantaged groups was provided via governmental and non-governmental initiatives for some projects, while others leveraged existing government-provided devices or personal devices (see **Figure 10**). The winning projects all relied on access to digital technologies, but only half of the initiatives provided devices, including four government initiatives to deliver devices at scale (GENIE, PRONIE FOD-MEP, the JEI, and the ICT-in-Education Programme in Egypt). Non-governmental initiatives that provided devices included academic institutions such as Shanghai TV University or the OUC, foundations such as Infocentro in Venezuela (Bolivarian Republic of), and NGOs which distribute devices in order to deliver other programmes, such as Can't Wait to Learn or Jaago Foundation Digital Schools.

In the second cycle, programmes were much more likely to leverage existing government initiatives to bring digital technologies to schools or communities, a threefold shift from 17 per cent in the first cycle to 50 per cent in the second. The trend was particularly strong in second half of the second cycle. Four of the six winning projects between 2017 and 2020 explicitly relied on infrastructure provided by governments, comprising five of the six initiatives in the second cycle that did so. Conversely, NGOs were half as likely to provide devices in the second cycle.

Initiatives in the second cycle were also slightly more likely to leverage personal devices, a shift from 50 to 58 per cent. However, in the second cycle their users were more likely to be schoolchildren. Half of first cycle initiatives leveraged personal devices, while the Cyber Home Learning System leveraged both personal and government-provided devices to families. The iZ HERO project and Internet-ABC targeted students in and out of school. In the second cycle, five initiatives targeted K-12 learners on both school and personal devices.

Figure 10. Provision of devices by cycle (n = 24)



Lessons learned

A number of insights can be drawn from the global analysis across these Prize-winning projects. This section summarizes five of the key lessons.

01 Iterate humanistic principles in thematic focuses to promote the digital common good

As stated and validated by the analysis, thematic focuses of the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICT in Education have been designed to promote the effective and innovative use of digital technologies to support equitable and quality education and lifelong learning for all. The themes of the Prize are closely aligned to the normative instruments of UNESCO and the United Nations, and have been evolving in response to the technological developments and shifts in global focuses over time. The themes also reflect major global events, most notably the COVID-19 pandemic in 2020. Overall, the themes significantly reflect efforts towards providing access to quality education for vulnerable learners, the use of technology to enhance teaching and learning, and more recently the use of AI in educational pedagogy and to increase access.

Considering digital technology as part of the global commons, UNESCO adopts a humanistic approach to ensure that the use of technology in education promotes respect for human dignity and is guided by human rights principles, namely inclusion, equity and gender equality. And the use of digital technologies including AI must be at the service of humans, supporting capacity building for all and facilitating the sustainable development of societies (UNESCO, 2022). The Prize should continue to act as an important catalyst to steer the planning and scaling up of digital learning solutions for the advancement of inclusion, equity and digital well-being, and the elimination of digital and educational divides. One of the most urgent thematic focuses ahead is to promote universal access to internet connectivity and digital devices, ideally, connections that are available both in schools and at home. In addition to the innovative use of technology in teaching and learning, projects should protect digital security, data privacy and the safety of teachers and students. Specific efforts should be made to deploy strategies to foster digital well-being, particularly of young learners, by preventing them from the harms of the misuse or overuse of technology in education, including internet addiction, prolonged screen time, identity theft, and exposure to disturbing content and hate speech.

02 Mainstream digital empowerment for girls and women

At the time when data on beneficiaries' gender was sought in the application form, projects often reported large gender disparities, and only three were able to report by the end of 2020 that they had made concrete steps to rectify these imbalances. Those that had addressed gender imbalances did so by changing registration processes, conducting gender-specific marketing campaigns, tackling school safety concerns and, in the case of GENIE, changing a government mandate. The efforts invested demonstrate that achieving gender equity will not be achieved easily, and that ensuring representation in materials is only one step which must be taken.

This is alarming and the gender divide will widen if no concrete programmes are rolled out. Multi-country studies reveal that boys are 1.5 times more likely to have a mobile phone than girls (Mlambo-Ngcuka and Albrectsen, 2020). In some countries, internet use is as much as four times greater for boys than for girls (Vodafone Foundation, 2018). The school closures due to the pandemic both reaffirmed the importance of digital

technologies and exacerbated existing inequalities, particularly the gender gaps in digital competencies and skills.

The findings here indicate that the selection criteria and process need to further consider digital gender equality and empowerment as significant factors. The criteria should fully consider the gender equality ladder relating to technology in education, starting from equitable access to AI and digital empowerment for girls and women, to encouraging women to study subjects related to digital technology and participate in the industry. The engagement of girls and women in designing and planning digital solutions are key for ensuring their needs are addressed.

03 Integrating digital content, digitalplatforms, and digital skills to enable resilient learning systems

With a combined total of 17 initiatives leveraging either blended or distance learning, the analysis of Prize-winning projects shows a clear trend that the digital learning is moving toward the hybrid mode of delivery and becoming ubiquitously accessible.

The shift in mindsets towards the systemic upgrading of education systems, especially the modes of provision of learning, is the most fundamental driving factor for digital transformation of education. Drawing on lessons learned from the COVID-19 school closures, there is a consensus that efforts should be made to leverage technology to transform modes of provision so that learning systems become more resilient to more frequent disruptions. The digital transformation should harness online platforms, digital content, human coaching, and personal mobile applications to make tutorials, social communications, and human caring accessible anytime and anywhere, opening up learning possibilities for all and fostering the healthy and responsible use of technologies. UNESCO (2022) has suggested a framework on resilient digital open schooling model (see **Table 1**). This refers to an open

Table 1. Guiding framework for a technology-enabled school system

STAGES	LAYERS	SUPPORT interconnected access	EXTEND learning spaces and time	TRANSFORM pedagogical practices
Policy and resource enabler	Leadership & governance	Basic open school policy	Online open school policy	Ubiquitous learning policy
	Financing and resource mobilization	Results-based financial mobilization	Recurring public budget and private contributions	Recurring public budget and society-wide resources
	Community & stakeholder engagement	School-home-community connection	School-home-community network	School-home-community partnership
Technology, content, and human infrastructure	Education delivery technologies	Inclusive TV/radio model supplemented by online learning	Inclusive online model supplemented by TV/radio	Pervasive online-merging-offline model
	Curricular courses and supporting resources	TV/radio content covering all subjects & grade levels	Online courses and OERs	System-led content and teacher-generated OER
	Human facilitation	Pre-set programme facilitators	Collaborative learning programme designers and facilitators	Technology and resource integrators and co-learners
Teaching, learning, and assessment	Social interaction and care	Technology-mediated care & support	Extended social care & support	Personalized social interaction and care
	Teaching & learning	Lecture-based continued learning	Student-centred and extended learning	Personalized learning and knowledge creation
	Assessment & credentialling of learning outcomes	Tech-assisted assessment and recording	Digitalized assessment and credentialing	Personalized learning analytics and credentialling

mode of delivering hybrid learning that mixes digital technologies, human competencies, and digital content to make curricular courses, tutorials, coaching, and well-being accessible across multiple physical and virtual spaces, including homes and alternative safe venues such as community learning centres, libraries, and temporary crisis shelters. The fundamental purpose is to ensure that alternative access to education can be 'switched on' or made available immediately, so that the right to learn is not disrupted during school closures precipitated by crises or emergencies.

Lessons can be drawn from the analysis of digital learning platforms and provision of digital content as well. Platforms should be built around accredited, well-organized and easy-to-find digital learning content that cover different subject areas and grade levels. This content should be accessible to all from a wide range of digital devices and usable offline. To the extent possible, state-provisioned or state-approved educational content should be consolidated under a single platform, rather than scattered across various sites and locations. The integrated platform should adopt one single universally unique identifier (UUID) and authentication for the majority of the online learning service.

Additionally, the prize should further prioritize the adoption of OERs and the shift in mindset toward open educational practices. A culture of truly open learning and collaboration is not yet in evidence among the Prize-winning projects. Open licences and open access to publicly funded educational resources are crucial and can incentivize the widespread sharing, reuse, appropriation and remixing of digital learning materials.

04 Promote linguistic and cultural diversities in digital learning

The languages included in the innovative winning projects were relatively diverse, particularly in ThingLink, which provides content in more than 80 unspecified languages. Most initiatives were designed to respond to the linguistic needs of their immediate communities, with the exceptions being initiatives targeting international markets, which tended to operate in global languages. Just under half of the initiatives (5 of 12) included a local language.

However, few initiatives were explicitly invested in language preservation, the advancement of minority languages or using technology to assist the 40 per cent of the world's children who are educated in a language they do not understand (UNESCO, 2016). Only ThingLink and the GENIE programme were specifically invested in minority languages, ThingLink by helping individuals create or preserve local language content and learn about minority languages and cultures, and GENIE by creating educational content in a local minority language.

Fairness and non-discrimination should be one of the core guiding principles for the Prize, and winning projects must be expected to take an inclusive approach to ensuring that the benefits of digital technologies are accessible to all, with consideration of the specific needs of different language groups and culturally marginalized communities. Projects should provide showcases to promote inclusive access, including locally relevant content and services, and respect for multilingualism and cultural diversity. Digital divides should be addressed to ensure inclusive access to and participation in the development of digital solutions. And projects that are designed and implemented by technologically advanced countries should support their less advanced counterparts to access digital learning opportunities and participate in the digital transformation life cycle.

05 Support teachers' digital competencies and pedagogical innovation toward digital transformation

Effective or innovative pedagogical methodologies, and support for teachers' continuous building of digital competencies, are key to the success of digital learning and the transformation of education. Although the Prize most often focused on the use of digital technologies for innovative practices and pedagogies, winning projects under these thematic areas on the whole do not demonstrate significant evidence on

pedagogical transformation. Generally, they focus on some combination of access to technology, the use of technology as a mode of delivering otherwise traditional learning (e.g. distance or blended learning), or, at times, the introduction of a new topic of learning (such as digital skills, computer simulation or a specific platform). Only the National Program of Educational Informatics (PRONIE) and ViLLE, the two initiatives that deploy hybrid learning, show genuine shifts in pedagogical approaches.

And the finding also implies that the role of teachers in designing, planning and facilitating digital learning in the winning projects should be redefined to reinforce the teaching and learning process. More particularly, the projects started to adopt AI-powered digital platforms primarily designed to engage teachers in a post-lesson evaluative process through providing them with visualizations of learners' performance and data-based predictions, which is meant to feed into further pedagogical adjustment. There were a limited number of examples where teachers and learners co-created meaning through the use of data visualizations and data-informed predictions. This suggests that teacher-learner-technology interactions are rarely being encouraged during lesson time. The Prize should iterate a principle that while digital technologies including AI may provide opportunities to support teachers in their pedagogical responsibilities, human interaction and collaboration between teachers and learners must remain at the core of education. It should also be clear that that teachers cannot be displaced by machines, and teachers' rights and working conditions should be protected when introducing digital innovations. Projects that that have reviewed and (re-)defined teachers' roles and required competencies, and provided adequate training and support so that they can implement innovative pedagogical methodologies, must be incentivized.

Concluding recommendations

The lessons learned from the Prize-winning projects invite countries and organizations to invest in the universal provision of digital infrastructure for all schools and for all students and teachers including when at home, and to ensure that technology is used in the service of humans to address challenges faced by countries, societies and education systems. Access to digital devices and connectivity is no longer optional, but a necessity for relevant, resilient education systems that also contribute to the achievement of SDG 4, a lesson further highlighted by increased negative effects of the COVID-19 pandemic on low-income students and girls. When designing and implementing digital innovations for education, a mix of factors should be taken into account. The target beneficiaries and their needs must be thoroughly explored, including attention to gender equity, vulnerable populations, and the needs of linguistic and cultural minority groups. The applications of technology by the winning projects show that technology is a very effective tool for increasing access to education and can be effective in facilitating foundational skills such as maths or language. But there are only a few emergent uses of technology in classrooms that transform pedagogical approaches for deeper teacher-learner and learner-learner collaboration, creativity and problem-solving. In response to this, the use of technology in education should seek to solve identified problems as well as enhancing or transforming methodologies for teaching and learning. Technologies that are adopted or invented should be the most efficient and effective at addressing existing challenges, and the approaches to pedagogy and role of the teacher throughout the project life cycle (before, during and after lessons involving technology) should be considered. Meanwhile, the teacher's role in designing and facilitating digital learning should be dynamically re-defined, and teachers should be supported to continuously develop their digital competencies and capacities in advancing the pedagogical transformation.

These findings also invite organizations and governments to adopt a humanistic vision to guide the integrated use of digital technology to transform education. This especially encompasses the modes of provision, the gender dimension, the creation and use of inclusive open content relevant to local communities and cultures, the universal provision of relevant infrastructure and connectivity, and methods to deliver innovative teacher training. Ultimately it is through efforts in these areas that emerging technologies can be successfully leveraged to innovate pedagogies and learning environments towards not only learner-technology interactions but also learner collaboration and improved real-time teacher-learner engagements.

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Innovative use of technology in education

Winning projects of UNESCO's King Hamad Bin Isa Al-Khalifa Prize

UNESCO is actively working with its Member States to ensure the inclusive and equitable use of technology, including artificial intelligence, in education. The UNESCO King Hamad Bin Isa Al-Khalifa Prize plays a strategic role in steering the use of digital technology toward the common good for education and human development. This publication synthesizes key information on the 24 winning projects of the Prize From 2006 to 2020, including their humanistic principles, and the design and planning of their integrated digital learning solutions, human facilitation, and innovative pedagogical practices and resources. It also examines the evolution of the locations, connectivity, technological platform, content development, and teacher preparation for digital learning over time. Finally, the publication puts forth recommendations for policy-makers and practitioners on how to plan and deliver the digital transformation of education while ensuring inclusion, equity, gender equality and digital well-being for all learners.

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4 QUALITY EDUCATION

Sustainable Development Goals