# Project Albus

## Assessment of Google Solutions for Education in India

*Dr Amina Charania,*
*Associate Professor,*
*Centre of Excellence in Teacher Education,*
*Tata Institute of Social Sciences, Mumbai*

*Sumegh Paltiwale,*
*Senior Research Associate,*
*Centre of Excellence in Teacher Education,*
*Tata Institute of Social Sciences, Mumbai*

भविष्य की पुनर्कल्पना RE-IMAGINING FUTURES
TISS

# Table of Contents

# Introduction

The National Education Policy 2020 advocates providing personalized computing devices to students to promote equitable access to education. It envisions integrating digital resources in a learner-centric manner to develop critical thinking, creativity, collaboration and other 21st century skills in students (Kay & Greenhill, 2019; Means et al., 2010; Voogt et al., 2015). The policy stresses building teacher capacity through professional development to effectively leverage technology, recognizing their key role in implementing this vision (Government of India, 2020).

Given the policy's focus, evaluating specific edtech interventions is important to guide effective scaling. While platforms like DIKSHA (Government of India, 2021) have enabled content access, core curriculum integration and teacher development are equally critical as outlined in Pragyata guidelines (Government of India, 2020).

Experts such as ISTE (International Society for Technology in Education), a key global edtech organization, provide frameworks and standards for effective technology integration in education. Similarly, Kozma (2003) underscores the need to utilize technology for innovative pedagogies leading to student centered use, like research, creating artifacts, and by training teachers and aligning assessments. Through field action research projects in government schools, at CETE, TISS, meaningful integration of technology is seen as integrated with curriculum, active, promoting authentic learning and constructivist pedagogies, students and teachers' agency, and systemic adoption( Charania, 2018, et al., 2020)

## The Albus project

Project Albus is a DX of a number of pilot schools in collaboration with the government and other organizations. Panl and Google for Education are collaborating to provide a trial program for schools in many countries including Indian schools. Through tools like Google Classroom, G Suite for Education, and others, Google for Education focuses on fostering multidimensional learning experiences for more than 120 million students and instructors worldwide.

Earlier studies on assessing effectiveness of google solutions have found benefits such as improved efficiency of learning through real-time communication and document sharing using Google Apps like Gmail and Google Docs (Sviridova et al., 2011). Case studies have shown that Google Apps supported collaborative, project-based, and real-time data sharing for scientific education, while also developing digital literacy skills

(Railean, 2011). Additional studies across several countries found that integrating Google solutions into teaching practices enhanced student engagement, collaboration, creativity, and critical thinking (Bartolo, 2017). Specifically, Google Classroom was found to improve communication and student engagement (Abazi-Bexheti et al., 2018). However, key challenges identified include lack of professional development on utilizing Google solutions (Railean, 2011; Abazi-Bexheti et al., 2011), reliance on stable internet connections (Sviridova et al., 2011; Railean, 2011), lack of student readiness (Abazi-Bexheti et al., 2011), limited access to devices (Abazi-Bexheti et al., 2011), and insufficient technical support (Kaur, 2020).

## Another One to One Computing initiative in India

The One Laptop Per Child (OLPC) initiative was launched in India in 2005 with the aim of enhancing educational equity and access by providing low-cost laptops preloaded with educational software to school children. Around 1900 laptops were distributed to schools across seven states including Maharashtra, Assam, Uttar Pradesh and Tamil Nadu as part of initial pilots (Padmanabhan & Wise, 2012). However, the program struggled to achieve its objectives in the complex realities of the Indian education system. Key challenges faced were high costs of around $200 per laptop, lack of relevant localized software, inadequate infrastructure and teacher training, and poor integration with the curriculum (Shah, n.d.).

The then Education Minister, Sudeep Banerjee, expressed concerns regarding the effectiveness and feasibility of the OLPC program stating, "The idea of Prof. Negroponte (founder of OLPC) is not suitable for our country. In India, we believe in empowering our teachers and students with technology rather than handing them a tool and expecting miracles to happen." This highlighted the importance of focusing on teacher training and pedagogical practices for integrating technology meaningfully.

While the OLPC program demonstrated the potential of technology to transform education, its limited success in India also emphasized the need for deeper understanding of local contexts. Initiatives must account for on-ground needs, infrastructural constraints, pedagogical practices, curriculum requirements, and sociocultural norms right from the planning stage (Selwyn, 2013). Collaborative design involving community participation is essential. The insights from OLPC's experience can guide future efforts to leverage technology, such as Google Solutions, for enhancing equitable access to quality education across India.

## Purpose of this Study

This study aimed to investigate the impact of providing Chromebooks and access to the premium suite of Google Workspace for education on student learning outcomes and to gain insights into how teachers and students perceive the use of technology in the classroom.

## Rationale of the Study

The NEP advocated leveraging technology to improve access to quality education, promote personalized learning, and develop 21st century skills. In a country like India, quality at scale is an important factor for larger sustainability. Comprehensive assessment of solutions like Google's is required against the NEP 2020 vision for integrating technology-enabled education. The Albus project promotes one to one computing through Chromebook and google applications.

It is essential to assess the effectiveness of providing 1:1 computing devices to students in enhancing teaching and learning processes. The primary aims of this study were to explore teachers' perceptions of the value and effectiveness of Google Solutions (chromebooks and Google Workspace for Education) as a digital tool in their teaching and learning processes, as well as understand how use of Google Solutions influenced the development of 21st century skills among adolescent students. The research applied a mixed-methods approach using surveys, interviews, and classroom observations.

## Background of the participating schools

### Kendriya Vidyalaya (KV) Anna Nagar Chennai

Kendriya Vidyalaya (KV) Anna Nagar Chennai is a school that operates under the umbrella of Kendriya Vidyalaya Sangathan (KVS), an autonomous organization under the Ministry of Education, Government of India. KV Anna NagarChennai [2] is one of the many Kendriya Vidyalayas located across India and abroad, catering to the educational needs of the children of employees of government organizations, including the armed forces and other central government employees.

KV Chennai Anna Nagar was established in the year 1977 and is located in the Anna Nagar West area of Chennai, Tamil Nadu, India. The school is affiliated with the Central Board of Secondary Education (CBSE), New Delhi, and provides education from Class I to

Class XII. The medium of instruction in the school is English, and the school offers Science, Commerce, and Humanities streams at the higher secondary level.

The school has a well-qualified faculty, and its infrastructure includes well-equipped science and computer labs, a library, a playground, and a multipurpose hall. The school also has a range of extracurricular activities, including sports, music, dance, and art, to provide students with holistic development opportunities.

Kendriya Vidyalaya Chennai Anna Nagar also has an Atal Tinkering Lab (ATL) established in 2019. The ATL is a part of the Atal Innovation Mission (AIM) launched by the Government of India to promote innovation and entrepreneurship among school students (NITI Aayog, 2018). The ATL provides a platform for students to explore their creativity and innovative ideas and work on projects related to science, technology, engineering, and mathematics (STEM) fields. The lab is equipped with state-of-the-art tools and equipment such as 3D printers, robotics kits, and electronics components to facilitate the development of prototypes and models. The lab also organizes various workshops, seminars, and training programs to promote innovation and entrepreneurship among students.

### Army Public School (APS) Hisar

Army Public School (APS) Hisar is a well-known co-educational school in the city of Hisar, located in the northern Indian state of Haryana [1]. Established in 1981, APS Hisar is run by the Indian Army under the aegis of the Army Welfare Education Society (AWES), which manages and operates over 130 Army Public Schools across India.

APS is also affiliated with the Central Board of Secondary Education (CBSE) and offers classes from Nursery to XII. It has a large campus spread over 18 acres and offers modern infrastructure facilities including smart classrooms, computer labs, science labs, and a well-stocked library. Additionally, APS Hisar also has a large playground and sports facilities for cricket, football, basketball, volleyball, and other sports.

APS also has an Atal Tinkering Lab (ATL). The school also conducts various technology-related activities, workshops, and competitions to promote STEM education among students.

## Some Albus Program Terminologies used in the Study

### a. Albus Program

The title of this study which focuses on assessing effectiveness of Google Solutions

## b. Chromebooks

A Chromebook is a type of laptop or notebook computer that runs on Chrome OS, an operating system developed by Google. Chrome OS is derived from Chromium OS, an open-source project. It is designed to provide a simplified and streamlined computing experience, primarily focused on web-based applications and cloud storage. Chromebooks are known for their fast boot times, efficient performance, and user-friendly interface.[1]

## c. Google Applications

Google applications refer to a suite of productivity tools and software developed by Google. These applications are designed to help individuals and teams collaborate, communicate, and manage their work. Some popular Google applications include:

1. Gmail: A web-based email service for sending, receiving, and organizing emails.
2. Google Drive: A cloud storage platform for storing, managing, and sharing files and documents.
3. Google Docs: A web-based word processing tool for creating and editing documents.
4. Google Sheets: A web-based spreadsheet tool for organizing and analyzing data.
5. Google Slides: A web-based presentation tool for creating and delivering slideshows.
6. Google Calendar: A digital calendar for scheduling and managing events, appointments, and meetings.
7. Google Meet: A video conferencing and communication tool for hosting online meetings and virtual discussions.
8. Google Forms: A tool for creating online surveys, quizzes, and data collection forms.
9. Google Classroom: A web service developed by Google for educational institutions that enables teachers to create, distribute, and manage assignments, as well as provide a platform for students to submit their work digitally. It streamlines communication between teachers and students, facilitating online learning and collaboration in a structured and organized manner.

---

[1] Globally, in the education sector, Chromebooks have gained popularity due to their affordability and integration with Google's suite of educational tools, including Google Classroom and Google Drive. They offer students and educators easy access to web-based resources, collaboration tools, and online learning platforms. Chromebooks are also known for their strong security features, ensuring a safe and protected environment for educational use (EdTech Magazine, 2022).

10. Chrome Cavnas: A web-based drawing and sketching tool provided by Google, accessible through the Chrome browser, allowing users to create digital art and illustrations.

The cloud feature of the workspace (and hence these applications) allows for easy access to files from any device with an internet connection, eliminating the need for local storage and enabling collaboration among team members.

### d. Google Workspace

Google Workspace is a comprehensive collection of the above mentioned Google applications. The study mostly uses the term google applications.

### e. Google Solutions

Google Solutions refer to the combination of Google Workspace and Chromebook, providing a comprehensive Google ecosystem.

# Research Methodology

This study was exploratory in nature and used a mixed-methods approach. The intervention involved distributing Chromebooks randomly to specific sections within a grade 8 or 9, primarily to match the number of CBs available for one to one student use. The study leveraged these two groups within each of the two schools, for some comparative analysis. The two classes in two schools, where CBs were distributed are referred as Intervention Group (IG) and two other sections where CBs were not distributed are referred to as Non Intervention Group (NG).

Both groups of students were interviewed regarding their access to digital devices at home, their familiarity and use of different types of google applications on CBs, as well as the challenges they encountered. A focus group discussion with three students was conducted for deeper insights into students use and challenges with Chromebook and google applications.

A subset of teachers, who had been trained by implementation partners, participated in semi-structured interviews. These interviews aimed to gather insights into the teachers' experiences, familiarity, and usage of Google applications and Chromebooks, as well as the training they received.

The Albus project also surveyed the teachers before and after the pilot year. However, the two surveys were not matched on the questions asked, therefore time 1 and time 2 comparisons could not be made. In this report, interview findings were combined with some of the survey data provided by the Albus project for a more comprehensive understanding of teachers' responses.

Observations were made in two Chromebook enabled classrooms that gave more first hand insights into teaching practices and pedagogy using CB.

In accordance with TISS's Institutional Review Board (IRB) guidelines, consent was obtained from both teachers and students' parents for their participation in the study. This study has cleared the ethical review of the TISS, IRB.

## Sampling

All available teachers in the week of interviews and observations, who had undergone the Albus training were invited to participate in the study.

For student interviews, a random sample of 30% of chromebook recipient students and 30% of non-recipient students present on the days of data collection were selected for participation. The random sampling allowed comparable groups to be interviewed. During the interviews students were requested to share their projects, and those projects received were analyzed using a validated rubric to assess 21st century skills (details in findings).

Focus group discussions with students used convenience sampling due to limited availability of students on the day of data collection as vacations began at one school.

| | |
|---|---|
| Student interviews (Intervention Group) | 34 |
| Student interviews (Non-Intervention Group) | 24 |
| Classroom Observations | 2 |
| Teachers Interviews | 14 |
| Focused Group Discussion | 1 |

## Tools

The classroom observation and interview tools were developed based on pilot observations and interviews conducted at the schools. During these pilots, some important aspects were identified that informed the final tools. For example, observers noticed that teachers were relying primarily on traditional chalk and blackboard methods during lessons while students used Chromebooks. Hence, specific points were stressed on the teacher's own use of technology in class. Interactions were observed to be largely unidirectional, with students responding only to teacher questions. The tools were designed to capture data on the frequency and nature of student questions. Lack of consistent internet connectivity was identified as an issue. The observation tool specifically noted classroom infrastructure like availability of wifi and charging stations.

By building on the insights gained during the pilots, the observation and interview tools were refined to focus on key aspects of technology integration, pedagogy, and challenges faced in these classrooms.

### Students Interviews

Both groups of students (intervention group and non-intervention group) were questioned about availability and access of devices at home, patterns of usage, and encountered challenges across a range of devices including basic phones, smartphones, tablets, computers, and laptops.

These responses provided valuable insights into potential disparities encompassing students' device engagement, access patterns, and encountered challenges. This analysis forms the basis for evaluating the intervention's efficacy. Additionally, by encompassing both groups, a contextual understanding is achieved, facilitating exploration of device behavior and challenges across diverse student backgrounds. This holistic approach enhances the depth and richness of findings, providing a nuanced perspective on the broader digital landscape within educational contexts.

### Computer/Laptop related questions

The student interviews investigated computer and laptop access and usage. Students were asked about access to these devices at school and the purposes they serve in academics. Questions examined home access to computers/laptops and tasks facilitated. Students shared their favorite computer/laptop activities.

For the intervention group, Chromebook usage was explored extensively. Students discussed ownership, utilization, and home usage. Preferences and favored features were evaluated. Frequency of in-school use was measured. Instructional integration and impact on learning were examined. Effects on teacher communication and potential impact of absence were investigated. This multifaceted inquiry enabled a nuanced understanding of Chromebook usage.

### Chromebook Usage

The student interviews thoroughly probed Chromebook usage and perceptions. Students discussed their specific usage practices with the devices. They detailed home usage patterns, including transporting Chromebooks and activities conducted outside school. Students shared their preferences for Chromebooks, favored features, and reasons for liking them. The frequency of in-school Chromebook use was quantified on a scale from "Not at all" to "Regularly."

Additionally, students were asked to reflect on the impact of Chromebooks on learning processes. They were asked whether they would miss having Chromebooks next year and to provide reasons for their perspective. This multi-faceted inquiry provided nuanced insights into student experiences with Chromebooks from usage behaviors to perceptions.

### Teachers Interview

The teacher interview tool collected background details on demographics, subjects taught, classes handled, and qualifications. It gathered information from teachers on

Google solutions training - number of sessions attended, duration, applications covered, and post-training usage. The tool prompted teachers to elaborate on using Chromebooks and Workspace apps including experiences, comfort levels, differences from regular computers, challenges faced, and potential improvements. It asked teachers to discuss integrating these technologies into teaching concepts and make comparisons with non-technology pedagogies. Scenarios in the tool assessed changes in practices when shifting to non-technology classrooms.

The interviews focused on links between technology usage, training, and professional development. It inquired about the format, number, content, and relevance of training attended. The teachers were asked to explain how training content was integrated into teaching methodologies and practical implications. It gathered insights into teachers' decision-making when selecting tools to integrate, aligning with goals. The tool examined implications of training for professional growth and career advancement. It also established connections between implementing Google solutions and career trajectories. Overall, the teacher interview tool captured relationships between training, technology use, teacher agency, and professional pathways.

### Classroom Observations

This study utilized classroom observations to examine the integration of Google solutions and pedagogical practices in classrooms. The observations were conducted using a structured observation tool that was developed to capture key aspects of the classroom environment, pedagogy, student engagement, and use of technology.

Observations were conducted in classrooms across multiple schools. The schools were selected based on their use of Google Chromebooks and other Google tools. Classrooms from grades 8th and 9th were observed.

The observation tool collected detailed information on the classroom setup including seating arrangements, student-device ratio, and availability of infrastructure like projectors and charging stations. It also noted the dominant teaching methods and activities used by the teacher. Questions on how concepts were introduced, student participation, and teacher-student interactions provided insights into the pedagogy.

The tool specifically focused on documenting the usage of different Google applications by teachers and students during the session. This included applications like Google Docs, Classroom, Slides etc. Details were gathered on how these tools were integrated into lessons. Observers also noted the extent of student engagement through questions asked and peer interactions.

Classroom observations were conducted during regular school hours with prior consent from school authorities. The classroom observation tool provided comprehensive data on pedagogical techniques, technology integration, and student participation. The observations were conducted in a structured manner by trained observers. The data gathered through this methodology provides valuable insights into the use of Google solutions for teaching and learning.

# Findings

The findings from this study are presented in this section in the form of teacher interviews, teacher survey responses, student interviews, observations and student project analysis. Analysis of the findings from each of the sources are documented at the end of each sub sections.

# Findings from Teachers' surveys and Interviews

## Teachers' Interviews Findings

Fourteen teachers out of 46 who were trained in using Google Solutions under the Albus Program were available for interviews from the two implementing schools (APS Hisar and KV Chennai Anna Nagar) and were included in the study. The interview included questions on purpose and frequency of usage of the Google Solutions, benefits and challenges faced while using the Chromebook and its applications, and teachers' engagement and their perception of effectiveness of training. The interviews were conducted using a semi-structured approach to ensure that all relevant questions were asked while still allowing the teachers to expand on their answers and provide insights and examples to substantiate their responses.

Data Analysis: The interviews were transcribed (translated where required) and analyzed using a thematic approach, a qualitative analysis software MAXQDA[2] was used to make thematic analysis. The findings were presented using frequency and quotes from the interviews. Following section presents the findings from the interviews.

## Teaching with Google Chromebook and Google Solution Tools

All (14) teachers (from both the schools) mentioned using YouTube for teaching purposes from Chromebook as well as their own devices. Many[3] teachers (8) reported using Google Classroom (more from Chennai school) out of which several (5) teachers used it on a daily basis.

Some of the teachers (4) utilized Google Docs and Google Sheets for assignments and data collection, using Google Forms for assessments (3), using Jamboard for classroom activities including collecting student responses (3) was seen (only in Hisar school). A few teachers (2) mentioned utilizing Google Drive for storage.

[2] MAXQDA is a software program developed for qualitative data analysis, offering tools and features to facilitate the organization, coding, and interpretation of qualitative data.

[3] The quantifiers utilized in this report to describe the findings are based on the following scale:
'Most' refers to a majority, indicating over 80% of the respondents.
'Many' pertains to a substantial portion, ranging from 60% to 79% of the respondents.
'Several' signifies a significant group, comprising 40% to 59% of the respondents.
'Some' encompasses a notable subset, representing 11% to 39% of the respondents.
'Few' characterizes a small minority, encompassing less than 10% of the respondents.

## Benefit of Using  Chromebook in Classroom

a. **Fosters  Visual Learning:**

Most of the (12) teachers highlighted the benefits of incorporating visual learning through mostly videos and other media. Some (3) teachers emphasized the positive impact of visual learning, as students find it easier to understand topics when presented through videos on YouTube channels using Chromebooks in the classroom and also mentioned that students show more interest and confidence in the topics after being exposed to visual learning in the classroom through Chromebooks.

b. **Enhances use of virtual TLM (Teaching Learning Materials):**

Several (7) teachers mentioned various methods of sharing, creating and curating Teaching and Learning Material (TLM) with the help of Chromebooks. Some of these teachers mentioned that they utilized the resources such as NCERT PDF textbooks, PowerPoint presentations, videos downloaded from YouTube, and virtual simulations Amrita online labs for teaching purposes. A few (2) teachers also mentioned that Google Classroom serves as a valuable platform for sharing content and videos with all students at one place.

***"In previous versions of the 9th class textbook (5 years back), there used to be a chapter titled "Kichad ka Kavya" (which translates to "Poem of a Puddle") which was later removed by NCERT. Now it's re-introduced but it is not printed in the textbooks. I found it using Chromebook and taught students from that file. This way students have benefited. They will have to find the book somewhere in the old collection and take a photocopy but the students who have chromebooks they have the easy access to this chapter"***

c. **Enables Research by Students:**

Some (4) teachers mentioned about encouraging students to research and share their views to seek answers using Google Search. They mentioned that they can get clarity on the doubts on any topic with less intervention from the teacher.

***"...If they don't know the answers, they will go to another tab, they will Google. But my opinion is that they learn through that…"***

*“Aryabhatta is in the textbook but if the students want to learn about some other scientist not in the textbook they can search and learn at the same time with youtube videos and google browser”.*

d. **Efficiency in Administering Assessments and Giving Assignments Online:**

Some of the teachers (4) highlighted the benefits of using Google tools for administering assessments, giving assignments, and managing their classrooms. They praised Google solutions, particularly Google Classroom, for streamlining the process of administering assessments and collecting assignments, making it more efficient and organized. Example, convenience to create and distribute assignments through Google Forms and students being able to access from home. These teachers also expressed that overall as these tools are integrated with emails and Google Drive (and their interoperability) saves valuable time for these compared to traditional pen-and-paper methods.

*“Sharing the document is much easier. So that was much better than any other thing. And here we connected to mails, it is an easy drive to save and they can give at home.”*
*(Teacher response from the interviews)*

e. Enhances Communication: Some Teachers (4) indicated using google tools to enhance communication and collaboration among students. However, how through Chromebook and google applications was not very clear from the teacher responses

f. **Allows Flipped Classrooms:**

A few teachers (2) mentioned the concept of the flipped classroom as a strategy to build more interest in students for learning. In this approach, students are provided with learning materials (to be accessed from CBs ) before coming to class, allowing for a more interactive and discussion-based classroom session.

One teacher expressed it as follows: “One use, Flipped Classroom concept is going on these days. So, before teaching the topic in the classroom itself, we can announce that particular topic in the classroom itself, we can send a video or notes, that before coming to the classroom, students go through this topic first and then we can discuss it in the class next.”

Sanskrit Teacher

Mr. Narayan (fictitious name) is one of the Albus project teacher and has used Chrome books in teaching Sanskrit. An interview and classroom observations revealed interesting views and the use of CBs in his teaching. A few distinct advantages of Google applications and CBP that surfaced during his interview and classroom observations were students exploring the topics beyond the content in textbooks, searching resources and sharing with the teacher to integrate into teaching and the power of Google translations for the study of Sanskrit language in classrooms and everyday lives.

Mr. Narayan explained that, first he used to research and bring resources to class to show to my students, now the students research on the given topic and bring it to me to share with other students. Example, an original audio clip on eclipses by Aryabhatta in Sanskrit, on google was brought in by one of the students in the classroom where Aryabhatta was discussed and requested the teacher to play it.

Aryabhatta is in textbook but if the students want to learn about some other scientist not in the textbook they can search and learn at the same time with youtube videos and google browser.

On the other hand, the classroom observation pointed out that more attention is required to harness full potential of Chromebook use in classroom.

One of the recurrent findings regarding the benefit of Chromebook in classrooms in teachers' interviews was it allows restricted use and access of digital connect for education purposes.

## Restrictions of Student's Usage

Many teachers (8) highlighted the advantages of implementing restrictions within Google solutions. A few of these teachers stated that restrictions are beneficial to prevent misuse and monitor students' activities. One of these teachers reported that Google solutions have helped control access to the classroom, with only students with specific IDs joining a particular classroom or meeting. Another teacher mentioned that the students' use of Google solutions is restricted, and they cannot access some services such as the Play Store or YouTube, which could be distracting.

A few of these teachers explained that the restricted access in Chromebook is good for students because it helps control access to educational materials and prevents them from getting distracted by other things. One of these teachers believes that restrictions on access are mandatory and necessary for children, especially at adolescence.

***"There should be some restrictions actually. As the students get matrued they should be slowly given freedom. First some sites should be stopped, later… you can give it step wise."***

A few teachers (2) expressed that only educational sites should be allowed to run on the system and that YouTube could be accessed from an educational point of view, but with restrictions. One of the teachers who also used Chromebooks for personal academic goals-professional development also mentioned that restrictions are not problematic for learning. A few teachers (2) also mentioned that they would want the right to modify these restrictions on Chromebooks.

***"There should be a system that only the educational sites should run and nothing else. If there is such option, then it will be very comfortable for us."***

## Personal Use of Chromebook by teachers

A few (2) teachers mentioned using Chromebook for regular tasks such as checking emails, and searching for videos on different aspects. One of the teachers reported usage of Chromebook by family members, another teacher mentioned teachers find Chromebook useful as a useful device for achieving personal academic goals.

## Challenges faced by the teachers in using Chromebook in classrooms

### Connectivity Issues

Several teachers (8) reported network issues as a major challenge in implementing online learning. These issues include difficulties in connecting Chromebooks to the internet, slow internet speed, and intermittent connectivity problems. The teachers also mentioned that these issues of unstable connections in the classroom results in students missing parts of the lectures and experiencing delays in accessing online resources.

### Hardware-Related Challenges

- A few teachers (3) expressed concerns about the lack of IT support available to address technical issues and provide training to students. This lack of support hinders the smooth implementation of online learning and troubleshooting of device-related problems. Password management issues were also mentioned, with students frequently forgetting or changing their passwords, requiring assistance from IT administrators to reset them.

- A few teachers (2) mentioned challenges related to laptop maintenance and repair, particularly with Chromebooks. They reported issues with keyboards and emphasized the impact on students' ability to effectively use the devices for learning. Additionally, there were concerns about the lack of technical support personnel available to address these issues promptly.
- Another concern raised by a few teachers (2) was the difficulty in connecting Chromebooks to projectors, which hindered their ability to demonstrate lessons to students.
- One teacher mentioned limited memory space on Chromebooks for both students and teachers, further highlighting the need for improvements in device quality.

## Dis-agreeable use of Chromebook by Students

- Some teachers (4) mentioned concerns about students playing games during class time, while one of these few teachers raised concerns about unauthorized activities such as taking selfies, playing music, running unauthorized applications, and sharing files through pen drives.
- Some teachers (3) expressed concerns regarding the potential misuse of Chromebooks by students. They highlighted issues such as restricted Wi-Fi connections within the classroom, the possibility of students not focusing on assigned projects, and finding ways to bypass restrictions. Specific incidents were reported where students were able to remove internet restrictions and access prohibited content.

## Continuation of Chromebook for students

When probed about what will the teachers do if Chromebooks are discontinued, some (4) teachers mentioned that students are already accustomed to using Chromebooks and taking them away would require a significant amount of time for students to learn something new. A few teachers (2) expressed concerns about students becoming handicapped if access to Google solutions is stopped. Some teachers (3) mentioned that they have various options available in the market (regular laptop with microsoft) and can easily shift to another technology if current access (premium) to Google services is no longer available. One of these teachers said, "this is just a teacher's helping tool, Google is not everything."

Hybrid mode for future pandemics: One of the teachers, who was also the IT administrator of the school, highlighted the need for a hybrid mode of teaching and learning(offline and online) to be prepared for COVID-19-like pandemic situations in the future. They specifically pointed out the usefulness of the cloud-based tools like Google forms which makes it easy for the teachers to administer assignments as well as share resources with the students.

## Usefulness Of Trainings

When inquired about trainings received to use google solutions, the teachers mentioned that the trainings were for 3-4 days. Some teachers (5) mentioned receiving both online and offline training. Some teachers (4) mentioned receiving only online training, while a few of teachers (2) mentioned receiving only offline training. Some teachers (4) mentioned that the training covered all Google applications, including Google Docs, Sheets, Forms, Classroom, and more. Some (3) mentioned that the training covered only basic applications such as getting Google Forms filled and adding attachments, along with exposure to some new (unfamiliar to them) Google application features such as sharing links, getting responses, and using hyperlinks.

One of these teachers also received guidance on finding more knowledge and collaborating with other teachers.

However, another teacher mentioned that the training, both offline and online, involved the same trainer and pedagogy and was difficult to understand.

***"Two training sessions (online and offline both). The person who came to train the teachers offline here, his method of teaching was not good and proper and he was actually in a hurry to deliver"***

*-Teacher from School 2*

Two of the teachers when asked what to improve in the programme, mentioned need for subject specific technology integration to be added in the trainings (described later in this section).

## Teachers’ Suggestions for Improvement with use of Google Solutions

During discussions in the interviews, when asked for suggestions, improvements in the programme Google solutions, teachers added new suggestions or reaffirmed on various areas for improvement in Google Solutions that were indicated earlier in the interview. These suggestions ranged from incorporating subject-specific trainings for integrating google solutions in teaching and learning, address connectivity challenges, promote a healthy technology balance, and ensuring language inclusivity.

A few (2) teachers emphasized the importance of subject-specific training to identify the most suitable Google tools for different subjects. They mentioned that such training would enable teachers to make better use of these tools. Besides suggesting training to be more pedagogy and subject focused, they suggested the development and inclusion of subject-specific tools that cater specifically to languages like Hindi and Sanskrit, recognizing the need for language-specific resources to support effective instruction.

Another insightful suggestion came from a teacher, who highlighted the significance of accommodating the needs of the areas with limited internet connectivity. The teacher recommended implementing an offline sign-in option for Chromebooks, which would allow students to access their devices and continue their work even when internet access is unavailable.

One of the teachers raised valid concerns about the potential drawbacks of excessive technology use in the classroom. They specifically mentioned the risks associated with prolonged screen time, such as potential vision problems among students and increased distractions.

The interview and survey revealed some similarities and differences between the two schools on their use of CBS, and feedback and engagement with trainings. All teachers in both the schools indicated use of Youtube resources through CBs for classroom teaching, very few teachers in both the schools indicated use of google docs, sheets, and forms for assessment. Higher proportion of teachers in Chennai used google classroom, and Hisar school teachers reported jamboard. A few teachers in both the schools were concerned about unauthorized or disagreeable (distracting) use of Chromebook by students.

Teachers at both the schools expressed the need to continue Chromebook use, need for IT support, Hisar teachers mentioned need for regular maintenance of Chromebook and replacing the broken ones. One of the teachers at both the schools expressed need for a plug in for CBs to be connected to projectors in classrooms.

Regarding the training, the teachers in Hisar school said the trainings were both F2F and online, while Chennai school teachers said the trainings were online only. Several teachers at both the schools indicated that the training covered most of google applications, and expressed need for including aspects of google applications integrations with subject pedagogies in the trainings.

### Summary and comments  on teacher interview Findings

The interviews clearly indicated that restricted use of Chromebook makes it appropriate and acceptable to be used in classroom teaching and learning processes. Overall the teachers at both the schools in their interviews indicated google solutions and Chromebook are very useful in their teaching and learning processes by making it more visual, active, and organized. However, besides Youtube resources, at both the schools teachers reported use of other applications seemed underused. A few teachers expressed difficulties with connectivity and hardware support for CBs. Most teachers wanted students to have continuous access to Chromebook and a few asked for integration of pedagogy and subject connect of technology use in the tranings.

## Teachers survey findings

## (The tables pertaining to this section can be found in Annexure)

### Findings from Pre Implementation survey of Albus Project

#### Subject Taught by the teacher

More than half of the respondents (68.42%) taught STEM subjects, including Mathematics, Science, and Computer Science/IT. While less than half of the respondents taught Social Sciences (13.16%), English (5.26%), Hindi (7.89%), and subjects categorized as "Other" (5.26%).

#### Benefit of Different Technology in the Classroom

The pre-test survey of teachers found that more than half of respondents (89.47%) reported perceiving technology as beneficial in the classroom and actively trying to use it wherever they can. Regarding attitudes toward technology use in the classroom, most teachers indicated that they perceive technology as beneficial to use in the classroom.

#### Comfortable and confident in Using different  Google  Tools by Respondent

Before the intervention, more than half of the respondents found Google Workspace apps (Google Slides, Google Forms, Google Sheets, Google Documents, Google Drive, Gmail, Google Search, Chromebook, and Google Classroom) tools comfortable to use. On the other hand, a little less than half of the teachers reported comfort with calendar and Youtube and Google maps applications.

### Obstacles in Using Technology in Classroom

Several of the respondents reported lack of internet access (44.74%), lack of access to technology (42.11%), lack of training (39.47%) as obstacles for using technology in Classroom. Some also reported lack of awareness of what tools to use (23.68%) as obstacles to using technology in the classroom. Lack of confidence (2.63%) as obstacles to using technology was reported by only one teacher.

More than half of the respondents experience technical interruptions with hardware and bandwidth limitations/outages on a weekly basis, while less than half experience technical interruptions with apps.

### Weekly Time Spent in Using Technology for Communication and Cooperation with activities other than teaching.

More than half of the teachers (65.79%) spent at least 1 hour, and up to 5 hours per full working week on communication and cooperation with parents/guardians. More than half of the teachers (60%) spent at least 1.5 hours and up to 3 hours per full working week on extracurricular activities (clubs, sports). Most teachers (73.68%) spent at least 1 hour and up to 2.5 hours per full working week on "Other" activities such as break (free-time) supervision, mentoring colleagues, and professional development. More than half of the respondents (57.89%) spent at least 1 hour and up to 2 hours per full working week on participation in school management activities, such as department head responsibilities. More than half of the respondents (60%) spent at least 1.5 hours per full working week on student counseling, while the majority (80%) spent up to 3 hours.

## Findings from Post Implementation survey of Albus Project

## Benefits of Google Solutions for Students Learning

More than half of the teachers reported that the use of Google Solutions encouraged the students to engage in seeking knowledge and information (research) and learn effectively. These teachers also reported that the Google Solutions enabled the students to express their thoughts and ideas better and improved their performance in the studies.

About half of the teachers agreed or strongly agreed that using GS encouraged the students to collaborate and communicate more with their classmates. heightened their confidence to participate actively in the class, improved students' ability, specifically in reading and writing, allowed students to absorb the core subject matter quicker, and helped students complete assignments quicker. They also reported that the students are more engaged and active in general.

Less than half of the teachers agreed or strongly agreed that Google Solutions allowed the students to be more creative and imaginative in their work and helped them improve their abilities in STEM subjects.

## Benefits of google solutions among teachers

About half of the teachers agreed that by using Google Solutions they could provide more meaningful feedback to students on their work, cover the basic teaching content more efficiently, and have a better understanding of individual student capabilities.

Less than half of them agreed or strongly agreed with certain statements regarding the use of Google Suite (GS) and Chromebooks in their classrooms. These statements include having an improved ability to monitor the entire classroom's work, being able to differentiate instruction based on specific students' needs, engaging students more deeply in the subject matter, and communicating more efficiently with non-student stakeholders such as parents, other teachers, and administrators. Additionally, fewer teachers found Chromebooks to be well suited to their individual needs.

## Evaluation of Professional Development Training - Post

More than half of the respondents agreed or strongly agreed that they found the Professional Development training useful and it met their needs and their trainers were knowledgeable and skilled. Wilcoxon test analysis revealed that the teachers in Hisar school had given marginally higher ratings for this variable.

## Recommending Google Workspace and Chromebook

A survey asked teachers to rate on a 1-10 scale their likelihood to recommend Google Workspace for Education and Chromebooks to fellow teachers. For Google Workspace, the mean response from teachers was 5.5, around the neutral midpoint, signaling mixed opinions on recommending this platform. The mean response for Chromebooks was slightly higher at 6.0, with over half of the teachers indicating a moderate likelihood or higher that they would recommend Chromebooks to other teachers.

# Findings from Student's Interviews

## Access to devices at Home

During interviews with students in the intervention (IG) and Non-intervention Groups (NG), it was found that most students had access to devices such as phones, tablets, and laptops. Availability of smartphone was prevalent in both the groups while other devices had varying availability. The following graphs show the availability of the devices at home as reported by the students from both the groups.

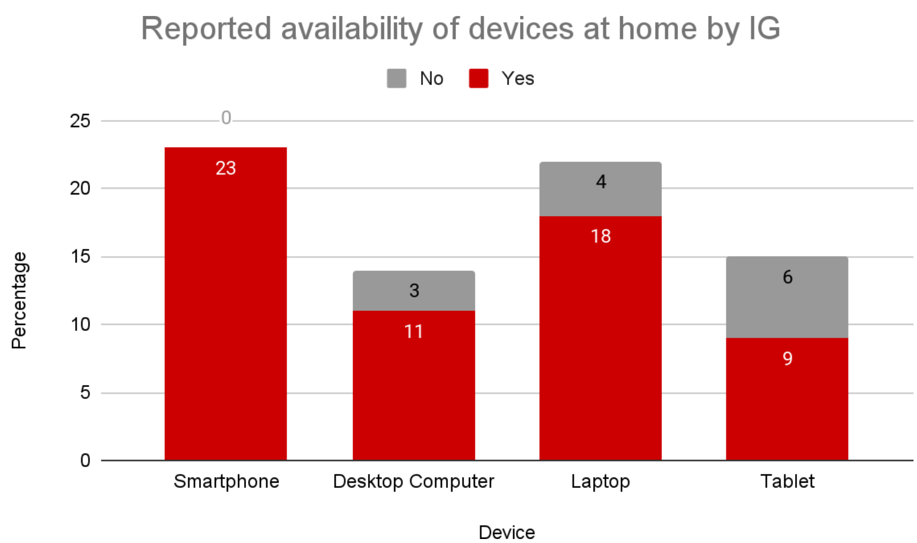



Figure 1: Availability of digital devices at ome as reported by Intervention Group Students

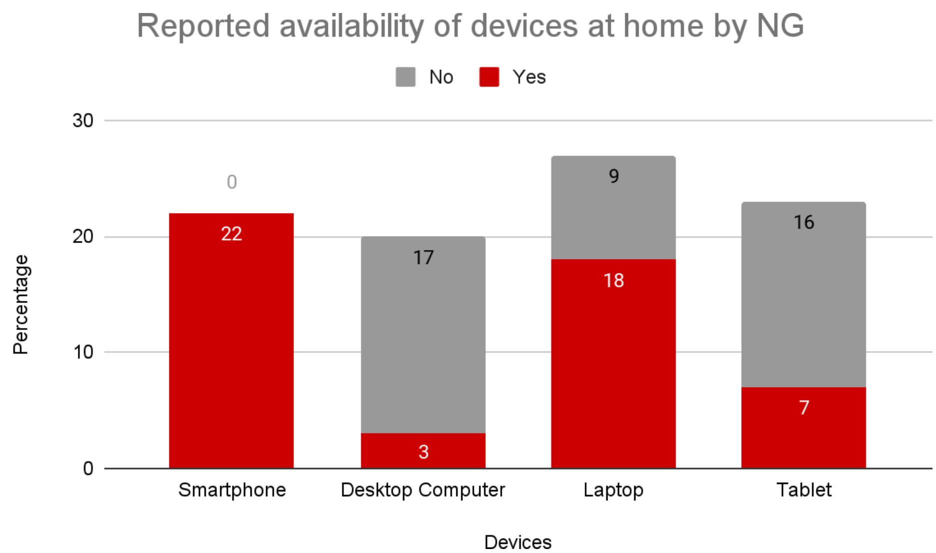



Figure 2: Availability of digital devices at ome as reported by Non-intervention Group Students

Compared to NG group, considerably less number of students in IG used laptops and smartphones for academic purpose. On the other hand, considerably more number of students in IG used laptops and smartphones for non academic purpose
Overall the graph also suggests that considerably less number of students reported use of digital devices for non academic use.

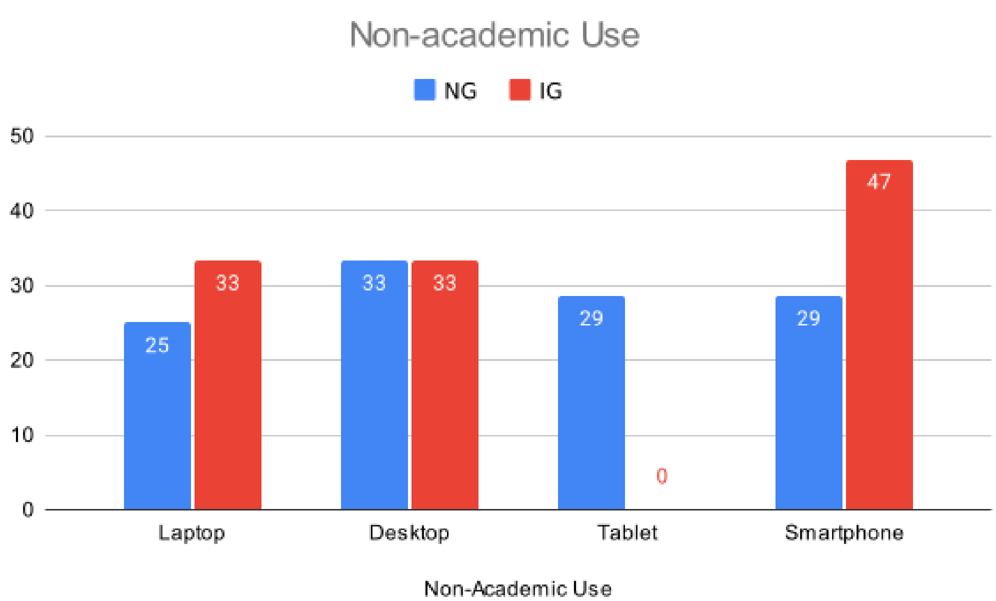



Figure 3: Use of digital devices for non-academic purposes

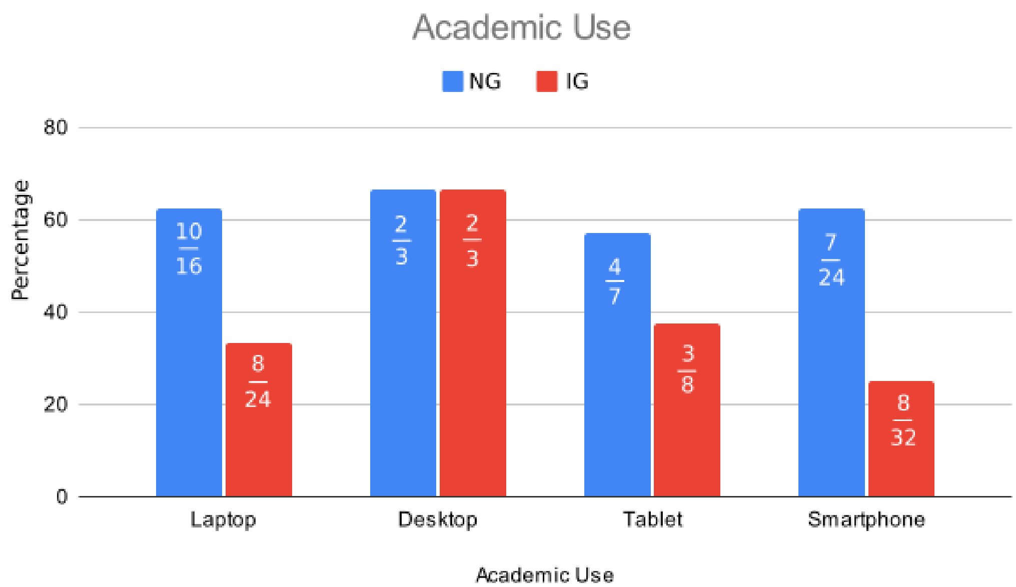



Figure 4: Use of digital devices for academic purposes

## Uses of Desktop at Home - IG

Most students (11 out of 34) had desktop computers at home either as personal or shared devices, out of which six students reported these desktop computers were connected to the internet. Several of these students described the type of activities they undertake with the desktop computer at home. Here are some examples: using the desktop computer for academic purposes, such as completing school projects and attending online meetings related to projects, using specific educational applications or platforms, an example given by the student was Doubtner app for working on Math-related doubts and accessing other learning resources. The students also mentioned using desktop computers for non-academic activities, such as watching YouTube videos and playing online multiplayer games like Battlegrounds Mobile (BGMI).

***"Doubtner app is for Math, to ask any doubts, we post the question and they post videos according to that question" (one of the student on favourite activity on computer)"***

***"We cannot install anything as there is no place in the Chromebook…"***

## Uses of Desktop at Home - NG

About half of the students (12 out of 24 students), had desktop computers at home either as personal or shared devices, and six of these were reported to be connected to the Internet. Activities reported to be conducted with the desktop computers were academic use: Using YouTube for doubt clearance and understating concepts, Accessing study materials and clearing doubts through online platforms and channels like Magnet Brains and Vedantu, Solving math problems by searching Google and YouTube and utilizing the computer for online classes during the COVID-19 lockdown period. The non-academic uses reported were engaging in favourite activities like watching YouTube videos, including tutorials and arts and crafts, and sharing the computer with siblings for typing.

***"No such specific website, but on youtube I like magnet brains channel. They have very nice videos. I have seen a lot of videos but their videos are better. They have big explain. Because they explain the concept in detail even if not in the scope of the class unlike teachers in school."***

## Laptop-IG

Most of the students had laptops (24 out of 34) connected to the internet (20 out of 24 laptops) at home either as personal or shared devices. A few students (less than half) mentioned use of the laptops for academic purpose at home including studying Mock papers for self-practice, completing assignments, researching and reading on specific topics like nature and pollution, accessing study materials from online sources (e.g., learncbse.com, Magnet Brains (YouTube channel, BYJUS), and programming. A few of the students used the laptop for Non-Academic uses like Watching movies, Playing games, Browsing social media, and Watching YouTube videos.

## Laptop-NG

Out of the 29 students interviewed, several students (16) had laptops at home either as personal or shared devices. Among them, several students (13) indicated that these laptops were connected to the internet. The activities they reported undertaking with the laptops at home were accessing NCERT textbooks, creating PowerPoint presentations, practicing Python programming , using BYJU'S coaching platform. Non-academic uses: students mentioned watching movies, playing games, browsing YouTube, engaging in daily diary writing and Drawing.

## Tablet-IG

Some students (8) had access to tablets connected with the Internet connection.
Some of these students mentioned using tablets for drawing, colouring and watching YouTube as favourite activities on the tablet. Use of the tablet for academic use included activities like taking School notes, Checking messages on the class WhatsApp group, using MS Office and Google Sheets, Downloading PDF notes, Watching YouTube videos for academic purposes, and taking online classes. Non academic use was watching videos for entertainment.
When asked about the preference of using tablets over other devices, two students mentioned better access to tablets than other shareable devices like desktop or laptop, and that it is easier to type on a tablet.

***"It is easy to type in a tablet. No extra keyboard. Tablet is easier than a laptop."***

## Tablet-NG

Some (7 out of 23) students had tablet at home with Internet connection and used it primarily for academic activities including accessing school notes, checking messages on Class WhatsApp group, and using MS Office and Google Sheets for academic tasks. Some of the students (4) also mentioned using tablets for non-academic activities including watching videos on youtube and other media streaming platforms.

***"I like to prefer tablet at home. My mother used to talk to her friends and her mother and suddenly she would take the (smart)phone from me. That is irritating for me. So I use Tablet."***

## Smartphone-IG

All students had smartphones at home, very few (3 out of 34) had personal smartphones, and 2 students did not have access to the smartphones at home.

Some of the students said they preferred smartphones over other devices for better. One of the

students mentioned that it is more comfortable using mobile phones than chromebooks because it is easy to use for apps, specifically Gmail. On the other hand, one of the students did mention that it is difficult to read on mobile phones due to smaller screen size.

***" …(I am) not comfortable in using Gmail in Chromebook,***
***more often use in smartphone."***

### Academic use

Searching for information related to studies, Checking school messages or updates, Watching educational videos on YouTube, Using specific educational apps or channels, Accessing online classes or extra classes, Clarifying doubts and finding solutions to academic questions, projects or assignments (mentioned 2 times).

***"For studies, I use YouTube for Maths, science Olympiad related questions,***
***Magnet Brains channel and MKG classes videos."***

### Non-Academic

Entertainment purposes, such as watching movies, series, or shorts, Playing games, listening to music or songs, communication with others, Watching funny or general content on YouTube.

***"I watch shorts, interesting facts in YouTube and online***
***games like candy crush, word Universe"***

## Smartphone-NG

All students had smartphones at home with Internet connection and were able to access it, one student had a personal smartphone. The students preferred smartphones than other devices, for the following reasons: Convenience and portability and therefore easy access to information and communication, school work, entertainment and gaming, camera and easy media sharing. A few mentioned this was the only device available at home.

### Academic Use

For academic purposes, studying, note-taking, and attending online classes emerged as the most frequent activities as reported by several students (11). Some students also utilize their smartphones to access educational content and tutorials on platforms like YouTube (8). Furthermore, the interviews highlighted that some (5) students mentioned using Google searches to gather information and enhance their learning. Additionally, some (4) students reported checking school WhatsApp group messages and updates. Moreover, few (3) students mentioned using their smartphones to clarify doubts and seek solutions to academic questions. Lastly, few (2) students mentioned utilizing specific educational channels or app.

***"Mostly for studies if I dont know something I go to google. I use it daily. There is no time limit. Whenver I have doubt."***

***"On WhatsApp I will ask friends to send notes, on YouTube I study little tough maths (problems), watch videos and clear doubts..I use Google for study and writing notes"***

### Non-Academic

The non-academic use of smartphones reported by students included entertainment activities like watching movies, cartoons, and comedy videos (11), playing games (4), and passing time or getting entertained when bored (2).

***"I use phone for study and entertainment. For studies I watch YouTube-Magnet brains, Sunlike study channel, Physics wallah channel, Padhaku Vimaan. For entertainment, I watch @lakshaychaudhary Roaster, @triggeredinsaan Roaster, @AbhiandNiyu channel about education & economy, @theadityasaini about Business studies, @DinoJames Rapper channels"***

## Preferences

### Preference of devices at school

Several (11) students in the intervention group preferred using a laptop (11) in the school. They mentioned reasons such as familiarity, practicing and learning, research in computer labs, and preference for presentations. The majority of students, preferred using Chromebooks (18). They cited advantages such as speed, better presentations, ability to download books, canvas integration, and a large screen for presentations makes it suitable for educational purposes. Although not accessible currently, some students preferred smartphones (5), because of its portability while a few students mentioned they preferred tablets (2) because of the broader virtual keyboard and large screen.

***"Laptop is also big screen but I still find it more convenient because I can just hold it."***

Among non-intervention Group students, Many (21) students expressed a preference for using laptops or computers in the school. They found computers/laptops more convenient due to their availability in computer labs and the presence of useful tools like MS Word, Undo-Redo options, and auto-correct that supported their studies. The larger screen size of computers/laptops compared to smartphones was also mentioned as a factor influencing their preference (5). On the other hand, a few (4) students mentioned a preference for using tablets or smartphones at school, emphasizing the comfort they provided.

***"When we use in school, latpop or computer is better because it has big screen and comfortable to read."***

### Preference of devices at home

When asked about the preference of device at home, most of the students in the intervention group preferred using smartphone especially for personal work (15). The reasons for choosing smartphones vary, including convenience, easy accessibility, comfort in hand, and the ability to watch videos. Some (4) students mentioned restrictions on using phones at home, leading them to rely on smartphones provided by their parents or using them for multiple purposes. Other preferred devices for using at home included laptops (5), Chromebooks (2), tablets (1). A few students preferred printed materials (1), and mentioned need for a larger screen for presentations (1 student).

In the non-intervention group, several (17) students mentioned their preference for using smartphones at home due to their small size and easy handling. One student specifically stated, "It is convenient to scroll actually rather than a laptop or computer. For scrolling

Pinterest also, Wattpad (Note-taking application), and also Inkitt (another note-taking application) - where one can scroll easily". Additionally, some (6) students mentioned their preference for using a laptop at home, highlighting the ease of use provided by the big screen A few (3) students mentioned that they preferred computers because of their bigger screens compared to smartphones. Lastly, a few (3) students expressed their comfort in using a tablet at home.
The preferences of the devices reported by both the groups aligns with their report of current usage of these devices. Overall both at home and school students of both the groups, preferred smartphone at home, and desktop/laptop/Chromebook at school.

### Preference of F2F, technology enabled or online classes (IG)

**Traditional F2F:** Some of the students preferred traditional offline (face-to-face) classroom settings (6). The reasons mentioned included preference for blackboard teaching over presentations (1 student), better interaction with teachers and peers (2) which enhanced ease of asking questions and clarifying doubts (1 student), Better focus and fewer distractions (1 student) and hence easier understanding and clear visuals (1 student)

**Technology enabled F2F classes:** Most of the students preferred this option.

**F2F with Chromebook tools:** Preference for F2F classes with Chromebook and Google Tools (7 students). Some of the reasons for the same expressed were: Enhanced learning through Chromebook and Google apps (2 students), Clear visuals, note-taking, and easy access to information (2 students), Improved communication and immediate doubt clarification (2 students), Preference for electronic devices and technology in the classroom (1 student). Preference for google tools used during teaching gave reasons like easier teaching and reduced strain for teachers (1 student)Online classes with Google Tools (Workspace and Chromebook) (2 students)

Convenience and time-saving due to reduced travel (1 student), Easy access to information and ability to search for content (1 student).

**Preference for F2F classes using smart board/projector** (2 students) for Enhanced learning experience with smart board/projector.

None of the students preferred totally online classrooms.

### Preference of F2F, technology enabled or online classes (NG)

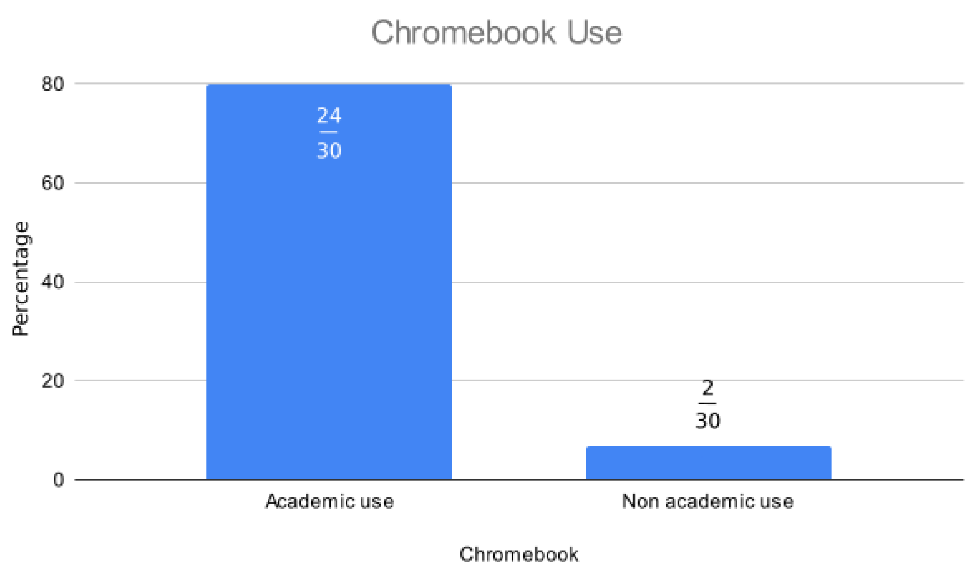
**Preference for Face-to-Face (F2F) Classes:** Some students (7) expressed a preference for totally offline (without technology or devices) classes citing reasons such as enjoyment, improved focus, better understanding, and familiarity with offline classes, comfort with the teacher's teaching method, better communication, clarity, and effective doubt clearance, as well as difficulties in understanding online classes and network issues.

**Some students preferred F2F Classes using Laptop (or chromebooks/similar devices):** Some students preferred face-to-face (F2F) classes using laptops or similar devices (or Chromebooks if they had access to) for the convenience, reduced book burden, and access to technology resources.

**F2F Classes using Smart Boards/Projectors:** Some students preferred face-to-face classes using smart boards or projectors due to the benefits of visual aids, interactive learning, and utilization of technology resources.

Both groups of the students did not prefer online classes.

## Use of Chrome book as reported by IG



Most IG students reported using chrome books for academic than non academic use. This also substantiates the above analysis which indicated that considerably less number of students reported use of digital devices for non academic use at their homes.

## Findings from Workspace-related questions

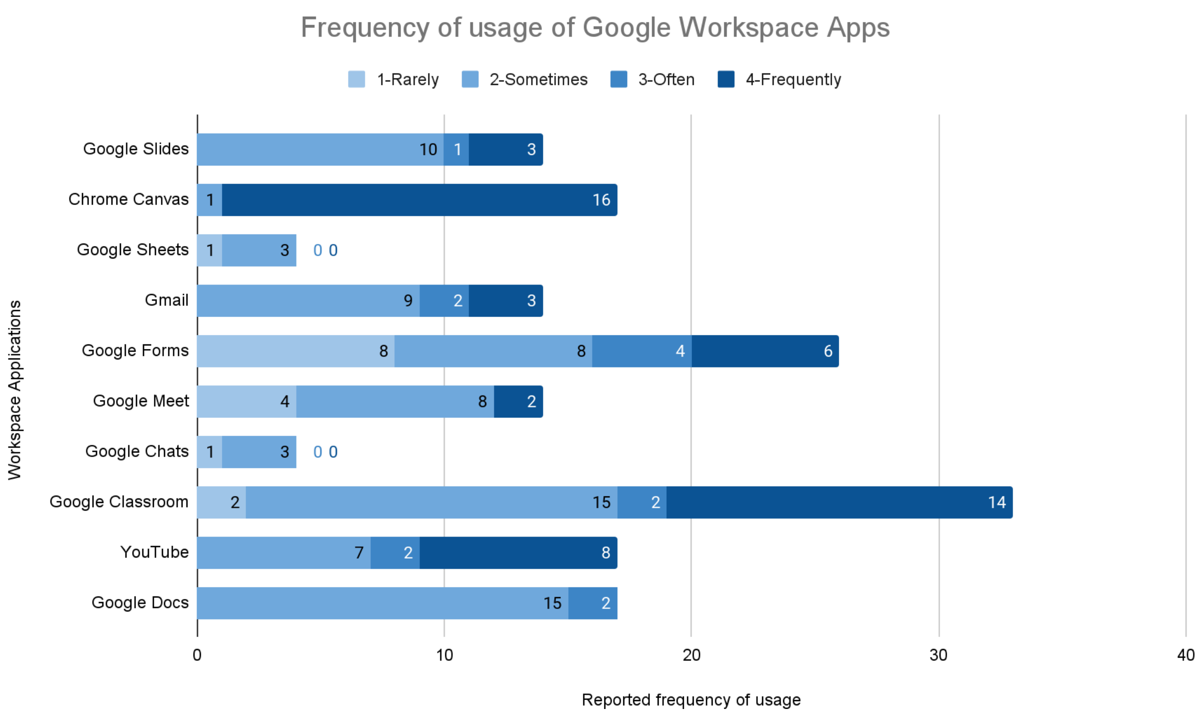



Figure 5: Frequency of usage of Google Workspace Applications

## Google Docs

### Usage

Most (23) of the students reported using Google Docs for academic purposes like assignments, note-taking, classroom tasks and working on PDF files A few(3) of these students used Google Docs for creating work reports and solving worksheets and assignments and for online classes.

### Challenges

Some students (6 students) mentioned that they encountered initial difficulties while trying to use the Share button because of unfamiliarity with the feature. A few students (3 students) experienced various technical issues, such as slow network connections, freezing, and suggestions popping up while typing. Another group of students (3 students) faced specific challenges related to editing and sharing Google Docs. Additionally, two students (2 students) mentioned that they encountered difficulties in converting their Google Docs to PDF format.

#### Frequency

The reported frequency of usage of Google Docs varied from occasionally (15) to often (2)

### Google Forms

#### Usage

Several (18) students used Google Forms for various academic purposes including quizzes, tests, submitting assignments, and online exams especially during the COVID-19 lockdown period. Some (4) of the students mentioned not using Google Forms at all while a few (2) of these students were not familiar with Google Forms.

#### Challenges

Some of the students (4) mentioned using Google Form without any difficulty, while some of the students (3) reported problem faced while using Google Forms on phones which included small screen size, sign in permission and incorrect authoring (no options to select)

#### Frequency

Several students (8) reported using Google Forms occasionally for quizzes, exams, and information submission. On the other hand, several students (8) mentioned that they use Google Forms rarely, typically limited to specific campaigns or tests. Some students (6) noted that they use Google Forms frequently, with a special focus on its utilization during the COVID-19 lockdown period. However, some (6) students mentioned that they do not use Google Forms.

### Google Meet

#### Usage

Several (19) Students used Google Meet during the COVID-19 lockdown period, for attending online classes, connecting with family and friends, and participating in extra classes. Some (5) students specifically used Google Meet for online classes during the lockdown, while 2 students used it for family video calling. However, several (8) students who did not use Google Meet at all.

### Challenges

Some (4) mentioned challenges related to using Google Meet. These challenges encompassed camera and microphone issues, network problems leading to blurred or low-quality video, as well as difficulties in joining or creating meeting links. A few students (2) reported network-related challenges, particularly encountering voice and audio issues during their Google Meet sessions. Additionally, othe few highlighted issue of not being able to see video presentations properly during meetings, and a few others expressed reliance on external devices or apps to effectively join Google Meet sessions were mentioned.

### Frequency

Several students (8) reported using it sometimes, while some of the students (4) used it during the COVID-19 lockdown period.A few of the students (2) relied on Google Meet extensively for study meetings. One of the student used it occasionally when WhatsApp had problems. On the other hand, "Few" students (3 in number) mentioned not using Google Meet at all, and "One" student used it in the past but not currently.

### Awareness

Among the respondents, 19 students were aware of Google Meet as a platform, while 3 students were not aware of it.

## Youtube

### Usage

Several (15) students reported using YouTube for study purposes, and mentioned that it easy to use and helpful for educational videos and clarifying doubts, utilized the platform for educational purposes. Few (2) of the students also students reported using YouTube to access educational videos shared by their teachers. Some (13) of the students, used YouTube for entertainment, indulging in watching shorts, interesting facts, motivational videos, daily lifestyle blogs, online games, and entertainment channels. Several (4) students used YouTube to access creative hobby-related content. Few (3) mentioned using YouTube for entertainment purposes to watch their favorite films, songs, and music videos.

### Challenges

Several students (11) found YouTube to be easy to use without encountering any specific challenges. However, Few (2) faced difficulties while using YouTube, such as encountering blurry videos and having difficulty reading text, primarily due to network issues.

### Frequency

Several (8) reported using YouTube frequently, utilizing it for both study and entertainment purposes. Some students (7) used YouTube occasionally, depending on their needs and availability. Additionally, a few (2 students) mentioned using YouTube often for study purposes and doubt clarification.

## Google Slides

### Usage

Many students (17) reported using Google Slides for creating PowerPoint presentations and projects. A few (3) students used Google Slides to open presentations shared by teachers.

### Challenges

Several students (4) reported no difficulties while using Google Slides. A few students (2) experienced difficulties in editing photos within Google Slides. Few students (2) reported facing difficulties in sending presentations due to network issues or limitations related to paste and copy options in features when using Google Slides on Chromebook.

### Frequency

A few (3) reported using Google Slides frequently. Several (10) mentioned using it sometimes.

## Google Sheets

### Usage

While some of the students (6) reported not using Google Sheets at all, a few of the students (3) students mentioned using Google Sheets in the past for organizing and managing numerical data. A few students had (3) had limited or exploratory use of Google Sheets, briefly exploring its functionalities without extensive utilization. A few (3) students were aware of Google Sheets but had not used it till the time of interviews.

### Challenges

Among the students, some (4) reported not encountering any challenges in using Google Sheets. During the demonstration at the time of interview, one student faced difficulty locating the share option and accessing Google Sheets on a Chromebook.

### Frequency

Several students (17) reported not using Google Sheets at all. Few (4) used it occasionally while one of these students mentioned using the Google Sheets extensively during the COVID-19 Lockdown Period.

## Findings from Chromebook-related questions

### Usage of Chromebook

During the students' interviews, they were asked about their use of Chromebooks both in school and at home. Most of the students (26) reported using Chromebooks primarily for schoolwork, including writing assignments, research, and creating presentations. Some (8) students also reported using Chromebooks for entertainment purposes, such as watching videos and browsing social media. Challenges that students reported while using Chromebooks included internet connectivity and battery backup issues.

When asked about their favorite thing about Chromebooks, the majority of students mentioned using YouTube for educational and entertainment purposes. Additionally, some students reported that they appreciated the lightweight and portable design of Chromebooks.

In terms of how Chromebooks have changed the way they learn and interact with their teachers, students reported that they appreciated the flexibility and convenience of being able to complete assignments and communicate with teachers from anywhere with an internet connection. However, some students expressed frustration with technical issues that arose while using Chromebooks, such as slow internet connectivity and battery drainage.

Most students (33 students) mentioned using the Chromebook for study and school purposes, such as completing assignments, making notes, working on projects, making presentations and accessing educational materials. Some of these students (6) also specified participating in online classrooms. Some students (8 students) mentioned using the Chromebook for personal entertainment activities like watching videos and interacting with friends.

During the interviews of the students, Many of the students (21) mentioned that they used Chromebook at home while several students (10) mentioned using it at home. Several (8) mentioned that they used chromebook at home as well as school

At home, many students (13) mentioned using the Chromebook regularly, while several students (9) mentioned using it sometimes. Few students (2 students) reported never using the Chromebook at home.

At school, some (7) of the students mentioned using chromebook regularly, some (9) mentioned using it sometimes.

## Impact on the learning

### Access to additional resources

Most students (27) mentioned that Chromebook allows them to access websites and online resources for further explanations and clarification when they don't understand a concept taught by the teacher.

### Improved note-taking and organization

Many students (19) found Chromebook helpful for note-taking, organizing their study materials, and saving digital copies of their notes and textbooks. They appreciated the ease of searching, copying, and pasting content for better understanding and managing their academic materials.

### Enhanced engagement and interest

Several students (14) expressed that using Chromebook in their learning process, especially for digital learning activities, assignments, and projects, increased their engagement, made the learning experience more interesting, and provided a change from traditional classroom teaching methods.

### Quick access to information and doubts clarification

Some students (13) highlighted the advantage of using Chromebook for instant access to information and resolving doubts. They appreciated the ability to search for answers and solutions promptly, saving time and improving their understanding.

### Reduction of physical load

Few students (3) mentioned that Chromebook has reduced the weight of their school bags by replacing or reducing the need to carry physical textbooks. They appreciated the convenience of having their study materials in a single device.

### Impact on interaction with teachers

A few students (2) felt that their interaction had increased, noting that Chromebooks facilitated concentration and immediate clarification of doubts during lessons. One of the students mentioned using Youtube (which was accessed on multiple devices) for improving English communication skills.

## Challenges faced while using chromebook

### Connectivity Issues

Several (15) students mentioned connectivity/internet issues with the Chromebook that led to less or limited usage of the Chromebook. Because Chromebook could only be connected to the internet via Wifi, a few (4) of the above-mentioned students said they face difficulty due to low or no connectivity problems specifically in the schools.

Some (7) students shared that they use/bring Chromebook in class only when the teacher allows them to do so. Quoted by one of the students from the interview; "Chromebook was allowed to bring in the school. Whenever we open the Chromebook, the teacher just asked to close it. Even if we are using it for study purposes like, the teacher would say, do it on your own."

### Battery Perforamnce (4)

Some mentioned the low battery performance of the Chromebook. About battery performance in one of the interviews, one of the students mentioned,

> *"Yes, I do carry the Chromebook at home, charge the battery, and when fully charged, it gives a battery backup of 3-4 hours".*

### YouTube Restrictions (2)

Students mentioned facing challenges related to accessing YouTube due to school policies or restrictions, which affects their ability to use the Chromebook for certain tasks.

### Camera Quality (2)

The backspace camera facility of the Chromebook is not good, and the image appears blurred.

### Speed and Typing Difficulty (1)

One student found it difficult to use the Chromebook due to its slow performance, particularly while typing. They mentioned that they type fast and struggle with the slower response of the device.

### Misuse and Lack of Focus (1)

One student expressed concerns about the misuse of Chromebooks by their peers. They mentioned instances where students watch YouTube videos instead of using the device for educational purposes, which affects their own study environment and hinders their access to resources.

### Safety issues (personal safety, data deletion, change of password)

Most (29) students mentioned using Chromebook for academic use only. The students (25) use their personal smartphones for personal use like chatting with friends or using social media. As discussed earlier, many students (14) also mentioned that they use chromebook for atching entertainment videos,like comedy videos, music, cooking shows, etc.

One student said in confidentiality that there is one open unauthorized by schools, wifi access on a particular floor of te school that a few students use to access non academic content on chromebook in the school.

One student mentioned that she is not having her personal smartphone or laptop, and her parents are not allowing her to use it frequently. So when she brings the Chromebook to school, she connected whatsapp web with the particular wifi access in school, and without other acknowledgment she checks the school group messages.

Also a few (2) students during FGD mentioned that they lost their data from Chromebook, one of them said, "Student A: I missed that because the teacher when she said something, I just noted it down hurriedly and I actually did not note down on the paper and pen like. So I lost it." THe stuent lostall her notes on the chromebook just before the exams, apparently this student had never changed the password and continued to use the password given by the administrator, whihc seemed common for many students .

Some students (6, all girls) mentioned about privacy issues they experienced. One of them as quoted; "he or she just keep on annoying by messaging calling. So I don't want this, so I just tell them, but they wont listen. So I just block them."

# Projects made

The students were asked if they made any projects in their classes in the last month, and descriptions of the projects. 23 out of 34 students in the intervention group reported making of projects, in a variety of subjects like computer science, social sciences, science, math and languages. Many (16) reported having made more than 1 projects, about one third (8) reported projects made were in the form of presentations, a student also reported making a project using python in computer science, some were not able to give more information  on the nature of the project.

A few projects that were available with students at the time of the interview were collected. Following is the analysis of these projects. Four of the seven projects were made using google slides, and rest were created using word editor.

Projects were graded using 21st century rubrics (Charania, et al., 2019), with nine indicators under six constructs. These indicators were authenticity of the content, authentic learning (real life connection), knowledge deepening (understanding, analysis, multidisciplinarity,higher order thinking), research undertaken, creativity, technical skills, organization and coherence. The rubric was based on a 4 point rating scale. One of the expert practitioners in project based learning with technology with prior experience of implementing and rating projects undertook the rating of the seven projects. The average score on the 7 projects was 1.80 out of 4. The indicators that had less than 2.0 average were authentic learning, multidisciplinary, higher order thinking, research undertaken, and creativity (Table 18).

In the Non-intervention Group, out of 23 students, 15 made projects, 8 students made more than 1 project, around 3 seemed to have been made with peers in a group. Eight out of the 15 students who made projects, reported using a digital device or application to make their projects. Examples of digital projects made indicated, 6 out of 8 used PowerPoint presentation, 1 spreadsheet Excel, and 1 unknown application downloaded from play store on the phone. A majority of the ones used technology applications were in the subject area of Social Sciences.The physical/non technology projects made were using cardboard on science concepts and experiments. The projects from Non-intervention Group were not collected for analysis.

Comments and analysis on Project Making: Overall, it seems both intervention and Non-intervention Group students were exposed to making projects. The interviews suggest that use of CBs in classroom influenced projects made with digital technologies, and the students directly related project making with use of technology, while in the Non-intervention Group the reporting of project making yield examples of both with and without technology, with a less proportion of students engaging with digital technology enabled project making than in intervention group.

Slides presentations dominated project making tasks with digital technologies in both intervention (google slides at home or classroom) and Non-intervention Group (ppt at home or computer lab).

Interestingly the intervention group had project making with digital technologies in a variety of subjects. This could be due to presence of CBs within classrooms with many subject teachers trained in use of google solutions. On the other hand, use of digital technologies in project making seemed limited to social sciences, and could be influenced by social science teacher/s competence and motivation to do so.

The intervention group digital project ratings on 21st century skills, and deep-authentic learning revealed that overall the projects showed above average ratings on use of authentic content, understanding, technical skills and organization in projects. However, projects rated low(less than average) on deep learning (multidisciplanirity, higher order thinking), research undertaken, authentic learning and creativity. These ratings were of only 7 projects that could be collected during the interviews from the intervention group. Overall, it suggests need to scaffold project making for higher order, authentic learning and creativity.

# Classroom Observations

## Observation 1

| | |
|---|---|
| School: | School 1 |
| Observation Date: | February 20, 2023 |
| Classroom: | Grade 8, Section D |
| Teacher: | Narendra Kumar (fictitious) |
| Subject: | Sanskrit |
| Topic: | Aryabhatt |
| Language of instruction: | English |
| Number of students: | 48 (26 girls and 22 boys) |

### Observation notes

This was an 8th-grade Sanskrit language class in School KV Chennai, with about 48 (26 girl students) students of both genders and 26 Chromebooks in the classroom. The arrangement of the class was traditional, with students in rows of benches, all facing the teacher's desk, on a given desk, students of the same gender were seated, with at least one chrome book to share. There were about CBs connected to internet provided by the school (seemed working at required speed), 4 electricity power charging points in the classrooms, a blackboard and a digital screen, and a large audio speaker.

The teacher was previously informed of classroom observation and chose to reinforce the topic already taught in the classroom, on Aryabhatta [4]. The teacher started the class by playing a prayer in Sanskrit using the audio speaker. Then students were asked to trace tutorials on Aryabhatta's life on their CBs which the teacher had sourced from Sanskrit tutorials. The students started viewing this resource on the life of Aryabhatta

[4] Aryabhatta, an ancient Indian mathematician and astronomer, made significant contributions to mathematics and astronomy during the 5th century. His works, including the "Aryabhattiya" [1] and the "Aryasindhanta,"[2] are renowned Sanskrit texts that delve into complex mathematical concepts and astronomical calculations. Aryabhatta's profound understanding of numbers, trigonometry, and algebra laid the foundation for many mathematical principles that are still relevant today. His works spanned from the field of mathematics to provided invaluable insights into the movement of celestial bodies and the measurement of time.

from their own CBs, since all audio was on and not in sync, it was creating a disturbance, so the teacher asked all the students to switch off their audio and watch, and started the central audio placed in the class, which may not have synced with videos on students' screens.

The teacher explained the content in the tutorial and also added his perspectives on ancient Indian rishis who according to him were the world's greatest scientists. (In Hindu literature Rishi's are usually documented as saints, always Brahmin-higher priest caste, who had expertise in a particular domain like maths, science, poetry, astronomy, astrology, medicine, etc). After this the teacher asked the students to access the google slide presentation on Aryabhatta from google classrooms, and when slide by slide explaining in a lecture form the life of Aryabhatta. The teacher has previously assigned the students to also make a google slide presentation on the topic by conducting their own research on the Internet and textbook.

It was noted in the observation that students seldom asked any questions during this class, and most of the questions asked by the teachers were closed ended. It was also noted that students sitting on one or two desks that did not have Chromebook were found sleepy and were moved by the teacher to join the desks with their colleagues using CB.

### Comments on the observation

Amidst the popular association and use of technology Math and Sciences, using Chromebook and its application in teaching Sanskrit language was in itself a notable achievement. Besides integration, the teacher tapped resources online integrating science and mathematics , making the class multi-disciplinary and connected. The potential of Chromebook seems underutilized in this class, where it was used for audio visual, and could have been easily replaces with using projector instead. The pedagogy used was highly teacher centric with minimal participation from students, evidence of critical thinking was not seen in this class. However, no generalization can be made with this limited observation on students' level of engagement. When combined with interview data with the same teacher, it was clear that Chromebook use especially google search in Sanskrit class enabled quick and easy way of learning the language, its context and created interest in the subject. The student's agency to conduct their own research and share it with the teacher for classroom use also indicated experiences quite contrary to what was observed in this classroom regarding student participation.

# Observation 2

| | |
|---|---|
| **School:** | School 2 |
| Observation Date: | February 27, 2023 |
| Classroom: | Grade 9, Section D |
| Teacher: | Aman Mallik (fictitious) |
| Subject: | Maths |
| Topic: | Types of Numbers |
| Language of instruction: | It was a mix of English and Hindi |
| **Number of students:** | 24 (13 girls and 11 boys) |

## Learning Environment

In the classroom each of the students had access to a Chromebook and also the teacher had his own Chromebook. The classroom was equipped with a desktop computer (on a computer table) near the teachers' table, speakers and two high-capacity routers. The classroom had three electric charging points. The teachers also had access to a whiteboard and a (Samsung) smart TV mounted on the wall and a large table placed in the front. The seating arrangement for the students included single chairs with folding resting pads.The classroom was connected to the ATL laboratory.

## Observation notes

The teacher used a combination of verbal instructions, questioning, and explanations to engage students. Hand gestures were employed to convey concept of speed and distance. The teacher often asked questions to the students. Some of these questions were following:

*"What is a rational number?"*

Most of the students answered this question by the traditional definition of the rational number which was:

*“any number that can be represented in p/q form”*

The teacher asked students to come up with another definition based on their understanding instead of repeating the one they learnt in the lower (7th) grades. The students spent time thinking about it but no one answered nor they looked up for the answer on Google on their chromebooks. The teacher himself answered the question by mentioning that “in a rational number the p/q should be in the simplest form. The teacher moved ahead explaining the concepts of rational numbers and facotorisations (LCM and HCF). The teacher then gave some numerical problems (to find LCM and HCF of a few numbers) to solve using traditional manual calculations often done on paper or blackboard, instead, the teacher insisted the students to draw these calculation tables using a stylus on chrome canvas. Most of the students were seen using chrome canvas to draw the tables and calculate HCF and LCM problems, a few students (about 5) used physical notebook to do the calculations. When the observer after the classroom checked with the teacher on possible reasons for some students not using canvas to make calculations on their Chromebooks, the teacher explained that some of the students’ struggle with using Chrome Canvas due to bad internet connection.

It seemed that especially the students who used canva to conduct hcf and lcm calculations made notes in canva, while the students who used pen and paper to make calculations used text editor feature in the chromebook.

After factorisation problems, the teacher moved to the topic of Prime numbers (and composite numbers), whole numbers and natural numbers. To differentiate between whole number and natural number the teacher used a mnemonic method:

In the word “whole” there is “O” which looks like “0”. Hence if you include 0 in whole numbers, while in “natural” there is no “O” so you don’t include 0 in natural numbers”. The teacher asked the students to find the sum of factors of 6. One of the students came up with an answer “5” (incorrect) after a quick mental calculation and the teacher insisted the student to write (the correct answer was 12). The teacher further added, “if sum of the factors is double of a number it is a perfect number”.

After teacher moved to the topic of importance of numbers especially in measurements. The teacher tried using his hand as a unit of measurement for which he said it can be used to calculate the volume of the room by using the formule $l \times b \times h$. But since everyone’s hands are not of the same there need to be a standard unit of measurement.

The teacher mentioned the use of LCM and HCF in area and volume calculations.

The teacher asked a few questions,

*T:"HCF's other name is?"*

*S: "GCF"*

*T: "GCD… "F" and "D" are same thing here."*

*T: "What is the difference between LCM and HFC?"*

The students remained silent.

The teacher asked students a word problem to calculate the time at which two runners would meet in a rate by providing them with a few initial conditions required to calculate using GCD and HCF methods.
Some of the students still answered by mental calculations (correct) but the teacher insisted on writing on the Chromebook canvas.

### Comments on the observation

Overall the Chromebook text editor (typing with keyboard) and canva (writing with stylus) were used instead of pen and paper. The advantage of using canva for HCF and LCM, was not clear except, it saved paper, more retrievable, and if the teacher used a shared access to review students' calculations. Therefore, the learning and pedagogical value of using canvas for HCF and LCM was unclear or not thought of. Similarly, the value of using text-editor for taking notes in the class also seemed to provide better retrievability and organization.

Other alternatives to using Chromebook applications for the topic discussed in this class could be:

Instead of using hand gestures to explain, the teachers could have used online simulations (like PHET simulations, Diksha Platform or other OERs) to better explain visualisations of the concepts, especially for the volume measurement.

Also, the teacher could show online resources for explaining the reason behind the nomenclature of the numbers (as the topic taught was Types of Numbers) rather than using mnemonics which focused on remembering the English names rather than understanding the mathematical concept.

Overall, the teacher asked closed ended questions, rarely when the teacher asked open ended questions, the students went silent, with no response.

# Focus Group Discussion

Four students who were available to visit the school during the visit by the researchers were enrolled for the focus group discussion. The transcripts of the FGD were used to summarize responses to the questions asked.

Below is the summary of Focus Group Discussion with three students. One of the frequent use of Chromebook mentioned by students was note-taking in Canva, this use was also found in student survey data. The students indicated that note taking with stylus was frequently used, however one of the challenges in doing so was short battery life of stylus that lasted for 15 to 30 minutes only. When probed further on the value of taking notes  in Canva, compared to the option of pen and paper, one of the students mentioned it gave an opportunity to use different colored highlighters without using physical color pens.

The students also indicated that they did not bring the Chromebook daily to schools, this was also consistent with the student interview findings. They brought CBs only when teachers asked them to do so. When probed further if they can use Chromebook without being prompted by the teacher, the students indicated that the teachers may or may not allow use of Chromebook in the classroom by students choice, but this could also depend on what the purpose of use. Overall, the students meant they bring and use Chromebook only when they are told to do so by the teachers, which does not happen on regular or daily basis.

One of the value of Chromebook expressed by students were able to download textbooks, when asked if this will replace physical textbooks, the students expressed not ready to replace textbooks yet as they are used to physical copies. Bringing both textbooks and Chromebook and its chargers in school bag packs was also indicated as burdensome.

Other value of Chromebook reported by the students was ability to find anything not understood using search engine, this was convenient and promt in clearing doubts as well. Prompt help as useful on Chromebook then accessing other devices separately (espcially as they dont mostly own smartphones) or physical resources to find facts and clarification. The students reported that the visual effects in multi media resources accessed through  internet browsing on Chromebook was quite helpful, and supported in remembering concepts better.

One of the students expressed that the Chromebooks were collected from the students just before the exams, so that the students do not play games on it and get distracted during the exams. The teacher interviews also revealed concerns teachers had on students divided attention due playing games and engagement on social media using Chromebooks during the class time. Because the CBs were taken away just before the exams, the student who expressed concern over it, lost all her lesson notes that she had taken during the classes in the semester/year. When probed further it seemed that the student had it on her google drive as well, but it was all gone from there, she had not changed the password fiven by the school administrator, and had no knowledge of changing password. The other student who did not lose notes had changed his password.

This discussion moved into internet safety and cyber security, they had very limited understanding of internet safety, and indicated that they were never taught in computer science class or any other class on internet and cyber security.

Another important aspect surfaced was regarding use of Chromebook in Atlal Tinkering lab (ATL), the students seemed to have fixed sense of ATL for non syllabus related, called as projects, while Chromebook for syllabus and not for big projects like in ATL. The students when challenged if Chromebook can be used in ATL, they revealed that it will require access to use of Collab application on Chromebook to use Python used in ATL.

Students also indicated desire to have access to watch movies ore documentaries, on Chromebook which are connected to subjects like history. WHen finally asked, if instead of Chromebook, students are mandated to bring their own laptops from home, the students mentioned that not all students will be able to afford but had no idea of how many in their class would not be able to afford.  ential feasibility and affordability issues related to mandating laptops for all students.

# Discussions

## Discussion points based on Students data

1. Although there was not a consistent response from teachers, students and administrators on the regularity of using Chromebook in the schools, overall from the data it can be concluded that the students did not use Chromebook on a daily basis. Some students mentioned using the Chromebook when the teacher specifically asked them to do so, such as for accessing PowerPoint presentations and study notes provided by the teacher, completing assignments given by the teacher, or for study purposes as instructed by the teacher. It appears that the students could use the Chromebook at school only when prompted by the teacher.

   *“We open the Chromebook only when the teacher asks us to do so."*

   *Student in the interview.*

2. The more frequently used applications on Chromebook reported by the IG students were Canvas for note taking, google forms for tests, Chrome for searching new information, Youtube for accessing media rich resources, and Google Classroom to access and submit assignments. The value of using these applications from a student's point of view was to make colorful notes, and go beyond the textbooks and to understand concepts by researching them. The google slides and google classroom use were mostly prompted by the teachers.

   One of the interviews suggests teachers facilitating students for self search on topics on Chrome. It was quite encouraging to find an example narrated by a teacher where students share their research on topics with the teacher and classroom at large.

   Google forms on the other hand, were used for administrative purposes, for example, students electing a representative for the classroom, or used by schools for some administrative survey. Google forms and Google meet, were used more prominently by teachers in COVID (before Chromebook or Albus program). Applications like Google sheet, google calendar were not mentioned to be used at all by the students. The students did not seem to have much knowledge about Google Drive, but their data was stored and managed on Google Drive by the technical administrator.

3. The IG group use of Chromebook at home was used comparatively more than other devices for school work. Overall, their preference for Chromebook was related to ease of reading on larger screens, use of multiple functions (e.g. note taking, surfing) all in one place, and easier access to it than other shared devices at home.

4. For non academic purposes, the IG used their smart phones more frequently than any other devices. Their overall engagement with non academic purposes on any device was higher than the NG. One of the reasons for IG's higher engagement of digital devices for non academic use than the NG could be the fact that they have CBs as their personal device, and less dependence on the shared devices (non CB/other devices) for academic purpose, leveraging time for non academic activities on the other devices. Other reasons could be transference of increased digital access and use from CB, higher competence and knowledge of digital affordances of digital devices in general to non academic use and other digital devices. The non academic use as reported were gaming, watching movies or you tubing, and chatting with friends, WhatsApp, Instagram, Snapchat are some of the applications reported by both the groups used by the students for non academic digital activities. These applications are not accessible on their assigned CBs.

5. Only a handful of students mentioned that they get spam calls, messages from unknown people on instagram on their smartphones. The common strategy used by the students was to delete messages, block or ignore. The FGD brought in another aspect of Internet safety, when a student described losing all the school notes on Chromebook just before the exam, leaving the student helpless. The student then reverted to handwritten notes. The FGD revealed that this could be due to not changing the password, or not being given instructions on need and how to change the password. Overall, this evidence suggests that students need Internet safety education which seems to not be a part of the Albus programme or not taught in any other subject in the school.
   Similar concerns have been raised in the literature about the need for educating students about online safety and security by Scherer (2016). Implementing Internet safety education in the curriculum may be necessary to ensure that students become responsible digital citizens.

   Thus, as students in IG have more access and engage more with digital world, self paced learning and researching, their knowledge and competence in safety and security in the digital world will be of prime importance is to focus on enhancing their engagement with technology as digital citizens (Passey, et al., 2018).

6. When asked what kind of classroom these students preferred, the IG group was happy to continue with F2F classes and aspired for continuous access and use of Chromebook or laptops in their F2F classrooms. The IG and a few students in IG without Chromebook, wanted CBs primarily to have a personal device of their own which they can even carry at home. When probed further on the need, they reported that this may take some burden (weight) of textbooks away. However, the IG students when asked for textbooks preferred the physical textbooks along with CB. It could be that although the teachers, the principals, students and also policy makers talk about digital devices to reduce the physical burden of backpacks, as this seems to be one of the obvious value of a digital device, none of the stakeholders are prepared and willing to shed off the load of physical textbooks.

   A few states have been experimenting with digital textbooks, QR codes in physical textbooks to access supplementary resources or workbooks, etc. However, physical textbooks has stayed intact at least in state board-affiliated and CBSE schools.The popular media and literature has also raised apprehension for digital textbooks, around equity as many parts of India still lack reliable electricity, internet access, and devices needed for e-learning (Jena, 2020).

   The NEP 2020 also emphasizes developing quality e-content and resources while ensuring equitable access (MHRD, 2020b). The teachers in this study have been using digital resources outside the textbook mostly through youtube. Further, their capacity can be built in understanding different types of resources and using Open Educational Resources. The Pragyata guidelines provide a framework but effective implementation remains a challenge (MHRD, 2020).

7. Analysis using 21st century skill rubric on projects-google slides collected from the IG students revealed that the projects demonstrated use of technical and organization skills, and use of authentic content. The higher order thinking, creativity, deep thinking including research skills were graded as low by the expert rater. Also, overall projects perceived by students were the ones made in Atal Tinkering lab with technology or ones made with concrete material. Google slides were not perceived as projects, and mostly used to consolidate information from web and other sources, often given as assignments. It was heartening to see google slides used in social sciences in the IG, another example of technology spreading beyond STEM. On the other hand, the NG did not create projects with

digital or google slides in any subjects but in Atal Tinkering projects which were not always aligned with the curriculum.

It has been established in the literature that Project based learning (Darling Hammond, 2017) and with technology (Charania, et al. 2021) if designed well has the potential to foster constructivist learning, authentic learning opportunities, and ability to transfer learning in newer contexts. The Albus project can explore TPD around such pedagogies with direct modeling from subjects, and leveraging multiple google applications.

## Discussion Points based on Findings from Teachers

Value teachers' attached to use of Chromebook: Overall, the restrictions on Chromebook won the trust of the teachers, it was thus the only connected device that could permeate the walls of the CBSE schools classroom for teaching and learning. The teachers clearly indicated that Chromebooks presence brought interest and engagement in students' learning, encouraged the students to engage in seeking information, and learn actively, collaboratively and effectively. The teachers most liked that with Google Solutions, they could make teaching more visually appealing, provide more meaningful feedback to students on their work, cover the basic teaching content more efficiently, and have a better understanding of individual student capabilities.

On the other hand, the data from the survey and interviews indicated a disconnect between teachers' perceived value or comfort and their actual use of various Google Workspace tools. Although teachers reported feeling comfortable using many Google tools in the pre-course survey, and indicated high suitability of these applications for students collaboration, creativity, lesson planning, classroom instruction and feedback in the post course survey, their reported actual usage of it on day to day basis was very limited to YouTube resources and Google Classroom.

This gap between perceived comfort and suitability of use and actual use of technology integration is found consistent with previous literature, which has found that teachers often overestimate their comfort with using technology in the classroom (Glazer, Hannafin, Polly & Rich, 2009).

One of the explanations contributing to this gap, also supported by the data, could be the ongoing challenges faced by teachers in using Google applications in the classroom. The literature in the past has also indicated that despite basic training and resource provision, connectivity issues, lack of technical support and confidence in selecting appropriate tools persisted as barriers to technology integration (Ertmer & Ottenbreit-Leftwich, 2010. Awuah, 2015; Martínez-Monés et al., 2017).

The post course survey did not ask for challenges faced by the teachers in using Chromebook and google applications, however, the interview reported connectivity issues as the main challenge in using google applications by teachers in the classroom (Krutka et al., 2021). Several other teachers in the post interviews indicated the need for IT support, fonts for other languages and mathematical formula/notations, and training more related to subject and pedagogical aspects of using technology (Kirschner & De Bruyckere, 2017).

At the pre course survey, many teachers stated lack of connectivity, computing related resources and training, also lack of awareness to decide which tools to use to teach as the reasons for not being able to use technology adequately in the classroom. The access to Chromebook and training in the Albus project seems to have adequately addressed challenges for computing resources and basic training that surfaced as challenges at the pre Albus implementation survey. On the other hand, the consistent challenges from pre (survey) to post (interview) were lack of connectivity, and to some extent awareness or confidence to decide which tools to pick for particular topics and subjects (Mueller & Oppenheimer, 2014; Warschauer & Matuchniak, 2010).

It can be reported that at post interviews, teachers' exposure and basic use of Chromebook in the Albus project had made them reflect on more nuanced or granular aspects of challenges in technology integration in their teaching. The teacher interviews also revealed teachers' apprehension of distractions in the classrooms by non academic use of Chromebook by students (Mayer, 2014). Similarly, the students in the FGD also indicated that teachers are on guard for students using social media or other applications for non academic activities in the classroom (James, 2021).

The study also aimed to explore teachers' agency in using Chromebook and integrating google applications in their classrooms.

Passey et al. (2018) defined digital agency as the capacity and power to act independently, reflecting on one's position in the digital environment, with access to individual and collective technologies and rights, to exercise freedom of choice over actions taken. It is a synthesis and interplay of multiple factors like digital competence, confidence, autonomy, and accountability. While the interviews and survey did not directly explore teachers' agency in using the Chromebooks and Google apps, some inferences can be made. Teacher digital competence and confidence can be reviewed in terms of teachers' comfort in using technology in the pre intervention survey, however, the extent of comfort level as earlier discussed was unparalleled to actual use. More integrated and continuous professional development can support teachers in more and variety of use in their subject pedagogies.

When it comes to autonomy, the interview and observation data indicated teachers had autonomy to decide and choose relevant technology applications for teaching. The teachers did not face any overt pressure from the school or project partners to use google app technologies, they themselves decided when and how to integrate these applications in their teaching and student learning. This autonomy could have led to their overall positive attitude (or attached value) towards use of Chromebook and google applications (Ertmer, 2005).

Thus unlike other technology enabled programmes in the market that dictates how a ready digital solution be used by the teacher in the classroom, the Chromebook and google applications provided autonomy to the teachers to design and adopt google applications to suit their own style and pace. This autonomy could also be linked to creative practice by a few teachers like using online Sanskrit resources and translations in teaching, allowing students to research beyond textbooks.

Similar creative use of technology was observed with another language teacgher who taught Hindi. The teacher created custom activities leveraging collaborative documents, forms and sites where students could co-author content, participate in peer assessments and showcase projects.

Again, with continuous TPD, including creating and participating in online community of practice groups with other teachers and experts, teachers in future can exercise their autonomy and feel empowered to leverage the Chromebooks and Google apps more frequently, in more student-centered, creative ways aligned to curriculum goals across subjects.

Another important part of agency is accountability and responsibility. Teachers at many points have expressed that Chromebook is a trusted device to be used in the classroom, the restricted access of applications keeps students safe and their classroom focused. At the same time a few teachers indicated that they would want to control or decide what gets restricted on students Chromebooks.

There was no indication of teachers undergoing any preparation on digital safety for themselves or their students. When asked about challenges they faced with use of Chromebook and its applications, the teachers did not express any safety concerns or a need to educate themselves or their students about it. On the other hand, the FGD data with students clearly indicated the need for internet safety education for the students (Jones & Mitchell, 2016).

# Suggestions

### Continuous and more frequent use of Chromebook and google application

As discussed earlier, Chromebook is the only trusted connected device in the classroom, as it has restricted access to applications. However, within the current restricted applications, there is much more scope than currently utilized. Frequent and continuous use of Chromebook and its applications in the classroom is required to optimize its potential in teaching and learning (Thompson, 2019). At the same time, as presented in the findings section, the Albus project can review students' requests to access more applications on the Chromebook.

### Teacher Professional Development

Continuous TPD will be more relevant to motivate frequent and a variety of use, and mitigate challenges for teachers while they are conducting Chromebook enabled classrooms. A hybrid model for training, preferably first F2F to build rapport and then moving to online might also be helpful. As the data also suggests, TPD needs to integrate subject pedagogies, building teachers TPACK. Demonstrating subject and pedagogy integration in training. A comprehensive credential model can be explored by Google education to systematically develop and credit teachers' professional development in integrating technology overall, and enabled by Chromebook.

Besides direct training or capacity building, teachers can be motivated to form Community of Practice groups to share their experiences with Chromebook across schools and subjects. Ongoing recognition keeps teachers motivated to integrate technology in meaningful ways. The Albus project can also seek opportunities within Google education initiatives to recognize teachers for effective practice in their schools, and build their capacities for spreading effective usage models across other schools.

### Fostering of 21st century or life skills in learners

The Albus project can focus throught TPD, teacher educator education and direct self paced interventions for students on promoting technology enabled pedagogies like Project/Problem based learning, inquiry based learning. These pedagogies situated within the curricular, authentic and constructivist learning principles, and global standards like ISTE. These pedagogies have been knowln in the literature to be useful in both affluent and marginalized setting in fostering 21st century skills in adolescent students.

### Sustaining autonomy and build intrinsic motivation for teachers

Unlike other digital solutions that dictate how and what teachers' should teach, the Albus project allows teachers to choose and design instructions with Chromebook and its applications. This is a big plus of the Albus project, and with effective professional development can build robust TPACK knowledge and practice, and a sense of digital agency in teachers. At the same time, the Albus project can consider effective TPD and allow teachers to decide and control what gets restricted on their students' CB.

### Ensuring equitable hardware access

Prioritizing procurement of robust uniform Chromebook models and prompt repair services is crucial to avoid uneven device quality and access, especially within the same classrooms.

### Digital safety

Comprehensive digital citizenship education for students and teachers. This should cover topics like internet safety, password authentication and storage, identifying misinformation online, responsible social media use, cyberbullying awareness and response, and healthy time management with devices.

### Digital citizenship and harnessing informal learning space

The data also revealed that Chromebook assigned students were more likely to engage with devices or Chromebook for non-academic purposes at home. Since students are allowed to use Chromebook seamlessly at school and home, nurturing their engagement with global communities of their personal and citizenship interests, and overall enriching their informal learning spaces, including social media engagement can be targeted by the Albus project. Similarly, TPD can address seamless interaction between formal and informal learning spaces to deepen and authenticate subject learning and life skills in the 21st century (Greenhow & Lewin, 2016, Lewin & Charania, 2018).

Besides informal learning space outside the school, the FGD also pointed out the possibility of convergence of Chromebook use in ATL with providing access to Collab apps on Chromebook to use Python in ATL. The Albus project can explore this possibility, which will also enable more participation in ATL by the Chromebook holding students which is more than devices ratio in ATL. On the other hand, with more access and participation through Chromebook in the ATL, the activities and larger projects in ATL can be integrated or connected to the syllabus.

### Sustainability of the 1:1 device model

The NEP 2020 has indicated BYOD is a futuristic strategy in schools. However, even for the current type of schools where a majority of students or their families own multiple devices, sustainability of 1:1 computing in school premises is a large issue. The administration and teachers are not prepared for the BYOD approach. Primarily as suggested also by the data, the teachers and administrators were very skeptical of the BYOD approach mainly because of their fear of disagreeable use by students in the classroom. Currently no attempts have been made towards piloting BYOD approach, in a brief communication with one of the principals of the schools, it was clear that what device gets used is a larger decision taken by the CBSE.

Chromebook with connectivity and restricted usage access, has brought trust and seems the only pilot for 1:1 in these two schools, and in CBSE schools in India at large. Thus, for now continuing Chromebook with preparation for optimal use may be required to also sustain and build the trust of teachers and administrators in allowing connected devices in teaching and learning within the classrooms.

The Albus project can explore options other than 1:1 computing. As presented in the introduction, sustaining at scale the 1:1 computing model in a country like India is challenging. There are many other models that have successfully used group approach, not only as mitigating scale issue but also leveraging on constructivist and collaborative pedagogies. The Albus project can explore other models in its pilot phase to study and compare its effectiveness across different types of schools.

### Limitations for Researchers

The pre and post surveys were not matched, therefore, the researchers could only base the findings on triangualting survey-quantitative with interviews-qualittaive findings. In the future, suggest close coordination of the design and data collection instruments and research timelines between all partners in the study.

Back-End Data Access. Also, no access to use data from the server-side or back end data on Chromebook and Google apps usage limited the scope of analysis for the study.

## Suggestions for future research

### Comparative School Sites

The type of school selected for this pilot were middle and upper middle class, the ownership of device data from students reaffirmed families affluence of providing at least 2 to 3 devices with connectivity to their young ones. The Albus project, should further pilot similar studies in schools attended by lower SES or underprivileged students, and schools with different administration systems. For example, low fee paid private schools and government schools, across rural and urban areas.

Purposefully select school sites across a range of socioeconomic statuses (SES) for the study. This will allow comparative analysis by SES on metrics like adoption rates, usage, impacts on learning outcomes.

The flexibility provided to the research partner allowed them to squeeze in wider research focus and scope.

### Formative Assessments

Incorporate incremental check-ins, usage tracking, surveys, and other design elements to formatively assess Google solutions, usage, challenges, and emerging best practices. Apply any key learnings in real-time.

# References


1. Abazi-Bexheti, L., Kadriu, A., Jajaga, E., Apostolova-Trpkovska, M., & Abazi-Alili, H. (2018). LMS solution: Evidence of Google Classroom usage in higher education. Business Systems Research: International journal of the Society for Advancing Innovation and Research in Economy, 9(1), 31-43.
2. Army Public School Hisar. (n.d.). Home. Retrieved May 4, 2023, from http://apshisar.com/
3. Awuah, L. J. (2015). Supporting 21st-Century Teaching and Learning: The Role of Google Apps for Education (GAFE). Journal of Instructional Research, 4, 12-22.
4. Banerjee, S. (2005). Interview with the Education Minister of India.
5. Bartolo, P. (2017). Integrating Google Apps and Google Chromebooks into the core curriculum: A phenomenological study of the lived experience of public school teachers. Liberty University.
6. Charania, A. (2018). ICT in education: indicators for meaningful integration in government schools. Learning Curve, (30), 18-22.
7. EdTech Magazine. (2022, February 14). K–12 Districts Choose Chromebooks for Educators to Elevate Teaching and Learning. Retrieved from https://edtechmagazine.com/k12/article/2022/02/k-12-districts-choose-chromebooks-educators-elevate-teaching-and-learning
8. Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of Research on Technology in Education, 42(3), 255-284.
9. Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? Educational Technology Research and Development, 53(4), 25-39.
10. Fleet, J. F. (1912). The Kaṭapayādi Notation of the Second ārya-Siddhānta. Journal of the Royal Asiatic Society, 44(2), 459-462.
11. Glazer, E., Hannafin, M. J., Polly, D., & Rich, P. (2009). Factors and interactions influencing technology integration during situated professional development in an elementary school. Computers in the Schools, 26(1), 21-39.
12. Gongol, W. J. (2003). The aryabhatiya: Foundations of indian mathematics.
13. Greenhow, C., & Lewin, C. (2021). Online and blended learning: Contexts and conditions for education in an emergency. British Journal of Educational Technology, 52(4), 1301-1305.
14. James, J. (2021). Confronting the scarcity of digital skills among the poor in developing countries. Development Policy Review, 39(2), 324-339.
15. Jena, P.K. (2020). Impact of E-learning during COVID-19 Pandemic among Higher Education Students. International Journal of Multidisciplinary Educational Research, 9(8), 82-92.
16. Jones, L. M., & Mitchell, K. J. (2016). Defining and measuring youth digital citizenship. New media & society, 18(9), 2063-2079.

17. Kaur, D. (2020). Post-Positivist Approach to Factors That Influence K-12 Teachers' Use of iPads and Chromebooks. International Journal of Technology in Education and Science, 4(1), 26-36.
18. Kay, R. H., & Greenhill, V. (2019). Personalized learning: The importance of relevance and context for engaging and meaningful student experiences. Journal of Educational Technology Development and Exchange, 12(1), 1-14.
19. Kendriya Vidyalaya. (n.d.). Kendriya Vidyalaya Annanagar Chennai. https://annanagarchennai.kvs.ac.in/
20. Kirschner, P. A., & De Bruyckere, P. (2017). The myths of the digital native and the multitasker. Teaching and Teacher education, 67, 135-142.
21. Krutka, D. G., Smits, R. M., & Willhelm, T. A. (2021). Don't be evil: Should we use Google in schools?. TechTrends, 65, 421-431.
22. Lewin, C., & Charania, A. (2018). Bridging formal and informal learning through technology in the twenty-first century: Issues and challenges.
23. Martínez-Monés, A., Reffay, C., Torío, J. H., & Cristóbal, J. A. M. (2017, October). Learning analytics with google classroom- Exploring the possibilities. In proceedings of the 5th international conference on technological ecosystems for enhancing multiculturality (pp. 1-6).
24. Mayer, R. E. (2014). Cognitive theory of multimedia learning. In R. Mayer (Ed.), The Cambridge handbook of multimedia learning (2nd ed., pp. 43-71). Cambridge University Press.
25. Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2009). Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies.
26. Ministry of Human Resource Development (MHRD). (2020). National Education Policy 2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
27. Ministry of Human Resource Development (MHRD). (2020). Pragyata Guidelines for Digital Education. https://www.education.gov.in/sites/upload_files/mhrd/files/pragyata-guidelines_0.pdf
28. Mo, D., Swinnen, J., Zhang, L., Yi, H., Qu, Q., Boswell, M., & Rozelle, S. (2013). Can one-to-one computing narrow the digital divide and the educational gap in China? The case of Beijing migrant schools. World development, 46, 14-29.
29. Mueller, P. A., & Oppenheimer, D. M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. Psychological science, 25(6), 1159-1168.
30. National Education Policy 2020. (2020). Government of India. Retrieved from https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
31. Niti Aayog. (2018). Atal Tinkering Laboratories: Guidelines. Government of India. https://niti.gov.in/writereaddata/files/document_publication/Atal_Tinkering_Laboratories_Guidelines.pdf
32. Padmanabhan, P., & Wise, A. F. (2012). Exploring situational factors shaping access in a laptop program for socially disadvantaged children in India: A case study. Educational Media International, 49(2), 81-95.

33. Passey, D., Shonfeld, M., Appleby, L., Judge, M., Saito, T., & Smits, A. (2018). Digital agency: Empowering equity in and through education. Technology, Knowledge and Learning, 23, 425-439.
34. Railean, E. Google Apps for Education–a powerful solution for global scientific classrooms. Proceedings on ICVL2011. Cluj Napoka: University "Babeş-Bolyal, 340-348.
35. Rizaldi, D. R., & Fatimah, Z. (2020). How the Distance Learning can be a Solution during the Covid-19 Pandemic. International Journal of Asian Education, 1(3), 117-124.
36. Selwyn, N. (2013). Education in a digital world: Global perspectives on technology and education. Routledge.
37. Shah, N. (n.d.). The One Laptop per Child (OLPC) Initiative in India: Challenges and Lessons. Boston University Writing Program Journal, 3
38. Sviridova, T., Sviridova, L., & Tymoshenko, B. (2011, May). Google Apps as solution of communication issues in educational process. In Perspective Technologies and Methods in MEMS Design (pp. 183-184). IEEE.
39. Voogt, J., Knezek, G., Cox, M., Knezek, D., & ten Brummelhuis, A. (2013). Under which conditions does ICT have a positive effect on teaching and learning? A call to action. Journal of computer assisted learning, 29(1), 4-14.
40. Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. Review of Research in Education, 34(1), 179-225.

# Annexure

**Table 1:** Pre Survey: Subject Taught by Respondent

| Subject taught | Number of respondents | Percentage |
|---|---|---|
| English | 2 | 5.26% |
| Hindi | 3 | 7.89% |
| Mathematics | 9 | 23.68% |
| Social Sciences | 5 | 13.16% |
| Science | 13 | 34.21% |
| Computer Science/IT | 4 | 10.53% |
| Other | 2 | 5.26% |
| Total | 38 | 100% |

**Table 2 :** Pre Survey: Benifit of Different Technology in the Classroom

| | Smartphone | Tablets | PCs | Other (projector) |
|---|---|---|---|---|
| Yes | 24 (63.16%) | 34 (89.47%) | 18 (47.37%) | 36 (94.74%) |
| No | 14 (36.84%) | 4 (10.53%) | 20 (52.63%) | 2 (5.26%) |
| Total | 38 | 38 | 38 | 38 |

**Table 3:** Pre Survey: Attitude toward Technology Use in the Classroom

| Q2.6. What is your attitude to technology in the classroom? | Number of respondents | Percentage |
|---|---|---|
| I am indifferent. | 1 | 2.63% |
| I see benefits but there are obstacles. | 3 | 7.89% |
| I see the benefits and try to use technology wherever I can. | 34 | 89.47% |
| Total | 38 | 100% |

**Table 4**: Pre Survey: Comfortable and confident in Using different Google Tools by Respondent

| Google App | Not comfortable at all, I would not try. | Mostly not comfortable, I might experiment. | Basic level of comfort, I could use them. | Ve Confident,I know them well. |
|---|---|---|---|---|
| Google Slides | 1 (2.63%) | 6 (15.79%) | 15 (39.47%) | 12 (31.58%) |
| Google Forms | 1 (2.63%) | 6 (15.79%) | 9 (23.68%) | 14 (36.84%) |
| Google Sheets | 1 (2.63%) | 6 (15.79%) | 12 (31.58%) | 12 (31.58%) |
| Google Documents | 1 (2.63%) | 5 (13.16%) | 13 (34.21%) | 14 (36.84%) |
| Google Drive | 1 (2.63%) | 5 (13.16%) | 11 (28.95%) | 15 (39.47%) |
| Google Maps | 2 (5.26%) | 7 (18.42%) | 7 (18.42%) | 11 (28.95%) |
| YouTube | 1 (2.63%) | 6 (15.79%) | 7 (18.42%) | 10 (26.32%) |
| Calendar | 1 (2.63%) | 7 (18.42%) | 10 (26.32%) | 11 (28.95%) |
| Gmail | 1 (2.63%) | 6 (15.79%) | 7 (18.42%) | 14 (36.84%) |
| Google Search | 1 (2.63%) | 6 (15.79%) | 8 (21.05%) | 12 (31.58%) |
| Chromebook | 4 (10.53%) | 7 (18.42%) | 18 (47.37%) | 9 (23.68%) |

**Table 5:** Pre Survey: Obstacles in Using Technology in Classroom

| Obstacles to Using Technology in the Classroom | Yes | No |
|---|---|---|
| Lack of Awareness of what tools to use | 9 (23.68%) | 29 (76.32%) |
| Lack of Access to Technology | 16 (42.11%) | 22 (57.89%) |
| Lack of Training | 15 (39.47%) | 23 (60.53%) |
| Not enough time to learn how to use technology | 1 (2.63%) | 37 (97.37%) |
| Non-supportive administration | | 38 (100.00%) |
| Lack of confidence | 1 (2.63%) | 37 (97.37%) |
| Lack of Internet Access | 17 (44.74%) | 21 (55.26%) |

**Table 6:** Pre Survey: Disruption in Using Technology

| Do you experience any of the following disruptions in the technology you use today on a weekly basis? | Technical interruptions with hardware | Technical interruptions with apps | Bandwidth limitations and outages |
|---|---|---|---|
| Yes | 31 (81.58%) | 17 (44.74%) | 24 (63.16%) |
| No | 7 (18.42%) | 21 (55.26%) | 14 (36.84%) |
| Total | 38 | 38 | 38 |

**Table 7:** Pre Survey: Weekly Time Spent in Using Technology for Communication and Cooperation with Guardians

| Time Spent (hours per full working week) for Communication and cooperation with parents/guardians | Number of Responses | Percentage |
|---|---|---|
| 0.5 | 1 | 2.63 |
| 1 | 18 | 47.37 |
| 2 | 8 | 21.05 |
| 3 | 5 | 13.16 |
| 5 | 1 | 2.63 |

**Table 8:** Pre Survey: Weekly Time Spent in Using Technology for Extracurricular Activities

| Time Spent (hours per full working week)for Extracurricular activities (clubs, sports) | Number of Responses | Percentage |
|---|---|---|
| 1.5 | 5 | 13.16 |
| 2 | 5 | 13.16 |
| 2.1 | 3 | 7.89 |
| 2.2 | 1 | 2.63 |
| 2.5 | 1 | 2.63 |
| 3 | 6 | 15.79 |

**Table 9:** Pre Survey: Weekly Time Spent in Using Technology for Other Activities

| Time Spent (hours per full working week) for Other (e.g., Break supervision, Mentoring | Number of Responses | Percentage |
|---|---|---|

| | | |
|---|---|---|
| colleagues, PD) | | |
| 0.5 | 2 | 5.26 |
| 1 | 14 | 36.84 |
| 2 | 13 | 34.21 |
| 2.5 | 1 | 2.63 |
| 3 | 2 | 5.26 |

**Table 10:** Pre Survey: Weekly Time Spent for Participation in School Management

| Time Spent (hours per full working week) for Participation in school management (e.g., Dept Head) | Number of Responses | Percentage |
|---|---|---|
| 0.5 | 3 | 7.89 |
| 1 | 10 | 26.32 |
| 2 | 12 | 31.58 |
| 3 | 2 | 5.26 |
| 4 | 1 | 2.63 |

**Table 11:** Pre Survey: Weekly Time Spent for Student Counselling

| Time Spent (hour per full working week) for student counseling | Number of Responses | Percentage |
|---|---|---|
| 1.5 | 9 | 23.68 |
| 2 | 1 | 2.63 |
| | | |
| 2.1 | 3 | 7.89 |
| 2.5 | 1 | 2.63 |
| 3 | 4 | 10.53 |
| 4 | 1 | 2.63 |

**Table 12:** Post-survey: Benifits of Google Solutions for Students Learning

| Benefits on GS in students' learning | Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree | Total |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| GS allows students to be more creative and imaginative in their work. | 1 (4.3%) | 3 (13.0%) | 8 (34.8%) | 9 (39.1%) | 2 (8.7%) | 23 |
| The use of GS helps students to find related knowledge and information for learning. | 2 (8.7%) | 1 (4.3%) | 6 (26.1%) | 11 (47.8%) | 3 (13.0%) | 23 |
| The use of GS encourages students to collaborate more with their classmates. | 1 (4.3%) | 3 (13.0%) | 6 (26.1%) | 10 (43.5%) | 3 (13.0%) | 23 |
| The use of GS encourages students to communicate more with their classmates. | 2 (8.7%) | 2 (8.7%) | 7 (30.4%) | 7 (30.4%) | 5 (21.7%) | 23 |
| The use of GS increases students' confidence to participate actively in the class. | 1 (4.3%) | 4 (17.4%) | 6 (26.1%) | 10 (43.5%) | 2 (8.7%) | 23 |
| The use of GS helps to improve students' ability specifically in reading, writing. | 1 (4.3%) | 4 (17.4%) | 6 (26.1%) | 10 (43.5%) | 2 (8.7%) | 23 |
| The use of GS helps to improve students' ability specifically in STEM subjects. | 2 (8.7%) | 3 (13.0%) | 7 (30.4%) | 9 (39.1%) | 2 (8.7%) | 23 |
| The students learn more effectively with GS. | 1 (4.3%) | 3 (13.0%) | 5 (21.7%) | 13 (56.5%) | 1 (4.3%) | 23 |
| The students are better behaved with the use of GS. | 1 (4.3%) | 4 (17.4%) | 6 (26.1%) | 10 (43.5%) | 2 (8.7%) | 23 |
| The use of Chromebooks and GS allows students to absorb the core subject matter quicker. | 1 (4.3%) | 2 (8.7%) | 8 (34.8%) | 10 (43.5%) | 2 (8.7%) | 23 |
| The use of Chromebooks and GS helps students to complete assignments quicker. | 2 (8.7%) | 3 (13.0%) | 5 (21.7%) | 11 (47.8%) | 2 (8.7%) | 23 |

| | | | | | | |
|---|---|---|---|---|---|---|
| The use of Chromebooks and GS helps students to perform better at their studies in general. | 1 (4.3%) | 3 (13.0%) | 5 (21.7%) | 13 (56.5%) | 1 (4.3%) | 23 |
| Chromebooks were well suited to my students. | 2 (8.7%) | 2 (8.7%) | 6 (26.1%) | 10 (43.5%) | 3 (13.0%) | 23 |
| The use of GS enables students to express their ideas and thoughts better. | 1 (4.3%) | 3 (13.0%) | 5 (21.7%) | 12 (52.2%) | 2 (8.7%) | 23 |
| Students are more engaged and active in general. | 1 (4.3%) | 4 (17.4%) | 6 (26.1%) | 11 (47.8%) | 1 (4.3%) | 23 |

**Table 13:** Post-survey: **Teachers ratings on recommending Google Solutions to fellow teachers**

| How likely are you to recommend Google Workspace for Education to a fellow teacher? | | | How likely are you to recommend Chromebooks to a fellow teacher? | | |
|---|---|---|---|---|---|
| Scale | Frequency | Percentage | Scale | Frequency | Percentage |
| 1 | 2 | 8.7 | 1 | 2 | 8.7 |
| 2 | 1 | 4.3 | 3 | 2 | 8.7 |
| 3 | 2 | 8.7 | 4 | 1 | 4.3 |
| 5 | 2 | 8.7 | 5 | 3 | 13 |
| 6 | 4 | 17.4 | 6 | 3 | 13 |
| 7 | 5 | 21.7 | 7 | 3 | 13 |
| 8 | 2 | 8.7 | 8 | 3 | 13 |
| 9 | 1 | 4.3 | 9 | 1 | 4.3 |
| 10 | 4 | 17.4 | 10 | 5 | 21.7 |
| Total | 23 | 100 | Total | 23 | 100 |

**Table 14:** Post-survey: Post-test:  Evaluation of Professional Development Training - Post

| | Please provide your opinion on this statement "I found the Professional Development training useful, and it met my needs." | Please provide your opinion on this statement "My trainers were knowledgeable and skilled". |
|---|---|---|
| Neither agree nor disagree | 2 (8.70%) | 2 (8.70%) |
| Agree | 18 (78.30%) | 17 (73.90%) |
| Strongly agree | 3 (13.00%) | 4 (17.40%) |
| Total | 23 (100%) | 23 (100%) |
| Strongly agree | 3 | 13% |

**Table 15:** Post-survey: Suitability ratings of tablets for various activities - Post

| Activity | Rating 1 | Rating 2 | Rating 3 | Rating 4 | Rating 5 |
|---|---|---|---|---|---|
| Focusing student attention on learning tasks | 1 | 1 | 4 | 0 | 9 |
| Student problem solving activities in class | 0 | 2 | 5 | 7 | 4 |
| Student collaboration activities in class | 0 | 2 | 6 | 0 | 10 |
| Student creative activities in class | 0 | 2 | 6 | 2 | 8 |
| Student homework completion | 1 | 4 | 6 | 0 | 7 |
| Teacher lesson planning | 0 | 0 | 8 | 0 | 10 |
| Teacher classroom instruction | 0 | 1 | 4 | 0 | 13 |
| Teacher feedback to students | 0 | 0 | 5 | 0 | 13 |

**Table 16:** Post-survey: Suitability ratings of chromebooks for various activities - Post

| Activity | Rating 1 | Rating 2 | Rating 3 | Rating 4 | Rating 5 |
|---|---|---|---|---|---|
| Focusing student attention on learning tasks | 0 | 4 | 0 | 0 | 19 |
| Student problem-solving activities in class | 0 | 8 | 0 | 0 | 15 |
| Student collaboration activities in class | 0 | 0 | 0 | 0 | 23 |
| Student creative activities in class | 0 | 0 | 0 | 0 | 23 |
| Student homework completion | 1 | 2 | 1 | 3 | 16 |
| Teacher lesson planning | 0 | 2 | 0 | 0 | 21 |
| Teacher classroom instruction | 0 | 2 | 0 | 0 | 21 |
| Teacher feedback to students | 0 | 2 | 0 | 0 | 21 |

**Table 17:** Post-survey: Suitability ratings of laptops for various activities - Post

| Activity | Rating 1 | Rating 2 | Rating 3 | Rating 4 | Rating 5 |
|---|---|---|---|---|---|
| Focusing student attention on learning tasks | 1 | 1 | 2 | 3 | 16 |
| Student problem solving activities in class | 0 | 2 | 2 | 0 | 19 |
| Student collaboration activities in class | 0 | 0 | 0 | 0 | 23 |
| Student creative activities in class | 0 | 0 | 0 | 0 | 23 |
| Student homework completion | 0 | 0 | 1 | 2 | 20 |
| Teacher lesson planning | 0 | 0 | 1 | 1 | 21 |
| Teacher classroom instruction | 0 | 0 | 0 | 1 | 22 |
| Teacher feedback to students | 0 | 1 | 1 | 2 | 19 |

**Table 18:** Post-survey: Project ratings

| **Project No** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Originality of content - no plagiarism, used own words and sources have been listed | 3 | 2 | 2 | 3 | 3 | 3 | 3 | **2.71** |
| Students make personal meaning or apply by relating to student's life or context - articulation in own life | 1 | 1 | 1 | 1 | 1 | 1 | 1 | **1.00** |
| Students show understanding/interpretation of information they have included in project (quality and depth of content) | 2 | 2 | 2 | 3 | 3 | 2 | 2 | **2.29** |
| Students make comparisons to other concepts/subjects/subject matter and interdisciplinary content in their project | 1 | 1 | 1 | 2 | 1 | 1 | 1 | **1.14** |
| Higher order thinking skills are visible in the project (project shows evidence of analysis, synthesis, evaluation and interpretation of content ) | 1 | 1 | 1 | 1 | 2 | 1 | 1 | **1.14** |
| Research undertaken - reference to multiple sources- evidence of different sources like local and online context, interviews,surveys and online sources ; Thorough research and depth of the topics visible in the project by finding information from relevant sources like internet, tv, textbook, media etc | 2 | 2 | 2 | 2 | 2 | 2 | 1 | **1.86** |
| Students are able to generate ideas that are unique, novel and out of the box. The project showcases students being able to choose a project, take a step forward and implement something in their context, take an action or make recommendations for development of something in their area. | 1 | 1 | ` | 1 | 1 | 1 | 2 | **1.17** |
| Spreadsheets- formula and charts appropriately displayed/ Multimedia- logical sequence in presentation, hyperlinks, use of multiple media and navigation is | 3 | 3 | 3 | 3 | 3 | 3 | 2 | **2.86** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| easy/ Photostory- logical sequence and technical features of video, ppt are used appropriately and navigation is easy/ Scratch- all the technical tools are used appropriately | | | | | | | | |
| There is a logical flow of content and ideas, making navigation easy/comparisons easy. | 2 | 3 | 2 | 3 | 2 | 2 | 0 | **2.00** |
| | **1.78** | **1.78** | **1.75** | **2.11** | **2.00** | **1.78** | **1.44** | |