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The Role of Digital Public Infrastructure in Supporting Equitable Access to Education: A Case-Based Analysis from India

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Abstract

India has made a considerable step towards closing education disparities by substantively developing its Digital Public Infrastructure (DPI). The article presents a case-based study of five key DPI platforms — DigiLocker, DIKSHA, SWAYAM, PM eVIDYA, and Academic Bank of Credits (ABC) — to evaluate their effectiveness in promoting equal opportunities in education. The study relies on secondary information, policy reports, institutional reports, and thematic analysis to investigate how the platforms address challenges related to digital inclusion, pedagogical integration, linguistic diversity, and plans of governance. The results indicate that the DPI initiatives have enhanced access, especially in times of the COVID-19 pandemic, yet the issues of the digital divide, insufficient teacher preparation, and top-down implementation maintain the challenge. Remarkably, achievements like multilingual content delivery via DIKSHA and credential access latest addition to the DigiLocker platform, help to reveal the change capabilities of thought-through digital tools. Nevertheless, their effect on potentially historically marginalised learners is restricted by a lack of localisation of their content, co-designing, and real-time feedback loops. The paper concludes that DPI could become an effective driver of educational equity in a context-sensitive, user-centric, and constantly evolving ecosystem. Policy suggestions also support the fact that an inclusive design, long-term digital capacity-building and participatory governance are integral in making sure no learner is left behind during the digital era.

Keywords: *Digital Public Infrastructure, Educational Equity, India, DPI Platforms, Access to Education, Digital Inclusion, Policy Implementation.*

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1. INTRODUCTION

According to widely shared beliefs in the 21st century, access to quality education is one of the major social equity, economic growth and individual empowerment drivers **(Gupta, S. & Singh, V., 2024)**. Nevertheless, the educational disadvantage and inequality in access and performance continue to be a serious challenge, especially in ethnically diverse and populated countries such as India. Among the socioeconomic status, geographic location, gender, and the digital divide are some of the reasons why these disparities occur **(Reddy, Jose, & Vaidehi, 2021)**. In addressing these issues, the government of India has been investing in research and development of Digital Public Infrastructure (DPI) to make educational systems more inclusive, accessible and efficient. The term DPI is used to refer to the basic digital platforms and services that are universal and have interoperability policies and are aimed at bringing public and private innovation; examples of these include Digi Locker, SWAYAM, DIKSHA, the National Academic Depository, and the Academic Bank of Credits **(UNDP & World Bank, 2023)**. It has the potential to lead to fair sharing of learning resources, recognition of credentials, training of teachers and smooth governance in the sector of education **(Maruwada, 2023)**.

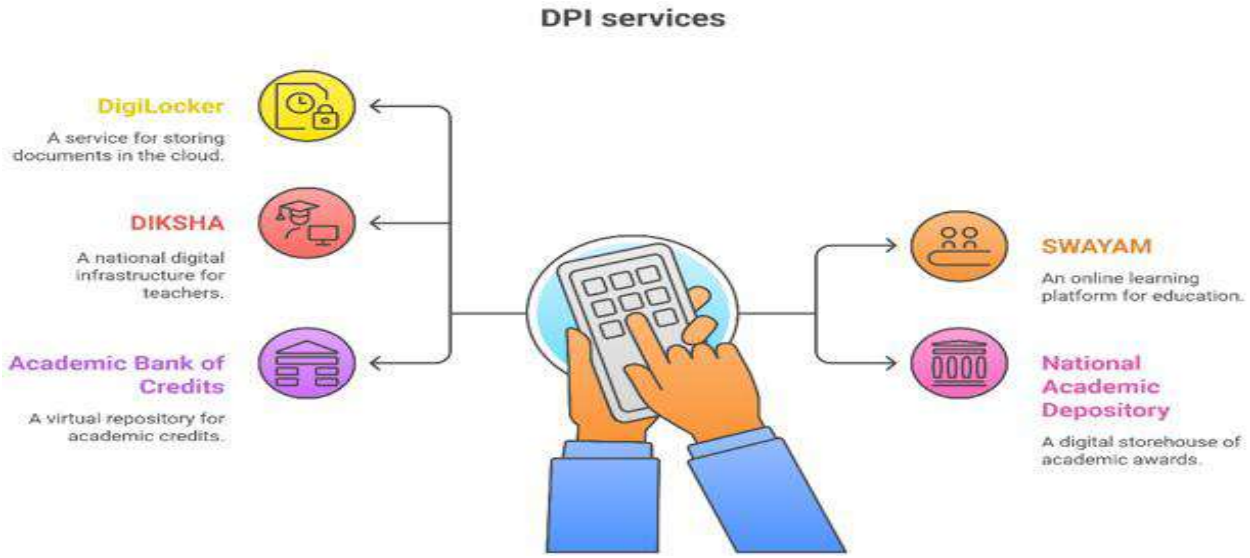

Figure.1: Digital Public Infrastructure (DPI) Services

Although DPI has shown potential to become a strong instrument, especially during the COVID-19 pandemic that made education delivery more autonomous and enhanced its capacity to eliminate disparities, certain elements define the discrepancy between its potential and actual performance. Such factors are digital literacy, the availability of infrastructure (e.g., internet connection and devices), cultural and linguistic inclusiveness, and the framework of policies about the implementation and use of digital instruments **(Rawal, 2022)**. Moreover, it is recommended that conducting empirical and contextual research that explores the effectiveness of DPI programs on various learner groups is necessary. Most of the literature available is concentrated on the technological or administrative aspects of these platforms, wherein the lived experience of learners, educators, and communities in largely underserved regions (including rural areas) is often ignored **(Reddy et al., 2021)**. The research discussed in this paper seeks to address that gap by presenting a case-based study of some key DPI platforms in India and how effective they have been in promoting equality in accessing education.

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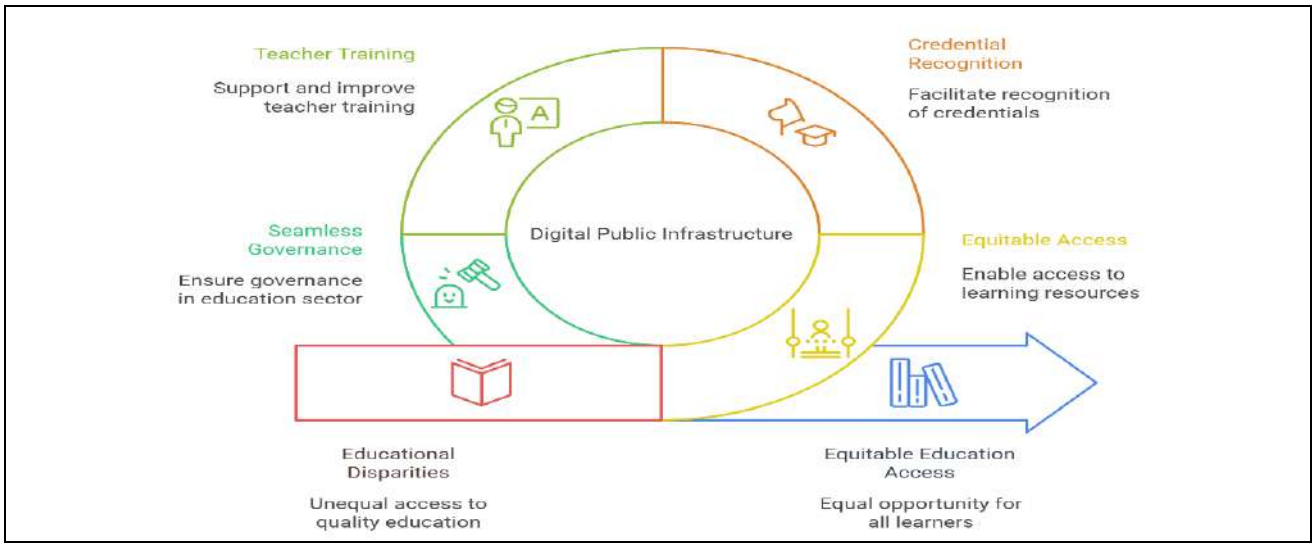
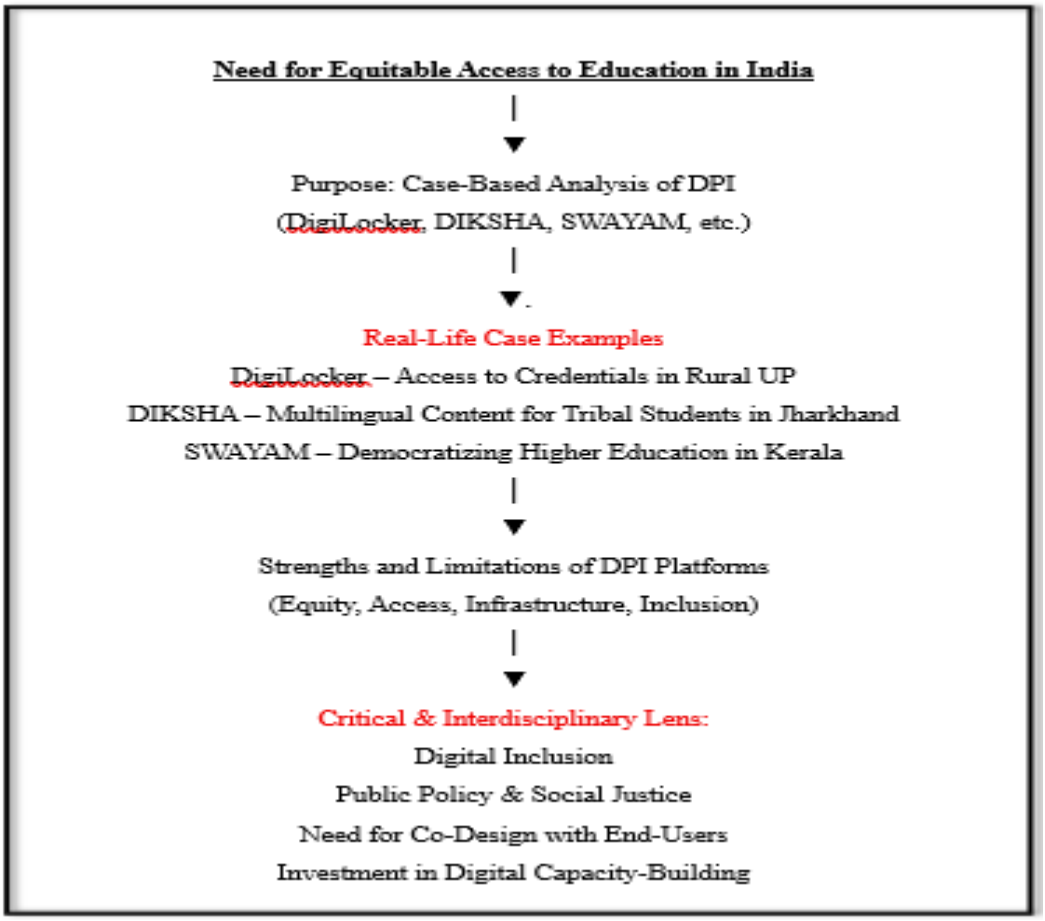


Figure.2: Conceptual exploration of DPI

The paper explains the potential as well as the limits of digital public infrastructure by referring to real life examples of implementation of such methods across states and contexts, including the role of DigiLocker in the process of granting credentials to the students in the rural areas, the use of DIKSHA as the source of Multilingual learning material, or development of SWAYAM as the source of higher education democratization. These case studies should be seen to illuminate the tangle of relationship between technology, policy, and pedagogy in attaining educational equity.



Flow Chart:1

Through a critical and interdisciplinary approach, the study puts the digital education programs in India into a larger framework of debates of digital inclusion, social policy, and social justice. It also makes reference to the need to co-design DPI solutions in most cases with the end-user experience while requiring long-term investments in digital capacity-building. In the end, the current paper makes the argument that, although DPI can even the playing field in education, its effectiveness should rely on mindful design, participatory governance, and ongoing assessment of its performance based on the needs of all students particularly those students who have traditionally been left behind

2. OBJECTIVE OF THE PAPER

- To analyze the effectiveness of key Digital Public Infrastructure (DPI) platforms in India

3. REVIEW OF RELATED LITERATURE AND RATIONALE OF THE STUDY

Such a trend towards more rather than less widespread utilization of digital technologies in education has led to international and national initiatives to promote infrastructures that would facilitate inclusive access and quality learning. India also experienced the evolution of Digital Public Infrastructure (DPI) (including DIKSHA, SWAYAM, DigiLocker, and the Academic Bank of Credits) that contributed to spreading digital access and governess to education **(UNDP & World Bank, 2023)**. During the COVID-19 pandemic, these platforms were particularly important, allowing to maintain education of millions of students regardless of socio-economic backgrounds **(Carnegie Endowment, 2023)**. Available research notes that DPI has a potential to reduce educational disparities, but a lot of issues remain. **(Reddy et al. 2021)** pointed out that infrastructural disparities, including problematic internet connectivity and digital illiteracy, still exclude disadvantaged populations and their involvement into digital education. In the same manner, **(Rawal 2024)** pointed out that the quality of use of digital tools by teachers influences their effectiveness in the classroom and remote conditions significantly. Surprisingly, however, there is still a dearth of case- and context-relevant studies that discuss the working of DPI in the Indian context, in various states, and in various communities of learners. The bulk of literature concentrates either on macro-level implementation or technical infrastructure leaving behind realities on the ground, user experiences and socio-cultural obstacles which affect the DPI adoption and effects.

It is on the basis of these gaps that the current research will attempt to make a case-based analysis of some of the major DPI platforms with a view to determining their ability to serve in the promotion of equity in access to education within India. This study aims at providing an evidence-based idea of the enablers and barriers with DPI given the real-life implementation experiences, particularly in rural or tribal or underserved areas.This is a relevant study that is essential to understand today given the ongoing investments in digital ecosystem in India as part of the National Education Policy (NEP 2020) and digital governance architecture. The discoveries can be used in the enhancement of policy, the more informed rendering and execution of DPI structures and making digital transformation in education becomes a reality. The interdisciplinary nature of the study is also in accordance with the global aims, such as SDG 4: Quality Education and SDG 10: Reduced Inequality, which presents practical information to the national and global stakeholders.

4. METHODOLOGY

This research adopts a multiple case study research **(Yin, 2018)** design by examining five well known Digital Public Infrastructure (DPI) platforms, in India, namely DigiLocker, DIKSHA, SWAYAM, PM eVIDYA, and Academic Bank of Credits (ABC). These cases have been chosen using the purposive sampling method, whereby the decision was informed by the policy relevancy, geographic representation as well as a strategic significance to the changing Indian digital education landscape. The entire process of data collection was purely qualitative and secondary in nature comprising of a thorough examination of official government reports (placed by the Ministry of Education, MeitY, and UGC), major policy papers such as the National Education Policy (NEP) 2020 and the Digital India initiative and institutional reviews carried out by other institutions like NCERT and NIEPA. Other sources of data were peer-reviewed scholarly articles, white papers, and respected news websites that

described how the platforms are realized in practice. A methodological desk research of the platform-level documentation, user case reports, and impact studies was conducted to develop elaborate case narratives, which will serve as the empirical basis of the paper

Data: These are the case studies about the Digital Public Infrastructure (DPI) platforms in India - DigiLocker, DIKSHA, SWAYAM, etc., proving the fact that they contribute to increasing the equity of receiving education. These case studies are based on a documented government report, reputable media coverage and scholarly research studies.

Objective 1: To analyze the effectiveness of key Digital Public Infrastructure (DPI) platforms in India

Table.1: key Digital Public Infrastructure (DPI) platforms in India

Platform	Case Study	State/Region	Educational Equity Contribution	Source
DigiLocker	The government of Uttar Pradesh also made DigiLocker compulsory among Class 10 and 12 students so that they could carry their marksheets and certificates. Learners in outlying regions were in a position to get records without commuting to school offices.	Uttar Pradesh	Less burdensome bureaucracy, less actual travel by the students in rural/remote regions.	**(Ministry of Electronics and IT 2023; TOI)**
DIKSHA	With the COVID-19 lockdown Jharkhand rolled out DIKSHA to provide grade-specific curriculum in QR-coded textbooks and mobile applications. The tribal students used information in their native languages such as Santhali and Ho.	Jharkhand	Multilingualism, universal access to tribal children who were not in any formal schooling settings.	**(NCERT 2021; NIEPA,2022)**
SWAYAM	A working student in Kerala with a low-income bracket, was able to enroll in one of the SWAYAM courses in Public Administration and get additional credits to his university degree, studying online and never having to step foot into a physical classroom.	Kerala	Enables inexpensive and pliable higher learning to non-standard students.	**SWAYAM Annual Report 2022**
PM eVIDYA	When schools were closed in Bihar, TV channels floated by PM eVIDYA provided subject-wise curriculum lessons to households where there is no internet. TV sets that were shared among families did not stop learning.	Bihar	Overcome the digital divide through the television to connect with smartphone and broadband unconnected homes.	**(Ministry of Education ,2021)**
Academic	The students of the Delhi	Delhi	Provided freedom of	**UGC ABC**

Bank of Credits (ABC)	University would take course credits through blended learning online through offline systems with various universities using the ABC system.		choice and optionality in college education by using a digital credentialing system.	**Guidelines (2022)**

The presented case studies show how Digital Public Infrastructure (DPI) can become transformative in filling education gaps in India. DigiLocker in Uttar Pradesh has been critical as it minimized the divide between urbanized and rural areas as students in far areas could now access their academic records with an easy touch of the button **(Ministry of Electronics and Information Technology [MeitY], 2023)**. This has avoided physical movements and the red tap all together and this has been of great benefit especially to students in low resource areas. In Jharkhand, DIKSHA has been used to a tremendous effect since it has deployed the localized, multilingual content, including the tribal languages Santhali and Ho, thus promoting linguistic inclusivity in the state by not leaving the learners of marginalized groups without the opportunity to receive quality digital education **(National Council of Educational Research and Training [NCERT], 2021; NIEPA, 2021)**. In Kerala, meanwhile, systems such as SWAYAM have offered members of the working population, and students not in the old formal university system, potential to take a more flexible, self-directed path in their studies. Under systems of enrolment in online courses and offering credits to these courses, SWAYAM offers access to higher education, opening the doors to it, lowering barriers of cost and accessibility **(Ministry of Education, 2022)**. In Bihar, internet penetration is low in a number of districts Prime Minister eVIDYA has filled the most critical infrastructure gaps through educational television that provides students who lack smartphones or broadband connections with a structured learning experience during school closures **(Ministry of Education, 2021)**. Finally, the Academic Bank of Credits (ABC) program, applied in Delhi, facilitates academic mobility since students can earn and transfer credits they have accumulated during blended and online studies across institutions **(University Grants Commission [UGC], 2022)**. All together, these efforts show the interactive balance between technology, policy design, and the contextual implementation in the further development of equitable and inclusive education to all in India.In order to investigate systematically the impact of Digital Public Infrastructure (DPI) platforms on improvement of equitable access to education in India, the study used a thematic framework of analysis as outlined by the overall set of research objectives. It was based on the patterns observed in national policy reports, international learning reports, and control over digital inclusion **(NEP, 2020; UNESCO, 2021; World Bank, 2021)**. Based on seven major themes (Access and Reach, Equity and Inclusion, and Pedagogical Integration), the analysis evaluated how available each of the platforms was to the learners of the various demographics (particularly rural, marginalized, and low-income students) **(KPMG & Google, 2021)**; whether the platforms could reduce the obstacles due to the language, disability, gender, or socio-economic background of the students **(NIEPA, 2021; Banerjee, Duflo, & Chattopadhyay)**. The Theme of Technological Infrastructure was based on access to devices, access to internet and electricity as a precondition to participation **(MeitY, 2023; UNESCO, 2021)**. The Governance and Co-design dimension covered the degree of user centered design, decentralization and stakeholder engagement in development of these platforms **(World Bank, 2021; MHRD, 2020)**. Moreover, the Monitoring and Evidence were analyzed in order to grasp the existence of the feedback loops and the tracking of outcomes **(UGC, 2022)**. Finally, Outcomes and Impact quantified the rates of certification, the completions of the content, and the learning progress **(Ministry of Education, 2022)**. It was possible to develop a comparative and nuanced analysis of five chosen DPI platforms in the frames of this thematic framework, and it made sure that the findings should be based both on the rich data and on the discourse on digital equity in education.

5. THEMATIC INSIGHTS ACROSS DPI CASES IN INDIA

Table.2: Thematic Analysis Across DPI Cases in India

Theme	Insights Across Cases	Supporting Literature
Access & Reach	The five platforms significantly increased access, particularly during COVID-19 (e.g. TV-based PM eVIDYA; rural UP based DigiLocker). But digital divide prevails in the low connectivity areas.	**(KPMG & Google 2021; Ministry of Education 2021; World Bank 2021)**
Equity & Inclusion	DIKSHA allowed regional and tribal inclusions with multilingual content; ABC allows mobility of learners. However, the majority of platforms do not have particular provisions of first-gen and disabled learners.	**(NIEPA 2021; UNESCO 2021; Banerjee et al. 2023)**
Pedagogical Integration	SWAYAM and DIKSHA had a good potential, but they had poor teacher training and were poorly integrated into classroom instructions. Majority of the platforms run side by side with mainstream pedagogy.	**(NCERT 2021; Mehta & Chandrasekhar 2022)**
Infrastructure Dependency	The device access, internet and electricity are instrumental to success. The best use of PM eVIDYA was in offline environment and SWAYAM/DIKSHA is not effective without the digital device.	**(Ministry of Electronics and IT 2023; UNESCO 2021; NEP 2020)**
Governance & Co-design	Community input is lacking in centralized design (e.g., DIKSHA, ABC). There is little evidence of co-design with students or teachers or local administrators.	**(World Bank 2021; MHRD 2020; Banerjee et al. 2023)**
Monitoring & Evaluation	Lack of any systematic process of real-time user feedbacks. The top-down review is done periodically. This constrains the responsiveness to the local needs.	**(NIEPA 2021; NCERT 2021; UGC 2022)**
Outcomes & Impact	Mixed impact. DigiLocker enhanced access to credentials; SWAYAM enhanced certification in certainty; however, the level of completion, user satisfaction and long-term outcomes of learning are under-assessed.	**(Ministry of Education 2022; Banerjee et al. 2023; UGC, 2022)**

6. DISCUSSION AND CRITICAL REFLECTIONS

Five key Digital Public Infrastructure (DPI) systems, such as PM eVIDYA, DigiLocker, DIKSHA, SWAYAM, and Academic Bank of Credits (ABC) were the subject of analysis, and some considerable gains and current issues that obstruct the way of improving educational equity all over India are evident. Several factors turned out to be working quite well. Benefits of low-tech solutions such as broadcasting through television were used by PM eVIDYA during the COVID-19 lockdown to ensure non-internet connectivity students did not lose their schooling **(Ministry of Education, 2021)**. DigiLocker was useful to authenticate, paperless and verifiable access to academic credentials especially those students living in villages where bureaucracy and corruption are high **(MeitY, 2023)**. In the same way, the incorporation of tribal languages, including Santhali and Ho, in DIKSHA contributed to linguistic inclusivity and thus it marked a major contribution in the area of culturally responsive

online learning **(NIEPA, 2021).**Nevertheless, a number of crucial limitations could be also observed. Digital divide and device dependency have become a significant barrier- platforms such as SWAYAM and DIKSHA assume that all learners have a steady supply of devices and internet connectivity, which is not guaranteed among the learners who are economically disenfranchised **(KPMG & Google, 2021)**.

Furthermore, the instructional quality of the platforms was impaired due to the low pedagogical integration; most teachers were provided with very little training opportunities regarding the utilization of digital materials, which resulted in the lack of instructional depth and continuity **(NCERT, 2021)**. Top-down model of most DPI platforms restricted platform flexibility to local requirements since platform design did not allow much student and teacher agency **(World Bank, 2021; Banerjee, Duflo, & Chattopadhyay, 2023)**. Moreover, the lack of real-time monitoring and feedback ties hindered the iterative development because it became challenging to adjust the platforms according to the changing user needs **(UGC, 2022)**.

7. CONCLUSION

Through a similar/case analysis of the five biggest platforms, the paper has expounded on the intricate issue of Digital Public Infrastructure (DPI) through fair access to education in India. Due to the evidence, such contextually real platforms and enabling policies have a tremendous potential as part of the long-term disparities of disparities in education. The most suitable credentialing system that is facilitated by Digi Locker to recognize, the multilingual feature of content that is also provided by DIKSHA and the usage of the television as the frontier to reach offline learners in PM e VIDYA are some of the examples that reflect the potential of the digital approach toward education in India. However, the investigation mentions that even with the potential of the digital learning approach in India, equity cannot be determined in advance due to infrastructure access. Such inclusiveness, adaptability, and persistence in the user interaction must also be viewed as one step to equitable education. It is possible that a digital environment as technically well-prepared as it might be, will still leave a big gap, unless it strikes the linguistic, cultural, as well as socio-economic domains of learners.

Moreover, absence of firm feedback loops, combination of pedagogical elements, co-designing with educators and students are a barrier to sustainability and efficacy of DPI intervention. Going ahead, education planners and policymakers should think in systems, which involves a combination of digital technology and a humanistic approach, locality, and ongoing reviews. That does not only mean investing in devices or broadband, but also in digital literacy training of teachers and learners, content development and governance of policy inclusiveness. DPI should be regarded as a good and democratically it should be transparent, participation and accountable. Secondly, in the future, studies must be conducted on the experiences of users based on gender, caste, region cross and disability in order to determine who is receiving the benefits, and who is being marginalized. Longitudinal impact studies are also required to not only measure access or use rates, but learning gains, levels of engagement and student progress over time. In conclusion, although the DPI platforms in India are an ambitious and worthy attempt to democratize education, their long-term success will require an equity-oriented planning, flexibility in implementation, and the political desire in ensuring that no learner is left behind. At a time when the world community is turning to the digital world as solution to the education sector, what happens in India is both encouraging and alarming: technology has the power to be useful, but its action will only be as inclusive as the vision informing it.

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