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Research and Digital

EDUCATION X-VERSE INNOVATION

Applying the PIE X lens to digitalized learning and skill development experiences

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1. The eXperience-verse revolution

"In the first report[1] in the “Digital India Innovation and the Experience-verse Revolution” series, we explored the contours of digital India innovations. We undertook a brief historical tour of India’s computing journey, and examined the role of research and educational institutions, the IT industry and startups, and the government, in pushing the boundaries of computing.

We then undertook a brief historical tour of enterprise value creation – looking at the four eras of Industrial Revolution, the accelerating pace of digital transformation of private, public, and plural sector enterprises in a tech-intensive modern world, and touched upon some important management frameworks of value creation (such as value chain, platform business, ecosystem innovation, and co-creation).

Next, we proposed a new framework of interactional value creation in this post-pandemic world – the “eXperience-verse (X-verse) Revolution”. (See Figure 1.) Unlike the previous four Industrial revolutions driven by technology, this new era requires an “experience-first” frame of reference of interactional value creation by every enterprise.[2] We also explored several examples of the X- verse in practise.[3]"

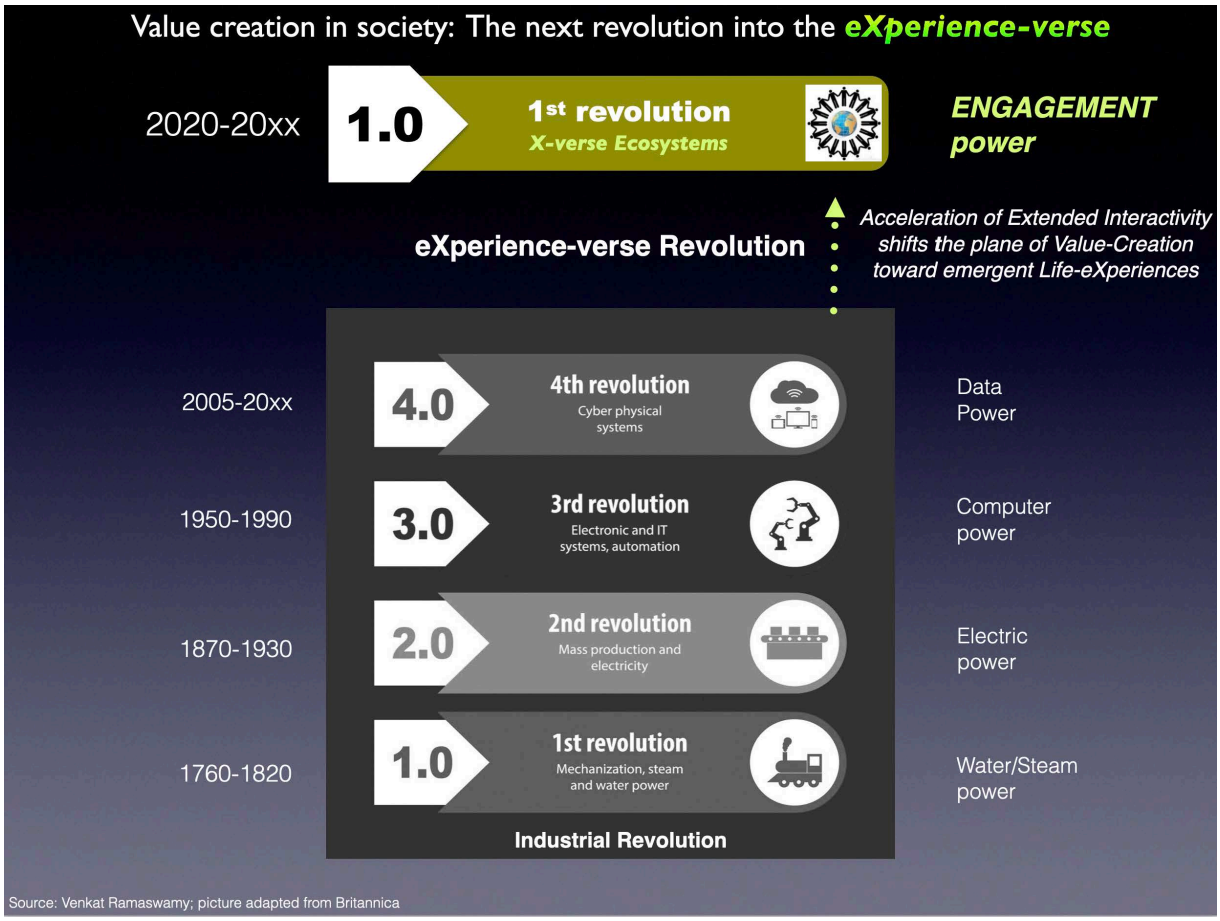

Figure 1: Experience verse Revolution (Source: Venkat Ramaswamy Picture adapted from Brittanica)

One such example is that of AB InBev, the largest brewer in the world. It uses Microsoft Azure Digital Twins to create a live digital model of their breweries and supply chain. AB InBev's brew masters can get a real-time view into the complex brewing process and are able to adjust the biological and chemical process parameters based on active conditions. Frontline operators leverage AI algorithms to automatically compensate for bottlenecks in the packaging process. They use mixed reality for remote assistance and to ensure uptime on the machines. Routing algorithms help the delivery trucks transport the beer cases so they achieve the lightest carbon footprint and ensure that the right beers are delivered to the consumer at the local pub for the perfect sip.[4]

Emerging technologies are leveraged at the moment of engagement between the enterprise and the experiencers -- the brew masters and digital-twin maintenance expert. The goal is to engender value to the individual-as-experiencer. This value to experiencers comes first in the form of various outputs and outcomes – such as maintenance service provided. Then, value is created through not only optimized processes and high-quality products but also through enhanced environments of emergent experiences throughout the brewing ecosystem.

We then presented the **PIE X (Platforms, Impacts, Engagements, eXperiences) lens**, that helps visualize opportunities and challenges for experience-centric innovation and multistakeholder value creation in interactive ecosystems of the X-verse. (See Figure 2.)

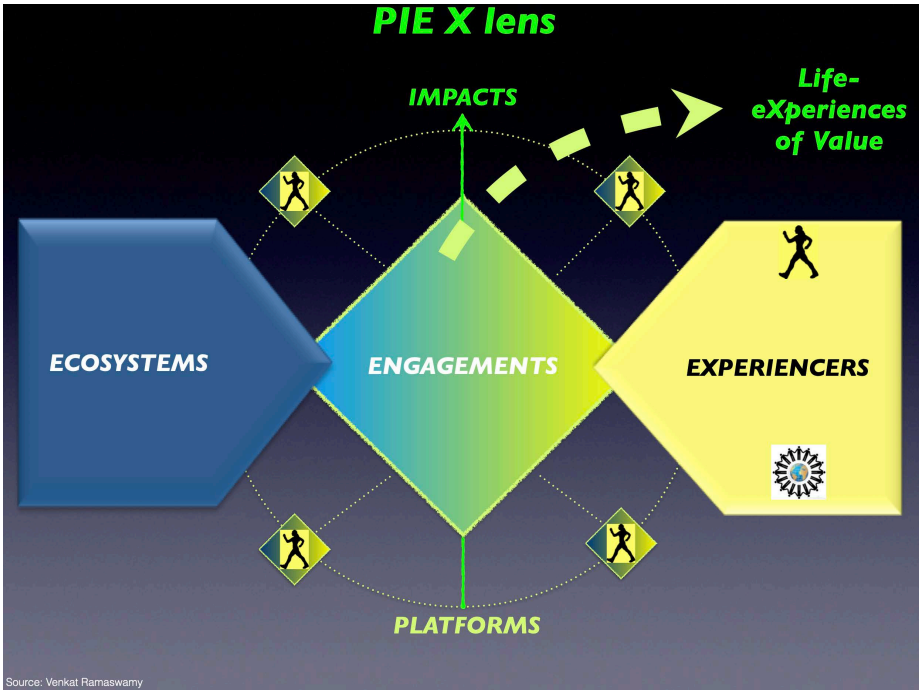

Figure 2: PIE X lens (Source: Venkat Ramaswamy)

In this report, we will explore education X-verse innovation and apply the **PIE X lens to various digitalized learning and skill development experiences.** In doing so, we introduce some key risk-managed levers for enterprises in expanding experience-centric innovation and value creation with stakeholders in interactive X-verse ecosystems, and discuss them in the context of facilitating education innovation ecosystems.

2 Visualising the education X-verse

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The inevitable shift towards digitalized learning and skill development

The education sector, long resistant to a wide-scale adoption of technology, had begun embracing digitalization even before the Covid-19 pandemic struck. From a demand perspective, it was shifting towards life-long learning and skill development, with personalized, modular learning pathways and micro-credentials or bite-sized learning and development of one's knowledge, talent, and professional skills. On the supply side, universities and schools incorporated digital platforms for virtual delivery of their content, created Massively Online Open Courses (MOOCs), and enhanced their digital presence through online learning platforms such as Coursera and EdX.[5] (See Figure 3.)

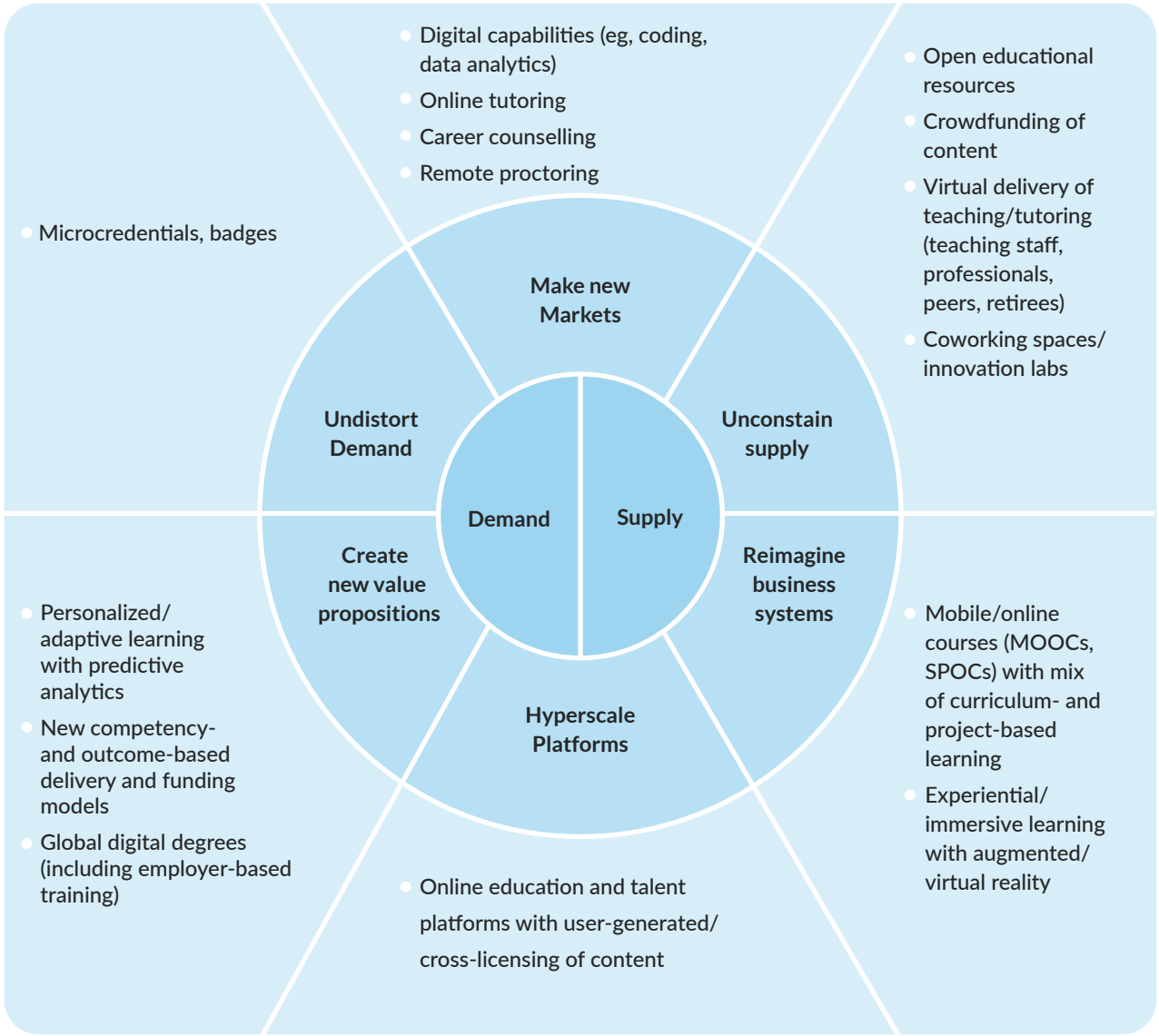

Figure 3 : Digital disruption in education (Source: McKinsey)

The pandemic dramatically accelerated the shift towards digitalized learning. It forced global experimentation with remote learning.[6] A number of lessons and questions have emerged from these experiments – i) universities will have to determine situations appropriate for campus / face-to-face and online interactions, and suitably embrace a hybrid model for good; ii) IT infrastructure and educational support (such as instructional design and student engagement) are required to enhance the online learning experience. At the same time, these infrastructural demands have led to an issue of digital divide, among students and universities; and iii) training efforts are required to facilitate changes in mindsets and behaviours among faculty and students.

Transformational shifts in the education X-verse

Let us understand some key transformations taking place in the education X-verse. Enterprises need to visualize strategic opportunities and manage risks at every moment of engagement of an experiencer in a digitalized interactive X-verse ecosystem. Rather than merely focusing on the activities in the value chain, enterprises now have to consider the lived-journey of engagements of all stakeholding individuals-as-experiencers and the extended reality of experiences that emerge from their interactions via new digital interfaces – from pure reality to mixed reality to pure virtuality.[7] Moreover, enterprises can no longer continue to measure their success only in terms of profits, revenues and earnings per share, but go beyond to include the geo-biological, psychological, socio-cultural, and economic wellbeing of all stakeholders.[8]

The major transformational shifts taking place can be viewed along five different loci of value creation: locus of interaction, locus of innovation, locus of value, locus of strategy, and locus of performance. (See Figure 4.)[9]

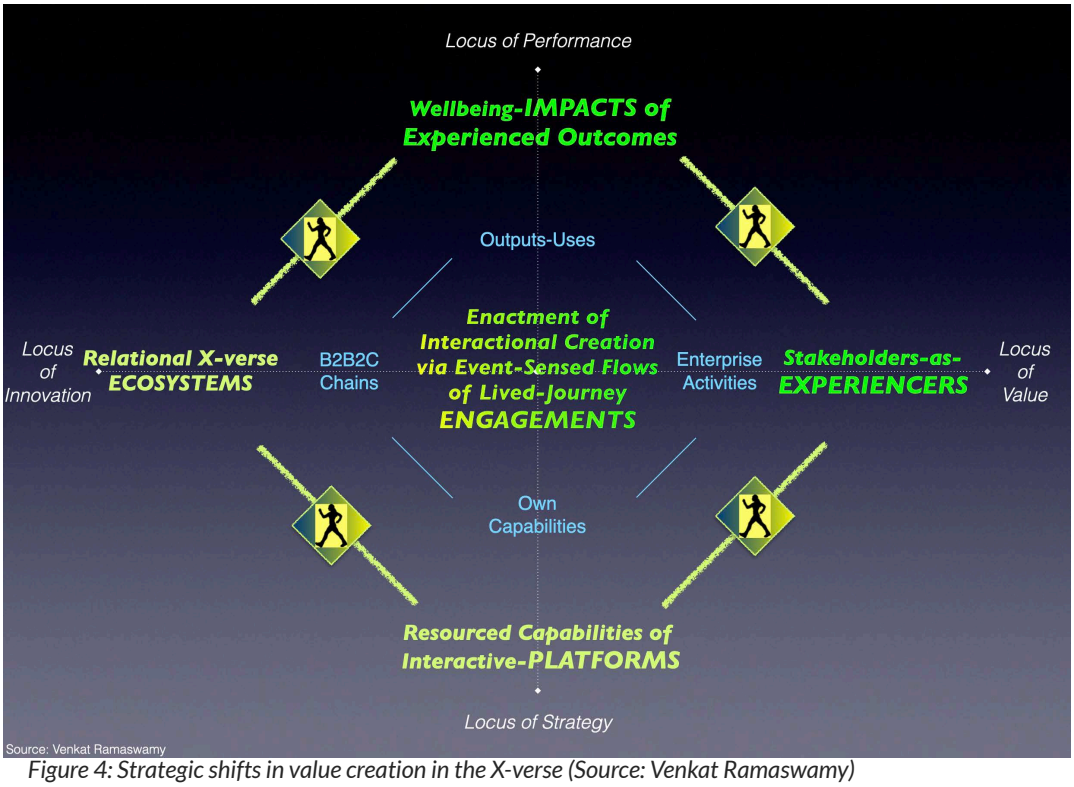

Figure 4: Strategic shifts in value creation in the X-verse (Source: Venkat Ramaswamy)

1. The locus of interaction shifts beyond 'industry boundaries of goods and services' to 'eventsensed flows of lived-journey engagements' of individuals-as-experiencers. The experiences happen at moments of engagements between the enterprise (say the educational institution) and the eXperiencer (say the students or the faculty).

a. Earlier the locus of interaction was centered on the university, and predominantly from the university to the student. For instance, the university had a defined set of courses and course-work, and the students had to pick from the given set of choices.

b. In the X-verse, the focus of interaction is on the student, who may be learning about the given subject from a number of different sources – online, from personal tutors, virtual worlds, etc. How does the university help the student personalize a learning plan given this context? Such a personalization falls under interactional creation via event-sensed flows of engaged learning.

2. The locus of innovation shifts beyond 'B2B2C chains' of goods and services to 'relational Xverse ecosystems'.

a. Earlier a student had to attend a university to learn. The emphasis was on the university – both the physical campuses and the dedicated virtual spaces. Value got created through the courses and programs that the university offered.

b. Now, the emphasis shifts to relational ecosystems of digitalized relational learning experiences. An individual anywhere in the world can plug into a MOOC network and virtual learning and skill development experiences, in which this university is a partner. This also means that the X-verse value creation is not just happening within a single enterprise, but across an enhanced learning and skill development network of multiple enterprises – in terms of educational content (from across multiple universities); innovative offerings (such as leveraging an education cloud solution for student engagement); and in terms of networked partner ecosystems (say for student outreach in new geographies).

3. The locus of value shifts beyond 'activities of enterprises' to 'interactivity of all stakeholders-as-experiencers', i.e., the interactive experiences of stakeholders as creators of value in their own lived-journeys of engagements.

a. In education we talk about flipped-classrooms, where it starts with the engaged learning experience of the student, and value is a function of student interactivity and exercising agency in their own personal development, rather than just the process of classroom teaching and lectures delivered by professors.

b. This shift applies to all **stakeholders**-as-experiencers, not just the students. In the case of faculty, the locus of value creation shifts beyond the process of hiring of resources by the university administration to the onboarding and lived-journey experience of the faculty members, as well as the learning partners in the interactive experience ecosystem.

c. An important aspect is to consider the lived-journeys of stakeholders-as-experiencers in their own creator ecosystems. For instance, one lived-journey is that of a student. While taking university courses, the student may also be running a startup. Does the university know this about that student? And does it provide interaction opportunities in the lived-journey of the person as an entrepreneur? Lived-journeys of employees, partners and

other collaborators may also be considered. Such a perspective helps expand the **"pie of value"** for the enterprise.

4. The next shift is on the locus of strategy – beyond 'own capabilities' to 'resourced capabilities of platforms'.

a. This manifests in multiple ways – from a university providing education in one specific space, the university campus, to locations where the students are present – a shift from the physical to the virtual world.

b. It also manifests as a shift beyond a system of records (like an ERP system in a university) to a system of engagements (like a communication platform for students where they can collaborate, exchange ideas etc.) and how this edge system now integrates with the backend.

5. Finally, the locus of performance goes beyond just 'outputs-uses' to 'sustainable wellbeing impacts'.

a. For a university, the performance metrics shift beyond number of students taught, revenues (and other wealth measures), to increasing Gross Enrolment Ratios of a nation, or alignment to UN SDG Goal 4 on education, or ESGs in higher education.

b. There is now emphasis on the wellbeing of the students and teachers, especially in the context of completely online learning, and amplifying positive developmental impacts at speed, scale, and scope, sustainably, while managing the risks effectively and efficiently.

A university in the metaverse

Mark Zuckerberg, founder and CEO at Meta in his Connect 2021 address, talked about the 'metaverse' as the next evolution of mobile Internet and of social connection.[10] He imagined a future of home-spaces or education-spaces in which 3D digital avatars of you and your friends could teleport, to a virtual space where you could feel the presence of others and interact with them using natural interfaces or VR headsets.

How can we create compelling learning experiences in the digital world, including the metaverse? Consider the following scenarios that provides a sharp contrast between a conventional virtual world of educational experiences and that of 3D immersive metaversal learning experiences.

Digital Education Scenarios (Extracted from "A whole new world: Education meets the metaverse") [11]

A virtual space is created that looks well-designed and is gamified. The graphics are spectacular and there is related content available to explore, but these puzzle pieces do not fit together to result in a full understanding of the times (picture the ability to click on what are essentially Wikipedia articles as children navigate the space). Ads for other virtual spaces abound. Children are given a list of tasks to complete to earn "points" that are linked to a project grade. Teachers log in to ensure that all children meet the minimum requirements, but their role has been minimized as they "supervise" the digital activities of 200 children a year.

VS.

Imagine a circular classroom, surrounded by white boards and populated with movable chairs. Suddenly, a 3D immersive timeline is projected onto the middle of the floor. Children whisk away their chairs to stand in the present, ready to move backward and descend into the year 300 BC—a year in which they will encounter a new reality. They enter the metaverse of Greek culture. Carts buzz by them, traders in marketplaces surround them and high atop the hill, they see—with their own eyes—the temples of the gods and the people who worship them. They explore, they ask questions, they ponder, and learn immersively and through each other.

Researchers, who studied the world of educational apps, have articulated a set of guiding principles to support learning goals and to create digital educational experiences with social interactions at the core. They believe that they are applicable for constructing engaging, immersive and collaborative learning opportunities even in the metaverse. The principles include: i) facilitating active learning; ii) be engaging rather than distracting; iii) tapping into something meaningful; iv) encouraging social interactions inside and outside the digital space; v) being iterative and allowing for different learning pathways and experiences on each interaction; and vi) creating experiences that are joyful.

Let us consider another scenario – Nick Clegg, President Global Affairs at Meta, visualizes an immersive learning-experience thus: "Learning won't be limited by geographical location — a student in Mumbai could attend a seminar hosted by a Professor in Frankfurt; a middle school class in Wyoming could take a field trip to Stonehenge or the Pyramids of Giza. Indeed, they could experience these landmarks as they would have been at the time of the Druids and Pharaohs."[12]

Let us apply the PIE X lens to a metaversal education context, with a student as the experiencer in an interactive ecosystem – that of a US university offering a virtual degree program in the metaverse; with professors and teaching assistants (both real and virtual metaversal assistants) who interact more intensively with students and address their clarifications in real-time.

- ***Experiencers*** – students from all across the world joining a virtual class in the metaverse.
- ***Platform*** – a 3D rendering environment via a digital twin campus of the US university (a fully spatial, 3D virtual replica of the university campus, where a student can move about, attend classes and interact with other students), VR headsets to access the virtual environment.
- ***Engagements*** –persistent, dynamic, personalized interactions across varying spatio-temporal contexts of a student's lived-journey of learning involvements that is meaningful to them
- ***Impacts*** – from a student perspective, the impact measures could include measures of how engaging the course is, or responsiveness of the online teaching assistant. From a perspective of psychological and mental wellbeing of the student, enterprises should, for instance consider how to address cyber-bullying, anxiety, emotional stress, or fatigue in the deeply immersive education metaverse context.

Having examined value creation opportunities from a student perspective, the PIE X lens could be applied next with a college administrator or an online teaching assistant as the experiencer, and the remaining entities as part of the ecosystem.

Enterprises need to empower all stakeholding individuals to become innovators. This requires givin those closest to the experience – customers, employees, partners and other stakeholders – the capacity to redesign new experiences in metaversal ecosystems of relevance to them. This wil require diverse groups of individuals coming together interactively -- from customers and frontline employees, to product managers, data scientists, and creative teams – to reconfigure lived-journey engagements through "large scale co-creation".[13]

Rather than merely focusing on the metaverse value chain from an enterprise perspective, organizations will have to equally consider the immersive flows of lived-journey engagements of people in the X-verse, as they seek to engender outcomes and impacts of value to various stakeholders. For instance, in the education metaverse, can the university identify, keeping in mind privacy concerns, that one of its current students in its history program is a docent, in real-life, at a museum in Italy, and having identified, reconfigure its system to make that student a teaching assistant for the course dealing with Italian history? Can it harness the knowledge and skills of its students, and involve them via an engagement platform in co-designing relevant content and new types of immersive and interactive learning experiences, including tapping into language-translation AI cognitive services?

Let us apply the PIE X lens to some real-world digital learning and skill development experiences.

3. Applying the PIE X lens to digitalized learning and skill development experiences

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Microsoft Cloud for Education

Ecosystem & Experiencers

"As part of helping organizations build resilience and innovations, especially in the pandemic-induced fluid business context, Microsoft introduced a series of Cloud industry solutions. The Cloud for Higher Education solution, powered by an education transformation framework, helps an education provider undergo digital transformation.

One of the important experiencers for a university is the student. The university considers the different lived-journeys of the student – first as an applicant, then as a student, and later as an alumnus. Each university aims to attract the best candidate and maximize recruitment through personalized outreach. It builds a 360-degree view of a student, from enrollment to graduation, and predicts student performance using AI capabilities. Once the student graduates, it can effectively target and engage the appropriate alumni community using intelligence from dynamic data dashboards and collaboration tools."

Platforms & Engagements

Flexa is an AI-powered continuous learning platform, developed by MIP Politecnico di Milano and Microsoft. It starts with a skill-gaps assessment and then recommends a personalized learning path for learners with access to 800,000 pieces of learning material from over 200 certified and selected sources.[14]

The collaboration tools also provide an immersive environment for students to learn, and content can be contextualized based on analytics about the student. For instance, the University of New South Wales in Sydney leveraged Microsoft Cloud platforms – Microsoft Teams and Microsoft Stream – to implement an engaging learning environment for engineering students. A Question Bot was created that assigned student questions to the relevant teaching assistant. The bot was also able to search video lecture transcripts and deliver time-stamped video clips to students. The university then put QR codes on the learning material, so that when students uploaded a picture of their worksheets, the Question bot could recognize what the student was working on using the Microsoft Custom Vision cognitive service.[15]

Impacts

In the example above, the re-designed learning environment resulted in an engaged student community and class satisfaction jumped to 99% at the engineering class. Universities are looking at impact metrics beyond just course learning outcomes and student satisfaction. The University of the District of Columbia, as part of its Equity Imperative, focused on digital literacy as part of elevating students in twenty-first century educational institutions.[16]

Other companies too, like Google, offer cloud-based solutions for education. The Walden University launched Julian, its interactive tutor that leveraged the Google Cloud learning platform. The interactive tutor uses APIs to present a chat-based experience for students, incorporating AI-generated learning activities. It can also generate targeted questions based on reading materials and individualized learning needs to help students practice concepts.[17] University of Michigan, in its Trans-Omics for Precision Medicine (TOPMed) program, a precision medicine initiative supporting

research into heart, lungs, blood, and sleep disorders, had generated over three petabytes of data that would take thousands of core years to analyse with traditional high-performance computers. Instead, they chose Google Cloud for performing speedy analysis and for collaborating with the consortium of around forty TOPMed studies.[18]

Coursera – the global online platformized learning ecosystem

Ecosystem & Experiencers

Coursera is a global online platformized learning ecosystem that offers anyone, anywhere access to online courses and degrees from world-class universities and companies. When Coursera started in 2012, it offered digital educational content in the form of massively open online courses directly to individuals. Now, it has created a lifelong learning ecosystem – and the experiencers have expanded to more than 250 partners of leading universities and companies worldwide that produce content, and 92 million learners, 100+ Fortune 500 companies, and more than 6,500 campuses, businesses, and governments that access Coursera to get world-class learning.[19]

Thus, academic institutions around the world are using the Coursera partner's digital content as a sort of 'digital textbook' to their students earning degrees. Learners can access not just courses but also full-degree programs online. The University of Michigan, for instance, now offers a master's degree online on Coursera. Not surprisingly, during the pandemic, over 30 million new learners came to Coursera and benefited from online education.

Platforms & Engagements

The platform allows for a personalized discovery of courses, based on the learner's input on interests, location, and so on. 'Skill Graph' maps skills to careers that the learners aspired, and helps them discover relevant course content. Machine translation allowed for rapid subtitle translations in over 16,000 courses in short time to cater to the language preferences of the learner.

It is not sufficient if more learners only join the platform, it is equally important that they stay engaged on it in order to complete the courses and demonstrate their acquired knowledge. The platform's 'In-course Coach' feature helps the learner stay motivated to learn and not drop off early from the course. The guided projects of 'Coursera Labs' provide for hands-on learning online.

Impacts

Coursera measures several metrices related to learner satisfaction and partner satisfaction – 81% of learners gave their course 5-star rating, 94% of learners would recommend Coursera to a friend, 71% of learners report career benefits or 89% of partners satisfied with Coursera overall.

Beyond these learning outcome measures, Coursera is also motivated by other sustainable impact measures. It considers education as one of the drivers of social mobility and creates programs to upskill the vulnerable workers whose job may be most affected by automation. Coursera also offers free learning resources to several communities in need, including refugees, veterans, justice-impacted individuals, and underserved high-schoolers, with 100+ community partners and 205K enrolments.

Coursera for Campus (C4C)

Ecosystem & Experiencers

In 2019 Coursera started providing a new offering, called Coursera for Campus, which integrated their online courses into university curriculum. The Coursera course could be provided either as a stand-alone for-credit offering, or as a blended for-credit offering where the faculty could use Coursera as part of their in-classroom teaching. By 2021, 3,200 campuses globally were using 'Coursera for Campus' and of these, over 30% were in India.[20] It included Indian educational institutions like Manipal Academy of Higher Education (MAHE), Symbiosis International University, and Narsee Monjee Institute of Management Studies (NMIMS).[21]

MAHE started weaving Coursera content into for-credit courses developed and taught by their own faculty and attached almost 70 online courses to their regular classroom courses, as of March 2020. NMIMS adopted a slightly different approach – they gave their engineering students the option to complete extra credits online on the Coursera platform, for programs they did not offer themselves, and receive an honours degree with a specialization in artificial intelligence, IoT and cloud computing.[22]

Coursera also partnered with Indian institutions to create new content on their platform. By 2022, it had a total number of 14 universities such as IIIT Bangalore (IIITB), Indian School of Business (ISB) and IIT Roorkee (IITR) and 5 industry partners such as PWC India and Tally Education, providing courses like the Master of Science in Data Science from IIITB, Global Management Program in Infrastructure, and in Operations and Supply Chain from ISB, and Post Graduate Certificate in Strategic Supply Chain Management with AI from IITR.[23]

Platforms & Engagements

Coursera leverages sophisticated digital technologies to enhance the experience of the different stakeholders on their platform – the universities and the students. “Course Match” is a machine learning algorithm, finetuned on data from over 1,800 schools’ catalogues and 2.6+ million schools’ courses, that matches each on-campus course to the most relevant courses in Coursera’s 3,800 course catalogue.[24] Thus, it allows for easier customisation of the online to a specific university’s needs.

“Guided Projects” allows for hands-on learning using real-world tools to learn practical skills. Students use cloud-based desktops in a web-browser with no need for any specific tool downloads or system configurations. Faculty can guide students by providing side-by-side and live instructions, and monitor the student’s progress in the project. Within a year of launching this feature, over 1.5 million students under C4C program had taken up Guided Projects in topics such as “Build portfolio website using HTML and CSS” and “Create your first Python program”.[25]

The ”Live2Coursera” feature allows teachers to record, share and upload their lectures directly from Zoom. This allows students to view all relevant content on a single platform on Coursera. Further, it allows students facing issues of low-bandwidth to download the Zoom lectures, either the video or just the audio, for viewing on a mobile device at a convenient time.[26]

Impacts

The students gain access to world-class, job-relevant content and certifications from top universities and companies. In some cases, they are able to specialise with additional degrees in programs that their Indian university / college is currently not offering. At MAHE, more than 20,000 of its students took online classes through Coursera, with average course ratings of 4.75 on 5.[27] The certificates from guided projects make students more attractive to employers, and they see better placement rates and higher salaries.

Universities also see many benefits – using high-quality content from Coursera saves faculty member's time, which they can focus on higher value-added activities in their own professional journeys such as research or executive education. Some of the schools are able to attract newer students because of the enhanced breadth of offerings and thus see a lowering of the cost of student-acquisition.

In 2020, as part of its Coronavirus Response Initiative, Coursera offered its C4C program free of charge for a limited time and was able to support over 1200 institutions and 40,000+ students.[28]

Digitalized Education in India

The Indian education system presents a picture of seemingly insurmountable challenges and infinite opportunities at the same time.[29] The state of foundational literacy and numeracy among school-children in India needs strengthening. The Annual State of Education (Rural) 2018 report indicates that of all Indian children enrolled in grade 8, only about 73% can read at least a standard 2 level text.[30] One of the main challenges currently plaguing the K-12 education sector in India is inadequate public funding and disproportionate focus on school infrastructure as opposed to learning outcomes.

There are similar issues of access, quality and severe fragmentation when it comes to higher education. India has over 900 universities and approximately 39,000 colleges, and a large proportion of them run only a single program. Although the Gross Enrolment Ratio (GER) of higher education has risen over the years to around 25%,[31] it is inadequate in the Indian context. Thousands of colleges have no quality teaching faculty. Technology has an important role to play in addressing many of these issues with higher education. Digital learning can address some of these challenges in terms of education access and quality. The number of online users in India has surpassed the number of people who have completed primary education. The Indian Internet subscriptions stood at 560 million in 2018.[32] In comparison, the number of Indians who are studying in school and university is about 435 million and the number of Indians studying in elementary school up to standard 8 is about 202 million.[33] The Internet and the digital medium provide an opportunity in taking education to a wider section of the society, without the constraints of getting students or their teacher to a physical school / college.

India is poised for a digital learning revolution.[34] A market study in 2019-20 found that digital technologies were rapidly disrupting the education sector in India – it predicted the online K-12 (across grades 1 to 12) education offerings to increase 6X and the post-K12 market to grow nearly 4X in just a few years.[35] The COVID-19 pandemic turbo-charged this transformation as education

shifted online across India. Startups and education technology companies like Byju's, Coursera, Unacademy, and UpGrad grew rapidly. Market estimates suggested that VC funding (of USD 1.7 billion) in edu-tech jumped 4X in the first nine months of 2020 as compared to the whole of 2019.[36]

The Indian government, with support from some leading educational institutions, has also undertaken several initiatives to promote digital learning.[37]

Key government initiatives to promote digital education

1. **NPTEL** (National Programme on Technology Enhanced Learning), is an online MOOC learning platform, created by the IITs and IISc and funded by the Ministry of Education, Government of India. It offers close to 600+ university-level courses for certification every semester in about 22 disciplines.

2. **DIKSHA** is an initiative of the Ministry of Education, Government of India. It offers a national digital infrastructure and tools for school education.

3. **SWAYAM** will provide one integrated platform and portal for online courses, using information and communication technology (ICT) and covering all higher education subjects and skill sector courses.

4. **SWAYAM Prabha**is an initiative to provide 32 high quality educational channels through DTH (Direct to Home) across the length and breadth of the country on 24X7 basis.

5. **National Digital Library (NDL)** project is to develop a framework of virtual repository of learning resources with a single-window search facility. As of 2018, about 1.5 Crore e-books and documents available on NDL contributed by 160 Content contributor and 30 lakh users from 9 thousand educational registered institutions

6. **e-Shodh Sindhu** is to provide access to quality electronic resources including full-text, bibliographic and factual databases to academic institutions at a lower rate of subscription.

7. **The Free and Open Source Software for Education (FOSSEE)** project promotes use of open source software in educational institutions.

8. **Virtual Lab** project aims to provide remote-access to virtual laboratories in various disciplines of science and engineering for students at all levels from under-graduate to research.

Consider the National Programme on Technology Enhanced Learning (NPTEL). NPTEL is a platformized MOOC learning ecosystem and is directed towards providing learning materials in Science and Engineering by adhering to the syllabi of All India Council for Technical Education and the slightly modified curricula of major affiliating Universities. The focus areas for NPTEL are:

i) higher education, ii) professional education, iii) distance education and iv) continuous and open learning.[38]

Ecosystem & Experiencers

NPTEL partners with around 4200+ colleges in the form of NPTEL local chapters, and each college has a coordinator with whom NPTEL works closely. The other educational institutions are encouraged to build their own versions of NPTEL courses based on their curriculum design. In fact, over 20% of the NPTEL audience is faculty from various colleges across the country. NPTEL courses are also taken to the teachers through many faculty-development workshops. The interaction between teachers in various colleges and the course developers in IITs/IISc is a mandatory and unique requirement for NPTEL. Several IITs such as IIT Madras, IIT Roorkee, IIT Tirupati, and IIT Palakkad and other colleges are now allowing these courses to be taken for credits.

Many colleges across the country, be it engineering or science, have very poor facilities in terms of laboratories for performing experiments, especially colleges in Tier 2 and Tier 3 towns. NPTEL conducts week long laboratory workshops at some of the top institutes, such as the IITs, IISERs and IIITs for NPTEL course toppers. From 2018 summer onward, NPTEL started offering internships to NPTEL online certification exam toppers with the respective course instructors.

Platforms & Engagements

Through an online portal, 4-, 8-, or 12-week-long online courses are being offered on NPTEL. The enrolment to and learning from these courses involve no cost. Following these online courses, an in-person, proctored certification exam is conducted and a certificate is provided through the participating institutions and industry, when applicable.

NPTEL is launching the new portal NPTEL+ to expand the variety of offerings and courses for learner upskilling. 3 types of training programs are proposed: i) NPTEL courses in self-paced mode; ii) short term training programs from the IITs/IISc; and iii) other programs that include specialised courses from institutes/organizations that are partnering with NPTEL.

The NPTEL team at IIT Madras have developed another innovative offering – the world's first online BSc Degree program in Programming and Data Science at IIT Madras, launched in June 2020. The program is split into three levels that have to be completed strictly in sequence: 1) Foundational Level (8 courses); 2) Diploma Level (6 Programming courses + 6 Data Science courses); 3) Degree Level (11 courses). While the course is completely online, IIT Madras has partnered with TCS iON for conducting proctored in-person exams.

Impacts

NPTEL has been hugely successful, in terms of its reach and impact. It is the largest online repository in the world of courses in engineering, basic sciences and selected humanities and social sciences subjects. It is the most accessed library of peer-reviewed educational content in the world.

NPTEL has seen 1.6 crore+ enrolments, 15 lakhs+ exam registrations, 4500+ local chapter colleges, 3500+ MOOCs completed, 60+ Industry associates, 2300+ unique courses available for self-study. The YouTube channel for NPTEL is the most subscribed educational channel, with 1.3 billion views

and 37+ lakhs subscribers.

Human resource requirement for trained engineers and technologists is far more than the numbe of qualified graduates that Indian technical institutions can provide currently. Also, the number of educational institutions having fully qualified and trained teachers in all disciplines being taught is a very small fraction. India needs many more teachers for effective implementation of higher education in professional courses. Due to NPTEL, it is now possible for anyone outside the IIT system (both students as well as faculty members) to be able to do an online certification course and get a certificate from the IITs.

The online BSc program addresses the issue of equity and access to high-quality education. Students and working professionals can get a degree / diploma from an IIT regardless of their age or location, and with a wide range of academic backgrounds. All applicants go through a qualifier process – they get access to four weeks of video content from the institute, after which they are eligible to appear for the qualifier exam. Thus, admissions are not based on the hypercompetitive Joint Entrance Examination (JEE), which allows for greater equity in terms of participation. In its first year of operations, this one program has enrolled nearly the same number of students as those enrolled in all other programs together at IIT Madras. Such initiatives are required to enhance GER in India.

Risk-managed levers for enhancing PIE X-verse ecosystem innovation and value co-creation with stakeholders

EDUCATION X-VERSE INNOVATION

Applying the PIE X lens to digitalized learning and skill development experiences

As we saw in the above examples, the PIE X lens helps in capturing the current state of value creation in a focal interactive X-verse ecosystem (i.e., the specific entities and relationships of an interactive ecosystem that is the focus of a particular enterprise in applying the PIE X lens).

Diksha – Digital Infrastructure for Knowledge Sharing in India

We now introduce key risk-managed levers for conceiving X-verse innovation opportunities and identifying new pathways for co-creation of unique value with all stakeholders-as-experiencers. To do so, we use the context of DIKSHA (Digital Infrastructure for Knowledge Sharing), an initiative of the Ministry of Education, Government of India. DIKSHA offers a national digital infrastructure and tools for school education. It caters to India's unique requirements of federal structure of education, very large population size, and an incredible diversity of languages – 1.5 million schools, 248 million students, 9.4 million teachers, 60+ educational boards across the country and 20+ regional languages (See Figure 5).[39]

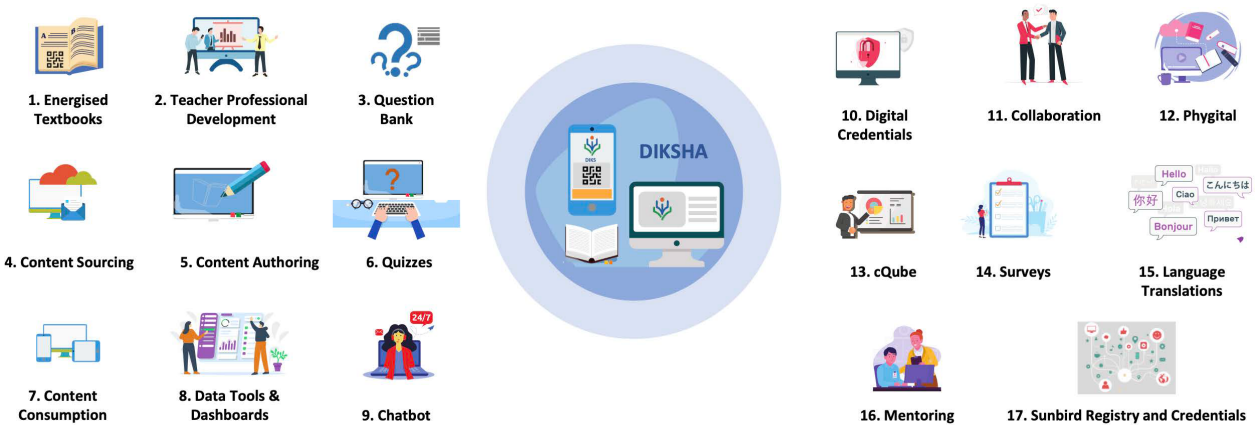

Figure 5 : Diksha's API based microservices digital stack capabilities (Source: Diksha.gov.in)

Diksha adopted an ecosystem-centric approach in its solution design and secured the participation of government, civil society and private organisations (Ministry of Education, NCERT, EkStep Foundation, Central Square Foundation, and 35+ state and central organizations). The solution caters to 5 personas across various learning services – student, teacher, parent, community member and administrator.

We now examine three sets of levers for enhancing PIE X-verse ecosystem innovation and value co-creation with stakeholders, corresponding to each of the facets of Platformization of Engagements, and engendering valuable experiences of Impacts to individuals-as-experiencers, in focal interactive X-verse ecosystems. (See Figure 6.) These levers draw on the X-verse value co-creation paradigm of Ramaswamy and Ozcan, and their original and ongoing work on theorization of practices in configuring risk-managed experience-centric innovation and value co-creation with stakeholders.[40] While all three sets of levers must be applied in **R**isk-managed fashion by enterprises

(hence the "**R**-" prefix), from managing strategic risks of cybersecurity, privacy, and identity management to various other relevant enterprise risks in value co-creation with stakeholders[41], we focus in this report on conceptually introducing the levers using the context of DIKSHA.

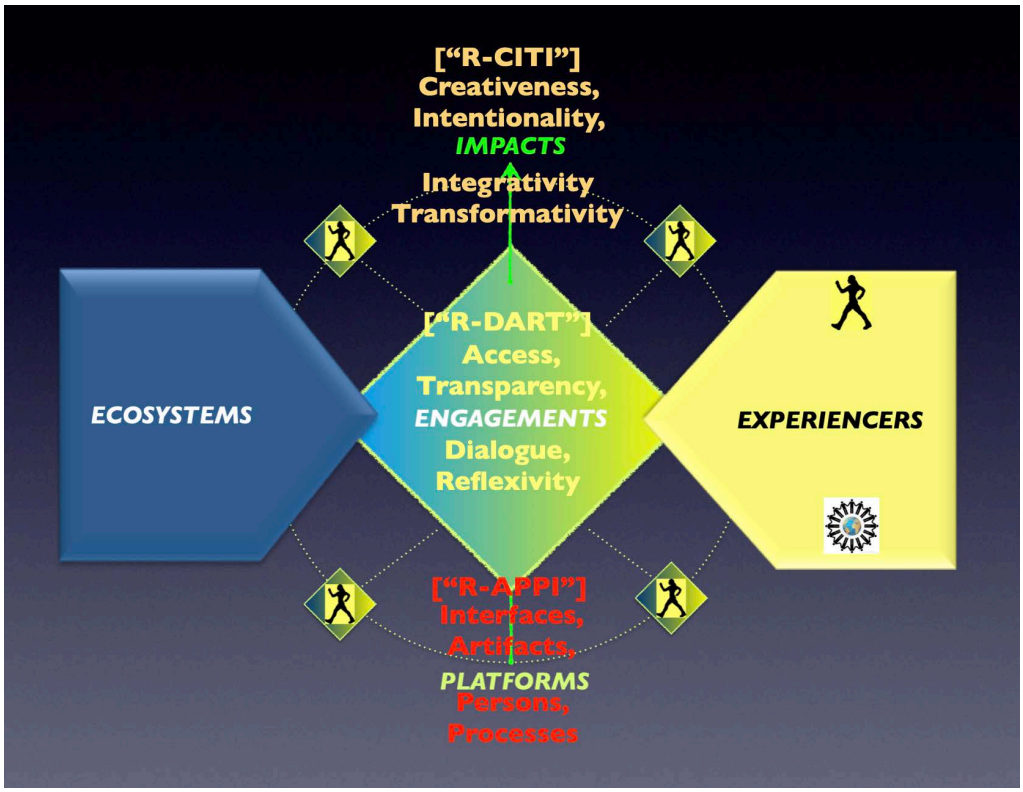

Figure 6: Risk-managed levers for PIE X-verse ecosystem innovation and value co-creation with stakeholders (Source: Venkat Ramaswamy)

Applying the R-APPI levers of interactive platformization

Digital infrastructure operates in various layers of the technology stack from hardware to operating systems, applications, content and data. In conceiving platforms of experience-centric innovation in interactive X-verse ecosystems, there are four specific "**APPI**" levers of **A**rtifacts, **P**ersons, **P**rocesses, and **I**nterfaces, which are often applied in the following sequence:

Interfaces: How might we bring together digital and physical interfaces (such as devices, apps, webfronts) in event-sensed flows of data, content, and service exchange in X-verse ecosystems?

Artifacts: How might we bring together digital and physical artifacts (such as products, symbols, data, text, pictures, audio, and video) in event-sensed flows of data, content, and service exchange in X-verse ecosystems?

Persons: How might we connect with the agency of persons (customers, employees, partners, and other stakeholders) in event-sensed flows of data, content, and service exchange in X-verse ecosystems?

Processes: How might we bring together digital and physical processes (increasingly software-enabled, such as algorithms) in event-sensed flows of data, content, and service exchange in X-verse ecosystems?

In the case of DIKSHA, at its core is an open digital infrastructure, with an API (application Programming Interface) based microservices digital stack of capabilities, built on open-source technology that enables **risk managed APPI** configured environments for a variety of educational 'use-cases' such as online courses, content authoring tools, digital credentials and so on. (See Figure 7.) An important design consideration was that DIKSHA not become yet another specific learning-services solution, but instead become a shared plug and play digital infrastructure that could work for all of India. A set of open standards and guidelines serve to enable creators to produce relevant and quality content. DIKSHA is being used to build contextualized solutions for under-resourced communities as it also supports offline use cases across a large variety of languages. These solutions enable anytime, anywhere learning flows of engagements for a range of teachers and learners, across age and proficiency in classrooms, homes, and communities.

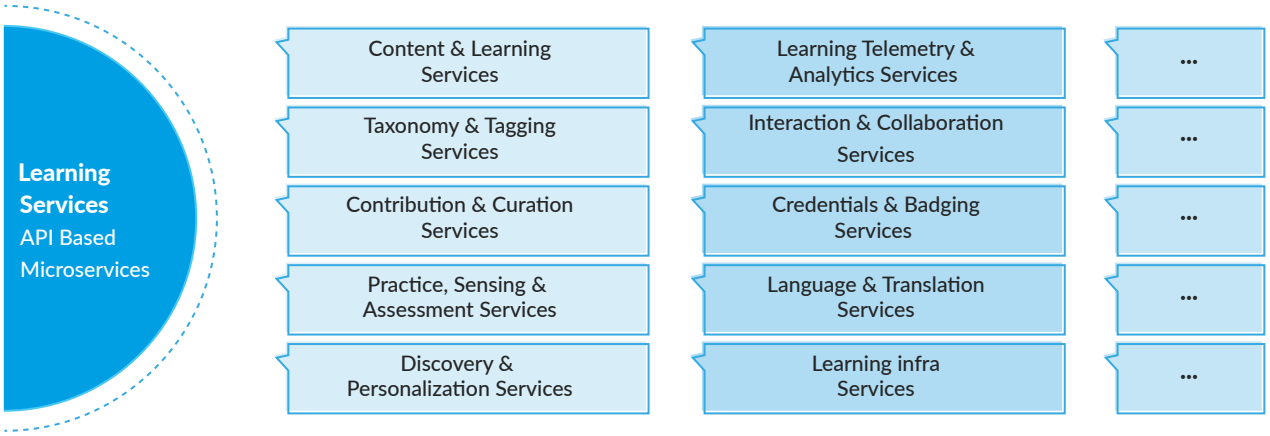

Figure 7 : Diksha's API based microservices digital stack (Source: Diksha.gov.in)

Applying the R-DART levers of value-creational engagements

DIKSHA accelerates the rapid systemic co-creation of 'distributed innovation' of highly contextual solutions. Systemic co-creation is about creating spaces (in physical and/or digitalized environments) that enable engaging actors in the ecosystem to design valuable solutions together with pooled resourced capabilities and solutions of other participating actors. By purposefully configuring the value-creational engagements among actors to be more collaborative and productive, the solutions that get defined are not only suited to local contexts, but face less resistance in adoption, especially if they are able to connect with the actual lived-experiences of individuals, and which can be iteratively refined in open shared fashion.[42]

To facilitate such value-creational engagements, there are four specific "**DART**" levers of **D**ialogue, **A**ccess, **R**elfexivity, and **T**ransparency, which are often applied in the following sequence:

Transparency: How might we enhance the transparency of information, tools, expertise, and skills, in value-creating engagements?

Access: How might we enhance access to resourced capabilities in value-creating engagements?

Dialogue: How might we enhance active, explicit dialogue in value-creating engagements?

Reflexivity: How might we enhance reflexivity (i.e., "feeding back into") in value-creating engagements?

The **risk managed DART** levers facilitate the dynamic iteration between systemic co-creation and the shared open digital infrastructure, as "cross-fertilization" of innovation occurs by re-purposing of shared digital solution components by actors through their creational engagements of value. It is like a restaurant where the customers are also chefs contributing to a shared buffet of available digital components, whose variety becomes exponentially more appealing when driven by local creativity of cuisines. In DIKSHA, content contributions can be made by individuals, teachers, educationists, subject experts, schools, government and non-government organizations registered on the platform – such as explanation videos, teaching videos, practice questions, competencybased items, lesson plans etc. Thus, the users of DIKSHA content may also be its *creators*.

As Dr. Santhosh Mathew, former Chairperson National Council for Teacher Education, and Anjali Hans note, "Shared Digital Infrastructure is an important aspect of making sure that extremely desirable changes in the Indian State move from "too big to solve", "too difficult to do" and "we can't do it in 24 months" to a feasible proposition… Reform champions in government will benefit greatly from having ready access to Shared Digital Infrastructure that they can then leverage and customise as necessary." [43]

In traditional organizational innovation, contextualizing solutions can lead to increased costs of delivering impact in terms of money, time, and expertise — and systemic societal innovation can become unviable. Systemic innovation co-creation using an open shared digital infrastructure ***breaks the tradeoff between contextualization and efficiency***, dramatically reducing the cost of contextualization. (See Figure 8). It harnesses the creative potential of various participating actors in the societal ecosystem, both individually and collectively, to achieve transformational societal impact. However, this has its limits, as the solutions typically have to be further refined in the lived-journey contexts of stakeholders in their own interactive creator ecosystems. For instance, in the restaurant metaphor, the buffet items being refreshed by customers have to undergo further cuisine co-creation suited to local culinary flavors, tastes, and individualization, for population scale adoption and impact. Effective systemic innovation co-creation is therefore coupled with another iterative dynamic in DIKSHA, that of amplifying co-creative innovation of engaging actors through cross-sector impact networks.

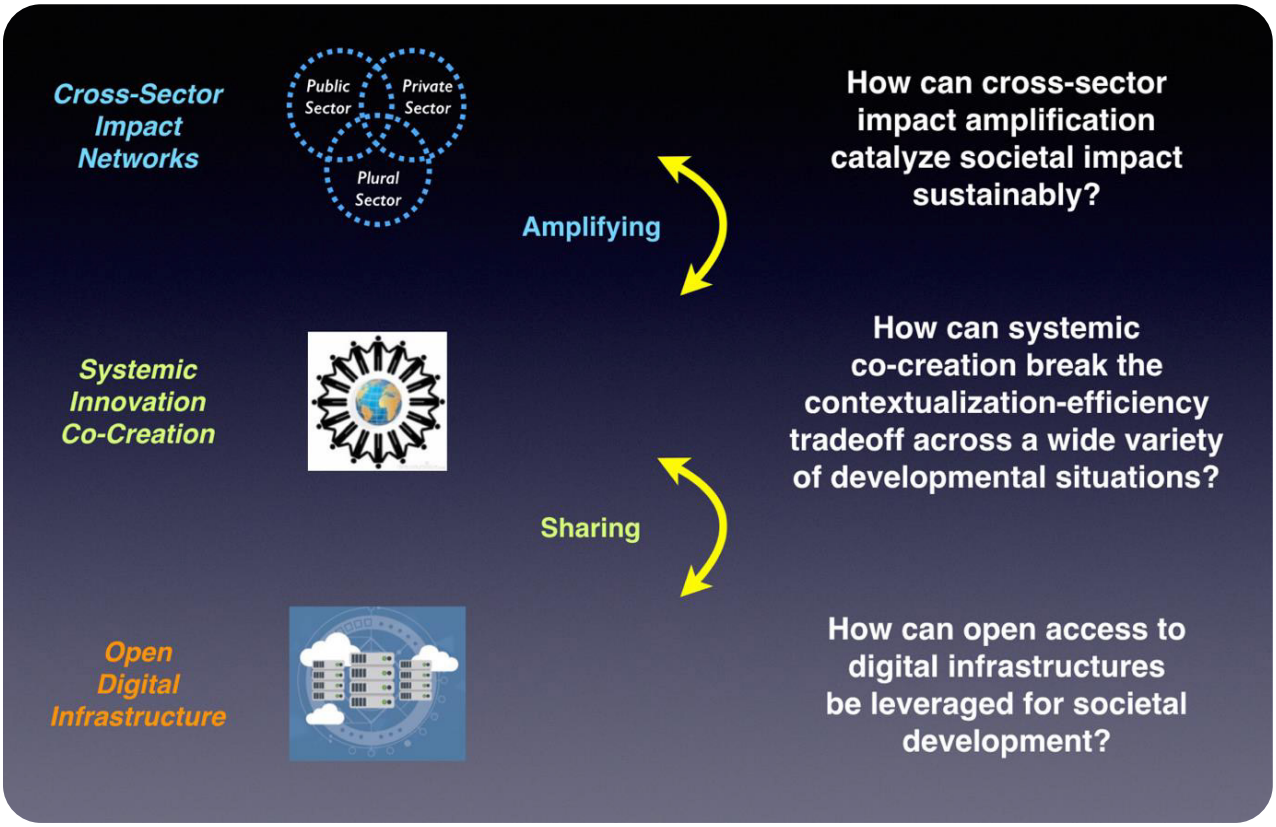

Figure 8: Amplifying co creative innovation through cross sector impact networks (Source: Venkat Ramaswamy)

Applying the R-CITI levers of wellbeing impact amplification

During the pandemic when schools were shut across India, schooling did not stop. Between April and November 2020, DIKSHA witnessed 1 billion learning sessions and 10 billion page hits. Similarly, 2.5 million+ primary school teachers were trained at 5% cost and 4X speed as compared to the usual physical classroom-based training.

Equitable access and inclusive content were other important impact considerations. 600 million+ ETBs were printed and distributed, and content was broadcast on television and radio – children across the country with access only to a mobile and not a laptop, a TV or a radio could still learn in a 'phygital' manner. DISKHA also included content for children with special needs (content for the hearing and visually impaired). DIKSHA has logged over 15 million usage events and has more than 100,000 active users every day. The usage and consumption data is used to continuously improve engaged learning experiences.

To facilitate the amplification of impacts, there are four specific "CITI" levers of Creativeness, Intentionality, Transformativity, and Integrativity, which are often applied in the following sequence:

Creativeness: How might we enhance the collective creative capacities of actor-networks of X-verse ecosystems to amplify valuable impacts?

Intentionality: How might we address the heterogeneous intentionalities of actor-networks to amplify valuable impacts?

Integrativity: How might we enhance the integration of resourced capabilities?

Transformativity: How might we enhance the transformation of resourced capabilities into experienced outcomes that amplify valuable impacts?

The **risk managed CITI** levers facilitate developmental services simultaneously to millions of people in a reliable and sustainable manner requires impact amplification through large active cross-sector networks of actors. For instance, in the case of India, shared open public digital infrastructures are being used as much by non-governmental organizations to run a host of diverse programs, and to contribute in terms of resources, and solutioning capabilities with varying degrees of digitalization (which is the means, and not the goal in achieving collective developmental impact). Catalyzing cross-sector actor-networks to amplify impacts propels further co-creative interactions among participating actors, and aligns innovators and implementers across civil society, government, and the private sector. Amplifying the wellbeing impacts of systemic innovation co-creation, however, requires a catalyzing entity that can neutrally orchestrate a coalition across sectors to maintain the balance of developmental missions, e.g. even as offerings are built from public goods, the private sector tends to ultimately focus on the economic viability of platforms (e.g., Linux, Redhat, and IBM; Github and Microsoft, etc.).[44]

To illustrate one such CITI-enabling catalyst in cross-sector amplification networks, consider the EkStep Foundation in the area of lifelong learning — particularly school education — in India[45], EkStep works like a priming catalyst for amplifying cross-sector networks and provides the impetus for: a) getting existing actors across the public, private, and plural sectors to participate together in specific developmental missions and b) enabling other open developmental missions. This not only multiplies developmental impact at speed, scale, and scope, but sustains it by fostering continued collaboration.

By way of background, about half of the children in India have illiterate mothers, with as many as 22 official languages and more than 1.3 million schools (not to mention as much as 20% teacher vacancies[46]). The situation is complex entailing chronic problems that have defied remedial solutions thrown at them, which often settle back into a painful and low performing equilibrium. John Kania and Mark Kramer note that in the field of education, even in developed countries, "the most highly respected nonprofits—such as the Harlem Children's Zone, Teach for America, and Knowledge is Power Program (KIPP)—have taken decades to reach tens of thousands of children, a remarkable achievement that deserves praise, but one that is three orders of magnitude short of the tens of millions of U.S. children that need help."[46] Multiply this another three-fold, and one to acknowledge the scale of the education problem in India. The complexities associated with lifelong learning also has its implications on post-education career transition, apart from traditional education systems. The Future of Jobs report in India claimed that, by the end of this year, 37% of the Indian workforce would be employed in new job roles and 9% in new jobs that do not exist today.[47] We would rather think of this as an enormous population-scale Digital India Innovation opportunity, as in the DIKSHA example, but one that requires re-imagination of cross-sector systemic co-creation of innovation and multi-stakeholder value creation through a PIE X lens based approach (combined

with careful risk-management application of the **R-APPI**, **R-DART**, and **R-CITI** levers of interactive platformization, value-creational engagements, and network amplification of wellbeing impacts), in expanding value with stakeholding entities in X-verse ecosystems, in a virtuous cycle of expansive design and organizational change, as shown in Figure 9.

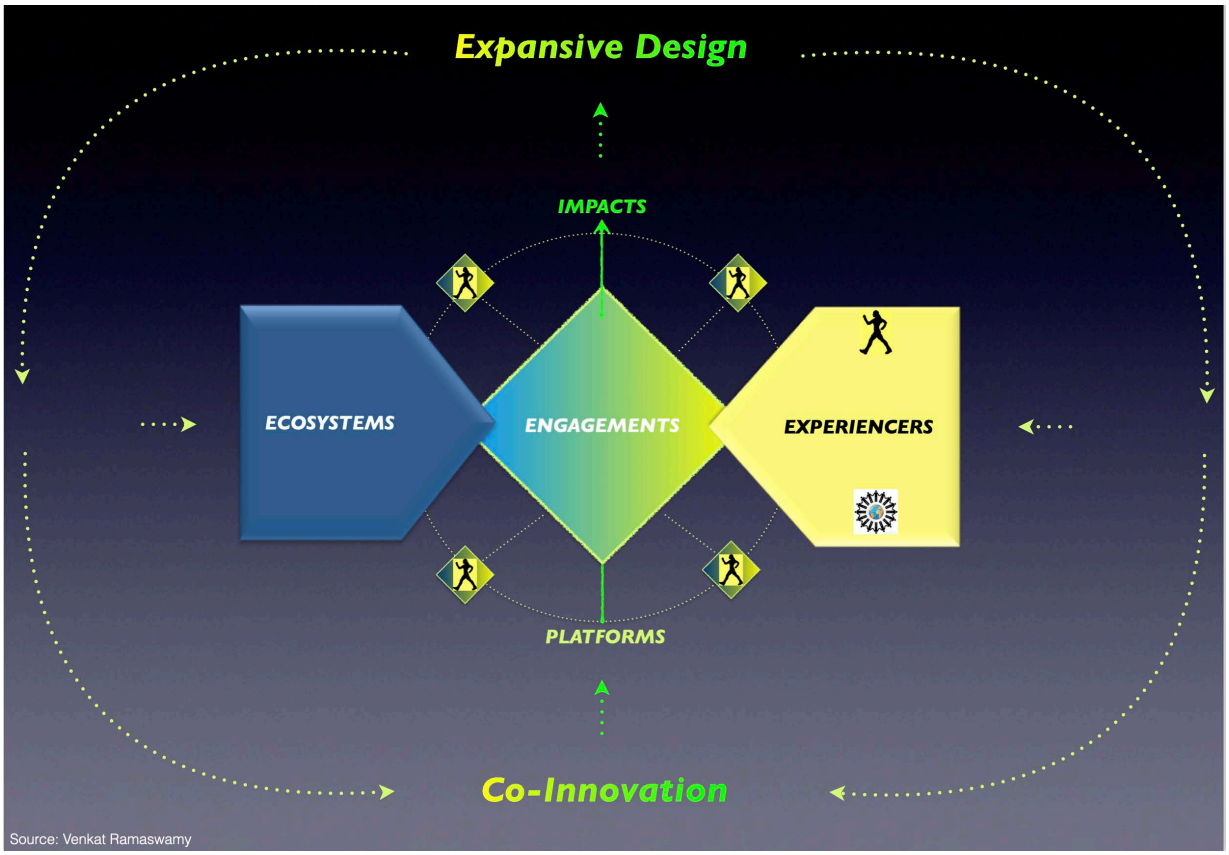

Figure 9: Leading eXperience verse Ecosystem Innovation and Value Co Creation to Sustainably Impact Stakeholder Wellbeing (www.venkatramaswamy.com)

For instance, in developing the DIKSHA initiative, the Government of India leveraged Sunbird software components (and the EkStep digital infrastructure) as a national teacher platform available to millions of teachers in India — focusing on the goal of enhanced digitalized learning impacts of experienced outcomes for teachers and learners. It took just under six months from the announcement in March 2017 to launch in September 2017. The Government's DIKSHA strategy document laid out the vision for the platform and the rollout document sets out the strategy to ease adoption of DIKSHA by different states in India to co-create their own solutions in context, with "reference solutions" for guidance. As of May 2019, twenty-five states and three Union Territories in India had adopted DIKSHA. It was accessible to nearly 106 million students and 3 million teachers and had more than 100,000 daily active users

Further, cross-sector partners also plugged and played at the intra-state and local levels, without reinventing the wheel. Non-state institution, group, or individuals became engaged in actor-networks, and adopt ed or used components of DISKHA in service of their stakeholders. This

mechanism for network participation enabled a multiplicity of solutions required at local levels to be built on top of solution standards and shared digital infrastructure at the state and national levels. Innovation co-creation was amplified in cross-sector networks, as several organizations across the plural and private sectors further co-operated, collaborated, and co-created solutions that addressed unique challenges across the diversity of idiosyncratic problem domains. For instance, Central Square Foundation, an education nonprofit, has been involved in managing DIKSHA, while others such as the Azim Premji Foundation and Tata Trusts have been involved in enriching DIKSHA with their expertise on taxonomy and teacher needs and in providing frameworks, models and content, respectively. Many other domain experts and organizations contributed learning content for teachers.

As a result, while the DIKSHA ecosystem may be anchored in the public sector, it has turbocharged impact innovation in the plural and private sectors with enterprises that shared a common focus with DIKSHA around the societal challenge of enabling lifelong learning for all, ***thereby enhancing collective SDG (Sustainable Development Goals) wellbeing impacts***. We next briefly discuss two examples, that of Infosys in the private sector and ShikshaLokam in the plural sector, both of which leverage the open-source digital infrastructure, Sunbird ED, for their digital learning platforms, while amplifying cross-sector wellbeing impacts.

Skilling initiatives at Infosys – Lex Wingspan and Springboard

The Indian IT industry, in its journey to become to the digital partners of the world, is undertaking a rapid and large-scale skilling and reskilling of its millions of employees on emerging technologies. TCS, under the broader umbrella of Secured Borderless Work Spaces (SBWS), has developed a talent development platform for skilling / reskilling its employees anytime, anywhere and on any device (ATAWAD). In the context of Infosys, its skilling platforms / programs are not only impacting its own employees, but they are also bringing about positive change amongst its client's employees and the society at large.

Infosys Lex Wingspan is a next-generation digital learning platform that is available within the company and to its clients for their employee's talent transformation. Infosys Springboard, based on the Wingspan platform, is a learning and reskilling program integral to Infosys' Corporate Social Responsibility (CSR) charter.

Ecosystem and Experiencers

The users of Lex Wingspan are the employees of Infosys or their clients to whom the platform is offered. The users are able to access Lex anytime, anywhere and on any device. The content offered is aggregated from multiple sources, both internal and external. The other important stakeholders include the educators or experts, with whom the employees / learners may interact at any given time.

The experiencers of the Springboard skilling program include students from Std VI onwards to professionals, from educational institutions, NGOs and self-help groups. Infosys collaborates with external partners like Coursera and Learnship to develop specialised courses.[48]

Platforms and Engagements

The Springboard program and Lex platform aim to pique the learner's curiosity and provide an immersive experience. Some of the engagement and platform capabilities include:[50]

- **A flight simulator** for participants to work on near real life problems in a 'safe' environment. The knowledge system contains employee learning, visual concepts and real project details showcasing application of technologies and skills.
- **Adaptive learning** powered by strong machine learning algorithms that understand employees' learning patterns, assessment results, production experience and manage feedback to provide proactive insights into learning that motivate learners to continue and complete their program.
- **A virtual assistant (chatbot)** that acts as a guide answering queries and actively recommends relevant courses for the learner
- **Gamification** of learning in the form of leader-boards, badges for task completion.
- The **Future of Education** project conceptualizes the future classroom experience as enhanced by the power of AI and mixed reality.

Impacts

Lex enabled the training of over 14,000 employees at the Infosys Global Education Center, is available to over 100,000 of their employees, and offers 1,500 courses in continuous education that includes more than 75 courses in emerging technologies and 250 self-learning programs.[51]

As part of Infosys' ESG Vision 2030, Infosys Springboard seeks to empower 10 million people globally with digital skills by 2025. Springboard already has 400,000 learners, and more than 300 educational institutions, NGOs and self-help groups use the platform.[52]

ShikshaLokam – catalyzing education leadership development

Ecosystem and Experiencers

ShikshaLokam enables and amplifies leadership development opportunities for individuals and institutions engaged in K-12 education systems. ShikshaLokam is focused on school administrators and leaders as experiencers. It has catalysed a virtuous cycle of education leadership developmen through its programs, solutions and open digital infrastructure, by developed several educational ecosystem application services required to accomplish the mission of enabling school leadership. [53] For example, the Unnati application "enables education leaders-as-experiencers (e.g., principal and headmasters) to create improvement projects based on their own professional developmentalexperiences, invite other people as collaborators, assign timelines, and execute it in the best way possible".[54]

It works with more than 10 NGOs / Civil Society Organizations (CSOs) across 8 states in India to work with the schools and their leaders. For instance, in August 2019, the Punjab Education Collective was formed to transform the public education system of Punjab. This collective comprises four organizations in the education space – Mantra, Sanjhi Sikhiya, Samarthya and ShikshaLokam, working in tandem to impact 23 lakh students across 19,000 government schools in Punjab.

Ecosystem partners reuse existing solutions or cocreate new solutions on the ShikshaLokam platform as part of their programs.

Platforms and Engagements

The **ELEVATE** (**E**nergizing **L**eadership with **E**nhanced **V**isibility and **A**dministrative **T**ransformation towards **E**xcellence) platform by ShikshaLokam is built on top of the Sunbird open-source digital infrastructure. ShikshaLokam has extended and built newer capabilities and has contributed them back to Sunbird, which are now available for other national platforms in India such as DIKSHA.

The platform generates a rich trail of telemetry data from interactions, providing a powerful basis for advancing experiencer engagement through adaptive learning applications. Built with an agile mindset, the solution-specific components (e.g., analytical infrastructure that makes data accessible) can speedily evolve services at scale, to continuously improve overall infrastructural capacities that benefit a diversity of actors and use contexts.

Impacts

The Punjab Education Collective has seen over 1 lakh system leaders onboarded on their platform. The collective helped set up and train 2 teams at the state level to assist in creating learning content and engaging with teachers and students to constantly collect feedback. During the pandemic, the efforts of the Collective proved opportune – as part of community engagement, the Collective organized statewide Parent-Teacher Meetings (PTM). A 3-day virtual PTM for 6000 secondary schools with 5 lakhs+ parents was conducted in May 2020. As part of the 'Learn from Home' campaign during the pandemic, 900+ learning resources were shared with students since June 2020 through daily schedules.[55]

Conclusion

EDUCATION X-VERSE INNOVATION

Applying the PIE X lens to digitalized learning and skill development experiences

In this report, we built on the concepts of the eXperience-verse and the PIE X lens that we introduced in our first report in the "Digital India Innovation and the Experience-verse Revolution" series. We explored education X-verse innovation and applied the PIE X lens to various digitalized learning and skilling development experiences.

Driven by market forces in general and catalysed by the pandemic, the education sector had begun its inexorable march towards digital learning. We considered transformational shifts in the education X-verse along five different loci of value creation: locus of interaction, locus of value, locus of innovation, locus of strategy, and locus of performance. Immersive 3D metaversal learning experiences offer a sharp contrast and with the potential for significant enhancement over the conventional virtual world of educational experiences and augment value creation in new ways.[56]

We then applied the **PIE X lens** to digitalised learning and skill development experiences in the real world – companies like Microsoft and Google offer cloud education platforms and services; companies like Coursera offer a global online learning ecosystem and a marketplace for online courses and degrees from world-class universities and companies. We also had a quick overview of the digitalized education challenges and opportunities in India. We examined how the National Programme on Technology Enhanced Learning (NPTEL) are addressing the higher education space in the country and are critical solutions in enhancing the Gross Enrolment Ratio of the nation.

We then introduced some key risk-managed levers for enhancing PIE X-verse ecosystem innovation and value co-creation with stakeholders (namely **R-APPI** levers of interactive platformization, R-DART levers of value-creational engagements, and **R-CITI** levers of wellbeing impact amplification) and discussed them in the context of DIKSHA, a national digital infrastructure and tools for school education in India. While the DIKSHA ecosystem is anchored in the public sector, we also discussed examples from the private sector (Infosys) and the plural sector (ShikshaLokam).

In the next report in this series, we will introduce additional key risk-managed levers for sustaining the growth of interactive X-verse ecosystems. We will illustrate and discuss them further in the broad context of health and insurance X-verse innovation, as the eXperience-verse revolution spreads across diverse industry sectors of digitalized transformation of markets, economies, and society.

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