ICT for Education: Lessons from China

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Abstract

India and China, the two most populated countries in the world, have both experienced explosive economic growth over the past thirty years. This growth has been accompanied by transformational changes which have necessitated changes in how citizens are trained to participate in their economies and societies. ICT has served as a key tool in both countries for both expanding quality education to all citizens and directly training them in the skills necessary to participate in a rapidly changing work environment. China, having led the way in ICT4ED adoption, has provided India with a set of unique lessons as India also seeks to leverage ICT to provide the greatest possible education to the greatest number of people. China's "national campaign" approach to achieving goals set by the central government has inspired creativity and innovation at lower levels of government to achieve those goals, but it has also encouraged narrow achievement of specific targets rather than the broader goals behind them. Likewise, failure to define targets in the most comprehensive possible detail allows room for the need to meet goals to influence how success is reported and defined, causing numbers to improve without a concurrent improvement in education quality. Furthermore, a national top-down approach that does not actively promote horizontal collaboration between lower-level policymakers will struggle to identify and implement best practices nationally. With this being said, China's policymaking process has produced numerous innovative initiatives to address the gaps that have emerged, initiatives India would also be wise to implement. Examples of such initiatives include the Nongyuan rural-modern distance education project, the "One Village, One College Student" plan, and village and township digital learning demonstration centers. Finally, although much potential exists for India to use ICTs to improve education quality, such efforts will be futile without a significant increase in funding for education by the government.

Introduction

Information and Communications Technologies (ICTs) stand at the vanguard of a series of economic transformations which are changing societies around the globe to their core. Over the course of the Third Industrial Revolution, ICTs enabled instantaneous communication and sharing of information over vast distances, catalyzing global commerce like nothing else before. The Fourth Industrial Revolution, which will witness the development of paradigm-shifting

technologies like generalized Artificial Intelligence and the automation of infrastructure, will accelerate these changes even further.

It is within developing countries, however, that ICTs could have their most lasting impact by serving as agents of development for the poor, the rural, and the marginalized. The nature of ICTs is to lower barriers to accessing knowledge and to accelerate transactions, while some of the most significant factors inhibiting development include uneven access to information and distance from infrastructure that facilitates transactions. If the inherent power of ICTs is mobilized to challenge education disparities, close the health gap, fulfill the potential of agriculture, and meet other development priorities, then the societies of these countries moving forward will be more mobile, inclusive, and ultimately, sustainable.

Education stands as a particularly important priority sector for ICT-driven development because it serves as the keystone which shapes how individuals participate in their societies. A proper education equips students with the skills necessary to thrive in a work environment which few may have envisioned just a few decades in the past, and if necessary, the ability to teach and adapt oneself to an economy whose demands on workers continues to rapidly change. A quality education also equips students with critical and holistic perspectives that prepare them to serve as better, more informed citizens. Quality education strengthens at least two of the three pillars of sustainable development, creating an economy that works for all and building a more cohesive and mobile society.

Citizens of India and China experience quite different demands as workers and citizens, shaped by historical circumstances and trajectories that continue through the present day. Education has played and will continue to play a critical role in adapting both Chinese and Indians to their societies, and when necessary, bending the arc of the status quo to make those societies more inclusive, equitable, and sustainable.

Background

India’s Economic Trajectory

While India’s early post-independence history was dominated by a series of economic experiments which largely failed to lurch the country’s rural masses out of crushing poverty, the economic story of modern India starts with the balance of payments crisis of 1991. Decades of gestures towards import-substitution industrialization driven by the promotion of cottage industries had led to the erection of vast networks of red tape and high protectionist barriers. This system of burdensome policies and regulations, collectively known as the “License Raj,” hindered India’s competitiveness and the growth of entrepreneurship and private enterprise to such an extent that the country’s resilience to global economic shocks was greatly weakened. As a result, once a new era of globalization arose following the end of the Cold War, the resulting wave of disruption that swept around the world turned policies that had previously been seen as assets for economic development into massive liabilities.

In pursuing such an inwardly-focused economic model, India had paradoxically hollowed out its own industries' ability to compete on the international stage in an era when trade had become paramount and virtually unavoidable. Middle Eastern conflicts disrupted trade routes and limited foreign supplies of oil, further undercutting domestic enterprises' ability to turn a profit in an economy whose foundations were shifting beneath their feet. Foreign exchange reserves rapidly depleted, and the government soon experienced difficulties paying its foreign debts. The country's economic situation hit an apparent rock bottom when the Reserve Bank of India, on a tight deadline set by its foreign creditors, dispatched 47 tons of gold to the Bank of England in order to secure an emergency loan from the IMF, only to have the van carrying the gold break down on the road to the airport, right in the middle of election season.

The economic policy framework had revealed itself to be intolerably ill-suited to a new set of global challenges, making clear the necessity of deep structural reforms. The government of Prime Minister Narasimha Rao, in partnership with the contemporary Finance Minister and future PM Manmohan Singh, kickstarted these reforms in July 1991. Starting with a formal 20% devaluation of the currency, which patched the balance of payments of problem long enough to confront the economy's deeper issues, the administration embarked on a series of gradual yet ambitious reforms to shape India into an export-oriented market economy. As state monopolies were dismantled, tariffs and duties were reduced, and the License Raj was disassembled piece by painstaking piece, a newly open India revealed a newfound dynamism which did not shun the role India could play in the global economy, but firmly embraced it instead.

Naturally, the credit for India's economic success post-1991 can't solely be awarded to policymakers who opened up the country and let the markets do the rest of the work. Luck lies at the intersection of opportunity and preparation, and opportunity in India's case came from the emergence of a global services sector hungry for educated, English-speaking workers to fill the needs of rapidly expanding western and international enterprises. Economic liberalization may have given these companies the legal permission to get their foot in the door of the Indian labor market, but advancements in ICT around this period played the key role in linking foreign corporations to Indian workers.

Initially, the pioneers of India's IT revolution were tasked with the low-skill back office work that a foreign company would expect to be completed after the conclusion of its own business day, a dozen time zones away. But with familiarity came greater practical competence, and eventually greater responsibility, skill requirements, and quality, specialized work opportunities. Indian IT workers have propelled India's services sector, the fastest growing in the world, up the value chain and into a position where Indian innovation and competitiveness have become inseparable from the success of the international services sourcing industry. With the lessons learned from this history, India's domestic IT companies have likewise surged to become some of the largest companies on the planet.

Never before has it been so important for India to champion not just the kind of quality education for every student that would give them access to such opportunities, but an education informed by ICT which would give students the tools they need to fully participate in the new reality of

their society. Such action is especially critical because the liberalization that made such economic growth possible also undermined protections which could have helped that growth be shared in by all segments of the population. Income inequality between the top and bottom deciles of the population doubled over the ten years following the start of reforms. The infrastructure that could help the India that has been left behind by growth, particularly through the application of ICT-driven development, has so far been lacking, as over 200 million Indians remain without power and only 25% have internet access. Up to this point, India's robust services sector has served as a reliable pathway into the middle class for the poor strata of the population. As the services sector becomes more IT-centric, and specialized ICT-adjacent skills become an increasingly salient qualification for employment in these positions, India must choose this moment to prepare its students for the inclusive future they deserve.

China's Economic Trajectory

Over the course of the nearly half a century that followed the independence of both countries, India and China had arrived at roughly the same level of development by 1992. Both countries had followed similar growth trajectories to arrive at a GDP of roughly 1200 USD per capita (PPP), despite the immense social upheavals that had taken place in both countries over that span of time. But while India had just started to begin a process of economic reform, China had already laid the groundwork for a complete economic transition that would power its rise as one of the fastest growing countries in the world and a newly awakened global power. Throughout this transition, heavy demands were placed on the Chinese people to flexibly adapt to the changing circumstances of a rapidly evolving economy. Education has played in irreplaceable role in adapting Chinese students to their new reality, and Chinese education policy has placed heavy emphasis on incorporating ICT both into the classroom and the curriculum itself in order to prepare students from all walks of life to become equal participants in the New China, a weighty task which remains very much in progress.

Modern China's reform process kicked off following the death of Mao Zedong in 1978 under the chairmanship of Deng Xiaoping. Deng spearheaded China's transition from a rigidly planned economy to the state-directed capitalism predominant in China today by piloting market reforms in Special Economic Zones (SEZs) such as Shenzhen, which enjoyed reduced taxes and tariffs, looser regulations, and a more lenient exchange rate as enticements for foreign investment. FDI boomed, and once Deng and his government started advocating for more entrepreneurship and open economic policies across the whole country in 1992, the SEZs became the seeds of industrial clusters that have since grown to become the world's biggest engines of manufacturing.

Just like India, China would not have achieved such great returns on its political investment if it had not occurred at a particularly fortuitous moment in world history. The end of the Cold War opened the door for the same blossoming of world trade that benefited India's service sector so greatly, except that the beneficiary in China's case was manufacturing. The legacy of a planned

economy had given China a comparative advantage in the manufacturing sector via both a significant existing manufacturing base and low wages relative to neighboring countries. Initially, Chinese manufacturing focused on simpler components that didn't require the expertise built through tradition. But as workers have become more educated, and Chinese manufacturing became more skilled and technologically capable, Chinese factories have transitioned into making higher-value goods that command more on the market. China's population, the largest in the world and heavily concentrated around its coastal ports, have also given it a specific advantage in integrating the supply chains that would typically sprawl across several countries. China's manufacturing labor force is so large and so geographically concentrated in centers of export that fully developed industrial clusters and enabling environments exist for virtually any industry.

Today, a burgeoning middle class and unprecedented levels of disposable income held by Chinese consumers has made China as much a consumer of global production as a global supplier. Having reached this benchmark level of national income, Chinese policymakers have made a concerted transition to spur the country further along on its growth trajectory by encouraging high-tech manufacturing and the growth of the indigenous services sector, particularly where it comes to ICT. Made in China 2025, one of the current government's most prominent initiatives, seeks to develop China into a global innovation leader in the hard and soft technologies that will drive the Fourth Industrial Revolution, such as AI and advanced semiconductor manufacture. Driven by the emergence of Chinese tech giants such as Tencent, Alibaba and Baidu, already among the largest companies of any kind in the world, the Chinese services sector has also recently surpassed manufacturing as the most productive segment of the Chinese economy by added value – a significant development in a country whose economy was defined by manufacturing for so long.

Like India, China's ability to successfully adapt to the future it envisions for itself will hinge on an education system that can train workers who will hold their own in this high-tech oriented future. That isn't just true for students in China's wealthy coastal cities, whose achievement can rival and even surpass that of students in Western countries, but also for the students in China's vast rural hinterlands who need that same opportunity to participate and succeed. Moving forward, ICT in Chinese education must not just prepare the most privileged students to take their place at the top of the global economy. It must also foster, inclusive, quality education for China's less advantaged populations, remaining conscious of specific barriers to opportunity, the specific roles technological tools can play in removing those barriers, and the steps that must take place before such initiatives can succeed.

For China's rural students, simple poverty isn't the only barrier to receiving a quality education. A crisis of family displacement and separation has heightened with the rise of employment-driven mass rural-urban migration. For China's left-behind children, whose parents leave to work in urban areas, rural schools must reckon with how their students' chances at success are impacted by the loss of such a key source of support at a pivotal stage in their development. On the other hand, rural children who accompany their parents to urban areas often struggle to even access education. China's Hukou system, a household registration program which limits a

family's public benefits to the location where they are registered in the manner of a domestic passport, long kept migrant children from accessing public education in the cities where they end up residing. Although schools for migrant children popped up to fill this gap, and the policy was revised in 2014 to gradually allow these children to enroll in local schools, a legacy of discrimination and exclusion continues to exist.[1]

Chinese Educational Policy

History of ICT for Education in China

China launched its first national initiative to move ICT for Education from the realm of theory to the realm of practice in early 1999, with the Modern Distance Education Project (MDEP). The State Council, having recognized both the power of ICT as a tool for expanding quality education to rural areas and the unavoidable hurdles which would have to be surpassed before this could be done successfully, launched the MDEP as a comprehensive project to build out the hard infrastructure, soft infrastructure, and human infrastructure that would make this possible. Over the four years of its existence, the state invested 460 million CNY into a series of overlapping and interlocking projects including physical infrastructure construction, resource construction, development of key technologies, research and formulization of standards, and early pilots of distance education. These projects were assessed by the Ministry of Education in 2003, paving the way for further refinement of these efforts.

Under the framework of the Tenth Five-Year Plan, which named the improvement of social IT levels as a key priority, the State Council continued these efforts under a broader action plan for education revitalization, approved in March 2004. The centerpiece of this plan was the Rural Primary and Secondary Modern Distance Education Project," which shifted the efforts of the prior initiative to prioritize China's most excluded schools.[2] Central and local governments together invested ten billion CNY to equip these classrooms with basic computer labs, satellite equipment, projectors and CD-ROM broadcasting equipment, and early digital teaching materials. The program, impacting 384,000 rural primary schools alone, reached the most remote parts of the country. Along the way, however, it was criticized for its delivery model for digital content, limited community participation and financial investment, and a need to establish reasonable goals and directions, challenges which would be addressed through the following iteration of China's informatization campaign.

The third major stage of China's digital education transformation began in March 2012 with the publication of the first formal strategic document for developing and implementing ICT in education, the ten-year development plan for educational informatization. Under these

[1] Shu Zhou, Monit Cheung. "Hukou system effects on migrant children's education in China: Learning from past disparities." August 18, 2017. https://doi.org/10.1177%2F0020872817725134

[2] Yu, S. Q. "Modern distance education project for the rural schools of China: Recent developments and problems." Journal of Computer Assisted Learning 22.4 (August 2006): 273-283.

guidelines, China has undertaken two major national initiatives to close the widening gap that was emerging between rural and urban schools as developed regions adopted and benefited from ICT innovations more quickly than under-resourced areas. A 560 million CNY project to promote digital education resources, for example, funded jointly by the central and provincial governments, expanded digital education resources such as rural-urban, interregional and interschool teacher partnerships via 64,000 teaching centers nationally. By supporting the spread of best practices by the most successful teachers, this initiative helped rural teachers effectively utilize the equipment and resources whose benefits and advantages many had not yet had adequate training to unlock. The "Three Links and Two Platforms," project, in operation since 2012, has continued building out infrastructure for the informatization of education, this time with an emphasis on improving educational equality for the left-behind minority regions of China's poorest provinces.[3] Through this infrastructure project, the internet access rate of primary schools rose to over 90% by 2017, 83% of classrooms were capable of using multimedia, and a higher share of classrooms and teachers than ever have been able to access, understand, and implement quality digital educational resources.

In April 2018, the Ministry of Education introduced its latest ICT for Education development strategy, the Education Informatization 2.0 Action Plan. The 13th Five-Year Plan, under which the new plan was introduced, called for a new era of ICT-informed education to prepare students to participate in a digital society, including focus areas on building up information-intensive infrastructure and on bridging persistent gaps in rural and urban welfare through the more efficient distribution and management of resources. The new plan has sought to do this by directing resources towards training nearly ten million primary and secondary teachers, more than 100,000 primary and secondary principals, and 200,000 teachers at vocational institutions in information literacy. In addition, the plan calls for subsidizing digital education resource services for left-behind areas and groups, the development of new teaching models that incorporate the internet, creating a business service support ecosystem for digital and distance education, and using the open sharing of big data in education to accelerate and improve the implementation of all these objectives.

As physical information infrastructure approaches 100% coverage for all of China's rural schools and classrooms, the goals of national policymakers can be summed up by the "three all, two high, one big" development goals elaborated in the Informatization 2.0 Action Plan. By 2022, the plan aims to bring ICT teaching tools to all teachers, ICT learning tools to all students, and digital campus infrastructure to all schools. In addition, it shoots for greater ICT competency for teachers, increased and more skillful integration of ICT into classrooms, and higher resulting levels of achievement. More granular goals include compiling ICT education materials into resources for general use, strengthening the linkage between ICT competency and attainment of knowledge, and the development of an information-age education governance model that uses

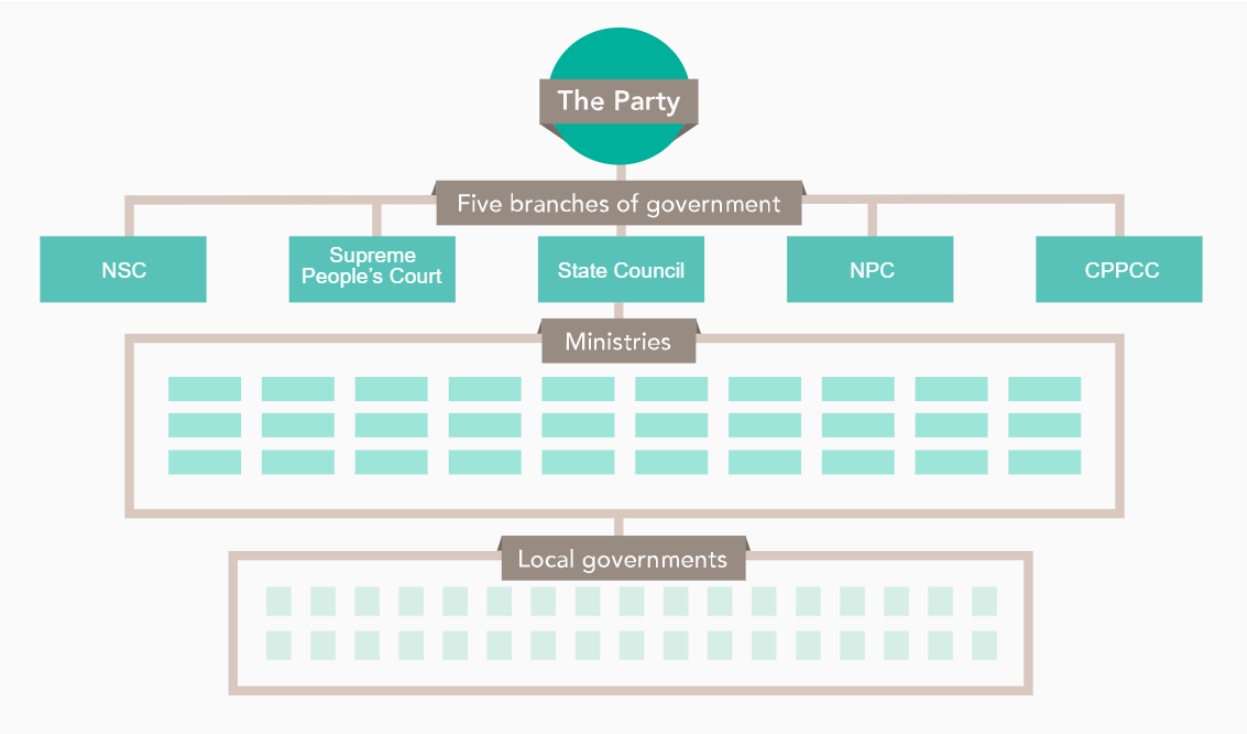
[3] Zhao Zhilin and Gan Jianhou. "Investigation and Analysis on the Construction Situation of "Three Links and Two Platforms" of Education for Nationalities in Yunnan." https://www.matec-conferences.org/articles/matecconf/abs/2017/42/matecconf_eitce2017_04006/matecconf_eitce2017_04006.html

digital tools and platforms, as well as analysis of big data, to help teachers develop into more adaptable, responsive and creative classroom leaders.

The Chinese Policy Approach

The history of Chinese policymaking in education is particularly reflective of China's overall approach to policymaking, an approach which is mirrored in the very structure of China's government. It also illuminates advantages to that process and cases where an improved process would yield positive and more responsive policy outcomes. As such, exploring China's experience with this policymaking mechanism yields highly useful insights for Indian policymakers in the ICT for Education field, who, given how much ground must still be covered, could easily be tempted into following a similar planning pathway with all of its benefits and drawbacks.

The policy direction of China's government at all levels, from local to national, is set under the ideological guidance of the Communist Party (CPC). A multi-tiered and very hierarchal bureaucracy is superimposed over the ideological framework advanced by the CPC and tasked with formulating and implementing actual policies to achieve those visions. The CPC and the government may be difficult to separate in practice, since there is a close overlap between Party and government leadership, but in theory, the CPC acts to lay down the values that will guide government and the broad objectives which will be prioritized by the government, while the government translates these goals into concrete and practical actions.



Organizational Structure of the Chinese Government. Source: Trivium China

The CPC's chief foray into formulating a national policy agenda takes place every five years, when the Party Central Committee holds a plenary session to draft recommendations for the next five-year plan. The next such session is set for 2020, when recommendations on the 14th five-year plan will be made. Such plans typically consist of blanket generalizations and a noticeable lack of specific details. This isn't necessarily a bad thing; when attempting to formulate a policy program that will fulfill the interests and meet the needs of the Party's nearly 90 million members, a statement of first principles is desirable as a point from which to start deeper, more granular conversations. Recommendations on the five-year plan serve exactly that purpose.

Once these recommendations have been published, the baton is passed to the National Development and Reform Commission, the body responsible for drafting the actual National Five-Year Plan. The NRDC assumes a representative role for the rest of the CPC membership by combining the Party's recommendations with inputs from government think-tanks, academics, and business leaders. After these conversations allow the NRDC to gain a sense of what targets are realistic for each broad policy goal and what resources will be required, the draft is written and presented to the Politburo, which approves the plan and releases it to the public. Under the 13th Five-Year Plan, adopted in March 2016, the topmost priority is ICT development, including the "Made in China 2025" program, a proposed a cyber power strategy, and a national big data strategy.[4]

[4] Yu Hong. "Reading the 13th Five-Year Plan: Reflections on China's ICT Policy." International Journal of Communication 11(2017): 1755-1774. https://ijoc.org/index.php/ijoc/article/view/6366/2007

National Five-Year Plans are unwieldy enough without specifying the exact pathway to achieving policy goals in any one area, and besides, the action of releasing a Five-Year Plan prompts a flurry of dialogue that would likely force any detailed policy pathway to be reassessed as new facts and perspectives come to light. Furthermore, the CPC's job is to translate values into objectives, not to lay out a perfect roadmap for governance. Instead of asking the Party to incorporate such a fine level of detail into the National Five-Year Plan, individual ministries within the government assume the responsibility of drafting issue-based Five-Year Plans to complement the Party's national policy strategy. The 13th Five-Year Plan for Education, released January 2017, incorporates themes such as innovation, education equality, poverty relief, structural reform and teacher development, as well as proposing strategies for promoting lifelong learning, distance education, and international research partnerships. Policymakers can get even more granular when faced with a multifaceted and intersectional topic: for example, the 13th Five-Year Plan for Poverty Alleviation features its own Five-Year sub-plan for improving access to education.

The five-year planning process, for all its detail, is still solely focused on setting goals, as opposed to mapping out a pathway to reaching those goals. Achievement of these goals is enforced by Implementation Notices and Measures, checklists tied to single tasks or focused objectives which administrators and officials down to the local level must adhere to indefinitely until a new set of notices and measures is issued. It is these officials who are tasked with coming up with actual strategies to achieve the benchmarks they are asked to meet by their superiors through implementation notices.

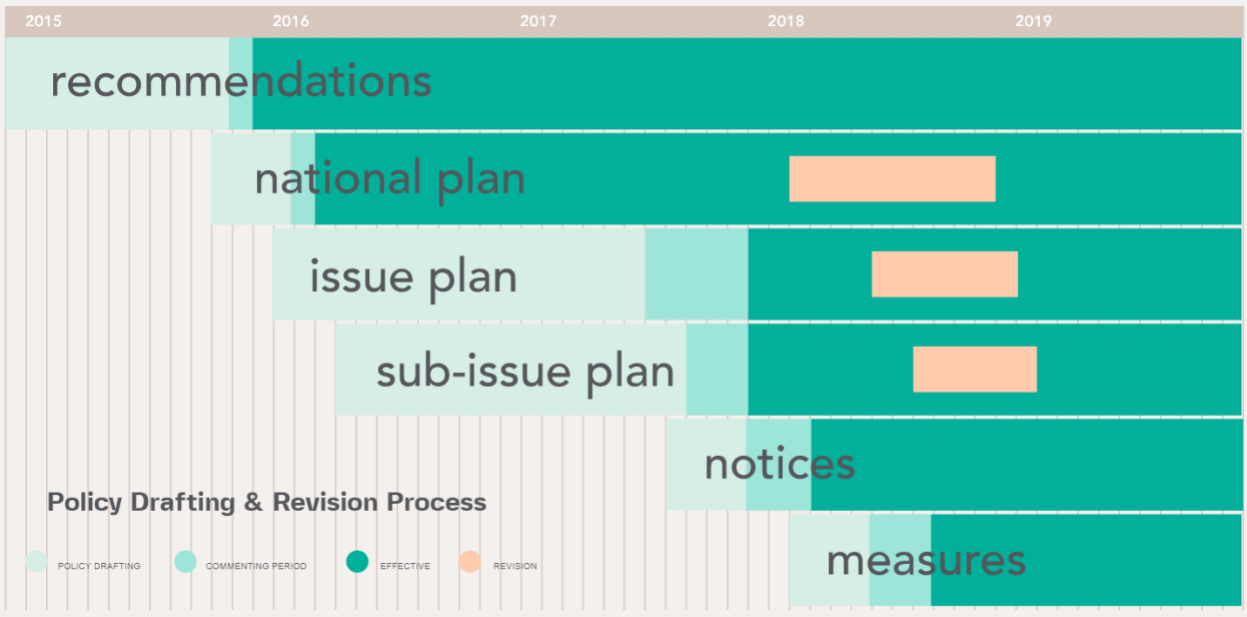
By engaging in "directed improvisation" to meet top-down economic planning targets through a system of mass participation, this tradition, known as the "policy campaign," can achieve speedy results as far as those specific named targets are concerned.[5] However, when officials are subject to overlapping mandates by multiple superiors, the creativity inspired by such an approach may flow towards doing all that is possible to meet numerical targets rather than towards identifying and overcoming localized barriers to deeper development objectives. Their job becomes even more complicated when domestic interest groups use the cover of national development policy to pursue their own narrow goals, for example by using infrastructure projects as a source of procurement deals and easy financing. When special interests come into play, and objectives sent down from on high come into conflict with each other when actually put into practice, the actions policy implementers take to meet the constraints of a target without consideration for the deeper reasons behind that target can turn counterproductive in unexpected and unpredictable ways.[6]

The Chinese system retains a capability to flexibly, agilely, and creatively adapt to shifting circumstances which should not be underestimated. But at the systemic level, that where national policymaking takes place, the periodic nature of the policymaking process means that resources

[5] Nathan, Andrew. Review of How China Escaped the Poverty Trap, by Yuen Yuen Ang. December 15, 2017. https://www.foreignaffairs.com/reviews/capsule-review/2017-12-15/how-china-escaped-poverty-trap

[6] Yuen Yuen Ang, "Demystifying Belt and Road: The Campaign Trail." Foreign Affairs: May 22, 2019.

are typically pushed in one specific direction over the course of the five-year plan, backed by the inertial energy of central political directives. When adaptation does take place, either during the formulation of the subsequent five-year plan or during a dedicated review period which typically takes place three years into implementation, it is typically at a point when unforeseen challenges have become too big to overlook. Only plans have set revision periods, with reviews conducted either by academic institutions or industry groups. The notices and measures supporting these overarching plans are rarely reviewed on their own, standalone merits.[7] In other words, for all the prior consultations and vision which lends the planning process an air of both authority and vision, policymaking still remains fundamentally reactive, rather than anticipatory.



Policy Drafting and Revision Timeline for the 13th Five-Year Plan. Source: Trivium

Implications for ICT in Education

Today, Chinese education policymakers advance a well-coordinated system of promoting ICT in the classroom that involves expanding information infrastructure to the last corners of the country where it remains insufficient, provincial and national-level funding to narrow the gap in classroom technology between urban and rural schools, and mutually reinforcing initiatives to promote the capacity of teachers in rural areas, many of whom were initially trained during an era when such technology in the classroom was inconceivable, to productively use digital education resources through trainings, exchanges and ongoing support programs. Future national policy initiatives are expected to bring Chinese education firmly into the era of Industry 4.0 by using big data, machine learning, and other revolutionary technologies on the verge of breaking

[7] "An Intro to China's Policymaking Process: From National Plan to Local Directives." https://triviumchina.com/2018/09/03/an-intro-to-chinas-policymaking-process/

out to enhance the educational experience and make the training students receive even more relevant for the 21st century.

Yet as the history of Chinese ICT4ED policy initiatives demonstrates, the informatization of Chinese education has not always proceeded under such a sweeping, comprehensive and intersectional vision. Any new policy, particularly when new technologies are involved, goes through an unavoidable process of trial and error. It is through this process that best practices emerge. But had China adopted a more constantly iterative and consultative process, particularly by soliciting greater school and community input on the relevance of notices and measures to promoting productive usage of ICT and improving education quality, the lessons which now inform the nuance of current policy may not have had to have been learned the hard way. In the process, countless students could have been kept from falling through the gaps of an education system which only adapted its approach to ICT at the national level when shortcomings in that ICT approach also became visible at the national level.

The top-down data-heavy approach favored by Chinese policymakers is most successful when it is applied to achieve hard, easily quantifiable targets. Infrastructure investment and technology procurement can be broken down into simple, discrete targets of the kind that can easily be communicated through an implementation notice. However, education is distinctly more complex than sectors such as agriculture because at its heart, it is a relational enterprise between teachers and their students. As such, achieving universal quality education necessarily entails achieving a series of soft goals of the kind that can not be easily entered onto a spreadsheet, or even achieved effectively as long as they are embedded within a unidirectional policymaking process. The experience of the Modern Distance Education Project for the Rural Schools (MDEPRS), the mid-2000s project aimed at bridging the digital divide between urban and rural education, and its subsequent evolution is an informative case study in the advantages of the "policy campaign" approach, its drawbacks, and the extent of its capacity for self-correction.

MDEPRS was the follow-up program to the Modern Distance Education Project (MDEP), initiated in 1998, which focused on laying the ICT infrastructure groundwork that would be necessary for any future ICT4ED efforts. Quite correctly, Chinese policymakers recognized that incorporating ICT into rural education initiatives was impossible while basic enabling infrastructure was so lacking, and prioritized building out this infrastructure before rolling out specific distance education initiatives in rural areas. At the same time, MDEP encouraged partnerships with universities to roll out online programs which enrolled 2.5 million students by the time of the MDEPRS. This initiative served as a pilot that allowed educators and officials to identify best practices for using ICT platforms to advance distance education.[8]

MDEPRS intended to build on the successes of both halves of the MDEP in order to promote distance education, using best practices identified under MDEP, in a newly infrastructure-rich rural environment. The pilot program alone, operating predominantly in interior and largely rural

[8] Ministry of Education. "University Name List Taking on Modern Distance Education Project." 2004. http://www.moe.edu.cn/edoas/website18/info16603.htm

provinces, planned to provide CD-ROM teaching materials for 110,000 rural primary schools, directly benefiting five million students; to build satellite-receiving centers for 384,000 rural primary schools to receive additional quality digital learning resources, impacting over 80 million students; and to equip the classrooms of 37,500 rural secondary schools, serving over 31 million students, with computers which could access the same educational resources being used by students at privileged urban schools in more developed regions.[9]

The scope of MDEPRS was staggering. The program was the largest informatization project at the time, and the rapid achievement of its ambitious targets was a testament to the ambition and efficacy of its administrators. However, several problems appeared over the course of the project which were not identified and addressed as rapidly as they could have been, had the project been subject to more continuous evaluation and incremental revision. Moreover, a number of these problems, largely related to the ability of schools to fully use the facilities provided to them, likely could have been prevented had the program from the start been designed through a more collaborative approach that invited the empowered participation of the stakeholders most affected, such as rural teachers, communities, and local experts. Even as China has revised and improved its approach to ICT4ED in rural areas on the basis of lessons from programs such as this one, the disparities that continue to exist can largely be traced back to the difficulty of achieving soft policy goals, as opposed to hard targets, within such a rigid policymaking environment.

First and foremost, MDEPRS focused on technology delivery, but not technology application. The program's "if you build it, they will come" logic may have been valid within the urban environments where distance education was first tested, environments where users were adequately familiar with current technologies to use them without hesitation. This was not the case in the rural areas where the program was rolled out. Many teachers did not know how to use new technological equipment, and even if they did, the high cost of electricity dissuaded them from doing so as long as they lacked confidence in the quality of the resources they could access. In Inner Mongolia, the high winds blowing across the steppes rendered the program's satellite receivers useless by knocking them out of alignment, an issue which could have been foreseen and avoided with more thorough local engagement. As a result of all of these factors, new equipment purchased through MDEPRS was often left to collect dust once the novelty of new technology had worn off.[10]

This technology did not have a realistic prospect of being used in the absence of a coordinated strategy incorporating teacher training, student preparation, and review and reform of teaching methods amenable to ICT and customized and integrated with local practices. Instead, technology was imposed on schools whose staff and students had little concept of its uses or potential benefits, and lacked any buy-in as a result. Even if the intention was to first distribute

[9] Ibid. "Implementing Scheme of Modern Distance Education Project for the Rural Schools in 2004-2005. 2003. http://www.moe.edu.cn/edoas/website18/info15208.htm

[10] He X.K. "Are they 'ornaments?' An examination of the equipment purchased through the Modern Distance Education Project for the Rural Schools." China Distance Education 4 (2005): 9-10.

technology, then develop an application strategy, such an approach would still have been flawed. Electronic technology depreciates so quickly that even if such a two-stage action plan had been intended, the technology it was intended to support would have gone obsolete by the time it was ready for use. ICT4ED must be specifically adapted to the endemic challenges of rural areas, with full understanding by school administrators of both what those problems are and exactly what new technology will do to solve them. Instead, the drafters of the MDEPRS fell to the temptation of the hammer that treats every problem as if it were a nail.

Along the same lines, educational materials provided through MDEPRS were misaligned with the needs and perspectives of rural students, teachers, and communities. Distance learning materials, which mostly consisted of recorded classroom activities in urban schools and model lecture notes from urban classrooms, had not been adapted to meet students' contextual knowledge and skill levels, despite the great differences in living conditions, lifestyle, and modernization between urban and rural China. As a result, these materials were not particularly good fits for the unique needs of rural students, and they did not dovetail well with traditional education methods grounded in local context. In addition, materials were structured around the college-bound track typical to urban students, but did not advance vocational education, the most likely employment track for the rural students served by the program. This missed an opportunity to make these students' education more relevant to their future careers at a time when the country was not only experiencing a shortage of higher education institutions, but enterprises and manufacturing industries were thirsty for well-trained and competent employees.

Likewise, improved community engagement could have expanded the scope of the program to embrace not just a different type of rural student, but a different and equally necessary type of distance education. Due to the Hukou system, migrant families from the countryside are largely excluded from taking part in the benefits of urban services. At the time of the MDEPRS, their children were also excluded from enrolling in urban public schools. Despite their urban location, these children were equally rural as their peers who had stayed back home: for the most part, their families had similar uneducated backgrounds, and their Hukou limited them from receiving the same ICT-enabled quality education as their urban neighbors.

If MDEPRS had made rural communities equal shareholders in the program's design and success from the start, then the needs of these quasi-rural families, whose roots are inextricably tied to the communities they came from, could not have been excluded from the project. Nor were migrant children the only ones in their families who would have benefited from distance education. Their parents, whose lack of education typically prevented them from finding skilled, well-paying labor, would have benefited from continuing education that would have given them the knowledge and skills necessary to fully participate in urban China's rapid economic development. The socioeconomic benefits from this continuing education would have rebounded onto their children, whose own education would have benefited from an improved home environment, and to rural areas, as skilled migrants returned home and used their newfound knowledge and skills to benefit their communities.

Table 2. Distribution of internet connectivity, by region

	Student enrollment [1]	Total schools		Schools without internet access	
	(national %)	(1000s)	(%)	(regional %)	(national %)
Rural	23	~136 [2]	53	11	6
Suburban	43	~76	30	5	1
Urban	34	~44	17	3	1
Total	100	~256	100	--------	8

[1] Total student enrollment = 163,785,323; Includes primary and regular secondary schools
[2] Excludes the total number of one-teacher schools, which is estimated at greater than 67,000 schools.
Source: 2015 data from the *Educational Statistical Yearbook of China.*

Table 3. National Distribution of ICT resources, by region

	Computers (%)	Computers used for instruction (%)	Tablets (%)	Networked multimedia classrooms (%)
Rural	20	20	15	20
Suburban	37	38	31	40
Urban	43	42	54	40
Total	100	100	100	100

Source: Authors' calculation from 2016 data in the *Educational Statistical Yearbook of China.*

The national distribution of student enrollment is roughly equal to the national distribution of ICT resources, meaning a rough parity in technology has been reached between regions as a result of national initiatives. However, rural students remain disadvantaged in the areas of basic computer awareness, computer literacy education, and technological resource integration[11]. Source: Yang et al, 2018.[12]

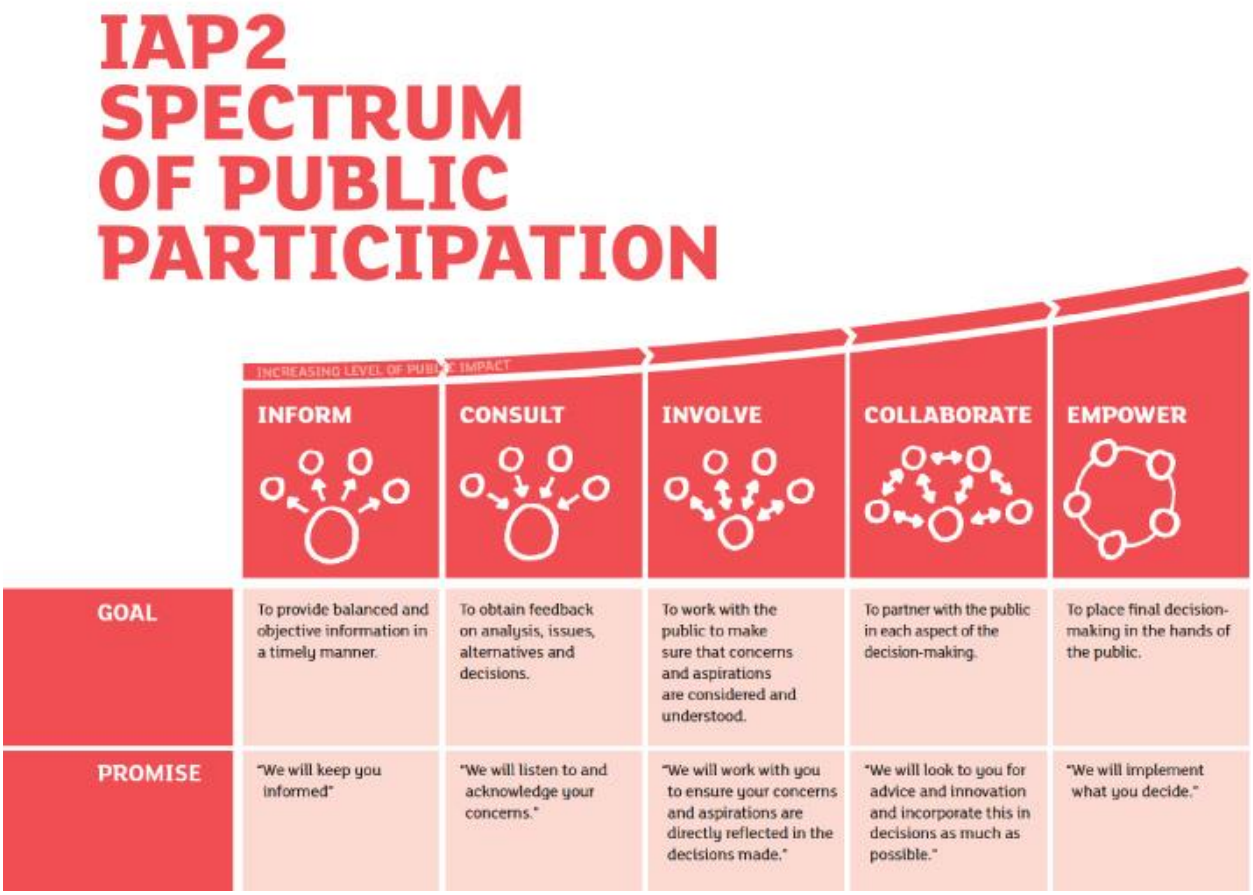
To their great credit, the Ministry of Education adjusted its approach in subsequent Five-Year Plans to prioritize the educational application of technology, rather than technology for its own sake. New initiatives have sprung up with national-level support to train and mentor teachers, use tools of distance education to link rural students to new opportunities, and build coalitions within the complex ecosystem of stakeholders and factors underlying rural education. But despite this correction of course, inequities persist between rural and urban education drawing a direct line of descent from these initial policy missteps. For example, while there is a rough parity in provision of classroom technology between rural and urban schools, rural schools continue to lag far behind in the actual usage of this technology in the classroom. How many countless students could have received a better education if policy design had been proactive rather than reactive? And how many countless students would have benefited from an education policy which, from the start, was centered around their needs and interests? Notwithstanding the undeniable successes of China's promotion of ICT in the classroom, any future effort must constantly keep these needs in mind, particularly when it comes to initiatives that plan to introduce new technologies on shaky footing.

[11] Yang et al, 2013. "Roots of tomorrow's digital divide: Documenting computer use and internet access in China's elementary schools today." China and World Economy 21.3: 61-79. https://doi.org/10.1007/978-3-319-41165-1_5
[12] Yang et al, 2018. "Promoting Education Equity in Rural and Underdeveloped Areas: Cases on Computer-Supported Collaborative Teaching in China." EURASIA Journal of Mathematics, Science and Technology Education 14.6: 2393-3405. https://doi.org/10.29333/ejmste/89841

Lessons Learned

Collaborative and Iterative Policymaking

Implementing and fully incorporating new technology is challenging in any complex environment, but it is especially difficult in communities lacking familiarity with such technology, and the education field demands particular care when it comes to outside interventions. While the MDEPRS experience presents particular challenges which India should reckon with, many of the issues with the program could have been avoided by providing input to local stakeholders and allowing them to shape the program to fit their needs. Furthermore, had the program undergone continuous and iterative review in collaboration with these stakeholders, and they were empowered to change the program to address what surfaced, some of the flaws in the program may not have persisted for so long.



The International Association for Public Participation presents a particularly useful framework for conceptualizing how to productively center potentially disruptive initiatives in the needs of a community. When members of the public are merely informed of changes which will take place,

they lack the platform to voice whether or not such changes meet the needs of their communities. Consultation allows them to voice these concerns, but without any accountability as to whether or not they will shape the design of the program. Moving beyond accountability, collaboration allows stakeholders to understand the synergies and tradeoffs between their mutual perspectives, and jointly present a vetted vision for accomplishing a mutually agreed-upon goal.

What would such a process look like for an ICT4ED initiative targeting rural education? Members of the public might partner with the business and academic community to identify what the education priorities of new digital resources should be. Teachers and students could openly discuss constraints on improving education quality, could open a conversation on whether or not ICT could play a role in removing those constraints, and could consider what challenges they personally would face to implementing improved classroom technology and how to overcome them. Finally, directly engaging with the community could broaden program designers' conception of what parts of that community could most benefit from access to improved education, opening the door to partnerships with continuing education efforts undertaken within other sectors, for example. These may seem like ambitious design goals, yet they are the bare minimum requirements to formulating a program that is both lasting and relevant, especially in the face of rapid technological advances which quickly render even recent technology obsolete.

Every shortcoming of the MDEPRS initiative can ultimately in some form be traced back to the flaws of the initial policy design and implementation approach. Yet it is still useful to flag the specific lessons from this program which Indian policymakers and practitioners should remain conscious of as they strive to expand informatization in schools. The MDEPRS experience is particularly relevant to India today because at this very moment, India is at a similar stage of its digital education transition as that which the MDEPRS supported in China. The MDEPRS was preceded by the MDEP, which built out the basic enabling infrastructure that would make ICT possible in rural classrooms. Likewise, India announced just last year that every village in the country had been electrified, marking a similar milestone in the construction of this universal basic infrastructure. India's next step will involve integrating specialized ICT infrastructure into classrooms and training teachers in its use, exactly what the MDEPRS aimed to do. Thus, the narrow lessons from this case study as presented below are just as useful as the broader lesson of pursuing participatory and adaptive policymaking.

Prioritize Technology Application over Delivery

The MDEPRS initially overestimated the familiarity of school staff with new technology and their capacity to use it. Banking on their experiences in urban environments, where well-trained teachers in good working environments could integrate new technology reasonably seamlessly, the program took the approach of simply delivering ICT equipment and materials to school, providing a cursory training, and leaving teachers the space to use their new tools from there. This plan did not work as intended for three separate reasons. First, infrastructure remained insufficient to support the use of these new technologies. Electricity, for instance, was too

expensive to justify turning on satellite receivers, many of which were rapidly knocked out by local climate conditions. Second, local teachers had not experienced how new technologies could be integrated with their traditional, time-tested teaching methods, leaving ICT equipment as little more than expensive toys which saw a few weeks of use before being abandoned to collect dust. And finally, the rapid pace of technological obsolescence meant that by the time teachers could have gained sufficient comfort and proficiency with new technology to productively use it in the classroom, the equipment in their schools would have gotten so out of date as to necessitate replacement.

As India develops its digital schools, it must follow the needs of teachers to avoid these same three pitfalls. First, infrastructure must not just exist, but be sufficiently developed so that the use of ICT is affordable and hardware is compatible with the local environment. Second, ICT should not be presented to teachers steeped in generations of traditional thinking about education as a solution in search of a series of unidentified problems. Rather, teachers should be convened to learn about new pedagogical techniques, consider their suitability for their classrooms, identify barriers to achieving desired outcomes, and only then familiarize themselves with how ICT can help overcome those challenges. New technology is most likely to succeed when it has already gained this level of local buy-in. Last but not least, this should all be accomplished on a timeline such that the soft and hard groundwork of preparing for new classroom technology has been laid down before equipment is sent to schools, so that obsolescence and poor maintenance do not render these purchases useless before they can even be used.

Match Digital Education Materials to Student Contexts and Needs

When digital education materials are developed for urban schools and distributed to rural schools during the scaling-up of a program such as MDEPRS, they often do not match the needs of these new students and their communities. On the one hand, these materials may rely on familiarity with a lifestyle that rural children simply lack exposure to, forcing them to view their lessons through the lens of a culture that is nearly foreign to them. On the other hand, while adhering strictly to state educational standards, these materials may still fit poorly into the educational needs and career prospects of students in rural communities.

One solution to the first problem, again grounded in a participatory framework, is to actually develop digital education materials within the communities where they will see use. This could limit interchangeability of lesson plans over platforms such as DIKSHA, but the resulting materials would be understood more natively and intuitively by the students they are meant for in the first place. As far as the second issue, changing the topics of instructional materials is difficult without also examining state educational standards. However, in these rural communities, digital education materials could also be expanded to the vocational classes which constitute the likely foundations of most students' future careers.

Expand Definitions of Rural Education

India may not have the same legal barriers that exclude rural-urban migrants from key services that China does. But in both countries, internal migration plays a defining role in the livelihoods of rural communities and the fates of rural families. In both countries, rural parents leave behind their families to work in cities, undermining support networks for their children and risking their children's academic and social success. Left-behind children in India experience such high stress and risk of mental illness that their brains undergo observable structural changes compared to children whose parents are present.[13] When whole families move as one to the city, in both countries, they likewise experience the exclusionary impacts of unplanned, informal settlement patterns, including but not limited to isolation from crucial city services. If education challenges for rural communities are to truly be confronted, then rural India should be considered not as a region bounded by geography, but as a diaspora woven into rural and urban environments across the subcontinent.

Students within this diaspora face a particular set of challenges which standard policymaking processes are unlikely to give voice to, and which ICT has the potential to solve. For left-behind children, those at greatest risk, ICT interventions should prioritize mental health support, perhaps through the use of telemedicine. Children who follow their families to cities may benefit the most from free and portable ICT-powered education materials in the case that they arrive in an environment without a real chance at a quality education. But educating the rural diaspora applies not just to children, but also their parents. Continuing education powered by ICT innovations can empower adult learners to gain the skills necessary to climb the economic ladder to find well-paid employment. If and when the family returns home, these adults can serve as agents of change for their own villages by using the knowledge and skills they learned both through continuing education and in skilled positions to contribute to community development.

Clearly Defined and Comprehensive Policy Goals

It's said that what can't be measured can't be improved, and education as a field is filled with the kinds of soft, qualitative goals which are extremely difficult to define and measure. Even when hard targets are met, such as delivery of classroom technology, failure to meet soft goals like training teachers in the full capabilities and uses of this technology, following up on incorporation of ICT into the curriculum, and ensuring digital resources are relevant enough to local contexts to be understood can undermine a project's overall success. For a set of policy goals to be meaningful, they must tackle a problem in its systemic totality.

In India, one major roadblock to measuring the degree of success in digitizing education, and by extension understanding what has worked and what must still be done, is that while the concept

[13] https://www.frontiersin.org/articles/10.3389/fncir.2019.00033/full

of the Digital School is promoted across the country, there is still no consensus on what a digital school is. This leaves the road open for the phrase to be defined by its lowest common denominator as individual administrators attempt to improve the image of their own school with a new, trendy label. Recent field research has indicated that in Maharashtra, a school can call itself a Digital School as long as any teacher is capable of using any piece of digital technology in the classroom – up to and including the cell phone in his or her pocket. Such a fuzzy definition renders the term meaningless and inhibits actual efforts to understand what keeps schools from digitizing and how to empower them to do so.

Ultimately, these two concerns go hand in hand. Developing detailed criteria for informatization will allow practitioners to see where schools are achieving and where they are struggling as they move towards incorporating ICT into every aspect of their operations, as long as these criteria factor in each and every barrier to success along the way. They will also create more concrete benchmarks for school leaders to aim for, provided these benchmarks are not simply quantitative targets that ignore the qualitative goals necessary to the success of the underlying project of improving education quality.

Closing the Funding Gap

China was able to make such large investments in improving rural education, including incorporating ICT into the classroom, because it has dedicated a sizable budget to its public school system. As of 2019, 4.4% of national GDP was dedicated to education spending. 8.5% of that education spending was reserved for ICT, representing a total funding amount of 47.28 billion USD. While data on education expenditures cannot be readily disaggregated by rural and urban areas, one can tell roughly how equitably these funds are distributed by examining the distribution of ICT resources between regions with different levels of urbanization. According to data found in the Educational Statistical Yearbook of China, the percentage of computers and networked multimedia classrooms is almost perfectly proportional to the national percentage of student enrollment in rural, suburban, and rural areas. Rural schools still remain somewhat disconnected compared to their urban counterparts, since the rural population is less dense, schools are smaller, and the most remote schools are frequently single teacher schoolhouses lacking any use of technology whatsoever. However, for the most part, public investment in education has succeeded in laying the groundwork for complete parity both in provision of classroom technology and fully informed usage of said technology.

For India, the same cannot be said. In 2014, India's entire education budget was only 11 billion USD, less than China spends on ICT for its school system alone.[14] Even though universal enrollment has been achieved, the impact of this chronic underfunding is most strongly felt in rural localities where staff are underpaid, students lack access to the most up-to-date materials,

[14] http://www.ncee.org/wp-content/uploads/2010/04/India-Education-Report.pdf

and teacher absenteeism remains high.[15] Even as advances in ICT4ED continue to be made across India, and best practices are identified and advocated for at the highest levels of government, such efforts will remain futile as long as basic funding requirements for implementing ICT nationwide, in all types of schools and communities, remains unmet.

[15] https://www.ibtimes.com/even-india-pours-billions-education-rural-schools-continue-totter-1783004