

Closing the Gap: Transformative Blended Learning for the Digital Age Kurukundi

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ABSTRACT

The COVID-19 pandemic profoundly disrupted global education, with India facing particularly acute challenges. This paper examines the severe impact on the Indian education system, especially the digital divide that the pandemic magnified. While the EdTech sector saw rapid growth, its benefits largely reached urban schools, leaving state-run schools in rural areas struggling with basic infrastructure issues.

In response to this disparity, Akshara Foundation, a Not-for-Profit Educational Organisation in India, introduced the Alternative Learning Project, a Blended Learning Model designed to mitigate the digital divide and ensure equitable learning opportunities. The project, piloted among approximately 400 students in grades 4 and 5 across government primary schools in Odisha's tribal regions, integrates digital learning with traditional classroom instruction through a Dual Lesson Plan framework.

The study conducted baseline and end-line assessments to evaluate the impact of this model, revealing significant improvements in student performance. Most students advanced to the First Division score band, highlighting the model's success in enhancing learning outcomes. This paper provides insights into the implementation of the Blended Learning Model as a post- COVID-19 recovery programme, demonstrating its effectiveness in bridging the educational divide and fostering meaningful student engagement. The data collected had pre-approvals from the state government of Odisha to implement the program and to publish the report.

Keywords: Tribal Schools, Blended Learning, Dual Lesson Plan, Digital Learning, Primary Education, Learning Outcomes

Introduction

The COVID-19 pandemic created unprecedented challenges across various sectors worldwide, with particularly severe impacts on health, livelihoods, and education. In many developing countries, one of the immediate measures taken by governments was to close schools to curb the virus's spread. This decision, although necessary, had significant negative repercussions on children's learning levels, especially for those with socio-economic disadvantages. According to a World Bank report from 2020, the pandemic shocked education systems globally and predicted severe damage to learning outcomes.

The disruption was historic, with UNESCO's 2020 report indicating that 94% of the world's student population was affected,

as over 190 countries closed their schools. The World Bank had already noted a global learning crisis before the pandemic, and the situation in India was no different. The Annual Status of Education Report in India consistently highlighted that primary school students' learning levels in language and numeracy were below grade-appropriate standards. Furthermore, the 2019 World Bank Learning Poverty report revealed that over half of all 10-year-old children in low- and middle-income countries could not read and comprehend an age-appropriate story. Disadvantaged children faced the worst access to schooling, highest dropout rates, and largest learning deficits.

The COVID-19 pandemic exacerbated these issues, leading to a significant educational setback. UNICEF's March 2021 assessment of six South Asian countries found that approximately 420 million children were out of school due to the pandemic, severely impacting maternal and child mortality, education, and

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the economy across these countries. In India, where the public schooling system is the largest in the world, many students lacked internet access or digital devices at home, creating a digital divide. Online learning, while beneficial in some aspects, posed significant challenges regarding accessibility.

To address the learning loss due to school closures, Akshara Foundation designed the Alternative Learning Project (ALP) in 2021. This learning recovery strategy leveraged existing resources within the education system, such as state-provided textbooks, workbooks, and government-approved digital content on the DIKSHA platform. Central to the ALP was Akshara Foundation's maths app, Building Blocks, which works both online and offline and offers a gamified version of maths. By blending digital and non-digital resources, Akshara piloted the programme when schools reopened immediately after the pandemic, aiming to mitigate the educational setbacks and bridge the learning gaps exacerbated by COVID-19.

Literature Review

Research on digital inequality shows that access is one of the major challenges. Several reports and surveys indicate a digital divide across rural and urban areas and among different gender groups. A study by Akshara Foundation showed that only 22% of the people surveyed had access to a digital device, and only 20% of those with access to smartphones used the digital space for educational purposes. The pandemic made the digital space an inescapable part of everyone's lives [1]. However, marginalized young children often missed out on lessons due to a lack of access. An Oxfam survey reported that 21% of students in urban India had access to a computer with internet compared to only 4% in rural India. Similarly, access to the internet through any device was better in urban India (44%) than in rural areas (17%).

The ASER 2023 survey of youths aged 14-18 revealed that around 44% of boys and 19.8% of girls owned a digital device. The overall availability of laptops/computers at home was a meager 9%. Although India has around 820 million internet users, with over half from rural areas, the lack of access to technology in schools significantly impacts students' education and future opportunities. Students without access to computers and internet connectivity are at a disadvantage, limiting their ability to compete in a digital world and access higher education and job opportunities. A study by the Azim Premji Foundation showed that almost 60 percent of school children in India cannot access online learning opportunities [2]. To unlock the potential of technology in achieving universal quality education and improving learning outcomes, the digital divide must be bridged. Bridging the digital divide in schools is crucial for ensuring equal opportunities for all students, regardless of their background or location.

The literature over the years provides insights into the evolving understanding of blended learning's efficacy and its implications for education [4]. In 2015, Clark's study on the flipped classroom model reported positive responses from students, noting increased engagement, improved communication, enhanced instructional quality, and more effective use of class time compared to traditional classrooms [3]. However, the study found that these experiential benefits did not significantly impact academic outcomes.

Further research on the effects of blended learning on student motivation and engagement, particularly in math education by Balentyne and Varga found that integrating technology into math instruction increased student interest and motivation, especially among younger learners who are drawn to digital tools. Additionally, studies have explored different blended learning models, such as adaptive learning technologies that personalize instruction and provide targeted support based on individual student needs [5,6].

A 2019 meta-analysis by Smith and colleagues highlighted the superiority of blended learning over traditional instruction alone [7]. In the same year, Fazal and Bryant's quantitative study in the US supported the effectiveness of blended learning models in enhancing math achievement among 6th-grade students [8]. Conversely, a 2020 qualitative study from Indonesia pointed out the challenge's educators face in using digital resources for language development, despite recognizing its potential [9]. More recent research in 2023, from Bangladesh indicated positive attitudes toward digital learning but stressed the need for a balanced integration of digital and traditional methods to meet the diverse needs of urban and rural areas [10]. Collectively, these studies illuminate both the promise and complexities of blended learning in contemporary education.

Ed Tech Perspectives:

Globally, over the past decade and a half, educational technology (EdTech) has shown significant potential for improving student learning outcomes, and India is no exception. The expanding role of mobile phones in social connectedness and economic development has been substantial, narrowing various gaps.

A 2012 meta-analysis report on the impact of digital technology on learning recommends that effective use of digital technologies in teaching and learning should include factors such as clarity in the efficiency and effectiveness of the technology in benefiting both learners and teachers [11]. It also emphasizes the importance of the role of technology in facilitating access to content, peers, and feedback, as well as promoting engagement among learners and supporting teachers. Continuous support and professional development are necessary, along with a clear understanding of what traditional methods will be supplemented or replaced by technology, ensuring that it enhances rather than displaces existing educational practices.

A study in India found that students using an EdTech product in an afterschool centre significantly improved their mathematics scores compared to a control group [12]. Similarly, in Punjab, Pakistan, a low-cost EdTech product implemented in government schools led to significant learning gains in mathematics and science [13].

Game (Digital)-Based Learning:

Digital game-based learning (DGBL) is an innovative method for teaching subjects like mathematics by leveraging the engaging nature of games to enhance learning experiences and improve educational outcomes. This approach makes learning math more enjoyable, motivates students to solve problems within a game context, provide instant feedback, help students understand mistakes, reinforces learning and corrects errors. Additionally, repeated practice in a fun environment helps solidify math

concepts, as games often encourage repeated play. Examples of effective math learning games include Prodigy, which adapts to the student's level and covers a wide range of topics; Dragon Box, which teaches algebra and basic concepts through interactive puzzles; Math Blaster, which combines action with problem-solving for various math skills; and Kahoot! a platform for creating interactive quizzes.

A cluster randomized study, conducted with 20 classrooms for early learners, on digital game-based learning (My Math Academy), indicates that after using the app for about 5 hours, treatment students significantly outperformed the students of control group in math knowledge and skills [14]. The more games students played, the greater the learning gains they experienced. Additionally, teacher survey revealed that it produced positive impacts on students' interest and self-confidence in learning math. Recent meta-analysis highlights that game-based learning in early childhood education can significantly enhance cognitive, social, and emotional development [15]. The study reveals that digital game formats, including mini games, educational apps, and programs, effectively promote cognitive development, problem-solving, and creativity. However, it emphasizes the importance of educator-guided gameplay and scaffolding to maximize learning gains. The analysis also identifies challenges such as the necessity for age-appropriate game design and the limited time available for gaming in classroom settings. By carefully selecting and integrating these tools into the learning process, educators can offer a more engaging, personalized, and effective math learning experience.

Building Blocks, developed by the Akshara Foundation, is a digital tool designed as a set of interactive games integrated into the learning process. These games provide an engaging, personalized, and effective math learning experience for students. Periodically vetted by educators from the Government's Teacher Education Institute (DIET Lecturers), Building Blocks ensures that the games meet educational standards and objectives. By incorporating these vetted interactive games, educators can enhance math education through innovative and enjoyable methods.

Challenges and Recommendations:

Kumar discusses the challenges of effective digital learning and offers recommendations for overcoming barriers to online and blended learning [16]. The study emphasizes how technology is set to revolutionize education. Rapid advancements in ICT have enhanced the sector's ability to better serve students and teachers, with the concept of "anywhere learning" poised to benefit students through technological breakthroughs for real-time and predictive governance. This vision positions India as a potential global superpower in digital education. Further, Sarkar asserts that blended learning is essential and advocates for designing inexpensive programs and obtaining buy-in from teachers and learners, highlighting the complexity of the approach and its connection to multiple factors [17].

Addressing Asymmetrical Learning:

A major limitation of traditional education systems is asymmetrical learning, where the pace of teaching cannot adapt to the varying learning capacities of students. Educational technology can make learning more effective. Blended learning

empowers teachers, standardizes quality content, and, combined with a robust monitoring and evaluation system, ensures inclusive and equitable quality education while promoting lifelong learning opportunities for all. The COVID-19 pandemic has shifted the discussion on EdTech from a question of "if" to "how," accelerating the adoption of online learning, particularly in Tier 1 and 2 cities and towns with purchasing power.

In India, the National Digital Educational Architecture (NDEAR) framework, a follow-up to the National Education Policy (NEP) 2020, adopts an 'Open Digital Ecosystem' approach, expected to serve as a model for developing a national digital infrastructure to energize the entire education ecosystem. DIKSHA, India's Digital Infrastructure for Knowledge Sharing in School Education, is available both online and offline [18].

The review of literature presented above suggests that blended learning approach is an effective approach for improving student outcomes. However, challenges such as access to technology and digital literacy skills among students and teachers must be addressed. The proposed Blended Learning Model seeks to address challenges of access, capacity building, and aligning digital resources with the curriculum, making it a unique approach.

Research Methodology

The objective of this paper is to detail out the Action research carried out to address the learning gaps in Mathematics education in government schools post COVID-19 pandemic. The pilot was to address the challenges faced in government schools in Mathematics education due to school closure. The objective was to implement a blended learning strategy by eliminating the challenges of access to digital device and digital resources and measure if the inputs provided impacted on learning outcomes.

Akshara Foundation a not-for profit organization has been implementing a math program called Ganitha Kalika Andolana, that advocates constructivism with a pedagogy that follows Concrete- Representation- Abstract approach based on activity-based, experiential learning [19,20]. In response to the learning loss due to school closures, Akshara Foundation designed the Blended Learning Project in 2021 as a learning recovery strategy. This project leverages existing resources within the education system, such as state-provided textbooks, workbooks, and government-approved digital content on the DIKSHA platform. Central to ALP is Building Blocks, Akshara Foundation's maths app, which works both online and offline and offers a gamified version of maths.

Blending these digital and non-digital resources, Akshara piloted the program when schools reopened immediately after the pandemic. The blended program capitalized the strengths of maths program (Ganitha Kalika Andolana), integrated both digital and traditional element. A structured digital component focused on playful learning, alongside a traditional approach involving textbooks, math kit, and worksheets. This fusion resulted unique blended learning model, offering students a comprehensive and engaging educational experience. The approach expected to cultivate high levels of engagement, transforming students into active learners and knowledge constructors.

This project was implemented as a pilot in an eastern state of Odisha. Odisha has around 33,000 government primary schools. The pilot covered more than 400 children studying in grades 4 and 5 in 22 government schools in Keonjhar district, Odisha. Students were from tribal families with limited exposure to formal education and with a limited learning environment at home. Most of these children had no access to digital devices for learning. The schools were selected by government officials based on network access. Data collected from a community survey of 424 parents/guardians revealed that 82% of the households belonged to the Scheduled Tribes (ST), and both male and female literacy was below the Odisha state average. It further found that 71% of the men were employed in the agricultural sector with the majority of the households having an annual income of less than INR 50,000 versus the state's Per Capita Income (PCI) of INR 150,676 in 2022-23. Further, 59% of the households reported having smartphones but only one-third of the children (28%) had access to smartphones for learning purposes.

Programme Design:

The program provided the device - a smartphone - pre-loaded with maths content to students and tracked their learning through Worksheets. The digital content enabled students to reinforce maths learning. The strategy was to work with the maths teachers in these selected schools and scaffold them in the blended teaching process during dedicated maths periods during the week.

The pedagogical strategy called the Dual Lesson Plan was based on the activities and Workbooks that were provided to the students and the digital content Akshara Foundation developed in pre-COVID times [21]. Dual Lesson Plans were created by considering the textbooks, the Learning Recovery Programme's Worksheets, the Ujjwal workbooks provided by the government and the digital resource called Building Blocks developed by Akshara Foundation and approved and uploaded by the State

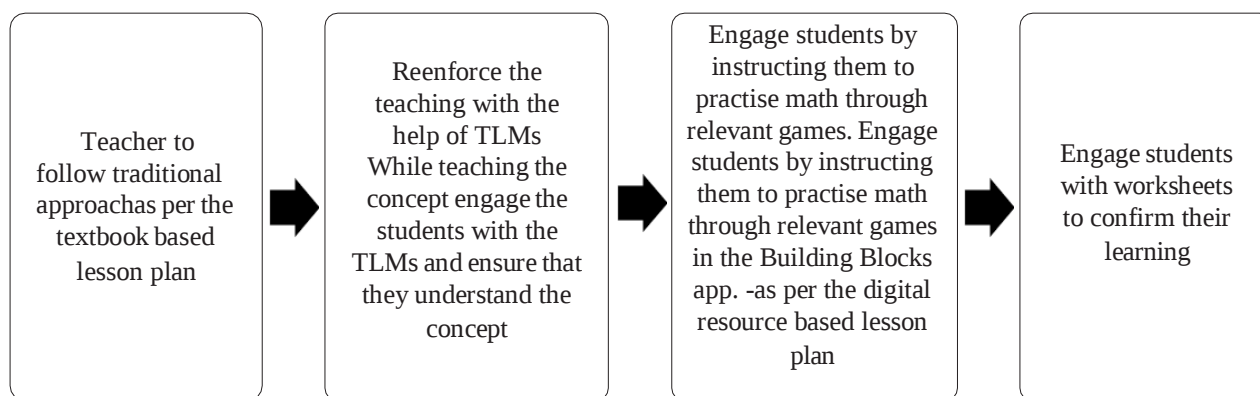
Council of Educational Research and Training (SCERT), Odisha on the DIKSHA platform [22-24]. Building Blocks provided supplemental opportunities for students to practise maths at home every day in a fun way through interactive and gamified digital content. The content is grade-compatible and aligns with policy guidelines. It follows the mathematics syllabus and is aligned with the textbook.

Akshara Foundation developed a Dual Lesson Plan. As the name 'Dual' suggests, two lesson plans were created. One as a routine text-book based lesson plan and the other digital-resource based lesson plan. The lesson plans were designed with weekly timelines so the maths teacher would know exactly which concept to deliver week after week. The maths teacher consulted the Cluster Resource Centre Coordinators (Government staff) and Akshara Foundation's Field Facilitators (Akshara's staff) if they faced any challenges regarding pedagogy. The maths teachers were expected to implement the lesson plan suggested by the programme.

The first set of lesson plans was followed by the teacher during her maths class and the second set, the digital content in pre-loaded smartphones, was handed over to students in the second half of the school hour. In addition to this Akshara Foundation designed Weekly Worksheets containing 10 questions for practice, to engage students in concepts in which they trailed. The Worksheets had problems that were uniquely formulated, based on the syllabus, but not linked to textbook content. These Worksheets enabled students to practise maths problems in addition to what was specified in the textbooks and the digital content. The maths teachers distributed the Worksheets to the 4th and 5th graders every week.

Classroom Process:

The classroom process -delivery of Dual -lesson plan is depicted in the picture below.



Capacity Building:

The teachers and the Education Department's Cluster Resource Centre Coordinators were trained for two days on the key components of the programme including the daily routines, pre-loading the digital content, the pedagogical framework, concept, classroom transaction, deployment of digital devices to students and follow-ups with them individually on their conceptual understanding of maths. Akshara Foundation appointed two Field Facilitators to support the teachers and the Cluster Resource Centre Coordinators (CRCCs) during their school visits. The

Field Facilitators visited the schools periodically to interact with the maths teachers, take stock of the students' learning, clarify doubts, and share the month's quota of Worksheets.

Results and Discussion:

The programme envisaged learning outcomes as one of the metrics for evaluation. The baseline and end-line assessments were designed as written tests based on the previous grade's competencies in maths, i.e., grade 4 students were tested for grade 3 competencies and grade 5 students for grade 4 competencies.

The baseline tests were administered in September 2022, before the teacher training programme, and the end-line in March 2023. Sixty-minute pen-and- paper tests were administered. Field Facilitators designated to carry out the assessments were oriented on their significance, the assumptions, and the nature of the tests. Akshara Foundation trained the Field Facilitators in the test administration process and evaluation of test papers.

All 22 schools participated in both the baseline and end-line assessments. Four hundred and thirty students were present for the baseline assessment and 429 for the end-line. However, from this pool 388 unique students appeared for both the tests and the scores of these students were considered for the analysis. Table 1 depicts the data dynamics of student attendance in the schooling system.

Table 1: Details of Student Participation in the Assessments

Details of Participation	Grade 4	Grade 5	Total
Number of Students who Participated in the Baseline	217	213	430
Number of Students who Participated in the End-line	215	214	429
Number of Students who were Absent During the End-line	21	19	40
New Students Present in the End-line	10	13	23
Unique Students in the Baseline and End-line	196	192	388

Test Scores:

The Field Facilitators administered written tests for both the baseline and end-line assessments. The tests had 15 questions. As previously mentioned, the grade 4 tests were based on grade 3 competencies and grade 5 tests on grade 4 competencies. The content of the questions differed from baseline to end-line. However, the blueprint and rubrics remained the same. The assumption was that students had acquired the language and maths skills of the grade below their current level. And that those students could read and comprehend the instructions given in the question paper.

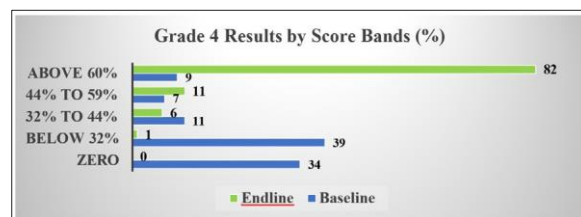
As per the High School Certificate Examination (HSCE) Odisha, students are required to score 33% to pass the exam. An analysis was carried out based on HSCE criteria [25].

Table 2: Distribution of Students by Score Bands

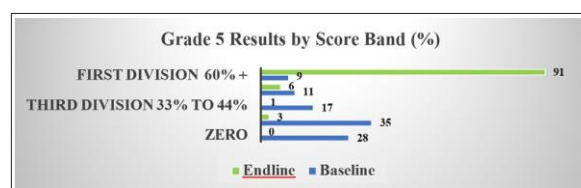
Score Bands	Grade 4		Grade 5	
	Baseline	End-line	Baseline	End-line
First Division 60%+	18 (9.2%)	161 (82.1%)	17 (8.9%)	174 (90.6%)
Second Division 45-59%	13 (6.6%)	21 (10.7%)	21 (10.9%)	12 (6.3%)
Third Division 33-44%	21 (10.7%)	12 (6.1%)	32 (16.7%)	1 (0.5%)
Below 32%	77 (39.3%)	2 (1%)	68 (35.4%)	5 (2.6%)

Zero	67 (34.2%)	-	54 (28.1%)	-
Total No. of Students	196 (100%)	196 (100%)	192 (100%)	192 (100%)

The table above shows that at the time of the baseline, less than 10% of grade 4 students (18 out of 196) had secured First Division marks. However, by the time of the end-line test, 82% of the grade 4th students (161 out of 196) secured First Division scores, 11% (21 out of 196) secured Second Division and 6% (12 out of 196) Third Division scores. Only two students (1% of 196) did not score enough to pass.



The data for grade 5 shows that 9% (17 out of 192) of the students were in the First Division bracket at the time of the baseline and this moved to 91% (174 out of 192) by the end-line. Further, 6% (12 out of 192) secured Second Division and less than 3% (5 out of 192) scored below 32%. All children passed the end-line test.

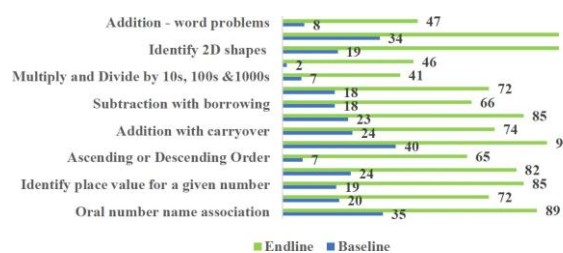


It is evident that in both grades there was a significant improvement and students had moved to a higher band. A drill-down analysis was carried out on the micro concepts in which students had acquired skills and those in which they were struggling.

Scores by Competency

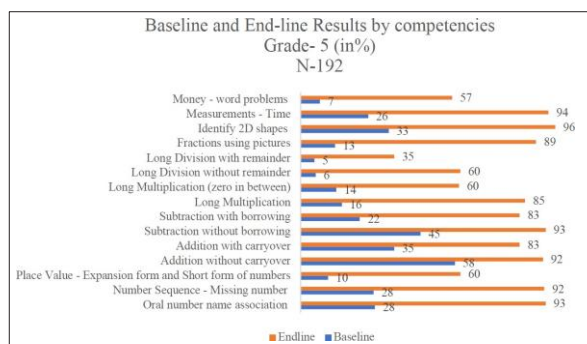
A competency-wise analysis of grades 4 and 5 students was carried out to see the scores gained across the competencies. The blueprint of the question papers was based on the competencies and micro competencies specified by the National Council of Educational Research and Training (NCERT) for grades 3 and 4 students.

Baseline and End-line Results by Competencies (in %) Grade 4 (N-196)



The above graph depicts that students of grade 4 positively benefitted from the programme in competencies like Shapes, Place Value and Measurement. However, the programme had

a limited impact on competencies like Long Division without Remainder, Addition - word problems, and Multiplication and Division by 10s, 100s and 1000s.



The above graph indicates that students of grade 5 benefitted a great deal from the programme in Long Multiplication and Measurement. However, the programme in its next iteration would do well to focus on Long Multiplication (with zero in between), Long Division with Remainder and word problems.

Multiple factors were key to the success of this pilot, like strong buy-in from the government, as in the programme was launched by the District Administration, and strong engagement of the maths teachers and officials of the Education Department. All the stakeholders found the digital content engaging. Children found the Building Blocks games very attractive and engrossing. Regular access to digital devices was another factor that contributed to the success of the programme. Initially the strategy was to get access to devices for every child twice a week. However, both the teachers and the students found it useful and therefore Akshara Foundation distributed these devices to students on a daily basis. Teachers found the capacity building effective as there was sustained support from the CRCCs and Akshara's Field Facilitators during the pilot period.

While most of the teachers were motivated, there were a few who saw the programme as additional work and looked on the field support as invigilation. During informal discussions with the teachers, they said that getting children back on the learning track was one of the major challenges. They said students had forgotten what was taught and engaging their attention was difficult. During implementation, sticking to the prescribed lesson plan was a challenge for the teachers due to the varying learning levels of the students. Some of the teachers and students faced technology issues such as non-responsive digital content (for example: downloading and navigation issues) and gadget issues. To scale the programme the government needs to invest in procuring the devices which may be a challenge. Another challenge would be to secure buy-in from the teachers on the new teaching-learning strategy.

Conclusions

The outbreak of COVID-19 effectively led to the closing down of over 1.5 million schools, affecting 286 million children from pre-primary to secondary levels around the world. As cited by many research studies, the learning loss has affected the education system badly. The literature on blended learning suggests it holds promise as an effective approach for improving student outcomes. However, challenges such as access to technology and digital literacy skills among students and teachers must be addressed. To

unlock the potential of technology in achieving universal quality education and improving learning outcomes, the digital divide must be bridged. The Blended Learning Model sought to address challenges of access, capacity building, and aligning digital resources with the curriculum, making it a unique approach.

As depicted in the paper the baseline and end-line results of the pilot showed that the majority of the students gained from the intervention. Both grades 4 and 5 performed better at the end-line as compared to the baseline assessment. Eight in 10 of grade 4 students and 9 out of 10 in grade 5 moved to the First Division score band at the time of the end-line indicating that the programme benefitted most of the students.

The pedagogical strategy, process and learning gains of the Alternative Learning Project indicate that a blended model could be the way forward in engaging children in a meaningful learning environment during COVID-19. The model focused on processes and possibilities in mathematics education, which could be adapted to other subjects as well. There is a need to design programmes and catching-up strategies to enable children to recover what was lost during the pandemic years and bring them back to expected levels of learning. While digital solutions are thought of as a way forward, in reality the digital divide has resulted in pushing students without digital facilities to a greater disadvantage. Needless to say, rural children are more susceptible to marginalisation than most others. It is in this context that Akshara Foundation took upon itself in these COVID-19 times to design and implement the blended learning model that had innovation as its centrepiece.

This paper concludes that Akshara Foundation's journey with its pilot post-pandemic proved that the concept of blended learning could be made to work with investment plans on provisioning the digital device and building the capacity of teachers. The blended learning programme could be implemented as a strategy to help students continue learning with the digital content at home after physical schooling hours as well.

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