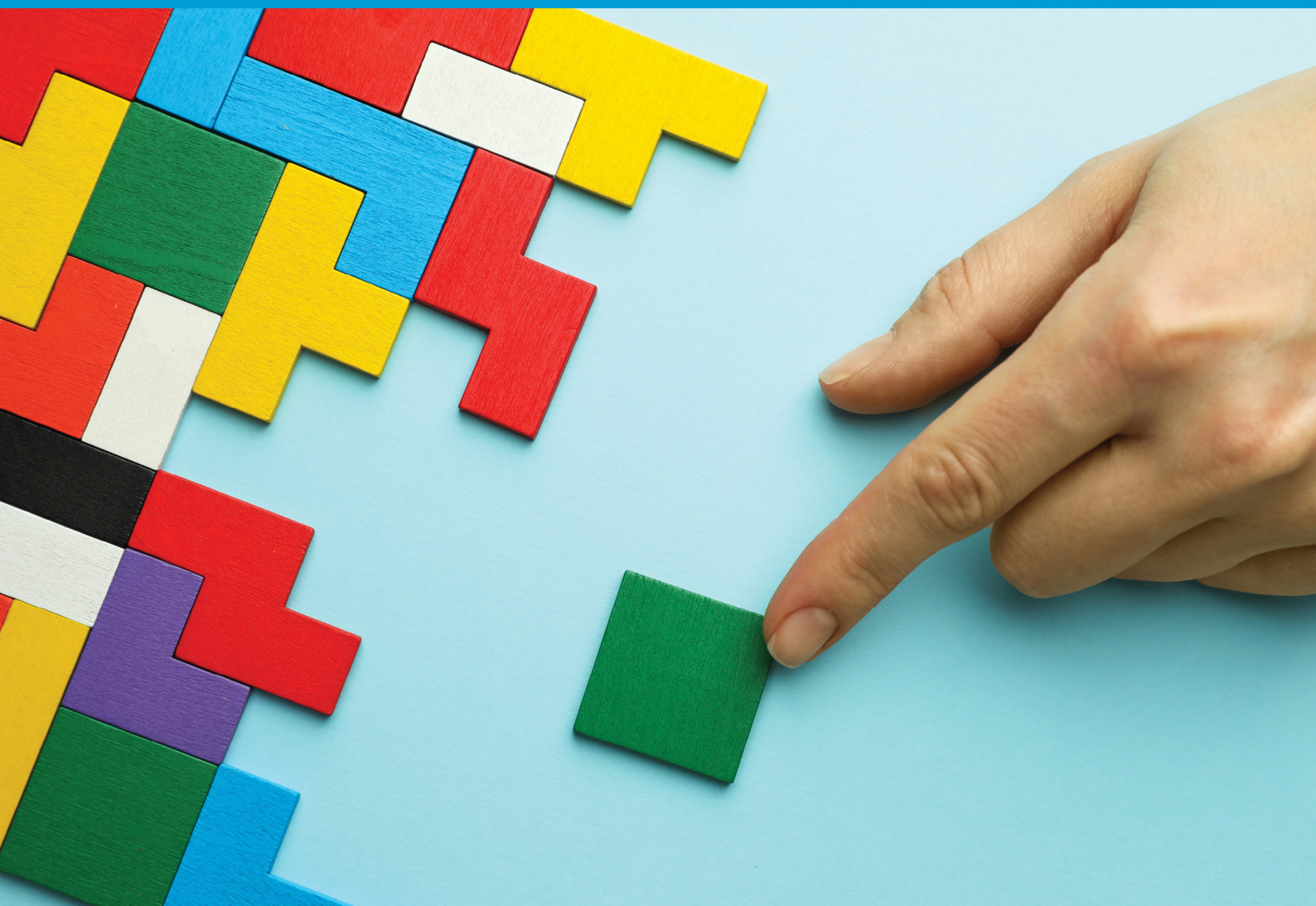


Building the Case for a Digital Public Infrastructure for Education

A cooperative vision for education development



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Authors:

- Märt Aro
- Anna Capps-Jenner
- Peter Fagerström
- Evelien Renders

Multiple people have contributed to the development of this document. Special thanks to Alex Wong, Hani Eskandar, Yolanda Martínez, Carolina Anselmino, Christien Bok, Kristo Vaher, Ben Cervený.

Design & illustration by Daniil Golubev

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Foreword



As many as 2.6 billion people – roughly one-third of the global population – remain offline, largely due to a lack of the necessary infrastructure to enable a basic Internet connection.

Alongside hard infrastructure like network cables, base stations, data centres, and satellites, every country needs multilayered "soft" infrastructure that integrates systems, institutions, and citizens.

These interoperable, scalable and inclusive systems allow essential public services and applications to be delivered through a variety of digital channels.

That's why the International Telecommunication Union (ITU), in partnership with other United Nations (UN) agencies, is committed to supporting Digital Public Infrastructure (DPI) as a critical enabler of sustainable and inclusive digital transformation.

But for DPI to succeed, it must prioritize interoperability, open standards, and secure citizen access to services.

ITU standards will help ensure that the people and technologies making up DPI ecosystems can exchange information seamlessly and securely.

A new resolution on Digital Public Infrastructure¹ adopted by the World Telecommunication Standardization Assembly (WTSA) in 2024, further supports the development of technical standards needed for Digital Public Infrastructure.

Public services supported by DPI can include social security, healthcare, finance – and crucially, education.

Today, millions of schools worldwide remain unconnected, leaving disadvantaged communities at risk of falling further behind.

Giga – the ITU-UNICEF initiative to connect every school in the world to the Internet by 2030 – aims to help build a solid foundation for the systemic transformation of education.

By bringing schools online, Giga enables learners and educators to access high-quality learning resources, participate in the digital economy, and contribute to developing inclusive digital societies.

This report lays out Giga's pathway to scalable, impactful digital education solutions that leverage DPI, with the objectives of fostering innovation, supporting personalized learning pathways, and empowering educational institutions to scale digital solutions tailored to their local contexts.

¹ https://www.itu.int/dms_pub/itu-t/opb/res/T-RES-T.103-2024-PDF-E.pdf

By supporting interoperability and learner-centric approaches, DPI offers the opportunity to transform traditional education systems and help achieve UN Sustainable Development Goal 4 (SDG 4): ensuring inclusive, equitable, and lifelong learning for all.

Doreen Bogdan-Martin
ITU Secretary-General

Executive summary



Executive summary

Education stands as the bedrock of societal advancement and innovation, empowering individuals and catalysing economic growth while also fortifying communities to face tomorrow's challenges. The expansion of the internet-enabled technologies, supercharged by advanced information sharing, big data and artificial intelligence, have delivered unprecedented connectivity, personalisation and system integration.

However, despite these technological advances, digital education solutions remain largely localised, and often replicate the existing frameworks of current institutions rather than innovating beyond them. This has led to the fragmented education landscape we see today, where educational stakeholder coordination is sparse, learner data sits in silos and the availability of innovative methodologies often depends on chance. All of this results in a suboptimal experience for learners, educators, administrators and policymakers alike.

Recognised as one of 12 high-impact initiatives¹ for accelerating progress towards achieving the 2030 Sustainable Development Goals, DPI for Education offers a cohesive framework for inclusive, equitable and high-quality learning. Crucially, DPI is not merely a set of tools, but represents a paradigm shift in educational philosophy, advocating and enabling a learner-centric approach that overcomes geographical and socio-economic barriers. It lays the foundation for a future where education is not just a one-way service, but an enriched collaborative digital learning ecosystem that thrives on the principles of openness, interoperability and user empowerment.

Aligned with the UN's commitment to digital cooperation² and its commitment to bridging the digital divide, the ITU's leadership in ICT development has positioned it at the forefront of driving digital transformation. DPI for education is a prime example of this commitment in action; by providing a robust digital infrastructure, DPI has the potential to significantly accelerate progress towards Sustainable Development Goal 4: ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all.

ITU's initiatives, such as GovStack³, which offers reusable digital building blocks for public services, the OpenWallet Forum⁴, which focuses on interoperable digital wallets, and Giga⁵, which aims to connect every school to the internet, are laying the foundation for a digital future where education is accessible, affordable and equitable. These efforts collectively demonstrate the growing global momentum behind DPI as a catalyst for educational revolution.

¹ International Federation of Library Associations and Institutions. "High Impact Initiatives for the Sustainable Development Goals: Opportunities for Libraries." Last modified September 2023. <https://www.ifla.org/news/high-impact-initiatives-for-the-sustainable-development-goals-opportunities-for-libraries/#:~:text=In%20September%2C%20the%20UN%20announced,at%20national%20and%20global%20levels>.

² United Nations. Report of the Secretary-General on the Work of the Organization. UN Doc. A/74/1. New York: United Nations, 2020.

³ GovStack, "Homepage," GovStack, August September 17, 2024, <https://www.govstack.global/>.

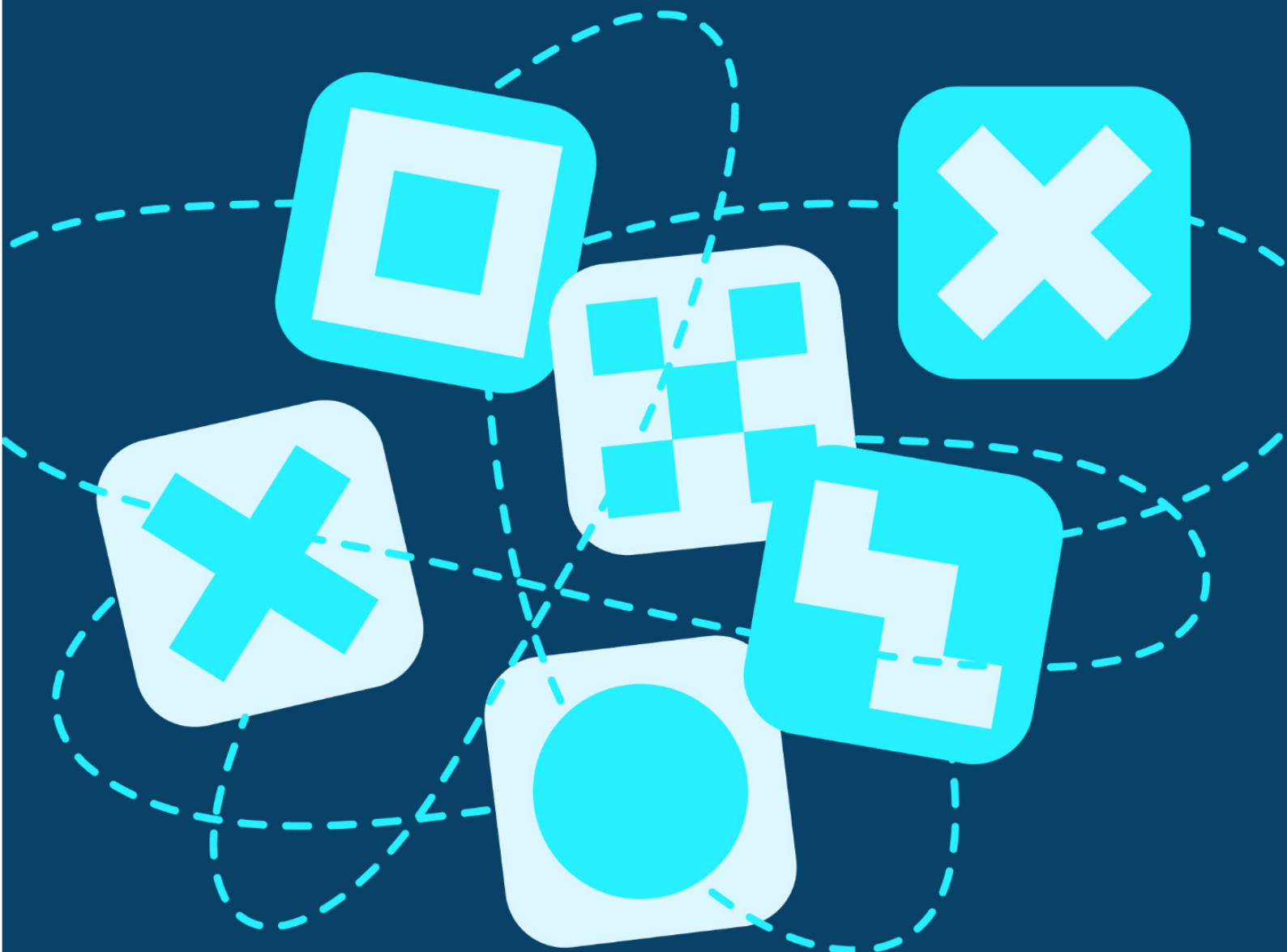
⁴ International Telecommunication Union. "ITU and Linux Foundation Join Forces to Create OpenWallet Forum." ITU Hub, May 30, 2024. <https://www.itu.int/hub/2024/05/itu-and-linux-foundation-join-forces-to-create-openwallet-forum/>.

⁵ Giga Global, "Homepage," accessed August 17, 2024, <https://giga.global/>

This inspirational paper explores the transformative potential of Digital Public Infrastructure to revolutionise education. By integrating existing digital services such as digital identity verification, data exchange and legal frameworks, DPI can streamline educational processes, promote collaboration in education development, and enhance learning outcomes. The document also describes the benefits and challenges and unique value proposition for each of the principal education stakeholders. The paper includes brief case studies of educational DPI in action worldwide and their impacts. Finally, it offers some recommendations for successful implementation of DPI for education.

This document aims to provide a clear, concise and accessible explanation of DPI for education, while acknowledging its constantly-evolving nature and the complexities of the educational landscape. The learner and teacher perspective are emphasised but the wider benefits offered are also explored, such as interoperability, connecting institutions and their systems, and the elimination of the silos that currently hinder innovation. Overall, this inspirational document demonstrates how DPI is a catalyst that can supercharge progress on achieving Sustainable Development Goal 4: ensuring inclusive and equitable quality education for all.

Glossary / definitions



Glossary / definitions

API (Application Programming Interface): A set of rules that allow different software applications to communicate with each other.

Digital divide: The gap between those who have access to modern information and communication technology and those who do not.

Cybersecurity: Measures and practices taken to protect digital systems and data from cyber threats and attacks.

Digital identity: A way of verifying an individual's identity online, often through government-issued IDs or digital credentials.

Digital public infrastructure (DPI): The foundational digital systems and services that support public needs and societal functions, such as identification, payments, and data exchange. It falls primarily under the category of soft infrastructure as it centres on the rules, protocols, and frameworks that govern access, use, and exchange of digital information and services for the public good.

Ecosystem: The network of people and organisations working together to create new ideas and improve teaching and learning. It includes educational institutions, standardisation bodies, governmental organisations and service providers such as educational technology companies, all interacting within an environment shaped by economic, social and technological factors.

Data Exchange Layer: A crucial component in digital infrastructure, especially within the GovStack framework. It serves as a gateway that facilitates communication and interoperability between different applications and ICT building blocks, known as the Information Mediator Building Block (IMBB) in the GovStack framework.

Interoperability: The ability of different systems and organisations to work together seamlessly, exchanging and making use of information.

Open standards: Agreed-upon guidelines and specifications that ensure systems can communicate and operate together, promoting interoperability.

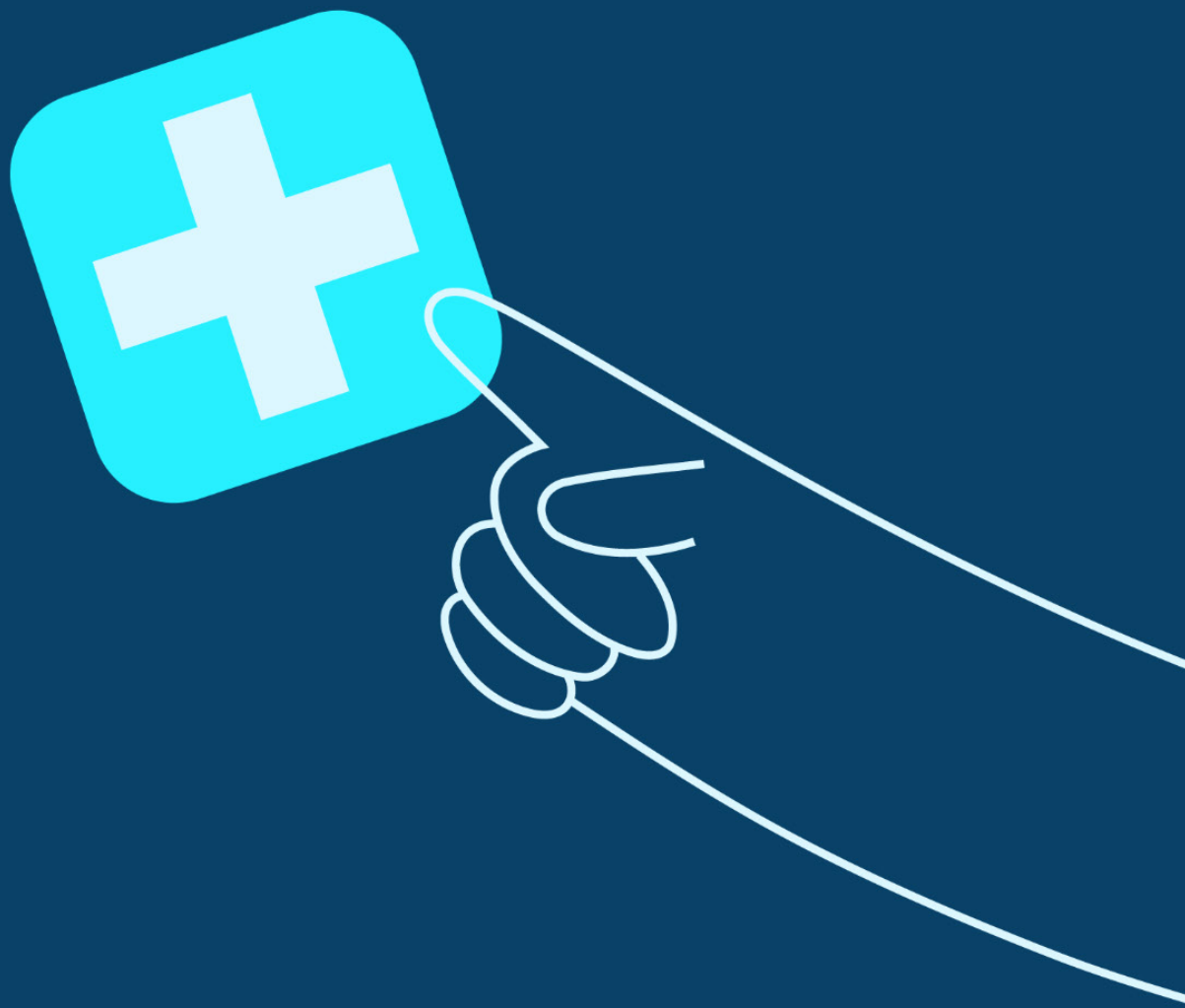
Microservices: An architectural approach to software development, where small, independent components work together to form a larger system.

User authentication: The process of verifying the identity of a user before granting access to a digital system or service.

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A beacon of hope



A beacon of hope

In a bustling city school, ten-year-old Jamie sat at the back of the classroom, fidgeting with the frayed edges of his notebook. His ADHD made it difficult to focus on the maths lesson being explained at the front. Numbers and equations swam before his eyes, and he felt a familiar irritation bubbling up inside him.

Jamie's teachers were well-meaning but often very frustrated. They didn't have the resources to provide the one-on-one attention he needed. His parents, worried and tired, struggled to keep up with the constant calls and meetings with the school. Jamie's grades were slipping, and his self-esteem was plummeting. He felt like he was in a race he couldn't win, a race where everyone else seemed to know the rules but him.

One crisp autumn morning, Jamie's school announced a new initiative. Each student would be paired with a personalised AI learning buddy. Jamie was sceptical. Technology hadn't helped him much before. But his parents were hopeful, and his teachers seemed excited.

The first day with his AI buddy, named Lexi, was unlike anything Jamie had experienced. Lexi greeted him with a friendly tone, "Hi Jamie! I'm Lexi. Let's make learning fun together!" Jamie's first task was a maths problem. His usual dread started to creep in, but Lexi broke the problem down into bite-sized steps and used games and animations to explain each part.

When Jamie got distracted, Lexi gently brought him back to focus with interactive quizzes and instant feedback. The AI could adapt in real-time, offering praise when Jamie succeeded and patiently re-explaining concepts he struggled with. For the first time, Jamie felt like someone was really on his side, understanding his unique way of thinking.

As weeks turned into months, Jamie's progress was remarkable. His grades improved, but more importantly, his confidence grew. Lexi

helped him organise his homework, manage his time, and even practise mindfulness exercises, to cope with stress and anxiety. Jamie's teachers noticed the change too. They saw a child who was more engaged, more willing to participate and increasingly independent.

One day, Jamie was working on a history project. Instead of the usual overwhelm, he felt excitement. Lexi had helped him plan each step, and he was eager to present his findings. When he stood before his class, Jamie spoke clearly and confidently. His classmates listened attentively, and his teacher beamed with pride.

At the end of the school year, Jamie received an award for the most improved student. He couldn't believe it. The child who once felt lost and out of place in the education system had found his footing. As he looked at his parents' proud faces and his teacher's approving nod, Jamie knew he wasn't alone. He had Lexi, his personalised AI learning buddy, to thank for turning his educational journey around.

The experience had taught Jamie that everyone has a different way of learning, and with the right support, anyone can thrive. The future looked bright, not just for Jamie, but for countless other children like him, finding their way with a little help from technology and a lot of determination.

This paper strongly believes that the digital world and interoperable education is like a time machine for jumping ahead: a way to experience the future which we may not otherwise see in our lifetimes. Thus, our motivation is to bring the future closer to us and enable opportunities to governments to provide better services to their citizens in a more sustainable way and using flexible technologies and architectures that will.

DPI for Education can bring this future closer to us by creating building blocks that empower

education innovators in making their dreams a reality. But it is essential to understand that to make such a wide-arching change a success - which will have global ramifications - requires stakeholder investment.

DPI for education should be seen as something other than a start-up or a passion project. It is the way of thinking, the way of working, and

the way of building that enables innovations in digital governments. With DPI for education, it is possible to achieve global education innovation at an unprecedented scale, and an unprecedented scale requires an unparalleled commitment from the parties involved.

Let's make it happen together!

Education challenges addressed by Digital Public Infra- structure

Education challenges addressed by Digital Public Infrastructure

The current educational landscape is characterised by a paradox of proximity and isolation. Digital advancements have narrowed geographical gaps and are fostering collaboration and knowledge sharing across various sectors. However, most educational systems are still confined to localised and isolated structures. These archaic systems are proving to be inefficient and ill-suited for the dynamic demands of contemporary society. At the same time, the traditional one-size-fits-all approach to education still present in today's models is increasingly considered obsolete, failing to accommodate the diverse needs of learners, educators and society in general. Furthermore, while the vital role that teachers play in student success is well known, the majority have limited access to professional development. These disparities are compounded in what is now understood as a persistent learning crisis, particularly evident in low and middle-income countries, where millions of children cannot read with adequate comprehension at the age of ten¹.

To enhance educational effectiveness, stakeholders must address several key challenges:

- improving access
- establishing robust quality control and continuous improvement processes
- empowering educators and increasing collaboration
- delivering equity and growth

The ways in which DPI effectively addresses these challenges is detailed below.

Improving Access to Education

Breaking Down Geographical Barriers

DPI will enable students in lower income countries to have the same access to top-tier educational resources as students in higher income countries. By providing robust and secure digital platforms, students everywhere can access lectures, learning material and interactive learning modules from the best educators globally. This democratisation of education, particularly for universal content areas such as physics, chemistry, biology, maths, technology and languages, removes geographical barriers, and brings world-class learning to every learner, regardless of their location.

Ensuring Inclusivity and Equity

DPI can enable creation of higher-level learning solutions designed to cater to diverse learning needs. The solutions can make learning more personalised, including those of students with disabilities, different linguistic needs. Solutions such as AI, adaptive learning materials, text-to-speech, and interactive content make this possible on a global scale.

Establishing quality control and continuous improvement processes

Quality and Efficiency

DPI for education allows a greater number of learners to have access to high quality learning solutions by enabling creation of modern learning solutions. It also means effective solutions can be more easily scaled. By building systems founded with scalability in mind, digital education will not only be

¹ <https://www.worldbank.org/en/news/press-release/2022/06/23/70-of-10-year-olds-now-in-learning-poverty-unable-to-read-and-understand-a-simple-text>

able to meet the demands of the present more effectively but also to adapt and grow in the future. The DPI allows for systems that are flexible, efficient and capable of handling increasing loads without compromising performance or user experience. This can create significant resource-savings over time for all stakeholders. This topic is elaborated in more detail under the sub header *Application of Artificial Intelligence (AI)*.

Personalised Learning

DPI for education connects solutions that facilitate personalised learning experiences. For example, DPI will contribute to development AI solutions that can be significantly more effectively developed thanks to access to data through the data exchange layer. AI algorithms that can seamlessly support a student's progress, identify strengths and weaknesses, and suggest resources and activities to help them improve (elaborated under Application of Artificial Intelligence (AI)). This personalised approach ensures that every student can learn at their own pace and according to their personal needs and circumstances and facilitates lifelong learning.

Interactive and Immersive Learning

In the same way, DPI will also contribute to the implementation of interactive and immersive technologies, such as virtual reality (VR), augmented reality (AR) and the metaverse for education can transform education from a passive to an active experience. Effective implementation of these technological capabilities can enhance a history lesson so that students can virtually walk through ancient civilizations or conduct virtual experiments in science class. These immersive experiences can foster a deeper understanding of the subject matter and make learning more stimulating and memorable.

Empowering Educators and increasing collaboration

Professional Development and Collaboration

DPI is not just beneficial for students; it also empowers educators through enabling the delivery of digital teacher training at scale. Teachers can access a wealth of professional development resources, collaborate with peers worldwide and stay up-to-date with the latest research and innovative methodologies, contributing to educators' continuous learning and improvement.

Efficient Administration and Resource Management

The foundational principles of DPI will also empower the creation of better administrative tools by focusing resources on building high-quality solutions that connect to other solutions at scale, enabling the reuse of solutions and thereby cutting waste of resources that normally comes from building large monolithic solutions. These tools can streamline administrative tasks, allowing educators to focus more on teaching and less on paperwork. Automated systems can handle time consuming tasks such as grading, attendance tracking, and resource allocation, making educational institutions more efficient. Freed up time and resources can then be redirected towards enhancing the quality of human-led education.

Delivering equity and growth

Bridging the Digital Divide

DPI will make it possible for best practices to move across country borders and impact education systems globally. By building on top of existing projects to improve digital connectivity, DPI provides the soft architecture that enables the future-ready education to be delivered, ensuring that no one is left behind in the digital age. This inclusivity is crucial for

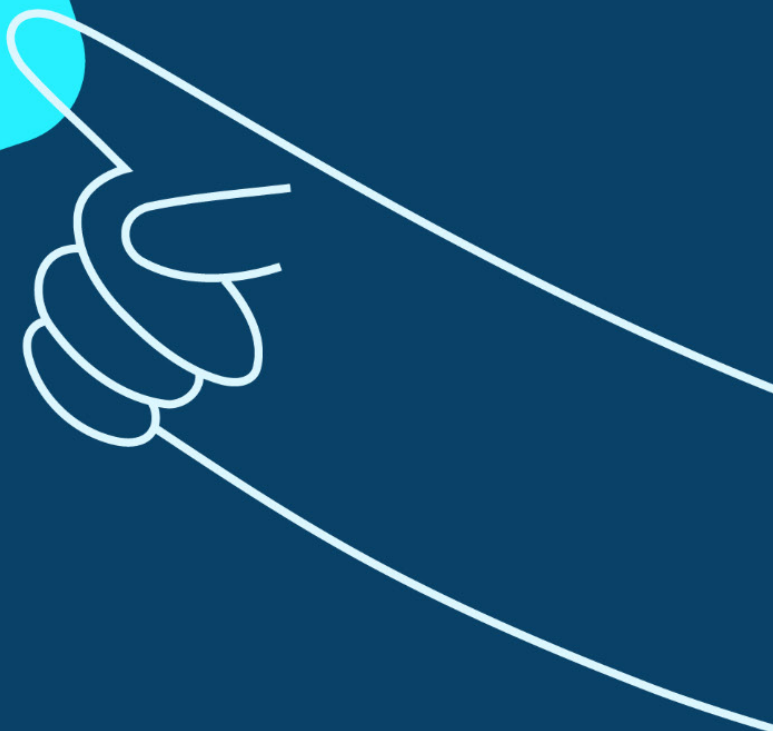
building a fair and just society where everyone has the opportunity to succeed.

Driving Economic Growth and Innovation

An educated population is the bedrock of economic growth and innovation. This population needs on-going access to meaningful learning opportunities. On the other hand, by empowering digital innovations

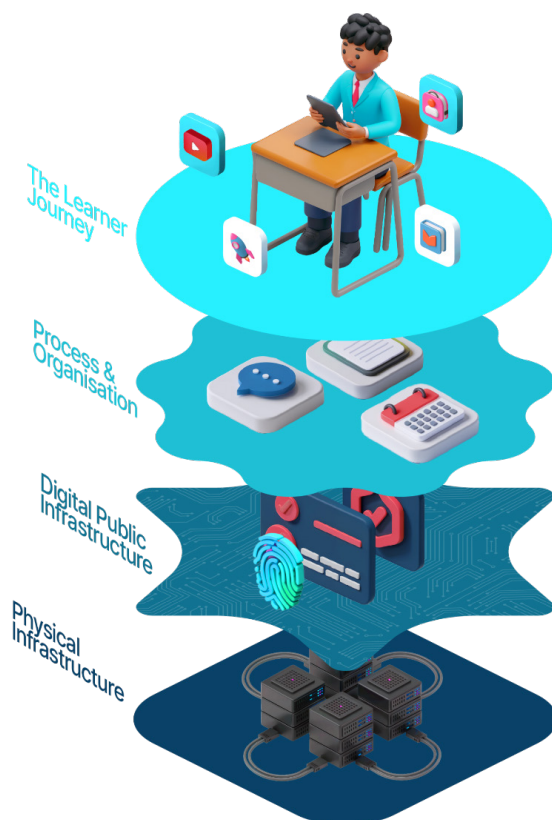
and through that creating new opportunities for establishing information-society businesses. By investing in DPI, we are not just enhancing individual lives but also fostering a more innovative and competitive economy. A well-educated workforce can adapt to changing job markets, drive technological advancements, and contribute to the overall prosperity of the nation.

The whole education digital ecosystem



The whole education digital ecosystem

The education ecosystem can be understood as consisting of several interconnected layers. This is one of several models designed to represent the digital education ecosystem.



The Learner Journey. This is the layer where teaching and learning happens. This dimension is the interface of the applications the learner uses, and these applications typically consist of learning content and methodologies.

Process & Organisation. The data is incorporated in the relevant applications. Operation processes involve a wide range of activities that are crucial for the effective and efficient functioning of the institution. These processes span administrative, academic and support functions.

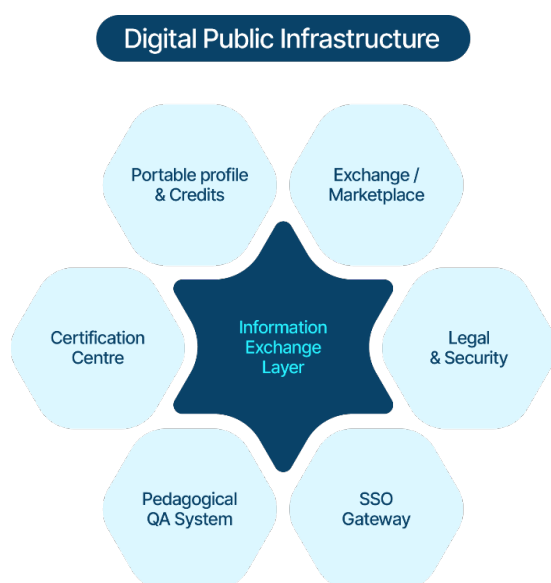
Digital Public Infrastructure. This layer consists of underlying services such as digital identity, access management and integration platforms and is facilitated by a data exchange layer. The DPI for education focuses primarily on this layer.

Physical Infrastructure. Servers and physical networks that enable the internet to work and to be accessed by its users.

DPI for education: summary

DPI for education: summary

The construction of a DPI for education should not be understood as standalone services. In fact, the services necessary for DPI for education will be able to develop in a way that is applicable in other sectors, as well beyond education. Alternatively, DPI from other sectors could be reused in education. The core services are summarised on this page. Further description is included in the following pages.



Information Exchange Layer (or what is known as Information Mediator Building Block in GovStack), enables interoperability, including the seamless movement of necessary data between education environments, saving tremendous amounts of work hours for both teachers and learners but also administrators. **Single sign-on (SSO)** enables accessing all learning and teaching opportunities globally with a few clicks.

The Pedagogical Quality Assurance System helps learners and educators to evaluate pedagogical effectiveness of learning content, methodologies and tools. **Portable profile and Credit systems** help to collect and systemise evidence of the learning that happened in a meaningful way. This could be also organised via learning analytics.

The Exchange / Marketplace enables learners and educators to find the specific learning content, methodologies and tools with the parameters that they need.

The Certification Centre manages a central repository of credentials for educational resources. This facilitates independent audits, both individual and professional, verifying that educational content, methodologies, and tools meet established quality standards. Furthermore, it ensures these offerings align with specific requirements by implementing a classification system that caters to learners with diverse needs, such as visual impairments or dyslexia.

Legal & Security functions as a compliance framework, providing educational institutions with clear understanding of relevant legal and security requirements, along with tools and resources to support their implementation. This includes key areas such as privacy, data protection and ethical considerations in education.

DPI for education: explained



DPI for education: explained

In order to enable better access to learning opportunities globally, DPI for education can include a wide-ranging combination of features and functionalities. The DPI for education should be developed in partnership between the public and private sector, considering all stakeholders' needs. This partnership must be carefully considered to maximise the benefits each sector can provide according to their unique competences. The following fundamental components described below should be incorporated. They are described in order of importance, beginning with those considered the most essential.

Data exchange layers

Teachers and learners working in digital learning environments leave digital footprints in the form of data. The more complex learning process, the more data is generated. In the case that the learner or their guardian consents to their data being used for research and analysis, data exchange layers make the process of capturing data easier and offer solution providers and education administrators much richer data sets. Equipping education researchers with larger data sets to undertake empirical analysis results in a net gain for all.

In order to solve this, a data exchange layer between information systems would provide a standardised and secure way to produce and consume services, avoiding the need for a large number of API connections. A standardised and secure data exchange layer would connect information systems in education. Data exchange layers would enable seamless teaching and learning by facilitating the secure movement of learner data between different learning environments. Digital identity and single sign-on (SSO) would ensure authorised data transfer.

To facilitate the secure and reliable data exchange, these layers implement a set of

standard features including access rights management ensuring only authorised parties can access data, organisation-level authentication that verifies the identities of participating institutions and time-stamping guaranteeing the accuracy of data transfer timing and usage.

One method of achieving high security standards would be requiring an onboarding process to join a data exchange ecosystem. During the process, the identity of each organisation and technical access point would be verified using certificates that are issued by a trusted Certification Authority (CA). The identities would be maintained centrally, but all the data would be exchanged directly between a service provider and the consumer.

Cross-border data exchange

For optimal knowledge sharing, it is essential to enable cross-border data exchange to avoid the creation of isolated islands. This could be organised through setting up a global education data exchange layer or through federation, which means joining together several data exchange layers. Members of the federated ecosystems would then be able to publish and consume services with each other.

Digital identity / Single sign-on (SSO) gateway

Currently educators and learners must have separate user-accounts for each learning solution provider's platform. Creating accounts creates work, it also creates significant additional inconvenience if the password is lost or forgotten. To facilitate seamless access to global learning opportunities, DPI for education should include a universally adopted Single Sign-On (SSO) gateway. This gateway would connect all SSOs and edtech solutions, enabling educators and learners

easy access to currently separate systems and removing navigation barriers. There are many SSO gateways² that could be utilised and can be incorporated beyond only education DPI.

By incorporating SSO into DPI, all users enjoy a seamless experience. This feature allows users access in as little as two clicks. The data that the service needs to operate is provided to the service automatically once the user authorises the sharing of their data.

Legal & Security

Although the digital world provides vast opportunities, there are always bad actors who seek to abuse the system. Educators and education technology innovators require tools that help them to maintain high standards in legal compliance and security.

The legal and security DPI consists of frameworks and systems that empower and facilitate a secure, lawful and efficient management of digital data and services within education. This infrastructure supports a wide range of activities from administrative tools to ensure compliance with data protection, and allowing user control over their data, and cybersecurity via strong encryption to minimise the risk of data breaches. In the DPI frames considers the tools that are needed to enable building lawful and secure digital education services³.

In addition, effective DPI must be built on top of suitable government policies and frameworks. Context matters, therefore, each country's specific legal context influences the implications of DPI frameworks. In some places, this may simply require reviewing and updating, but in other places, it may mean the complete development of necessary legal frameworks and security standards that enable DPI to serve citizens properly.

² Several examples of SSO are provided in Further reading regarding SSO

³ Further reading regarding L&S

Pedagogical Quality Assurance

The current educational technology landscape presents challenges in identifying suitable learning solutions. Educators and learners often struggle to assess the effectiveness of a particular solution to meet learning goals, the prerequisite knowledge required and its suitability for learners with diverse needs, such as those with dyslexia, ADHD or autism. Crucial information, which include effectiveness metrics and key performance indicators, is typically fragmented or unavailable, hindering informed decision-making.

Pedagogical Quality Assurance (PQA) in the context of Digital Public Infrastructure refers to the systems and processes designed to ensure that educational practices, content and technologies meet high standards of teaching and learning excellence. This set of tools supports the continuous improvement and assessment of educational quality through digital means. PQA-related services may or may not be considered a DPI in and of itself, but the use of these tools become critical in the context of education DPI and improving the quality of education as a whole. This can be achieved through big data collection, enabling automated comparisons of different approaches, learning analytics and specialist tools for quality assurance. A detailed explanation is provided in the annex⁴. Much work has been undertaken on PQA that would be suitable for DPI for education, some of which is referenced by EduXS⁵.

Certification centre & quality assurance system

The challenge for users selecting edtech solutions are the varying standards around the globe. Often it is unclear which standards need

⁴ Further reading regarding Pedagogical Quality Assurance

⁵ EduXS, "Homepage," accessed August 17, 2024, <https://eduxs.eu/>.

to be followed and how, or if they are met by the technology developer. DPI for education would provide a portal where solution providers can log in and get an overview of what requirements or standards they need to meet. The certifications could include legal, ethical and technical standards.

A model service would work in the following way. First, the provider logs in and ticks boxes for criteria that they fulfil (self-evaluation). They also could ask a trusted third party to verify and certify that they fulfil certain requirements. The buyers should be able to mark all standards required for a specific tender and add it to the tendering document. The cert centre profile would be accessible to everyone that needs to have access to it.

- Legal standards (such as GDPR-compliant)
- Technical standards
- Security standards (such as ISO 27001)
- Data exchange standards (such as RESTful API)
- Ethical standards (such as 'suitable for visually impaired users').

Portable Profile & Credits

When learning happens online, it is often difficult for the learner to prove that the learning has occurred. Without adequate crediting, the learning is not formally validated. Also, when a learner moves between education providers, they are usually unable to prove their prior knowledge or display their current skill set at an early stage. New learning environments evaluate the learner, saving time for both the learner and learning provider.

The tools in this segment need to enable learners to keep track of all the learning that they have done by collecting certificates, degrees and diplomas in one verifiable skills profile. The learner needs to be able to share what level they have achieved in a certain subject matter in a machine understandable

way. A mechanism is needed to address data integrity issues.

- > Portable profile (which could include learning preferences for adaptive learning)
- > Micro learning and micro credentials
- > Nano degrees

This approach could enable innovators in developing targeted learning opportunities for currently left out audiences. Like working mothers that have very limited time, for example they could learn on their commute to work in case such foundational infrastructure is provided⁶.

Exchange / Marketplace

It can be challenging for educators and learners to find the learning solution they need at this point in time and for the intended purpose. DPI for education needs to empower setting up exchanges where on one hand educators and learners could conveniently find solutions that could support them in learning according to their interests, needs, skills, etc. On the other hand, the solution providers need to be able to conveniently offer their solutions. Elaboration of [considerations](#).

What could be built upon:

- > Ability to build curriculum
- > Data exchange backbone
- > Analytics systems
- > Skills mapping
- > AI learning buddy
- > Formatting assistant to address user learning preferences and available tech, such as gamification tools, text to audio, automated translation, etc.

Application of Artificial Intelligence (AI)

Currently a major hurdle for developing effective AI for education is accessing the

⁶ Further reading regarding Portable profile and credits

large quantities of high-quality learning data necessary. There are several reasons for this. Many educational institutions lack comprehensive, standardised data collection systems. Even when data is available, its quality often varies widely. Inaccurate, incomplete, or biased data can lead to unreliable AI models. Strict regulations around student data privacy limit data sharing and accessibility, hindering data aggregation for AI development. Lack of standard data formats and definitions across different educational systems also make comparing and analysing data effectively more difficult.

The goal is not to develop AI within DPI but rather to empower creation of meaningful AIs that support educators and learners in their specific context. Depending on the concrete DPI, it will aid the development of different kinds of AIs such as more precise recommendations on learning sources (matchmaking), more precise and personalised AI tutors, etc.

In order to fulfil this goal, learning data needs to be made accessible. For example, to make learning outcomes machine-understandable, so it would be possible to develop automatic evaluation and assistance systems. As one

example this could be achieved by establishing a machine-readable knowledge graph, which would enable data to be collected regarding successful strategies of learners' development across different subject areas. Hence after several learners have used such a system, the system would have high enough quality big data. On top of this AI systems could be developed that could automatically compile recommended pathways for teachers and learners to follow, to optimally achieve their learning goals.

When the data is generated, it should be made public so innovators and researchers could use it to research learning and also to develop the (AI) tools with help of such data. For example, it could entail teacher/learner dashboards that enable learning goals to be set by teacher/learner and could then the dashboard could compile a pathway / map, how to achieve such a goal.

Whilst DPI focuses only on soft infrastructure, building higher level solutions will become possible or more efficient thanks to the DPI. Direct education challenges are addressed by the higher-level solutions / end-user solutions.

Beneficiaries, challenges and value proposition



Beneficiaries, challenges and value proposition

Digital public infrastructures have wide-reaching benefits for society in general, but specifically for core education stakeholders. The three main beneficiaries of DPI are learners, facilitators and service providers. Each potential beneficiary currently faces a distinct challenge and therefore stands to gain unique value from the ecosystem.

1. **Learners:** All learners globally gain from the DPI, however learners currently underserved by existing e-learning solutions in low-resource settings would experience a significant benefit.

The key challenge for learners is attaining meaningful lifelong learning that goes beyond existing geographical, socio-economic and institutional barriers.

Value proposition: Learning experience is tailored to match the learner's level and preferred learning needs for optimal outcomes, helping them to reach their specific learning goals, such as acquiring the skills for a qualification, getting a job or a return to formal education, and to develop necessary digital literacy skills for the future.

2. **Facilitators:** The teachers, mentors and coaches helping others to reach their learning objectives.

The key challenge is integrating digital tools with pedagogy and cultural sensitivity to ensure inclusivity, while also safeguarding learner safety and privacy. Additionally, they require continuous professional development to address digital inequalities that can exacerbate educational disparities, particularly for disadvantaged students.

Value proposition: Greater access to learning content, solutions and tools, facilitated

learning material selection and dissemination, and enhanced learner progress monitoring. Note: DPI for education can also aid the administration of education at an institutional level, thereby saving educators time.

3. **Service providers:** Universities, NGOs and private learning solution providers.

The key challenge is access to sufficient learner data and education market insights for the sustainable revenue creation essential to allow further development and effective iterations of the solutions.

Value proposition: Provide access to tools, services and marketplace to accelerate development of high-quality learning solutions catering to the global audience of learners.

The Digital Public Infrastructure for education serves as a foundational framework that enables the development and dissemination of educational solutions tailored to the diverse needs of stakeholders within the educational ecosystem. By providing this set of digital systems, DPI facilitates the integration of innovative teaching and learning methodologies, resources, and tools, thereby enhancing accessibility and personalization of education. It supports educators in adopting best practices and emerging technologies to foster an environment conducive to quality education. Furthermore, DPI's scalable architecture accelerates the global advancement of educational standards and practices, ensuring equitable access to superior learning opportunities for students worldwide. By bridging the gap between these stakeholders, DPI ensures a synergistic approach to enhancing the quality and reach of education worldwide.

Digital Public Infrastructure for Education in India: A Case Study

Digital Public Infrastructure for Education in India: A Case Study

There are already several existing initiatives evolving in the field in different parts of the world. One of these is in India. Here, DPI for education has already revolutionised the way educational services are delivered, particularly in the wake of the COVID-19 pandemic. India presents an especially compelling case due to its sheer scale, diversity and therefore complexity. India has 248M children in school, 9.4M teachers, over 20 languages of instruction and 60 different boards of education. Examining the policies, frameworks, and principles that have contributed to its success can provide valuable insights for future education DPI in other locations.

Launched in 2017, India's DPI for education uses enabling technologies such as DIKSHA (Digital Infrastructure for Knowledge Sharing), which is a versatile, free-to-use platform that has been adopted by almost all states and union territories. It offers solutions for students, teachers, and administrators in primary and secondary education, including "energised" textbooks (ETB) using QR codes to link to relevant digital content, online courses with digital credentials, assessments, quizzes, chatbots, online courses and assessments.

India's DPI for education is designed to cater to its diverse educational landscape, including its multiple regional languages and educational boards. This inclusivity ensures that it is accessible to a wide range of users.

Key to the success of India's project is the effective collaboration between the

government and private sector (Ekstep Foundation and the Central Square Foundation). This public-private partnership (PPP) has facilitated the development and implementation of scalable and sustainable digital solutions⁷.

Since its launch in 2017 it has already begun to have a significant impact. Firstly, and most notably, it has significantly improved access to educational resources, especially for students connected from remote and underserved areas. In addition, the platform's design allows for continuous updates and scalability, ensuring its long-term sustainability. Furthermore, teachers have access to a wealth of resources and tools that enhance their teaching methods and professional development which provides a strong foundation for continuous improvement across the sector.

It should be noted that India still faces some fundamental difficulties. Despite the progress, challenges such as the digital divide and infrastructure limitations in rural areas persist. For this reason, ongoing efforts are needed to address these issues and further enhance the platform's capabilities.

India's DPI for education serves as a model for other countries looking to implement digital solutions in their educational systems. Its success lies in its inclusive design, effective public-private collaboration and continuous adaptability to meet the evolving needs of the education sector.

⁷ Ministry of Education, Government of India. "Secretary DoSEL Presentation World Bank Webinar." Ministry of Education, Government of India, 2024. https://www.education.gov.in/sites/upload_files/mhrd/files/Secretary_DoSEL_Presentation_World_Bank_Webinar.pdf.

Digital Public Infrastructure for Education in Mexico: A Case Study

Digital Public Infrastructure for Education in Mexico: A Case Study

The Story

Maria is an Information Systems student at the University of Guadalajara in Jalisco, Mexico. She has been granted a Fulbright Scholarship to attend Carnegie Mellon University (CMU) in the US. To complete her registration process at CMU, she needs an electronic copy of her bachelor's degree in four-weeks' time. However, issuing the degree by electronic means is not possible and the normal processing time is between six months to a year, since all degree documentation is processed by the Mexican Ministry of Education in Mexico City. The only way to speed up the process is by commuting to Mexico City with the acceptance letter from CMU and other related documents to obtain the degree certificate directly from the office of the Ministry of Education. Once the degree is issued, a Professional License (Cédula Profesional) in a plastic card format must also be requested. Altogether, this trip costs Maria an eight-hour bus ride, a night in a hotel, and a few days of waiting.

Until 2018, millions of graduates from universities across Mexico faced a lengthy wait of six months to a year for their bachelor's degrees to be processed in paper format and for them to receive their Professional License card. As part of the National Digital Strategy, a digitisation effort was launched. In just three months, university degrees were standardised to facilitate data exchange between universities and the Ministry of Education. This enabled the issuance of the Electronic Professional License (Cédula Profesional Electrónica) entirely online, in a single iteration, and in electronic document format. The digitalization of this government service reduced the delivery time from months to a few minutes. This democratisation of access to key documents

boosted people's professional careers and contributed to increased national productivity.

Furthermore, this high-impact use case was successfully implemented using the existing Digital Public Infrastructure (DPI) within the Mexican Government Stack, including eID, eSignature, ePayments, and other foundational building blocks. It serves as a compelling example of how other governments worldwide can effectively utilise their own Government Technology DPI Stack resources to replicate this transformative experience.

The use case

The Cédula Profesional is an official document issued by Mexico's Secretariat of Public Education (SEP), validating the completion of professional studies and authorising individuals to practise their professions within the country. As Maria's story illustrates, obtaining this document historically involved a complex and time-consuming process that required in-person visits, extensive paperwork and lengthy processing times.

Implementation of the Electronic Professional License

The introduction of the Electronic Professional License in 2018, significantly streamlined the Mexican government's processing capacity. This digital transformation allowed professionals to apply for and receive their licences entirely online in one iteration, leveraging the country's public digital infrastructure and standards. Digital teams around the world can replicate this approach using GovStack end-to-end DPI Implementation Framework and resources. The table below illustrates the tech stack used in Mexico and the GovStack resource that can

be used to enable digitalisation of government services.

Importance of Standardization

A critical aspect of the Professional License Use Case is the standardisation of electronic documents issued by governments, such as online birth certificates using the National Population Registry Number (CURP) as the key to identify the user in all government services. Standardising these formats is essential for creating a cohesive digital identity ecosystem in Mexico. It facilitates interoperability between various government systems, simplifies administrative processes for citizens and enhances data security by allowing more

effective verification and reducing the risk of fraud across digital transactions.

Impact and Relevance

The implementation of the Electronic Professional License is a successful example of how digital public infrastructure can transform traditional government services. It not only improves service delivery but also enhances accessibility for professionals across Mexico, making it easier for them to obtain the necessary credentials to practise their professions from anywhere in the world. Additionally, the system's ability to handle high transaction volumes efficiently demonstrates the robustness of Mexico's digital infrastructure and sets a precedent for future digital government initiatives.

Mexican Institutional set up, regulatory framework and tech stack	GovStack resources that digital teams can use to replicate the experience
Institutional & regulatory FW National Digital Strategy as part of the National Development Plan 2012-2018 Presidential decree for establishment of the one-stop shop gob.mx as a single point of access to all government information, and services Service design standard - applicable to all government services	Public Administration Ecosystem Reference Architecture (PAERA)
Service design Co-design session took place between the Mexican Ministry of Education, personnel from Universities responsible of issuing bachelor degrees, university students and Gob.mx service design team	GovStack Playbook Service design principles User journey mapping Service blueprint
Unified digital service experience: Applicants can access the https://www.gob.mx/cedulaprofesional to get their professional licence in one iteration. The web form and sequence of the steps follows the digital service standard.	Specs UX/UI Guidelines Sandbox resources Wireframing kit Service Catalogue Service prioritisation & ranking One Stop Shop Approaches

(Continued)

Mexican Institutional set up, regulatory framework and tech stack	GovStack resources that digital teams can use to replicate the experience
Advanced Electronic Signature (eFirma): The use of eFirma, a core component of Mexico's digital infrastructure, ensures secure authentication of the applicant's, as well as digitally signing electronic documents. This digital signature is used to sign the application (legal requirement), providing a secure and verifiable method of identity validation without requiring physical presence.	Specs Digital Identity BB eSignature BB Sandbox resources Compliant solutions with GovStack Tech Specs eID DPG Consent Management Software eSign Software
Licences registry: The SEP maintains a centralised, secure database that allows for quick verification of the authenticity of issued licences. This feature is crucial for employers and institutions to easily validate professional credentials online, reducing the risk of fraud.	Specs Registration/Registries BB Sandbox resources Registries DPG
Payments: The payment gateway provides users of the service to pay using debit, credit and printable cash order.	Specs Payments BB Sandbox resources Payments DPG

Note: Digital Public Good (DPG) accounts for open source software that went into a recognition process with the Digital Public Goods Alliance (DPGA) in order to be named DPG. In GovStack Sandbox, some of the building blocks that won international tenders are recognised as DPGs. All software products in the GovStack Sandbox are GovStack compliant with the GovStack Technical Specs.

Digital Public Infrastructure for Education in Estonia: A story of a seamless government experience

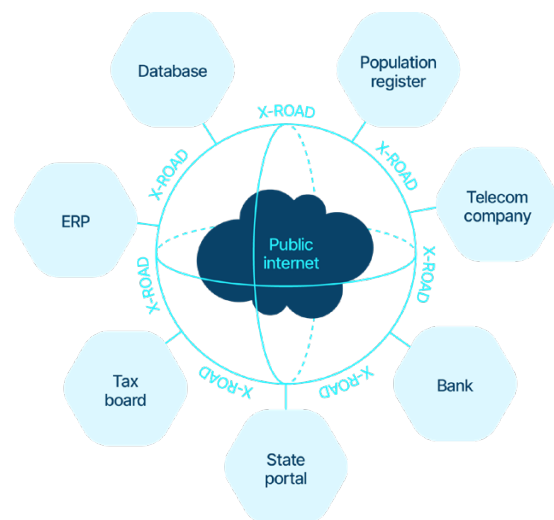
Digital Public Infrastructure for Education in Estonia: A story of a seamless government experience

As part of a global GovStack implementation, digitising high school records emerged as a priority use case. During a discovery phase focused on best practices in other countries, a session with Estonian experts was organised. When discussing the digitization of high school records, an Estonian expert posed a thought-provoking question: 'Why would a government institution within the same country request a high school record to access other government services?'

The expert explained that in Estonia, education registries, like many others, are accessible to any ministry via X-Road, the country's interoperability platform. This seamless exchange of information highlights Estonia's mature digital government ecosystem. The interoperability platform eliminates the need to digitise services that involve routine consultations between government registries with citizen consent. It simplifies service catalogues, reducing the number of documents that need to be exchanged between government entities.

The Estonian experience demonstrates how digital service teams worldwide can leverage

interoperable registries to significantly reduce the number of services requiring digitization. A digitalization plan should prioritise the development of key registries and their associated APIs. This focus on essential services allows for greater investment in creating exceptional digital experiences and proactive services that anticipate citizen needs. In Estonia's next-generation digital government services, AI-enabled solutions are a high priority, leveraging the vast data resources accumulated over the years.



Source: [Estonian World](#)

Governance of the ecosystem

Governance of the ecosystem

While governments may own the digital public infrastructure, setting standards and regulations, coordinating public and private partnerships, and being accountable for the effective use of public resources, they should ideally act as neutral facilitators. This means overseeing the ecosystem without directly influencing decision-making. To avoid conflicts of interest, it is advisable to establish an agile coordination body to manage the ecosystem of DPI for education. This body should consist of a diverse set of experts to foster increased creativity and innovation, and to enhance problem-solving and decision-making. Their task would be to develop inclusive DPI that embody open standards, thereby boosting

the digital learning ecosystem that supports microservices.

The GovStack Public Administration Ecosystem Reference Architecture (PAERA) provides comprehensive guidelines on DPI governance. It explains how reusable software components, or building blocks, interact with Enterprise Architecture practices. This framework enables governments to offer cross-sector and sector-specific digital services—such as school records, vaccination certificates, and social benefits—in a technology-neutral and standardised manner.

Conclusion



Conclusion

The digital divide in education, characterised by unequal access and fragmented solutions, urgently requires comprehensive action. Education DPI, acting as the railways for learning, offer a path forward. By establishing and supporting soft infrastructure initiatives, we can create, curate and maintain accessible learning opportunities for all. Furthermore, robust frameworks necessitate investment in capacity building, including relevant training programs, awareness campaigns, and targeted skill development initiatives. These efforts will ensure effective DPI implementation for all stakeholders across various education levels and contexts, from preschool to lifelong learning.

The vision of Digital Public Infrastructure for education is one of hope, inclusivity, and progress. It promises to democratise access to quality education, enhance learning experiences, empower educators and learners and build resilient societies.

To unlock the full potential of digital transformation in the education space, a strong foundation is needed – an infrastructure that enables a plug-and-play approach for educational applications, fostering innovation and driving real impact. This foundation is Digital Public Infrastructure. The implementation of soft infrastructure components such as data exchange layers, digital identity and legal and security frameworks, alongside pedagogical quality

assurance, ensures a comprehensive approach to educational excellence. Additionally, the application of AI, offering tailored solutions for individual learners provides innumerable overarching benefits.

DPI is crucial for systemic transformation, preparing future generations to harness technological advancements. Much work is currently being undertaken and yet much work is yet to be done. As existing case studies indicate, its success depends in part upon successful and well governed PPPs. Moreover, DPI built with interoperability at its heart, delivers a sustainable solution to education challenges that reach beyond connectivity, providing the next level of functionality for delivering quality educational services. Learners gain access to personalised educational services that serve them throughout life, while educators benefit from accelerated development of high-quality teaching and learning tools to boost their teaching. Education service providers benefit from this digital infrastructure that empowers the creation of targeted content and solutions, therefore fuelling transformational objectives.

Finally, as we stand at the crossroads of technological advancement and educational transformation, the need for DPI has never been more pressing. Embracing this vision can ensure that education becomes a powerful force for good, unlocking the potential of every individual and paving the way for a brighter, more equitable future.

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International Telecommunication Union
Place des Nations
CH-1211 Geneva 20
Switzerland

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