IMPACT EVALUATION STUDY

Akshara Foundation's Building Blocks Mobile Application for Mathematics

PREPARED BY

SATTVA
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COMMISSIONED BY

Akshara Foundation
EVERY CHILD IN SCHOOL AND LEARNING WELL

Acknowledgment

This study report on 'Impact Evaluation of Akshara Foundation's Building Blocks Application for mathematics' in Karnataka and Odisha is undertaken by Sattva Consulting Pvt. Ltd., for Akshara Foundation.

The study included an evaluation of the Building Blocks application that has been launched by Akshara Foundation, as part of Cisco's social responsibility initiative, to provide access to mathematics practice and learning to children from grades 1-5.

We would like to extend our sincere thanks to the organization and all its functionaries who extended their wholehearted cooperation in accomplishing the study at different levels. Our team is immensely grateful for the valuable guidance and support extended by Ms. Pushpa Thantry and her entire team, for their priceless cooperation and for offering valuable suggestions and inputs during the field work.

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Abbreviations

ASER – Annual Status of Education Report

BB – Building Blocks

COPPA1 – Children's Online Privacy Protection Rule

DIET – District Institutes of Education and Training

Ed-Tech – Education Technology

FGD – Focused Group Discussion

GDPR2 – General Data Protection Regulation

GKA – Ganitha Kalika Andolana

IDI – In-depth Interviews

NITI – National Institution for Transforming India

NCF – National Curriculum Framework

SDG – Sustainable Development Goals

TRAI – Telecom Regularity Authority of India

UDISE – Unified District Information System for Education

EXECUTIVE SUMMARY

This report presents the results of an impact assessment study conducted for Akshara Foundation's Building Blocks application. Akshara Foundation launched Building Blocks, a smartphone-based application in 2018 as a part of Cisco's social responsibility initiative, to provide access to mathematics practice and learning to students from Grades 1-5. The application has been designed for early grade mathematics learners and the games are meant for 'practice' and reinforcement of concepts learnt in school in an engaging and gamified way.

The impact assessment study of the Building Blocks application conducted between July 2019 to March 2020 was a **pre-and-post analysis** for the students who were introduced to the application at the start of the implementation period. The exercise looked at assessing the following aspects:

- Mathematical competency (Number Sense, Measurement, Number Operations, Shapes) of students
- Motivation and confidence to learn and practice mathematics using a tech-based learning application
- Influence of parents and teachers in using Building Blocks application
- Students' and parents' perception related to technology-based learning
- Provide insights and recommendations on factors influencing the adoption, usage of the application and increase in mathematical ability of students.

Sattva followed a mixed research methodology comprising of qualitative and quantitative method of research for data collection. The methodology encompassed developing a set of research questions to draw evidence towards each of these areas, which helped draw reasonable conclusions at the current stage of the program.

As part of the data collection exercise, Sattva surveyed and took assessments of **1440 students across 13 schools of Karnataka and Odisha**. Apart from quantitative surveys, Sattva also conducted FGDs and informed interviews with teachers, headmasters and parents of students to understand the current usage of the Building Blocks application and its perceived benefits amongst the community members.

Key insights from the Impact Evaluation Study

Activation refers to the factors influencing or restricting the download of the application, using Building Blocks at least once to set up the profile of the user.

Number of students who have access to the application

- Technology based platforms are an essential medium of student learning and engagement but cannot replace classroom learning completely. Schools were open to the idea of technology-based learning to aid the teaching process but not replace it. Also, currently, most of the schools lack the necessary funds from the government or the infrastructure (like availability of projectors, screens, smart TVs, etc.) to support the use of technology in the classrooms.
- Access of smartphones to a student is limited due to the nature of employment of their parents. A majority of the households included in the study (94%) had access to at the most 2 smartphones at home.

Number of students who have downloaded and retained the application

- Building Blocks application was downloaded by 67% of the students who were part of the study and 49% of them continued using the application till the time of the post-test.

  The main reasons for uninstallation of the application as reported by the parents included phone hanging (29%), lack of understanding on how to use the application amongst children (26%) and lack of space in the phone (24%).

- From the discussion with teachers and headmasters across schools, it was highlighted that the main reason for not downloading the application was the lack of awareness of its benefits and demanding job schedules which gave parents minimal time to help their child in his or her education.
- One of the key factors that the parents quoted as an influence for downloading Building Blocks was the fact that the application was free of cost and had the ability to operate in the offline mode also.
- It was highlighted during the discussions with the parents and mathematics teachers across schools that the availability of Akshara Foundation's Building Blocks application in 9 regional languages is a favorable factor that influences the acceptance of the application.

Perceived value of the application

- Parents feel that the Building Blocks application improved their child's interest in mathematics. Parents who downloaded and retained the application after the awareness sessions were the ones who understood the merit of it in helping their child practice their mathematical skills.

Usage defines the factors leading to continuous usage of the application by the intended users for the application.

Frequency of usage of the app

- The trend of application usage was dependent on engagement activities planned by Akshara Foundation. From the back-end usage data of the application, the number of students using the Building Blocks application has reduced over time.

User Interface & User Experience

- Students find the Building Blocks application visually appealing and enjoy solving problems and scoring stars while doing so. 76% of the students said that solving problems was the best feature of the application followed by the ability to score stars (72%) and the music in the background (69%).
- The application is based on competencies that match the school curriculum and so becomes an ideal practice tool in the home environment, as highlighted by the mathematics teachers across schools.
- Building Blocks application is user-friendly and has clear prompts to help navigate the questions though there have been some reported technical difficulties in usage. Also, unavailability of an application support team of the application is a challenge.

Role of parents, teachers, headmaster

Parents feel that they have become more involved in their child's education over the period of the study but the school officials did not feel similarly. Teachers feel that the parent's role in their child's education can be further improved quoting the low parental turnout in parent-teacher meetings and low parental monitoring of usage of smartphones.

Outcomes are the critical factors influencing progress of the child's mathematics learning ability through the application.

Sharing progress

- There has been an increase in the learning outcomes of the students during the post-test who were not at their grade specific foundational competencies in mathematics during the pre-test.

Competency	Change in competency	% of students who moved atleast 1 level*
Number Sense	Improved	72.5%
Number Operations	Improved	50.0%
Shapes	Improved	54.4%
Fractions	Not Improved	20.4%
Measurements	Improved	74.2%

** Excluding students who were already at the highest level in any competency during the pre-test*

Academic progress & interest in mathematics

- There has been an increase in the interest of students in mathematics after using the application. Between pre-test and post-test, the number of students who dislike mathematics as a subject has reduced (from a drastic 92% to 25% by the end of the post-test). There has been a significant increase in the number of students who said that they enjoyed studying the subject (67%

to 96%) and that they find it useful (34% to 98%).

Confidence

- There has been an increase in the confidence of the students to do mathematics.

Recommendation to other students/friends/parents

- Students feel excited to discuss the levels they have completed on the application with their family and friends. 64% of the students were discussing the application with their friends and family.
- When asked about their overall satisfaction with the application, the average rating given by 354 parents was **4 on a scale of 5**. They are also starting to recommend the Building Blocks application to their friends, neighbors and relatives.

Key Recommendations

Sattva suggests a 4-step approach to design outreach and marketing efforts based on the target group

- Policy advocacy through engagement with decision makers within state governments, publishing houses, other NGOs to help scale up operations.
- Build incentives for schools and teachers to get the students to use the application more and leverage the credibility of schools as trusted institutes in the community.
- Create a demand for the product amongst the parents by establishing credibility of the application and linking learning outcomes of the application to school curriculum.
- Build governance mechanisms to track the implementation progress across communities.

Plan and execute concurrent engagement and monitoring activities for user support and nudges

- Establish a call center for customer care for responding to troubleshooting on the application.
- Digital product relationship managers can be deployed across communities to do door-to-door interaction with parents at regular intervals and hence, drive usage of the application.
- Child controls can be created on the smartphone to prevent its misuse.
- If possible, nudges to drive engagement with parents could be sent as automated messages through the application itself.
- Engage with students to understand their inputs on user interface and user experience.

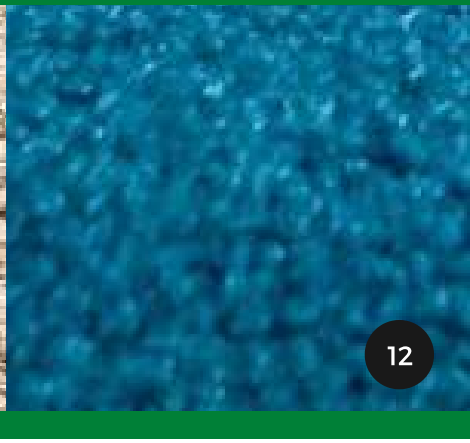
Launch periodic version updates of the Building Blocks application

- Strengthen the content of the application by adding more questions and increasing the difficulty levels across competencies.
- Introduce a cartoon character that helps the child in navigating through the application.
- The application should be able to navigate the child to the level most

suitable for the user by being adaptive in changing the levels for each individual user.

- The progress of the user should be quantified and visualized using dashboards on the Building Blocks application. These visualizations could be aggregated at a grade/school/community level for tracking of the class progress by the teachers and by Akshara Foundation's implementation team for reporting purpose.

CHAPTER 1: OVERVIEW OF BUILDING BLOCKS APPLICATION



Overview of EdTech as a Learning Tool in India

As per the SDG India Index & Dashboard 2019-20[1] prepared by NITI Aayog, India has gained considerable success in enhancing enrolment rates and the emphasis has now moved towards improving the quality of education and outcomes. The rapid technological change also demands that the students are equipped with transferable skills. Despite various government efforts and progress achieved in the education sector in different dimensions, various learning assessments point to the regional disparity in literacy and numeracy skills among children in primary schools.

One of the key priorities of the National Education Policy 2019 is the appropriate integration of technology into all levels of education - to support teacher preparation and development; improve teaching, learning and evaluation processes; enhance educational access to disadvantaged groups; and streamlin educational planning, administration and management. Further, technological interventions including applications and games on smartphones and tablets available in regional languages will be made available to teachers and students. This will in turn help teach literacy, numeracy, and other foundational and curriculum material, and carry out adaptive assessments and other personalized learning.

The rapidly increasing access to internet, smartphones, and other technologies has led to an expansion in the number of potential EdTech users. In 2016, 40 crore Indians had internet access and 29 crores owned a smartphone. By 2021, these numbers are expected to reach 74 crore and 47 crores respectively (Khaitan, et al. 2017[2]). Accompanying these growing rates of access, the total market value of all EdTech products used online is large and growing quickly (by around 50% a year). This market is expected to value nearly ₹ 14,000 crore by 2021 (Khaitan, et al. 2017[3]). In addition to sales, Indian companies are seeing massive investments. In 2018, India had the third highest levels of investment in EdTech globally (behind US and China) (Khaitan, et al. 2017[3]).

Education technology (EdTech) has demonstrated significant potential for increasing learning outcomes for students globally and in India. In Delhi, students who used an EdTech product in an after-school centre increased their mathematics scores by twice the amount as opposed to a randomly assigned control group (Muralidharan, Singh and Ganimian 2019[3]). In Punjab, Pakistan, a low cost EdTech product implemented in government schools similarly led to a doubling of learning gains in mathematics and science (Beg, et al. 2019).

[1] https://niti.gov.in/sites/default/files/2019-12/SDG-India-Index-2.0_27-Dec.pdf
[2] https://assets.kpmg/content/dam/kpmg/in/pdf/2017/05/Online-Education-in-India-2021.pdf.
[3] https://www.nber.org/papers/w22923.pdf

However, most students need products that offer vernacular mediums of instruction, use different examples and references, target different learning gaps, and are sold at different price points than the products currently on the market. Parents, schools, and state governments must be provided guidance and support in adopting, implementing, and evaluating EdTech products. They must be able to make decisions on adoption based on product effectiveness, and not be motivated only by hardware procurement.

Given this gap, Akshara Foundation, an organization working in the field of education has launched Building Blocks, a mathematics application that fits into a smartphone and hence is available to children at their homes, is available in 9 different languages and is based on the National Curriculum Framework 2005.

Akshara Foundation - Introduction and Vision

Akshara Foundation runs multiple educational programs with government primary schools to **upgrade education** for resource-deprived, bottom-of-the pyramid children across Karnataka, that have been designed to be comprehensive, scalable, replicable and cost-effective.

Over the past 18 years, Akshara Foundation has implemented a number of programs designed and cultivated to be comprehensive, scalable, replicable and cost-effective. All the programs focus on the child and are created to ensure that the enrolment rate in schools increases, drop-outs decrease and the learning outcomes and overall development of the child improve.

Figure 1.01: Akshara Foundation's Intervention Model

Objectives of the Building Block Application

In 2014, a program called Ganitha Kalika Andolana, (GKA) was implemented in collaboration with Akshara Foundation to improve numeracy skills and facilitate the classroom teaching of mathematics for students studying in government primary schools. The program aimed at focusing on students from grades 1 to 5 to develop their proficiency in mathematics in a child-centric manner. The state Government of Karnataka is supported by Akshara in scaling up the programme to all the 44,000 Government primary schools in the state in a phased manner.

The GKA model includes:

Government Order

Strong government buy-in

Pedagogy

Developing high quality teaching and learning materials that conform to the National Curriculum Framework 2005

Teacher Training

Training teachers to make effective use of the Teaching Learning Materials (TLM) developed by Akshara

Support

An Android application-based reporting system that ensures that the programme is on track

Assessments

Technology based assessments for children in a non-intrusive manner

Community Engagement

Engaging both the community and local governmentainstitutions to be supervisory so that the intervention continues beyond Akshara

GKA is an in-school programme. It unfolds in the classroom. With the advent of digital technologies, however, there was an opportunity to provide children access to learning mathematics on their family's smartphone without any adult supervision. By creating learning content in a child- friendly format, Akshara Foundation would have a complete set of tools both within and outside the classroom that would strengthen mathematics concepts and make children proficient in a key area of learning. Through this programme, Building Blocks, which presents mathematics in an app that fits into a smartphone, Akshara will ensure that a complete suite of games which is based on India's National Curriculum Framework (NCF- 2005) is made available to every child on his/her family's smartphone.

Implementation of the Building Blocks Application

Figure 1.02: Akshara Foundation's Implementation Timeline

Features of the Building Blocks Application

Akshara Foundation launched Building Blocks in 2018, a smartphone-based application as a part of Cisco's social responsibility initiative, to provide access to mathematics practice and learning to students from grades 1-5. The application has been designed for early grade mathematics learners and the games are meant for practice and reinforcement of concepts learnt in school in an engaging and gamified way. It has the following features:

A complete suite of games which is based on India's **National Curriculum Framework (NCF-2005)** is made available to every child on his/her family's smartphone.

According to NCF 2005, there exist almost **200 sub-themes for grades 1- 5**. In Phase 1 (July 2017-January 2018), Akshara Foundation digitized 77 themes for students in grades 1-4. Each theme and sub-theme is mapped to a group of competencies.

It is programmed on an Android device, version 5.1 and above which is best suited for Akshara's band of digital technology users. The application functions **independent of cellular connectivity and is completely offline**.

The games were developed using the open source technology stack and were distributed at **NO COST** to the end-user.

The games adhere to COPPA1 and GDPR2 guidelines. The application was created by mathematics pedagogy experts, and the animation assets were **curated by design experts** who are alumni of the Srishti School of Design. The games were coded by companies that have prior experience in the early education gaming business.

The games also provide an **instant feedback mechanism** to the end-user so as to ensure a greater level of engagement. This therefore acts as a very useful tool for parents to understand the growth and development of their students in terms of mathematics.

The application is currently available in 9 languages: **English, Gujarati, Kannada, Hindi, Urdu, Odia, Marathi, Tamil and Telugu**. There are currently over **100,000 downloads** done of Building Blocks from the Google Play store.

Learnings from the pilot study

Between November 2017 and May 2018, the application was **piloted** amongst 1500+ students in 3 clusters – one peri-urban (Hoskote) cluster and two rural (Kushtagi, Mundargi) clusters to evaluate the effectiveness of the solution across geographical scenarios.

The key learnings from the pilot phase were:

- Students were eager to practice on a digital device and in fact waited for more than an hour for their turn to use the device.
- Students loved learning in groups. (Group Learning is advocated by the National Curriculum Framework-NCF)
- Parents were heavily invested in their children's learning both in terms of time and effort.
- Students studying in higher grades were asking for similar applications.
- Caste, creed and religion have no boundaries when it comes to education. Communities arranged venues for children to come together to learn mathematics using the Building Blocks mathematics application.

Engagement activities by Akshara Foundation

Akshara Foundation in collaboration with Sattva Consulting planned the impact evaluation study of the Building Blocks application in Bengaluru Rural and Urban in Karnataka and in Bhubaneswar, Odisha during the months of Aug'19 – Feb'20. The following engagement activities were done with parents, students and headmasters across schools during this period:The key learnings from the pilot phase were:•

- School visits during parent-teacher meetings
- Teacher workshops
- Testimonials/Feedback from parents, teachers or students
- WhatsApp messages to parents

CHAPTER 2: STUDY APPROACH AND METHODOLOGY

Objectives of the Impact Evaluation Study

As a part of the engagement, Sattva assisted Akshara Foundation in understanding the impact of the Building Blocks application launched as part of the Ganitha Kalika Andolana program. Specifically, the exercise looked at assessing the following aspects:

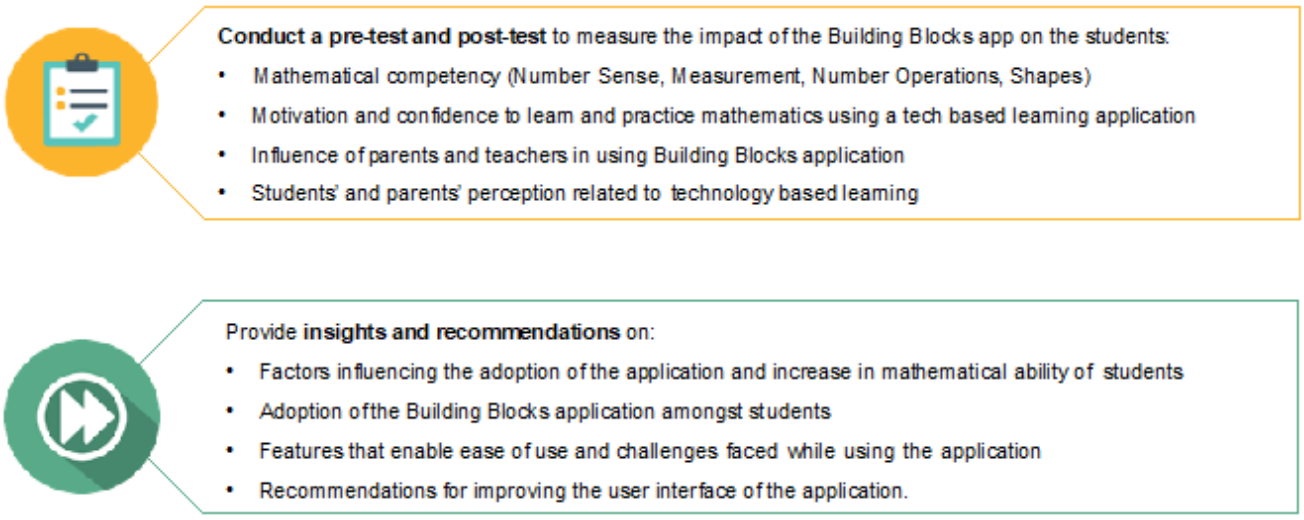


Figure 2.01: Objectives of Impact Evaluation Study

Outreach for the Impact Evaluation Study

The pre-test & post-test was conducted in urban and rural Bengaluru in Karnataka and in Bhubaneswar, Odisha covering 13 schools and 1000 students.

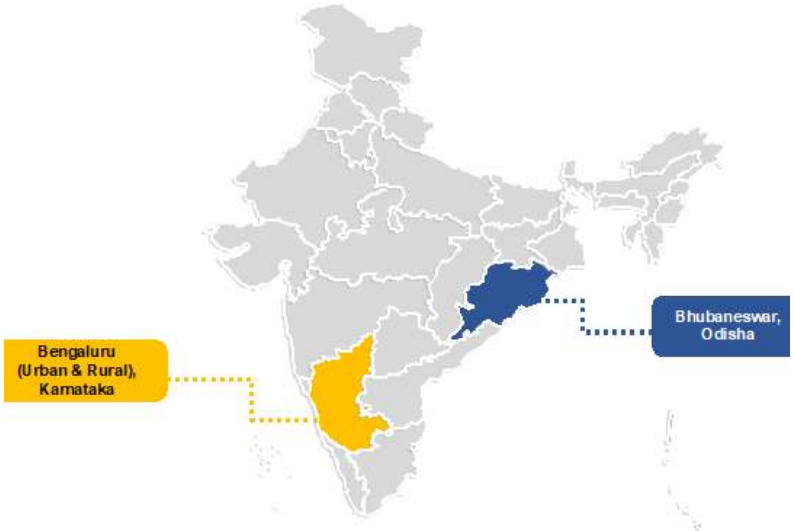


Figure 2.02: Outreach of Impact Evaluation Study

Framework for the Impact Evaluation Study

The framework below has been designed based on Sattva's experience of conducting impact evaluations for projects deploying technology in education.

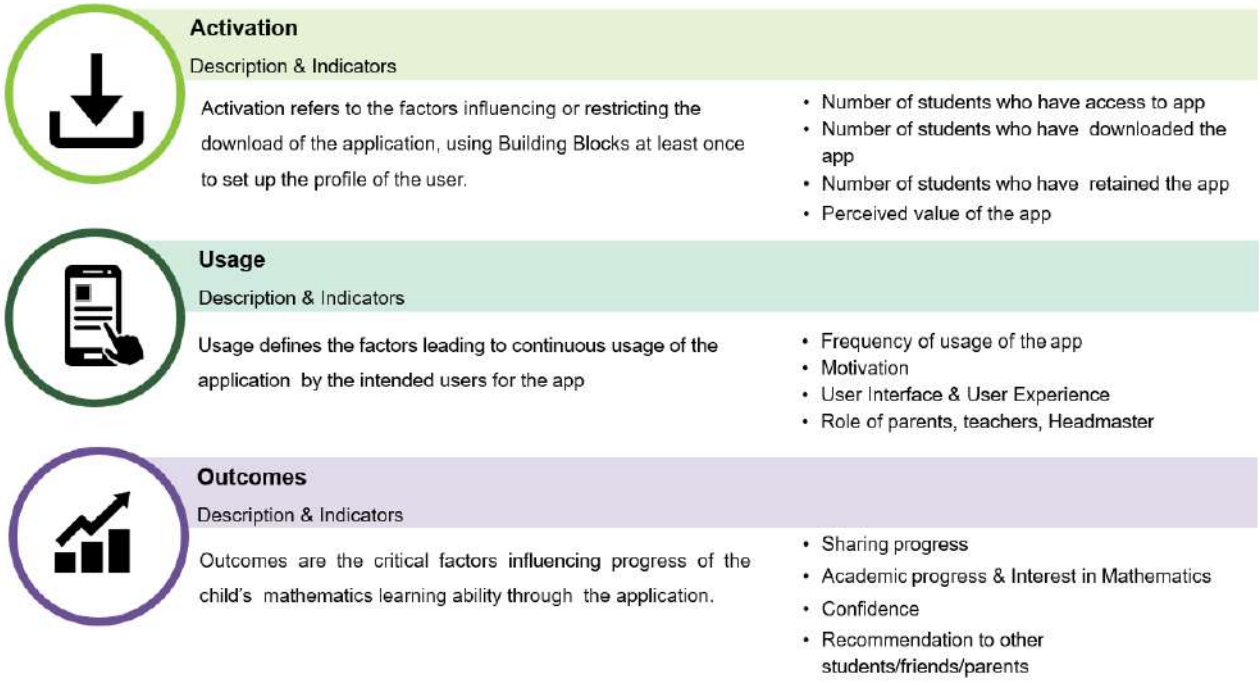


Figure 2.03: Framework of Impact Evaluation Study

Methodology for the Impact Evaluation Study

Sattva conducted a **pre-and-post analysis** for the cohort that was introduced to Akshara Foundation's Building Blocks application across pre-test and post-test evaluation. A **mixed-method approach** consisting of quantitative (surveys and assessments) and qualitative research techniques (focused group discussions (FGDs), in-depth interviews (IDIs)) using primary and secondary data collection methods was used.

The methodology for the impact evaluation exercise encompassed developing a set of research questions to draw evidence towards each program, which would then help draw out a reasonable set of conclusions within the constraints of time, availability of information and depth of the research.

Approach for the Impact Evaluation Study

Sattva conducted the impact evaluation study in the following phases as mentioned below. At each phase, every deliverable was aligned with Akshara Foundation for inputs and finalization. For the post-test study, phases 2 and 3 were repeated.

Figure 2.04: Approach for Impact Evaluation Study

Data sources

The following were the data sources used for the impact evaluation study:

Primary Source of data

The data collected from various stakeholders during the study using data collection tools designed for this study will be treated as primary data.

- *Quantitative data collection:* The pre-test and post-test evaluation and survey data collected from various stakeholders during the study using data collection tools designed for the study.
- *Qualitative data collection:* IDIs and FGDs with the different stakeholders

Secondary Source of data

The data gathered by a secondary party, other than the researcher. The key secondary data sources used during the study are :

- Akshara Foundation's back-end application data on usage of the platform by students.
- Published reports on learnings through EdTech, math assessment tool (ASER[5]),etc.

Figure 2.05: Data Sources

Stakeholders for the Impact Evaluation Study

The stakeholders and the data collection tools used for gathering information from them are as follows:

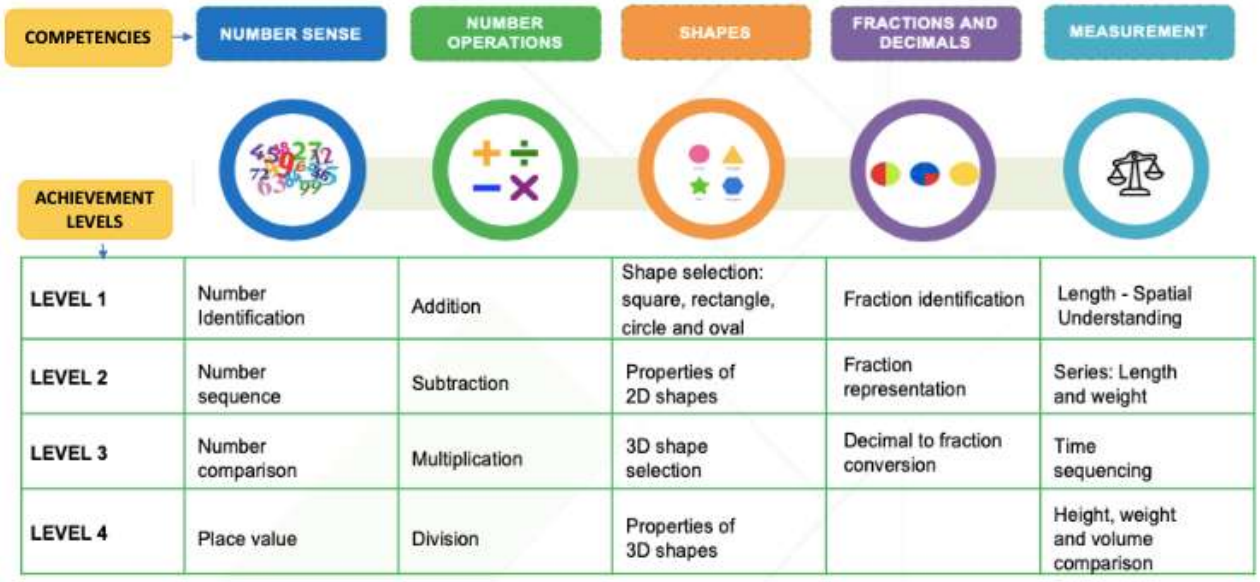
Stakeholder	Data collection tool
Students from grades 3-5	• Assessment • Survey
Parents	• Focussed group discussions
Mathematics teacher	• In-depth interviews
School headmasters	• In-depth interviews

Figure 2.06: Stakeholders

[5] http://img.asercentre.org/docs/Publications/ASER Reports/ASER 2016/aser_2016.pdf

Assessment of Mathematical Competencies

An assessment tool was designed to test mathematical competencies of students from grades 3-5. The competencies were mapped to Akshara Foundation's Building Blocks application which in turn are based on the grade wise state board curriculum defined by the National Curriculum Framework 2005.



LEVEL 1	Number Identification	Addition	Shape selection: square, rectangle, circle and oval	Fraction identification	Length - Spatial Understanding
LEVEL 2	Number sequence	Subtraction	Properties of 2D shapes	Fraction representation	Series: Length and weight
LEVEL 3	Number comparison	Multiplication	3D shape selection	Decimal to fraction conversion	Time sequencing
LEVEL 4	Place value	Division	Properties of 3D shapes		Height, weight and volume comparison

Figure 2.07: Mechanism of Assessment Administration

Sampling

A purposive sampling approach was adopted to ensure the right representation of the population for the impact study. The following was the process followed to do the sampling :

Step 1: Selection of Languages

- 11 States with lowest math learning levels of students as per Annual Status of Education Report (ASER) 2018[6] were chosen.
- Out of the 11 states, ranking of states was done on the basis of digital penetration[7], per capita income, male literacy and female literacy[8] to choose 3 states which had English, Odiya and Kannada as languages spoken by the majority of the population.
- Given the constraints of time, budget and logistics, in collaboration with Akshara Foundation, it was decided to choose only 3 languages at the time of study design and as the application was available in 5 languages only – English, Hindi, Kannada, Odiya and Gujarati.

[6] http://img.asercentre.org/docs/ASER 2018/Release Material/aserreport2018.pdf
[7] https://main.trai.gov.in/sites/default/files/PIR_04042019_0.pdf
[8] http://censusindia.gov.in/2011census/dchb/DCHB.html

Step 2: Our population was defined as the number of students in grades 3 - 5 whose parents had a smartphone. Here, the number of government schools was taken from UDISE data and digital penetration was obtained from TRAI statistics. For each state, this number was reached by the following formula:

Total number of children in a state who had access to a smartphone in grades 3 – 5 =
No. of government schools * No. of grades (3) * Minimum number of students per grade (30) * Digital penetration in state

Step 3: Using Cochran's formula, sample size[9] was calculated at 95% confidence interval and 5% margin of error which was of 384 students for schools of English, Kannada and Odiya mediums respectively. Therefore, the total sample size was **1152 students** for ensuring the results of the study are statistically significant.

Step 4: Considering dropouts from pre-test to post-test, we incremented the sample size by 25% for the group that was introduced to the Akshara Building Blocks application to bring the sample to 1440 students.

Step 5: The sample size of 1440 students was proportionately distributed across medium of instructions that were to be included in the impact evaluation study.

Step 6: Roster Creation

On the basis of the pre-test study, a roster of students in the sample was created to help track their activation, usage and learning progress between the pre-test and the post-test periods. The information collected as part of the roster is below:

Unique id	School name	Child name	Grade	Parent name	Phone number	Parent name	Address

Execution of the study

The data collection exercise was done across Karnataka and Odisha in two phases over a period of 7 months,

- Pre-test Period (Aug'19 – Sep'19)
- Post-test Period (Dec'19 – Feb'20)

Data collection execution Timeline	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-19	Feb-20
Pre-test Execution							
Karnataka (Bengaluru Phase)							
Odisha (Bhubaneswar Phase)							
Post-test Execution							
Karnataka (Bengaluru Phase)							
Odisha (Bhubaneswar Phase)							

Table 1: Data Collection Execution Timeline

[9] https://www.tarleton.edu/academicassessment/documents/Samplesize.pdf

For both pre-test and post-test periods of the study, the Sattva team conducted student assessments and parent surveys across 13 schools as follows (For school wise details, refer to Annexure 1):

Medium of Instruction	Planned	STUDENT ASSESSMENT		PARENT SURVEY	
		Pre-test	Post-test	Pre-test	Post-test
Kannada	480	286	229	146	137
English	480	664	573	233	156
Odiya	480	169	141	101	87
TOTAL	**1440**	**1119**	**943**	**479**	**380**

Table 2: Data Collection Execution Details

Student Assessment

- Preparation of student roster of students of grades 3-5 who had access to at least 1 smartphone at home
- Verbal one-on-one assessment in the schools using a pre-defined tool (For details, refer to Annexure 2) that mapped levels to competencies
- The study covered 1119 student assessments during the pre-test period and 943 student assessments during the post-test period of the study.

Parent Surveys

- Parents of students who were part of the roster prepared in the school were surveyed by means of calls, house visits and school meetings based on time, availability and permissions available from schools.
- The study covered 479 parent surveys during the pre-test period and 380 parents surveys during the post-test period of the study.

Qualitative Data Collection

- As part of the data collection exercise, we collected one-on-one informed interviews (IDIs) with students who had been using the Building Blocks application during the post-test period and also did 15 IDIs with teachers and headmasters during the pre-test and 20 during the post-test. We also did focused group discussions with parents during the 12 parent teacher meetings attended across schools. (For details, refer to Annexure 1)

Data Analysis

- The following gives a description of the sample sizes for the different sections of the survey tools used for student and parent surveys:

Description	Total sample (n)
STUDENT SURVEYS	
Number of students surveyed during the pre-test	1119
Number of students surveyed during the post-test	943
Number of students who had downloaded the application atleast once after introduction of the Building Blocks application during the pre-test	630
Number of students who said that they had discussed the features of the Building Blocks application with others	400
PARENT SURVEYS	
Number of parents surveyed during the pre-test	479
Number of parents surveyed during the post-test	354
Number of parents who had uninstalled the Building Blocks application after using it atleast once before the post-test	80
Number of parents who said that there is a need for improving the math skills of their children in the post-test	339
Number of parents who had their children around during the post-test and hence, were able to answer the survey question related to the student's level of confidence	106

Ethical Considerations

- As part of data collection, team members ensured ethical data collection by explaining the **purpose of the study** and ensuring informed consent from the participants
- The interview sessions were conducted in an **environment** that ensured the privacy of the respondents as per their convenience and comfort
- Only the respondents who gave **consent** for being part of the study were considered i.e. the participation of respondents was ensured to be voluntary and they were not compelled to answer any question
- The respondents were assured about the **confidentiality** of their information and the usage of data

Limitations

- **Deviation of sample covered in assessment and parent surveys:** The achieved number of students for assessment is not the same as the target because of absenteeism of required students from school.
- **Unavailability of parents:** Parent surveys were done by deployment of different survey techniques like phone calls, house visits and during parent-teacher meeting sessions in the schools. However, there were limitations of adequate mobilization given the busy schedules of parents, unwillingness to speak to data collectors, lack of working smartphones and lack of smartphone access amongst parents at the time of the survey.
- **Student absenteeism during the post-test period:** There were drop-outs in the sample covered between the pre-test and the post-test because of absenteeism of students and unavailability of parents in the planned timeline of the surveys.

CHAPTER 3: FINDINGS OF IMPACT EVALUATION STUDY

The following section of the report details the key results and insights of the longitudinal study across the parameters of Activation, Usage and Outcomes as outlined in the framework for the study. The insights have been drawn using the 360-degree approach of data collection by gathering data from qualitative and quantitative methods by engaging with students and their parents, mathematics teachers, and headmasters.

As part of the impact evaluation study, 1119 students across 13 schools and two states were included in the study during the pre-test. 176 students dropped out in the post-test as a result of student absenteeism on the day of the surveys bringing the sample to 943 students in the post-test.

Profile of Students

Students were equally distributed across grades for the study

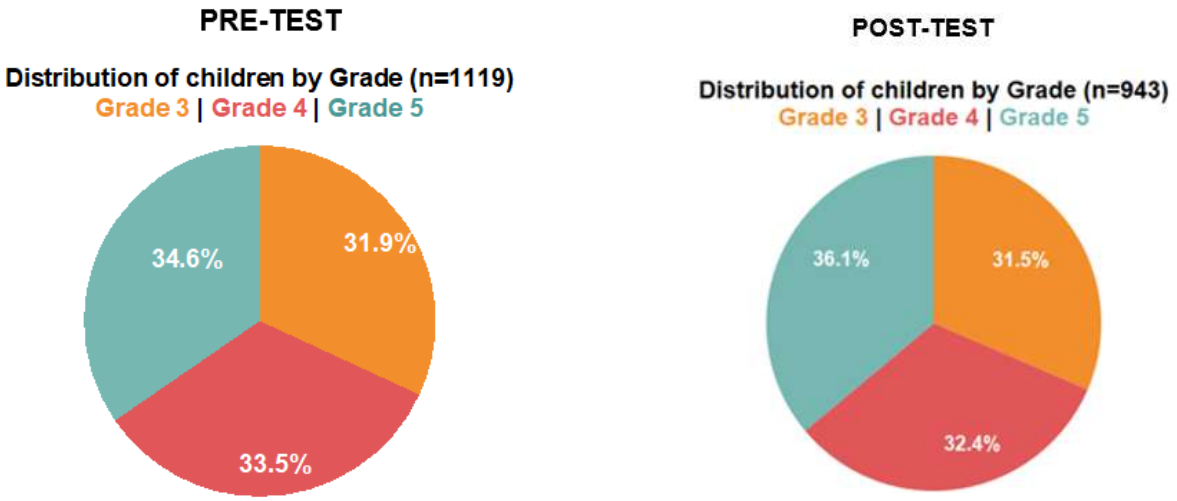


Figure 3.01: Grade-wise distribution of students

There is a marginally higher representation of female students in the study

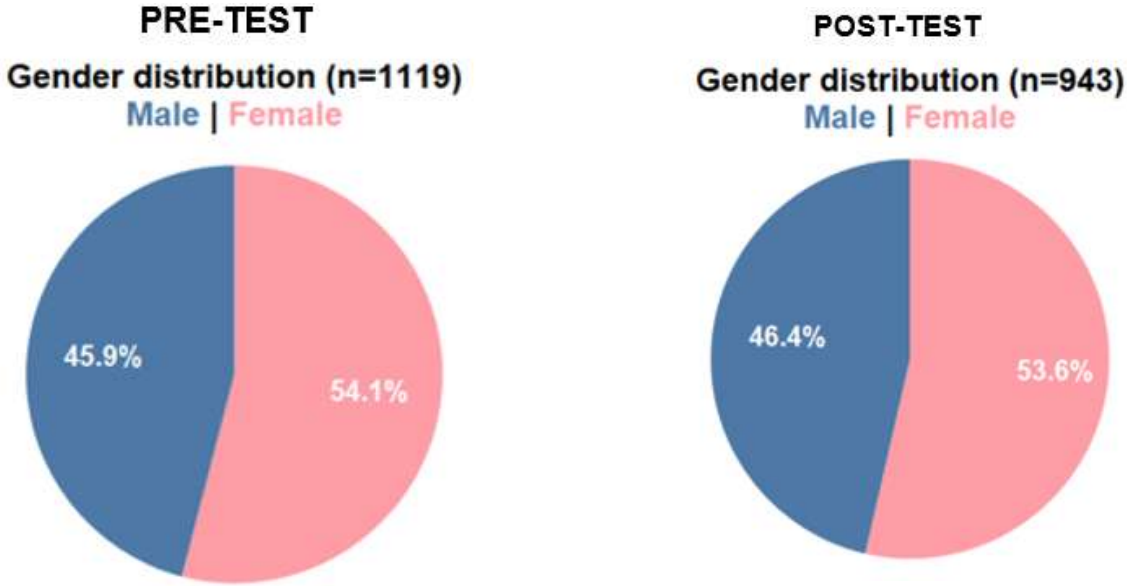


Figure 3.02: Gender-wise distribution of students

A majority of the students were studying in English medium schools

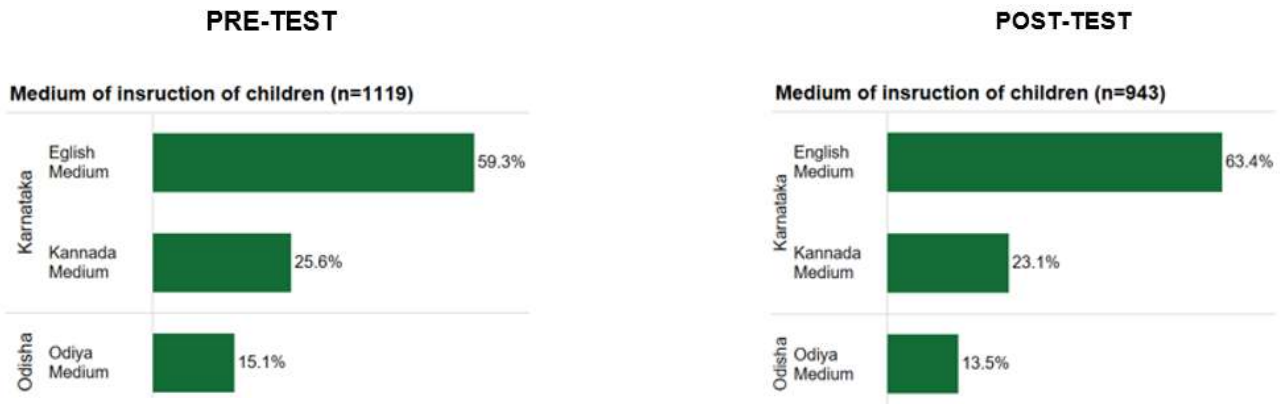


Figure 3.03: Medium of instruction wise distribution of students

Factors influencing learning among students

Based on Sattva's experience of working in education, and available literature in the education space, it can be concluded that the following are the key factors, that influence the learning outcomes among students:

- **Intelligence factor:** The mental level of a student is referred to as intelligence. It has been observed that the students with low intellect, have difficulty in comprehending and internalizing concepts taught in school.

- **Learning factor:** Students are known to learn using multiple senses and accumulate knowledge thought different ways of learning, based on their cognitive abilities

- **Physical factors**: Student's health, physical development, nutrition and motor skills are also known to influence learning and their ability to concentrate.

- **Mental and emotional factors**: Student's mental status and well-being affect their motivation to learn and engage in process of gathering knowledge and information.

- **Social factors:** Students imbibe from their social environment and the associations they have with their parents/relatives, friends, teachers, headmaster, and even tutor.

- **Environmental factors:** The socio-economic background and the environment provided to students at home as well as the learning space provided to them at school, depending on the type of school (government, government-aided, private) is also known to influence the efficiency of learning among students.

Figure 3.04: Factors influencing learning among students

Factors influencing use of Building Blocks for learning

According to the Technology Acceptance Model, developed by Fred Davis, Richard Bagozzi, and Paul Warshaw, acceptance of a technology is a gradual process which is influenced by external variables which define perception of users regarding the ease and use and usefulness of a technology.

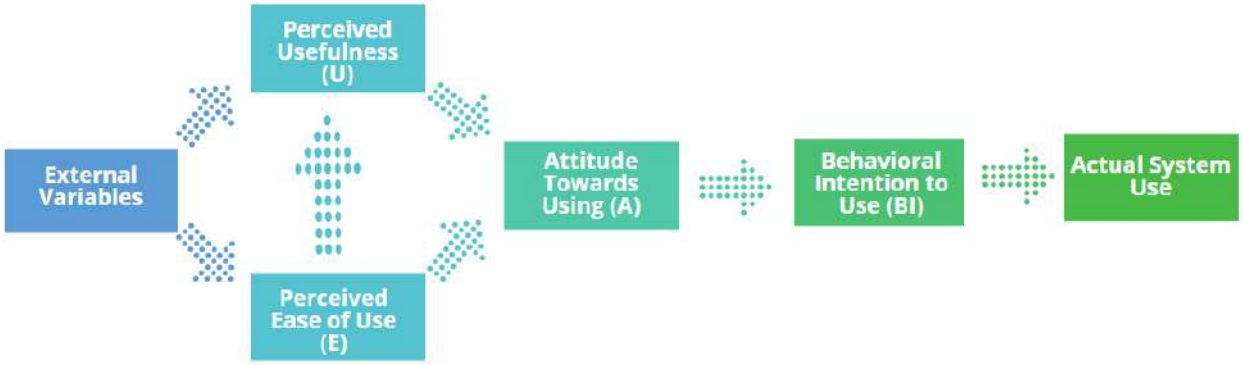


Figure 3.05: Factors influencing use of Building Blocks for learning

Contextualization of this model for the Building Blocks mobile application would reveal the following parameters that influence the actual use of the application by the intended users (students) of the application:

- **External Variables:** Access to smartphone with internet connection, parent's openness to embrace learning using mobile phone, promotion of the use of technology to practice mathematics by school teacher are the key variables, external to the application, that influence the activation and usage of Building Blocks

- **Perceived Ease of use:** On the onset, once students and their parents are introduced to the mobile-based application, the following factors were seen to influence the usage of the application:

  1. Ease/Complexity of navigation
  2. User interface and user experience
  3. Availability of content in vernacular languages

- **Perceived Usefulness:** For a student who is likely to use the application, the perceived value of the application is improvement in understanding of a complex concept through enjoyment and entertainment. The zero cost and offline mode capability also act as a motivator for downloading the application amongst the diaspora of parents who belonged to an economically backward section of the society.

Activation of the application

Technology based platforms are an essential medium of student learning and engagement but cannot replace classroom learning completely

Technology access at home is influenced by the socio-economic background of a child's parents which in case of activation of an application like Building Blocks would influence the access to smartphones. Technology access in the school is similarly dependent on funding available for the schools and access to infrastructure to enable Edtech learning amongst students.

Access to technology in schools

Schools across Karnataka and Odisha recognize the fast-paced environments that we live in and how adoption of technology in education is essential for student exposure and learning. They were **open to the idea of technology-based learning to aid the teaching process but not replace it**. They value the importance of a teacher-student relationship and think of it as a core foundation to building a child's skills.

- Across schools in Karnataka and Odisha, classroom teaching is majorly done on blackboards and student practice and learning is checked through regular homework. Computer classes are conducted regularly to increase technology-based learning amongst students. Some of the schools like Christel House, Carmel Jyothi, SG English Medium School, Lavanya English Medium School were also using models, showcasing videos and activities to teach mathematics. GGHS school in Bhubaneswar also uses Ujjwal practice work book which has been very helpful.

- Schools were willing to use technology in their classrooms also as they believe it to be an engaging and child-friendly format of learning which **captures a child's attention quickly** through the effective use of animation, videos, pictures, etc.

- Despite the willingness to use technology, currently, most of the schools (except Christel House and Carmel Jyothi schools in Doddaballapur) **lack the necessary funds from the government or the infrastructure** (like availability of projectors, screens, smart TVs, etc.) **to support the use of technology in the classrooms**.

- Schools like Christel House, Carmel Jyothi, SG English Medium and Lavanya English Medium School which were using models and activities to teach mathematics, showcasing videos which would have an influence on the efficiency of learning among students as mentioned before.

Access to technology in the household

Ayan M | *Student of Grade 4, Christel House*

"We have only one smartphone at home. I generally use the phone when my father comes back from work in the night or on Sundays."

Ayan is a grade 4 student at the Christel House School and is currently a user of the Akshara Building Blocks App. His father is a carpenter and his mother is a housewife. Both his parents have completed their schooling. He uses his father's phone every day for half an hour as there is only one smartphone in the house.

Access of smartphones to a student is limited due to the nature of employment of their parents

Presence of smartphones in the household

A majority of the households[10] included in the study (94%) had access to at the most 2 smartphones at home. During discussions with parents and school teachers, it was reported that most of the parents were daily wage workers and their busy schedules gave them limited time at home. This may be one of the

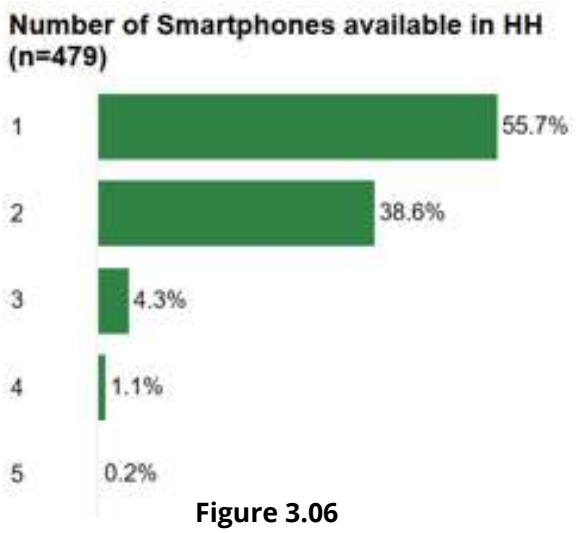


Figure 3.06

[10] Here, n = 479 which is the number of parents surveyed during the pre-test

factors that would restrict access to technology for their children.

> *Most of the parents of the students in our schools are daily wage workers. They leave for work early morning and come back late evening which restricts the time their child can have access to the smartphone*
>
> - Mrs Cynthia, Mathematics teacher, GMPS, Bellandur

Access to technology in the household

In both the pre-test and the post-test, students were mainly using their parent's smartphone for less than 1 hour/day.[11]

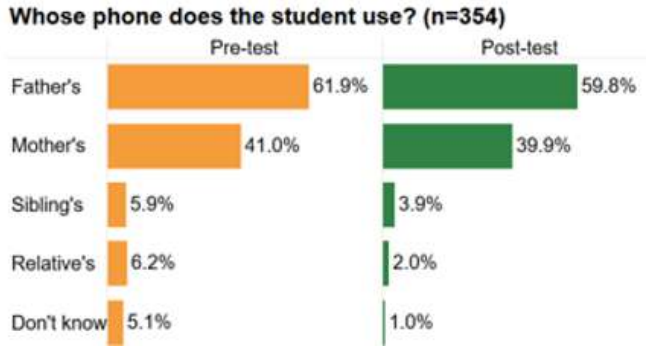


Figure 3.07

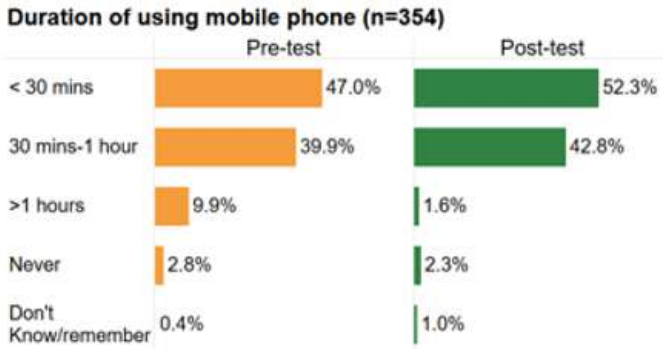


Figure 3.08

Purpose of using smartphones

A majority of the students use smartphones for playing games (92%) and watching videos (73%). The study found that the usage of smartphones increased marginally for games, watching videos and for educational purposes at the time of the post-test.

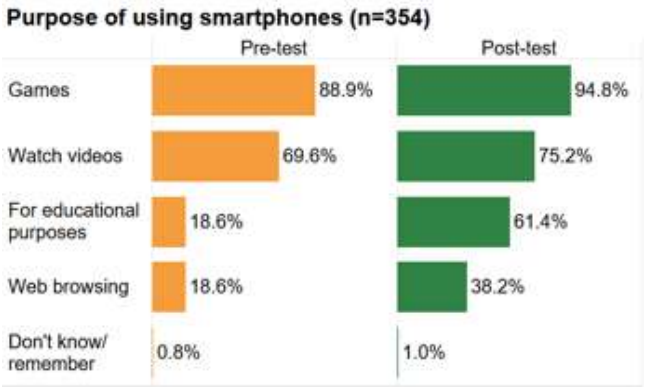


Figure 3.09

Also, discussions with some teachers from Carmel Jyothi and Christel House revealed that they have deployed other learning tools like kahoot, online websites like quizzes, softschool and learning tool like mindspark between the pre-test and the post-test. These along with use of the Building Blocks application could have contributed to the increase in the use of smartphones for educational purposes.

Building Blocks application was downloaded by 67% of the students who were part of the study and 49% of them continued using the application till the time of the post-test

[11] Here, n = 354 which is the number of parents who had downloaded the application atleast once after introduction of the Building Blocks application during the pre-test

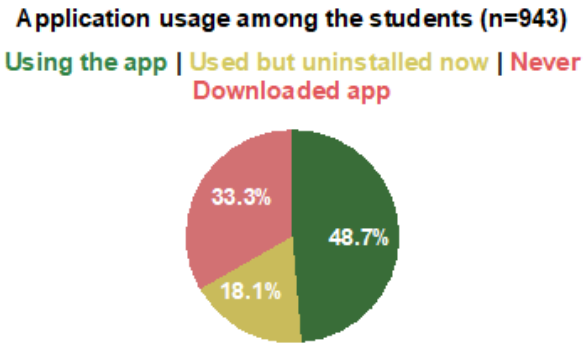


Figure 3.10

Lack of awareness

From the discussion with teachers and headmasters across schools, it was highlighted that the main reason for not downloading the application was the **lack of awareness** of its benefits and demanding job schedules which gave parents minimal time to help their child in his or her education.

Zero Cost of the Application

One of the key factors that the parents quoted as an influence for downloading Building Blocks was the fact that the application was free of cost and had the ability to operate in the offline mode also.

Acceptance of the Application

Students belonging to schools from English and Odiya mediums of instruction had a greater acceptance of the application compared to students from the Kannada medium.

- Within the English and Odiya medium schools, a majority of the students were still using the Building Blocks application.
- A majority of the students[12] (43%) going to Kannada medium schools had not downloaded the application.
- Based on our discussion with teachers and parents across schools, it was noted that acceptance of the application was largely driven by the awareness of the parents regarding the same.

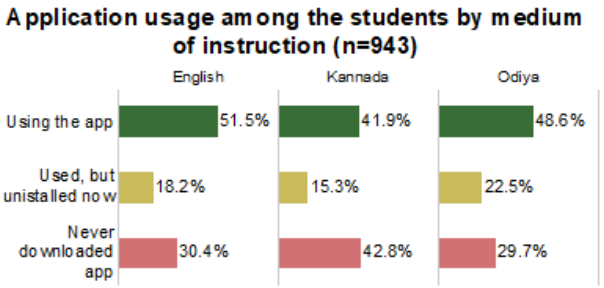


Figure 3.11

- Parents sending their children to English medium schools had a higher incidence of attending school and also completing graduation in some cases vis-à-vis parents of Kannada and Odiya medium students. Also, according to an Azim Premji report[13], "School choice in low-information environments: A study of perception and realities in four states" published in November, 2018, Indian parents have a tendency to believe that sending their children to English medium schools is linked to better learning outcomes and career growth. This may be the driving force behind the higher acceptance of Building Blocks amongst parents who are sending their children to English medium schools.

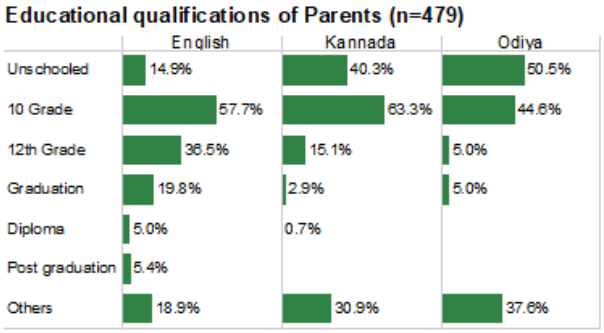


Figure 3.12

Availability of content in child's mother tongue

It was highlighted during the discussions

[12] Here, n = 943 which is thenumber of students surveyed during the post-test and the pre-test
[13]] https://azimpremjiuniversity.edu.in/SitePages/pdf/SchoolChoices_Web.pdf

with the parents and mathematics teachers across schools that the availability of Akshara Foundation's Building Blocks application in 9 regional languages is a favorable factor that influences the acceptance of the application.

A large body of evidence also shows that primary school students are most effectively taught in a language that they are fluent in[14].

Reasons for un-installation of the application

65% of the students[15] reported that the application was uninstalled by their parents.

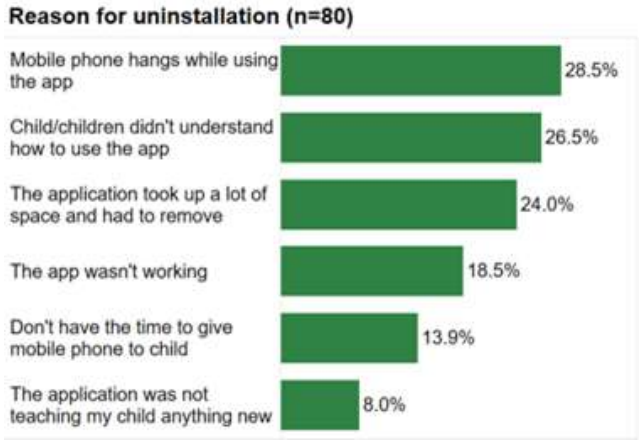


Figure 3.13

- The main reasons for uninstallation of the application as reported by the parents included phone hanging (29%), lack of understanding on how to use the application amongst children (26%) and lack of space in the phone (24%).
- Mobile phone hanging could be linked to:

1. Low memory of smartphones
2. Running too many applications at the same time
3. Running heavy applications on low memory
4. Lack of updating software at regular intervals

- On further discussion, 47% of these parents mentioned that they would be interested to continue using the application if the stated problem gets resolved.

Parents feel that the Building Blocks application improved their child's interest in mathematics

Awareness strengthens acceptance of the application among parents

During discussions with parents in the pre-test phase of the study, some of them said that they had no idea about the utility and functioning of the Building Blocks application. To help the parents understand the merits of the Building Blocks application, Akshara Foundation conducted demo sessions for parents and students during parent-teacher meetings across 13 schools.

Parents who downloaded and retained the application after the awareness sessions were the ones who understood the merit of it in helping their child practice their mathematical skills. Some of them were also willing to take some time out and monitor their child's application usage and demanded a training manual for greater understanding of the same.

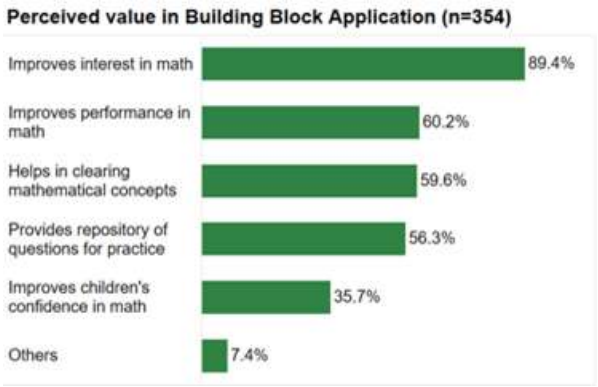


Figure 3.14

[14] https://www.teachingenglish.org.uk/sites/teacheng/files/C413 Juba Publication_FINAL_WEB ONLY v3.pdf
[15] Here, n = 80 which is the number of parents who had uninstalled the Building Blocks application after using it atleast once before the post-test

- 89% of the parents[16] said that the Building Blocks application improves their child's interest in the subject.
- 60% of the parents said that use of the application helps improve academic performance in mathematics, clears concepts and provides a repository for practicing questions.
- From research and study of educational models, learning is a multi-step process starting from the introduction of a tool/skill to gaining expertise.

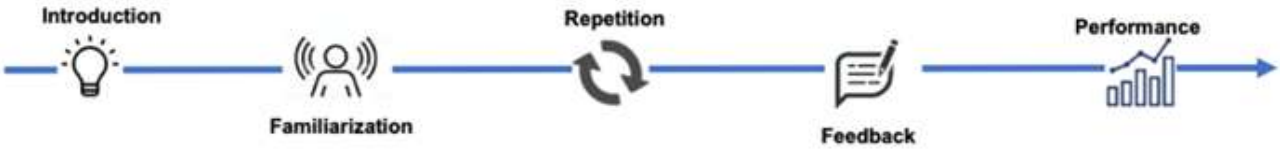


Figure 3.15

This could help explain how parents perceived that the Building Blocks application had led to enhanced interest in the subject of mathematics but not necessarily towards improvement in performance in the subject between the pre-test and the post-test.

[16] Here, n = 354 which is the number of parents who had downloaded the application atleast once after introduction of the Building Blocks application during the pre-test

Usage of the Application

Parents feel that they have become more involved in their child's education over the period of the study but the school officials did not feel similarly

The participation of parents in a child's education not only has an indirect effect on their academic achievement through affecting learning attitudes and behaviors, but also has a direct impact on children's academic performance.[17] The following insights help understand the role of parents in the student usage and learning from the Building Blocks application.

Educational support given majorly by mothers

- 42% of the students were supported by their mothers in their studies during the pre-test, which rose to 57% by the post-test period.
- The support from tuition teachers (34% to 42%) and fathers (22% to 23%) has also risen from pre-test to post-test.

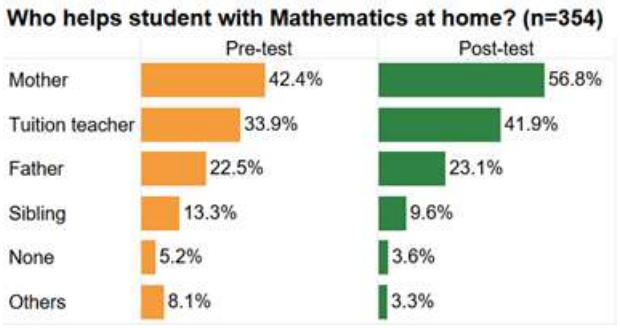


Figure 3.16

Support for homework and doubt clarification improved

- Students were primarily supported in their homework and the percentage of students who were supported in the same has risen by the post-test period of the study from 76% to 96%.
- The number of students who were supported for doubt clarification in their studies has risen from 58% to 72%.

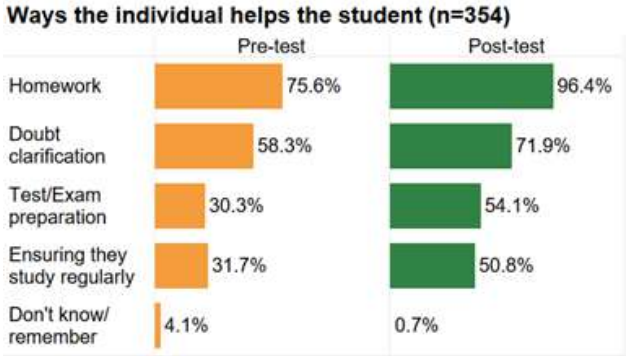


Figure 3.17

[17] https://journalofchinesesociology.springeropen.com/articles/10.1186/s40711-018-0083-8

Duration of support to students increased

- The number of students who were supported in their education for an hour or less has reduced from 82% to 79%.
- The number of students who were supported in their education for more than an hour has increased from 11% to 20%.

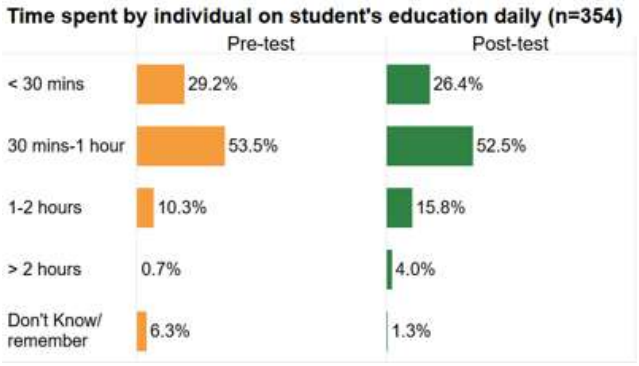


Figure 3.18

Parents perceive that their child's mathematics skills can be enhanced through external support from teachers, tuitions and at home

- A majority of the parents[18] (55%) felt that sending their children for tuition could help improve their mathematics skills during the pre-test. This number rose to 58% by the post-test.
- Increased investment by teachers was the second most reported method of improving their child's mathematics skills during the pre-test (48%) though this number reduced to 40% by the post-test.
- Increased investment by themselves was another reported method of improving their child's mathematics skills during the pre-test by 38% of the parents and this number increased to 51% by the post-test.

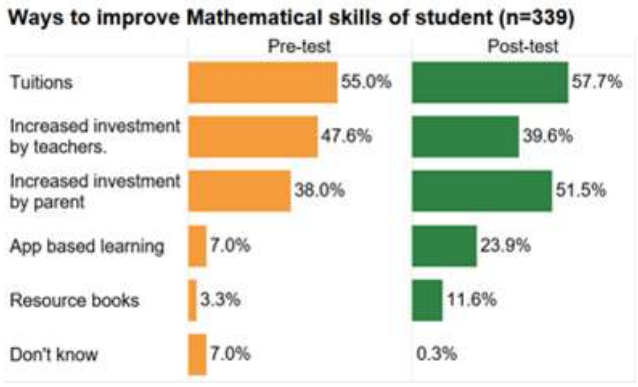


Figure 3.19

Parents perceived to be actively involved in improving the mathematics skills of their children

- A majority of the parents (60%) have been attending parent-teacher meeting and this number has gone up to 81% by the post-test period of the study.
- 39% of the parents were sending their child for tuitions during the pre-test period and this has gone up to 53% by the post-test period of the study.
- Also, parents who had taken no steps (None category in figure below) towards improving their child's mathematics skills has reduced from 14% to 5% over the course of the study.

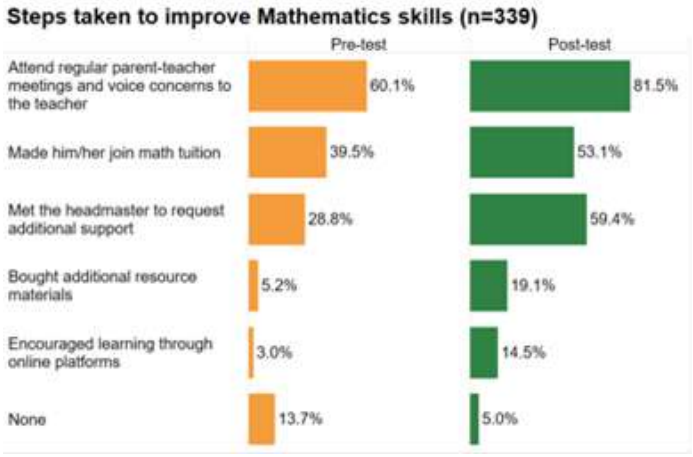


Figure 3.20

[18] Here, n = 339 which is the number of parents amongst the sample size of 380 who had said that there is a need for improving the math skills of their children.

Teachers feel that the parent's role in their child's education can be further improvement

- **Low parental turnout in parent-teacher meetings:** On an average, only 30-40% of them visit parent-teacher meetings and rely on school staff for many needs of their children.

> *Parents attend PTMs where we discuss the child's progress but the key onus of the child's development is left on us, the school. Parents mainly rely on teachers for improving their child's performance*
>
> -Mrs Nirmala, Mathematics Teacher, National Academy School, Bengaluru

- **Low Parental monitoring of usage of smartphones:** Misuse of smartphones by students when unsupervised by parents was one of the factors that deterred its adoption and continued usage. Children could easily get distracted when left unsupervised by games and websites which were not intended for educational purposes. In such a scenario, the schools also did not encourage the use of smartphones and hence, practicing mathematics on the Building Blocks application.

> *There were a few instances where parents reported that because of the application, students were getting distracted and were playing games and videos on the smartphones. This was mainly when they were not supervising their child's usage of the phone and we advised them to start doing the same.*
>
> -Mr Venkatesh, Headmaster, Lavanya English Medium School

The trend of application usage was dependent on engagement activities planned by Akshara Foundation

Engagement activities drive usage of Building Blocks

From the back-end usage data of the application, the number of students using the Building Blocks application has reduced over time.

- Most of the engagement activities were conducted during the periods of August and September 2019 for all the schools. In December 2019, the engagement activities were conducted in a few of the schools. The trend of usage could be linked to the engagement activities conducted with students, parents and teachers in the vicinity of the schools.

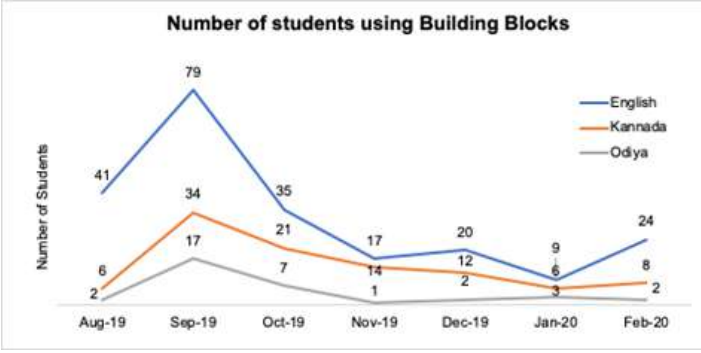


Figure 3.21

- The average number of hours has also reduced over time with maximum usage during August and September 2019.

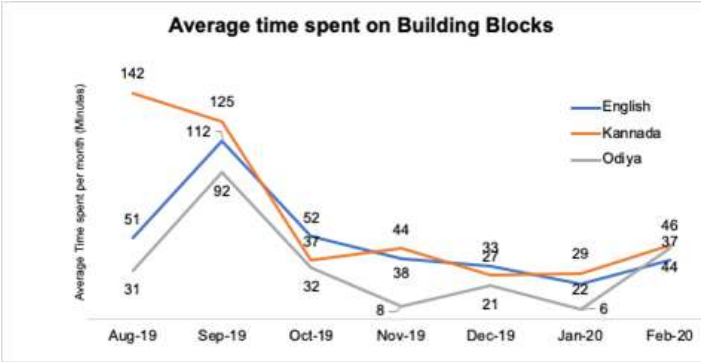


Figure 3.22

Gautami | *Student of Grade 4A, Christel House*

"Akshara's Building Blocks has helped me to learn fractions and numbers. I like the pictures and the colors used in the games and feel excited about crossing levels."

Gautami is a student of grade 4 who has been using the Building Blocks application after it was introduced in her school last year. Her father, Mr. Narasimha, is a construction worker who has studied till grade 5 while her mother works as a house-help. She plays the game for 30 minutes every day and enjoys learning numbers and fractions from it.

Students find the Building Blocks application visually appealing and enjoy solving problems and scoring stars while doing so

Building Blocks as a tool is a visually appealing and gamified version of learning mathematics

- 76% of the students said that solving problems was the best feature of the application followed by the ability to score stars (72%) and the music in the background (69%).
- More than 60% of the students also liked the visual features like images, pictures and animations.
- Further, from our discussions with teachers across schools, it was reported that the students were able to grasp mathematical concepts easily from the application given that the visual medium attracts their attention.

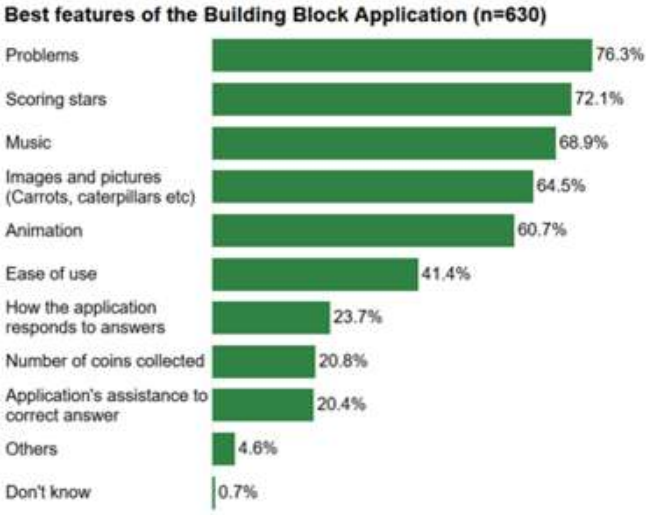


Figure 3.23

- Teachers also said that the fear of the subject is slowly reducing as students now have access to a user-friendly, easy to understand and gamified version of basic mathematical concepts.

Curriculum on Building Blocks is aligned with the school syllabus

The application is based on competencies that match the school curriculum and so becomes an ideal practice tool in the home environment, as highlighted by the mathematics teachers across schools. The relevance of the games that the children were playing on the application makes it a possible teaching aid without increasing the workload of the teachers and an ideal practice tool for the children.

Building Blocks application is user-friendly and has clear prompts to help navigate the questions though there have been some reported technical difficulties in usage

The application is easy to use

- More than 70% of the students[19] were able to see, read and understand the message pop-ups on the application.
- 49% of the students were able to understand the prompts given to answer questions.
- 29% of the students were able to answer all the questions while 28% were able to understand their progress on the application.

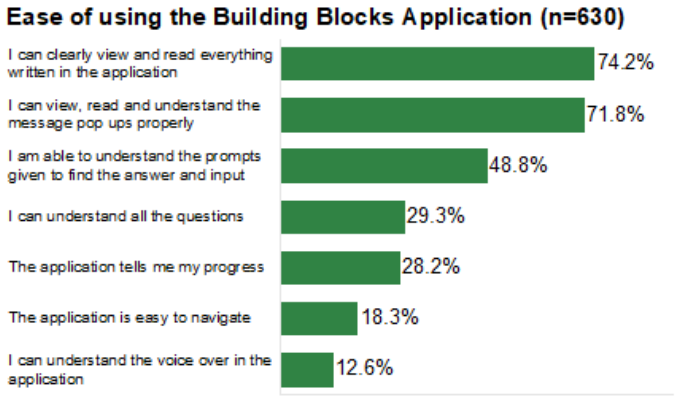


Figure 3.24

Technical performance of the application is a challenge

Some of the parents and students, however, mentioned that the application often took too long to open or was hanging. This was also one of the reasons reported for uninstalling the application by parents.

> *Often, the phone hangs for some time while opening the application. No other technical difficulties are faced while using Building Blocks*
>
> *- Mrs Muniratna, Parent of Manasa, a student from Christel House*

Unavailability of an application support team was a challenge

Continuous help from full-time on-site support personnel (often called school coordinators) or an on-call product company support team is critical to sustaining use. 21% of the parents had uninstalled the application after downloading. On enquiring the reasons for uninstallation, many teachers and parents reported the need for technical support in the following:

- Setting up the product
- Navigation to the right content
- Use of various features
- Deal with software glitches or hanging of the application.

Impact of the application

Divya | *Student of Grade 5, Carmel Jyothi School*

"I started using Building Blocks after seeing my neighboring friend use it. Earlier when I used to play on the application, I'd get 2 stars out of 5 but now I often get 5 out of 5."

Divya is a grade 5 student of Carmel Jyothi School. She is currently a user of the Akshara Building Blocks App. Her father runs a shop while her mother is a housewife. Divya tells us that she has played the games in all the chapters except for food partition (game that teaches fractions) as she found it a little difficult to understand. By using the application, she tells us that division and multiplication have become easier for her.

[19] Here, n = 630 which is the number of students who had downloaded the application atleast once after introduction of the Building Blocks application during the pre-test

There has been an increase in the learning outcomes of the students who were not at their grade-specific foundational competencies in mathematics during the pre-test

Students improved their levels across all competencies except Fractions between the pre-test and the post-test.

Competency	Change in competency	% of students who moved atleast 1 level*
Number Sense	Improved	72.5%
Number Operations	Improved	50.0%
Shapes	Improved	54.4%
Fractions	Not Improved	20.4%
Measurements	Improved	74.2%

** Excluding students who were already at the highest level in any competency during the pre-test*

Assessment Results - Number Sense

As per the assessment results, a majority of the students were at level 4 i.e. they were able to identify place value of 3-digit numbers[20] by the post-test period.

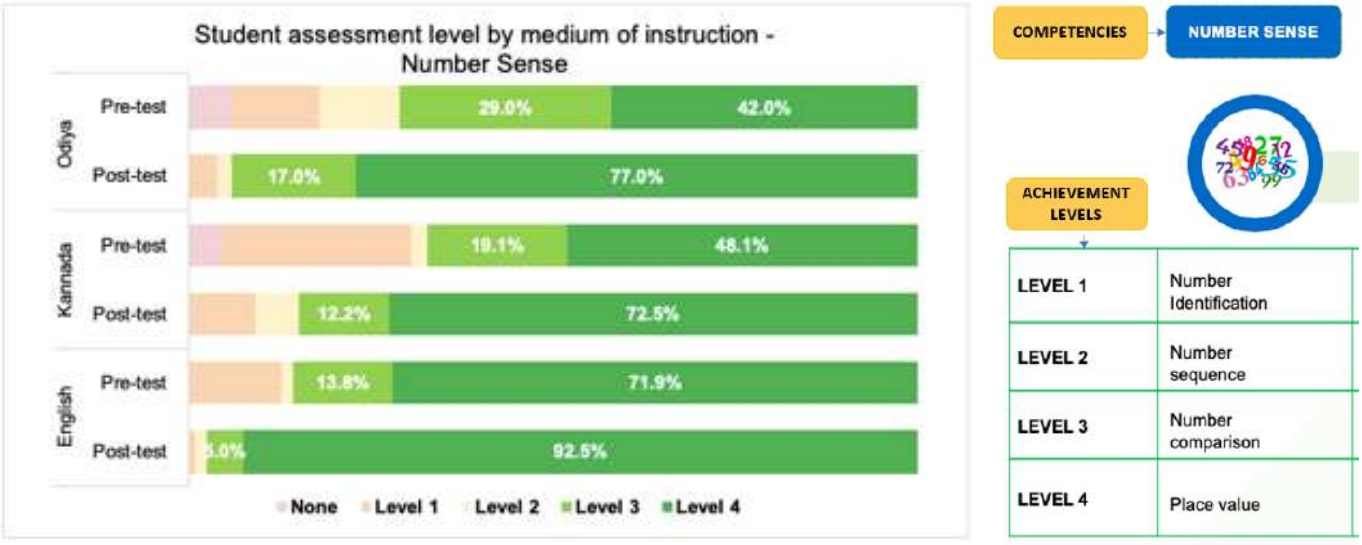


Figure 3.25

- During the post-test, 93% students of English medium, 72% students of Kannada medium and 77% students of Odiya medium were at highest level of application defined competency in number sense.

[20] http://www.dsek.nic.in/Misc/learningoutcome.pdf

The below table shows the level improvement of students across levels in the number sense competency between the pre-test and the post-test. On an average, the change or improvement in levels was statistically significant at 95% confidence level.(Using the Wilcoxon signed rank sum test[21], test statistic v=0, p-value=<0.005).

Level improvement in students – Number Sense

Pre-test	Post-test				
	None	Level 1	Level 2	Level 3	Level 4
None	0.0%	38.5%	0.0%	38.5%	23.1%
Level 1		15.6%	16.7%	16.7%	51.0%
Level 2				10.0%	90.0%
Level 3				27.5%	72.5%
Level 4					100.0%

1 level jump | 2 level jump | 3 level jump | 4 level jump

Figure 3.26

- All the students could identify the numbers during the post-test assessment.
- 23% of students who could not identify the numbers were able to solve the questions related to place values which is the highest achievement level or level 4 as per assessment tool.

Assessment Results - Number Operations

As per the assessment results, a majority of students from English (57%) and Odiya mediums of instruction (54%) were at level 4 i.e. they were able to do equal grouping division of 2-digit numbers[22] by the post-test period.

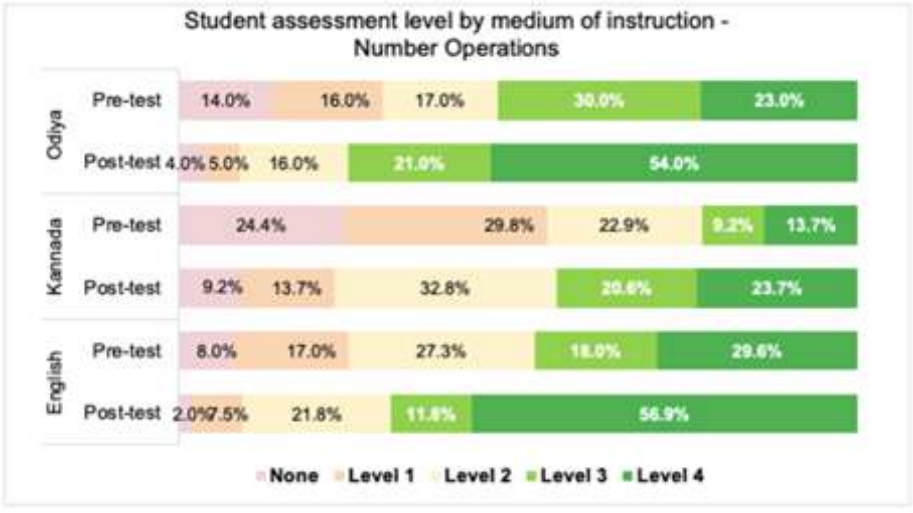


Figure 3.27

[21] https://www.statisticssolutions.com/how-to-conduct-the-wilcox-sign-test/
[22] http://www.dsek.nic.in/Misc/learningoutcome.pdf

The below table shows the level improvement of students across levels in the number operations competency between the pre-test and the post-test. On an average, the change or improvement in levels was statistically significant at 95% confidence level. (Using the Wilcoxon signed rank sum test, test statistic v=0, p-value=<0.005).

Level improvement in students – Number Operations

Pre-test	Post-test				
	None	Level 1	Level 2	Level 3	Level 4
None	30.8%	23.1%	37.2%	6.4%	2.6%
Level 1		28.7%	32.0%	11.5%	27.9%
Level 2			50.0%	19.2%	30.8%
Level 3				40.2%	59.8%
Level 4					100.0%
		1 level jump	2 level jump	3 level jump	4 level jump

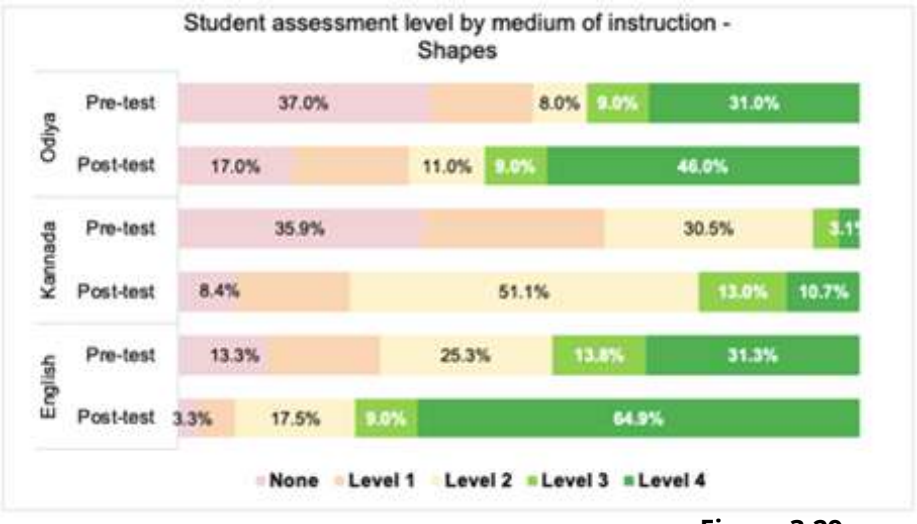
Figure 3.28

- In number operations, atleast 50% of the students have been able to move one level up between the pre-test and the post-test periods.
- 31% of the students were not able to do 2-digit addition questions (level 1 in assessment tool) even during the post-test.

Assessment Results - Shapes

As per the assessment results for the shapes competency,

- A majority of students from English (65%) and Odiya mediums of instruction (46%) were at highest level of competency i.e. they were able to identify properties of 3D shapes[23] by the post-test period.
- Majority of the students from Kannada medium of instruction students (51%) were at level 2 i.e. they were able to identify properties of 2D shapes only.



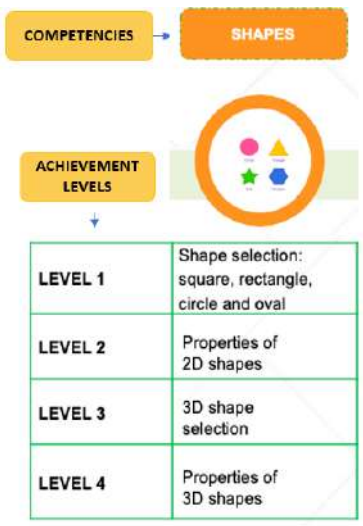


Figure 3.29

[23] http://www.dsek.nic.in/Misc/learningoutcome.pdf

The below table shows the level improvement of students across levels in the shapes competency between the pre-test and the post-test. On an average, the change or improvement in levels was statistically significant at 95% confidence level.(Using the Wilcoxon signed rank sum test, test statistic v=0, p-value=<0.005).

Level improvement in students – Shapes

Pre-test	Post-test				
	None	Level 1	Level 2	Level 3	Level 4
None	29.9%	20.4%	27.7%	8.0%	13.9%
Level 1		27.8%	36.5%	9.6%	26.1%
Level 2			45.6%	12.1%	42.3%
Level 3				30.9%	69.1%
Level 4					100.0%

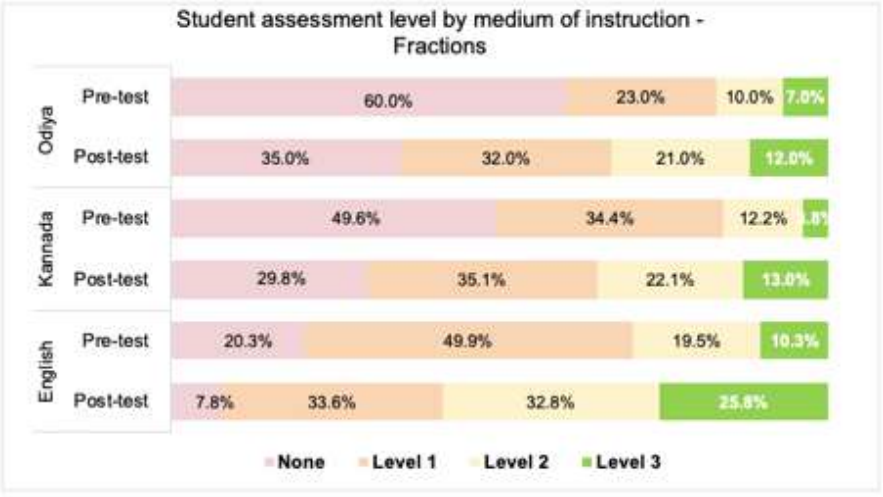
1 level jump | 2 level jump | 3 level jump | 4 level jump

Figure 3.30

- 14% of students who were struggling to identify shapes during the pre-test were able at the highest level of the application defined competency by the post-test.
- Across levels, atleast 54% of the students had a one-level improvement from the pre-test to the post-test.

Assessment Results - Fractions

As per the assessment results across
the different mediums of instruction, there is increase in students who were at the highest level of this competency i.e. they were able to convert numbers from decimals to fraction[24]. This increment was 15% in English medium students, 5% in Odiya medium students and 9% in Kannada medium students by the post-test.



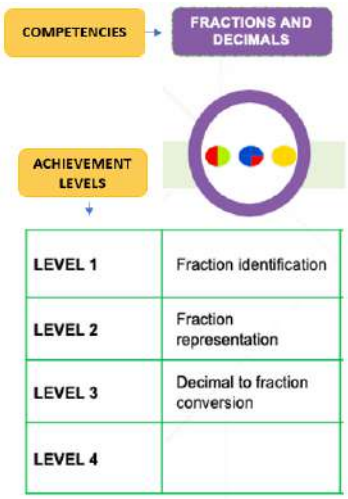


Figure 3.31

[24] http://www.dsek.nic.in/Misc/learningoutcome.pdf

The below table shows the level improvement of students across levels in the fractions competency between the pre-test and the post-test. On an average, the change or improvement in levels was statistically significant at 95% confidence level.(Using the Wilcoxon signed rank sum test, test statistic v=0, p-value=<0.005).

- Across levels, atleast 20% of the students had a one-level improvement from the pre-test to the post-test.
- 7% of the students who were not at any level of the fractions competency during the pre-test, were at the highest possible competency by the post-test.

Level improvement in students – Fractions

Pre-test	Post-test			
	None	Level 1	Level 2	Level 3
None	51.2%	27.3%	14.1%	7.3%
Level 1		58.3%	25.9%	16.2%
Level 2			79.6%	20.4%
Level 3				100.0%

1 level jump | 2 level jump | 3 level jump

Figure 3.32

Assessment Results - Measurement

As per the assessment results, a majority of students were at the highest measurement competency i.e. they were able to do height, weight and volume comparisons[25] by the post-test period.

- A majority of the English medium students (96%), Kannada medium students (80%) and Odiya medium students (79%) were at the highest level i.e. at level 4 by the post-test.
- All students of Odiya and English students are able to solve questions related to spatial relationship i.e. were at level 1 or beyond by the post-test. 1% of Kannada medium students, however, were still not able solve any problems related to measurement.

[25] http://www.dsek.nic.in/Misc/learningoutcome.pdf

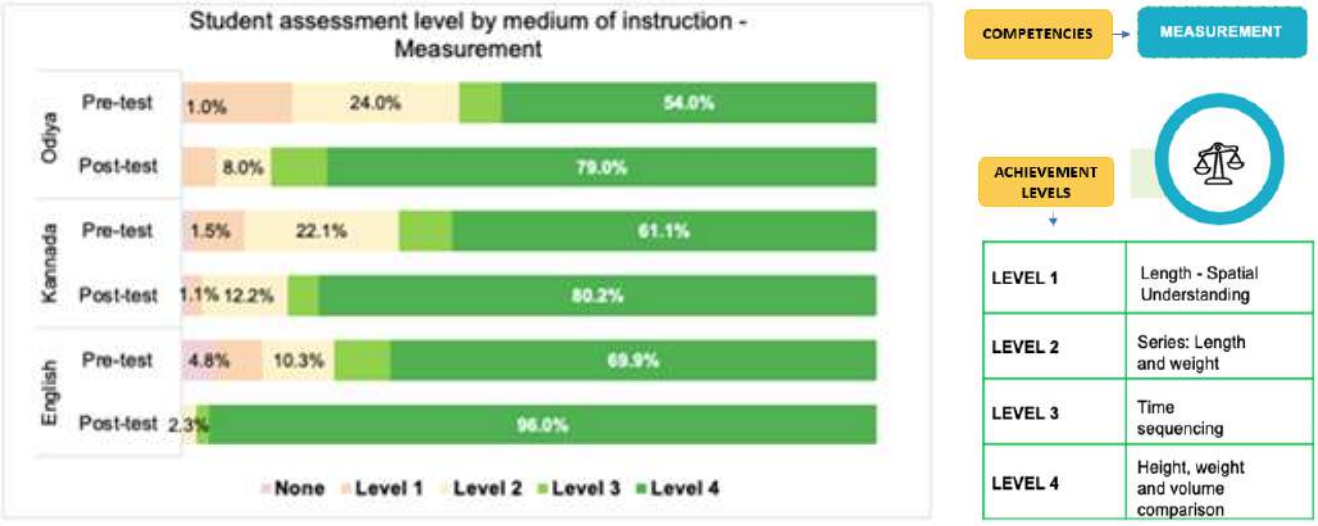


Figure 3.33

The following table shows the level improvement of students across levels in the measurement competency between the pre-test and the post-test. On an average, the change or improvement in levels was statistically significant at 95% confidence level. (Using the Wilcoxon signed rank sum test, test statistic v=181, p-value=<0.005).

Level improvement in students – Measurement

Pre-test	Post-test				
	None	Level 1	Level 2	Level 3	Level 4
None	4.5%	4.5%	0.0%	0.0%	90.9%
Level 1		9.4%	20.8%	3.8%	66.0%
Level 2			25.8%	8.6%	65.6%
Level 3				22.9%	77.1%
Level 4					100.0%

1 level jump | 2 level jump | 3 level jump | 4 level jump

Figure 3.34

- 91% of the students who could not do any of the measurement problems in the pre-test were solving height, volume and weight comparison questions (level 4 in our assessment tool).
- Measurement is the competency where considerable improvement was seen in level among students. On an average, about 65% of students were able to clear all the levels.

[25] http://www.dsek.nic.in/Misc/learningoutcome.pdf

The application's difficulty level and competencies should be adapted to students of varying learning abilities

As per the 2019 report, "Insights from rapid evaluations of EdTech Products"[26] by Central Square Foundation, it was established that one of the factors that impact student learning ability is when competencies are mapped to student capability levels, especially by using adaptive technology. In case of Akshara Foundation's Building Blocks, it is designed for a basic understanding and knowledge of mathematics amongst students and not for the higher level in accordance with the Bloom's Taxonomy[27]. Some of the students in the study who were already at understanding and knowledge level from the taxonomy, expected more challenging questions from the application.

In schools like Carmel Jyothi and Christel House in Doddaballapur, one key feedback from the teachers was to increase the difficulty of the questions in the application to accommodate students of their school who were already at foundational level in their mathematical skills.

> *In the last 6 months, children who had difficulty understanding mathematical concepts earlier are now showing improvement in their exams. Three of the children from grade 4 used to secure 4-5 marks out of 50 earlier but now they are getting 10-15 marks*
>
> - Teachers from Govt. Girls High School, Bhubaneswar

There has been an increase in the interest of students in mathematics after using the application

The mathematical skills of students have improved

More than 60% of the students are able to solve mathematical sums without anyone's help and have begun to show interest in learning the subject.

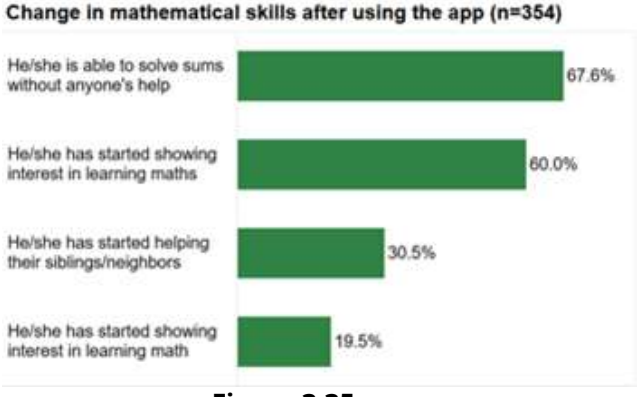


Figure 3.35

[26] http://centralsquarefoundation.org/wp-content/uploads/EdTech Lab Report_November 2019.pdf
[27] https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

> *The application has led to a change in performance of students, especially amongst those who are weaker in their foundational skills compared to others*
>
> - Mrs Manjula, Mathematics teacher, Lavanya English Medium School

Regularity of practicing mathematics at home has increased

- Over the period of the study, students have become more regular in practicing mathematics at home (92% to 99%).
- An increasing number of students (97%) are practicing mathematical sums everyday now vs the pre-test (82%).

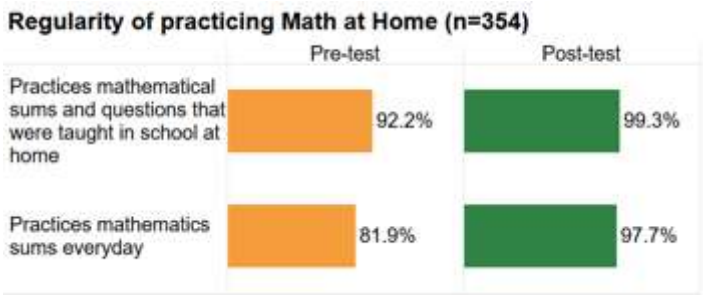


Figure 3.36

Monisha G | *Student of Grade 3, Lavanya English Medium School*

"I like the music, shapes, colors used in the different games on the application. I feel that by using Building Blocks, I can learn mathematics better."

Monisha's mother is an anganwadi worker. Both her parents have studied till grade 10. There are 3 phones in her house. She tells us that she uses the application for 30 minutes every day.

Students have started enjoying mathematics and find it useful

- Between pre-test and post-test, the number of students who dislike mathematics as a subject has reduced (from a drastic 92% to 25% by the end of the post-test)
- There has been a significant increase in the number of students who said they enjoyed studying the subject (67% to 96%) and that they find it useful (34% to 98%).

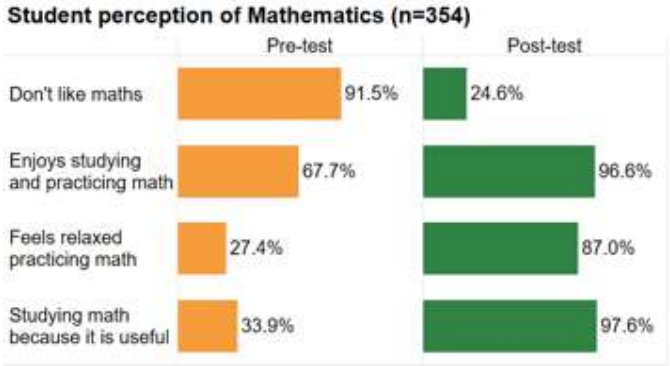


Figure 3.37

Integration of the entire mathematics curriculum on the application will be beneficial for students

Sufficient content coverage of every sub-topic within mathematics would have helped students and teachers dependably use products. The product can then be easily adopted as a regular routine of doing practice at home to help improve a child's learning ability.

With regard to the Building Blocks application, many teachers felt that the number of questions could be increased to cover some of the missed topics by grade. Students also said that they needed to be challenged with even more games and practice questions.

There has been an increase in the confidence of the students to do mathematics

84% of the parents said that there has been an improvement in their child's ability to solve Mathematical problems.

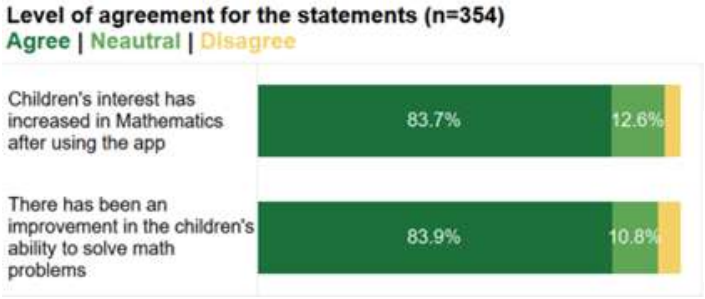


Figure 3.38

> *The students are now able to discuss doubts with their Math teacher and have more confidence in answering questions. They are also able to do single digit multiplication which is a marked improvement from earlier times*
>
> - Mrs Bhanumati, Headmistress, National Academy School

During the parents' survey, the confidence of the students[28] was tested using a mental mathematics question relevant to their grade. There was a clear increase in confidence amongst students across grades from pre-test to post-test.

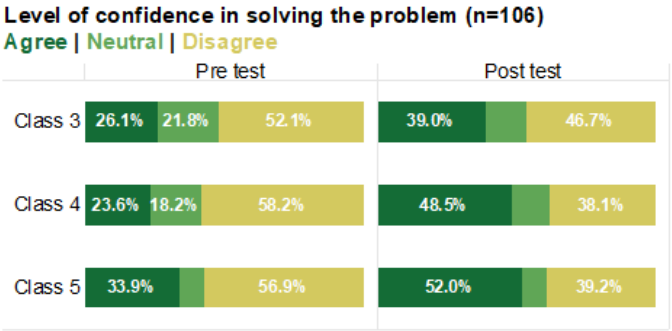


Figure 3.39

From the qualitative discussions with school teachers during the pre-test, it was reported that the confidence of students to do mathematics was not very high and needed improvement. During the post-test, the same teachers said that there has been some improvement in the confidence of the students to do the subject.

Sanika | *Student of Grade 5, Carmel Jyothi School*

"I told my friends and neighbors to use Building Blocks and now they are also using it."

Sanika is a user of Akshara's Building Blocks. Her father is a truck driver while her mother is a housewife. Her parents support her in using the application and also recommend it to her neighboring friends to use it.

Students feel excited to discuss the levels they have completed on the application with their family and friends

64% of the students were discussing the application with their friends and family. Amongst them, more than 68% and more[29] were discussing the number of levels and stars/coins earned in different modes of the application.

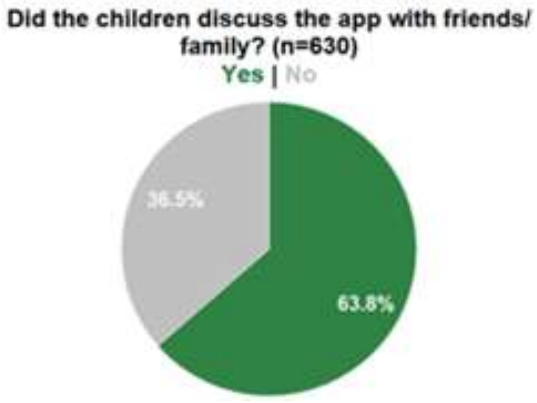


Figure 3.40

[28] Here, n = 106 which is the number of parents who had their children around during the post-test and hence, be able to answer the survey question related to the student's level of confidence.
[29] Here, n = 400 which is the number of students who said that they had discussed the features of the Building Blocks application with others

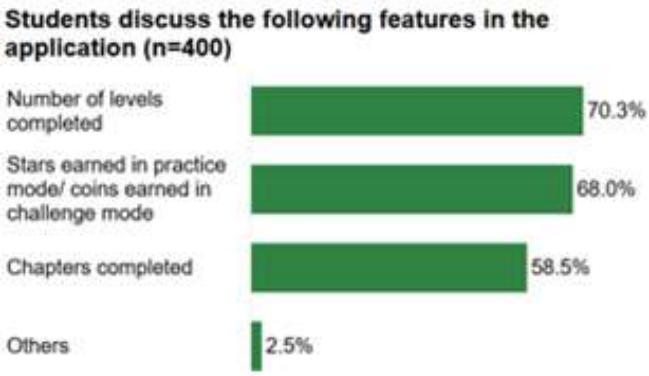


Figure 3.41

Mr. Ramesh and Mr. Ashwatappaiah from Vivekananda School mentioned that the students told them about the games they were playing and the number of coins they earned on Building Blocks. Similar instances and
discussions were also noted from teacher discussions done at Christel House, Carmel Jyothi in Doddaballapur and GGHS School in Bhubaneswar.

Parents who have awareness about the Building Blocks application are satisfied with it

- When asked about their overall satisfaction with the application, the average rating given by 354 parents was 4 on a scale of 5. They are also starting to recommend the Building Blocks application to their friends, neighbors and relatives.

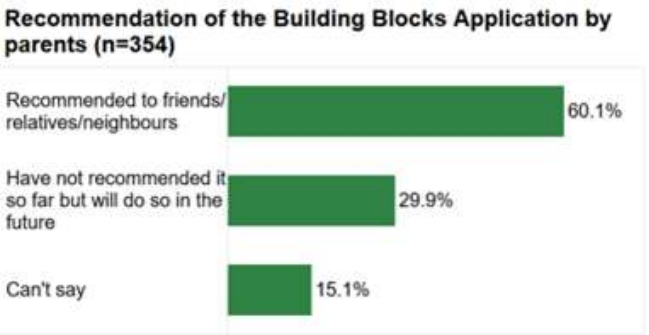


Figure 3.42

> *I think Building Blocks is a very useful application. I have referred two parents whose children study at Dignity School*
>
> - Mrs Muniratna, Mother of Manasa from Christel House

CHAPTER 4:
KEY RECOMMENDATIONS

This section details the recommendations that Sattva provides Akshara Foundation to improve the overall effectiveness of the implementation of the program. This will help in improving the impact that the program will be able to achieve on ground.

For building recommendations on scaling of the Building Blocks program, Sattva conducted in-depth-interviews with internal and external experts who have worked with education technology programs in the past. This included people who have worked with Kaivalya Education Foundation, Teach for India and Sattva's internal project team working on assessing the Google Bolo application.

Challenge 1

Lack of awareness about the Building Blocks application due to limited stakeholder engagement leading to parents not realizing the potential of application-based learning in aiding traditional methods of teaching mathematics

Why is it important to address this?

- A key reason for not downloading the Building Blocks application, as reported by parents, was the lack of awareness about the application and its use among parents.

- The background of the parents included in the Impact Evaluation study is highly diverse in terms of the educational background they provide their children. Their wards study in government-funded schools, low-cost affordable schools as well as private schools. The acceptance of the application was lowest in Kannada medium schools, where most of the parents in the study had never been to school.

- The learning levels of the students across these schools were different owing to the access to resources and technology that the schools provided.

- Also, there is a potential bias towards traditional means of education where parents still feel that school teachers and tuition teachers are key to improving the learning outcomes among students.

What can be done?

Sattva suggests a 4-step approach to design outreach and marketing efforts based on the target group

1) Policy advocacy through engagement with decision makers within state governments, publishing houses, other NGOs to help scale up operations

How to go about it:

- **Liaison with decision making nodal agencies** in the education department across districts to incorporate Diksha books as part of their curriculum. Given the success of this model in Odisha, it is worth replicating the efforts across other states of the country. At the district level, Akshara Foundation should engage with officers from the District Institutes of Education and Training (DIET) who help in coordinating and implementing government policies while the block level co-ordination can be done by coordinating with officers from the Block Resource Centres and Cluster Resource Centres. This will enable ease for the launch and use the application in

primary government schools. States with lowest mathematics learning levels as per latest available data from ASER can be used to prioritize efforts for the same.

- Another approach is to **engage with publishing houses** who have a trusted presence within the community. For e.g. : An established publishing house like Navneet Publications can add the barcode of the Building Blocks application on its mathematics books and can help in word of mouth recommendations to prospective buyers.

- Given the strong focus on digitization of education by the MHRD, Akshara Foundation could also think about **partnering with other NGOs** with similar focus on quality education and with a strong community presence across different geographies. Partnership can be explored with organizations like Pratham, Leadership for Equity, Saajha for outreach in rural and urban communities and this would also help in optimizing cost and resources for Akshara Foundation.

- Establish the presence of the brand through website and digital media channels along with advertisements in local newspapers, magazines and radio channels. It is also crucial for Akshara Foundation to embed Building Blocks application in all its community interactions and establish its branding as a learning application.

2) Build incentives for schools and teachers to get the students to use the application more and leverage the credibility of schools as trusted institutes in the community

How to go about it:

- **Awareness sessions and engagement for teachers:** Teachers have a strong influence on students as well as their parents. Introducing the application in schools will aid the teachers as they can enable and prompt students to practice specific topics that are being taught at school using the application.

- The application can be modified to be better adjusted as a **homework tool** that the teachers can prompt their students to use at home. They could be given admin access to monitor the usage and progress of the students in their class directly in the application itself.

- Teachers could also conduct application-based tests to measure the progress in learning outcomes of the students over time. The teachers could share the progress with the parents and hence, involve them in the learning process on the application. This could reduce their load of giving and correcting regular pen and paper homework. Also, if this model is institutionalized, the application can work as an engagement mechanism between the parents and the teachers.

- In the initial phase, Akshara Foundation could work with the schools to recognize teachers and students that are performing well on the application through newsletter publications for internal school and community consumption.

3) Create a demand for the product amongst the parents by establishing credibility of the application and linking learning outcomes of the application to school curriculum

How to go about it:

- Awareness campaigns for **parents** (specially mothers as they are mostly responsible for the child's education) in collaboration with

  1. Schools (Parent-Teacher Meeting, Annual Day, Sports Meet, etc.)
  2. Community leaders (Festivals and community programs)
  3. NGOs working with same target group (Gandhi Fellows who are part of the Kaivalya Education Program, Teach for India Fellows working with government schools, other NGOs working directly with schools)

- **Mobilize mothers** from community-based organizations like Self Help Groups, Joint Liability Groups, Panchayats, School Management committees based on rural and urban geographies to help build awareness for the benefits of the application.

- Engage with community youth as **digital product relationship managers** to do door-to-door interaction with parents on the merits of the application and help reduce stigma associated with the use of education technology for learning.

- The most crucial factor to get parent buy-in is to build their trust that the usage of the application will help their child score better in school tests. It is imperative that the value proposition of the application is conveyed to be an **extension of the school curriculum** as schools are considered to be a trusted institution by most parents.

- Parents could also be more involved in the learning of their child on the application if they are able to **monitor the progress of their child** on the application through customized visualizations specifically meant for them.

4) Build governance mechanisms to track the implementation progress across communities

- Dissemination efforts can be tracked by **creation of online communication platforms** like on WhatsApp. A digital product relationship manager of a community can help Akshara Foundation create and monitor the groups where parents can post their queries.

- From the discussions for the study with one of the education experts, Saarthi Education, an NGO dedicated towards transforming parents' engagement in their child's development has deployed this successfully for their dissemination efforts. Currently, they are able to reach around 900 families in Delhi through WhatsApp. In their model, a user signs up through a centralized WhatsApp number post which grade-wise information is disseminated by coordinators using broadcast messages and feedback data is

collected through digital automations for furtherfollow-ups.

- This model apart from serving as an effective governance mechanism could also help Akshara Foundation to amplify success stories of the users through videos and snippets.

Challenge 2

Usage of the Building Blocks application reduced (in some cases also leading to uninstallation) after the introduction of the application in September 2019 (when the baseline was conducted) up until February 2020, when the end line was conducted for the study.

Why is it important to address this?

- Most of the students have limited access (less than 1 hour) to smartphones as parents are mostly daily wage workers and feel that the children use the application for playing games rather than for educational purposes. Owing to the parents' occupation, there is limited to low monitoring of what the child is using the smartphone for.

- The key reasons for uninstallation of the application include:

1. Hanging of the smartphone and/or Building Blocks application while opening/using the application
2. Reduced motivation of the child to use the application due to lack of clarity on how to navigate through it
3. Some students, who are at the highest level of a competency, seek more difficult questions and challenges and this may also be leading to uninstallation of the application.

What can be done?

Plan and execute concurrent engagement and monitoring activities for user support and nudges

- Establish a call center for customer care for responding to troubleshooting on the application.

- Digital product relationship managers can be deployed across communities to do door-to-door interaction with parents at regular intervals and hence, drive the usage of the application.

- Child controls can be created on the smartphone to prevent its misuse. Training can be done of women groups mobilized in the implementation process or of the community based digital relationship managers to help families set up these controls.

- There could be an additional functionality in the application for parents to enter details about their availability by time in the day. Nudges to parents could then be sent as automated messages by timing them to this information through the application itself.

- Engage with students to understand their inputs on user interface and user experience.

Launch periodic version updates of the Building Blocks Application

- Strengthen the content of the application by adding more questions and increasing the difficulty levels across competencies. The application should be periodically updated mapping the usage data at the backend and from feedback received on the experience from users.

Teachers across schools could be the nodal communication to receive feedback for all the students who are using the application in their class.

- Introduce a cartoon character that helps the child in navigating through the application.

- The application should be able to navigate the child to the level most suitable for the user by being adaptive in changing the levels for each individual user.

- The progress of the user should be quantified and visualized using dashboards on the Building Blocks application. The dashboard could help build insights on the following:

1. Level or grade for different competencies as per the student's current performance
2. If 100% is the highest level for a particular competency, what is the improvement needed by the student to achieve that level
3. Percentage of active users who are on a level below and above the student in the same grade

- These visualizations could be aggregated at a grade/school/community level for tracking of the class progress by the teachers and by Akshara Foundation's implementation team for reporting purpose.

ANNEXURES

Annexure 1: Execution of the study

The following describes the final list of stakeholders that were included in the study across 13 schools in Bhubaneswar and Bengaluru.

School-wise Data Collection execution details

			STUDENT ASSESSMENT		PARENT SURVEY	
Location	**Medium of Instruction**	**School name**	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
Bengaluru Urban	Kannada	GHPS Bellandur	73	56	35	33
		GMPS Kamala Nagar	25	21	8	5
		SG Kannada Medium School	84	75	38	37
	English	SG English Medium School	106	92	49	45
		Bengaluru Montessori School	27	16	6	1
		National Academy School	35	33	1	1
Bengaluru Rural		Lavanya English Medium School	70	56	29	18
		Carmel Jyothi, Doddaballapur	285	254	127	72
		Christel House, Doddaballapur	141	122	21	19
	Kannada	Swami Vivekananda School, Doddaballapur	104	77	65	62
Bhubaneswar	Odiya	GPUPS IRC Village	65	56	37	39
		GPS Saliasahi	69	56	42	30
		GGHS Unit 2	35	29	21	18
TOTAL			**1119**	**943**	**479**	**380**

Table 3

Qualitative Data Collection details

		TEACHER/ HEADMASTER INTERVIEW		CASE STUDIES
Location	**Medium of Instruction**	**Pre-test**	**Post-test**	**Post-test**
Bengaluru Urban	Kannada	3	4	8
	English	1	2	14
Bengaluru Rural	Kannada	1	3	9
	English	4	6	28
Bhubaneswar	Odiya	6	5	30
TOTAL		**15**	**20**	**89**

Table 4

Annexure 2: Students Assessment Tool

Number Sense

Level 1

Identify 5 or more of the following numbers to progress to the next level

Level 2

Question for child: Sequence the following numbers in the given form

(Ascending): 19, 78, 12, 33, 51

(Descending): 19, 78, 12, 33, 51

Level 3

Number comparison: Larger of the two numbers

Which bundle has more no. of sticks

i) 12, 14

ii) 11, 13

iii) 16, 18

Level 4

Find place value of the given number.

i) 1 in 137

ii) 3 in 239

iii) 4 in 874

iv) 9 in 891

v) 6 in 765

Number Operations

Level 1

Addition

91 + 45	35 + 68	34 + 25	37 + 61	62 + 78

Level 2

Subtraction

39 - 12	27 - 19	34 - 18	54 - 29	16 - 7

Level 3

Multiplication

17 X 3	13 X 7	19 X 4	29 X 2	28 X 3

Level 4

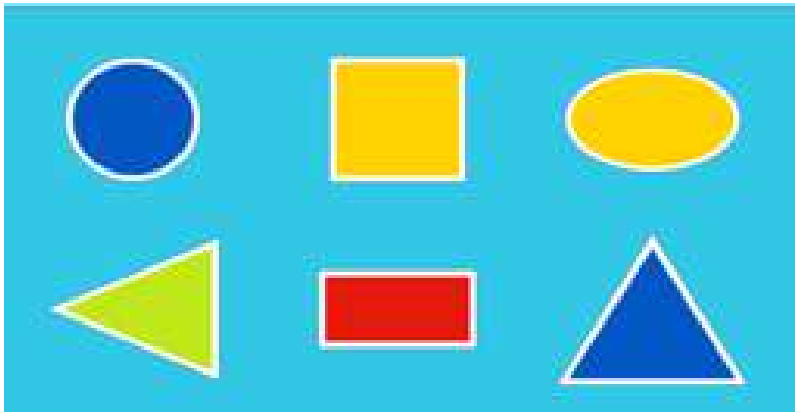
Division

39 ÷ 3	36 ÷ 9	21 ÷ 7	18 ÷ 6	72 ÷ 8

Shapes

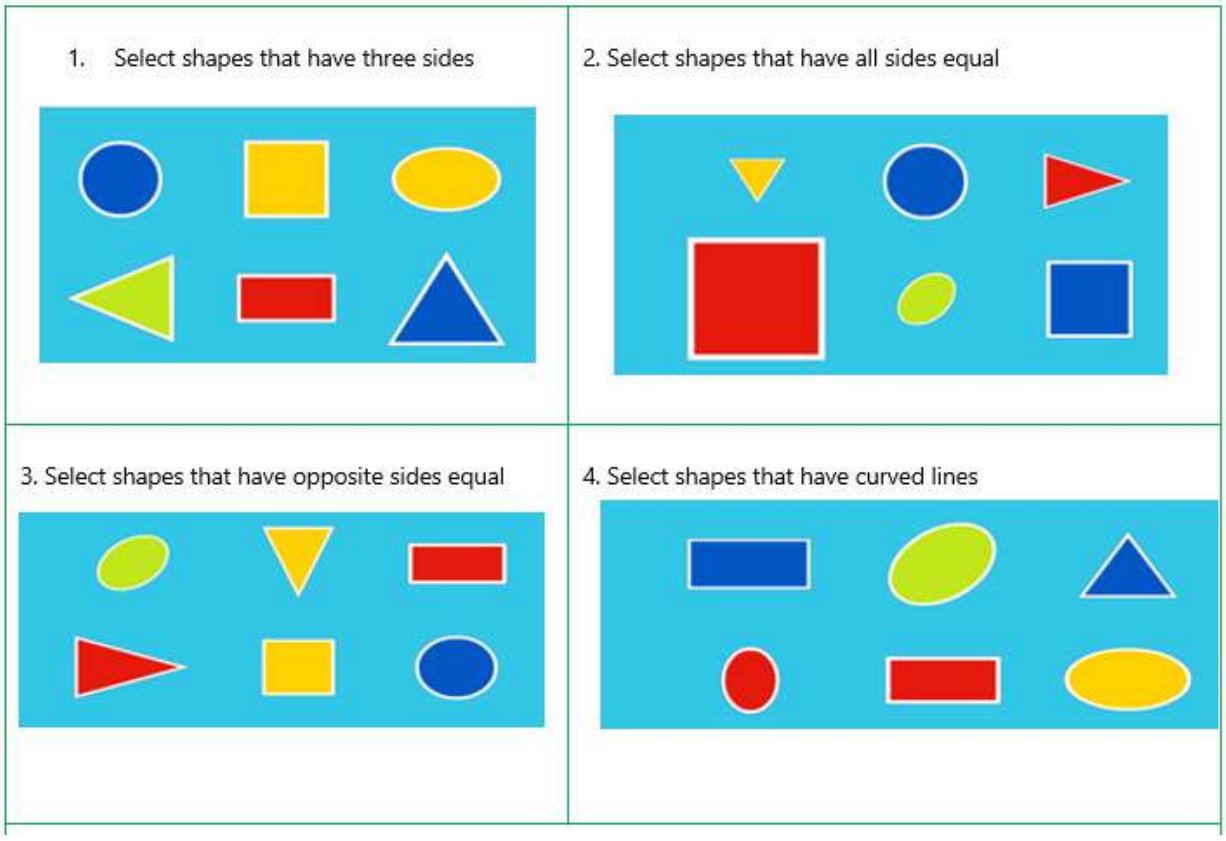
Level 1

Please identify the shapes

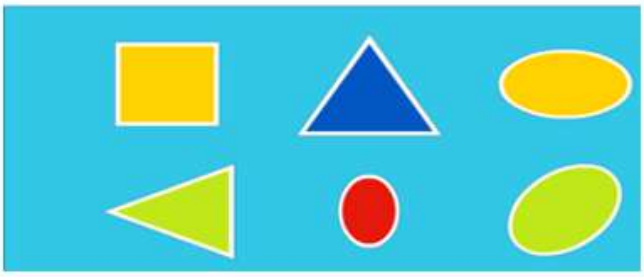


Level 2

Properties of 2D shapes:

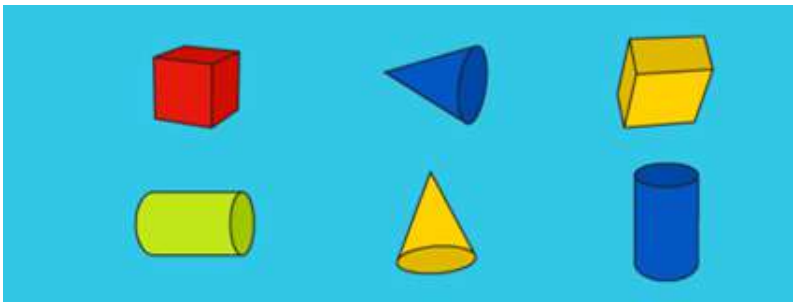


5. Select shapes that have only three corners



Level 3

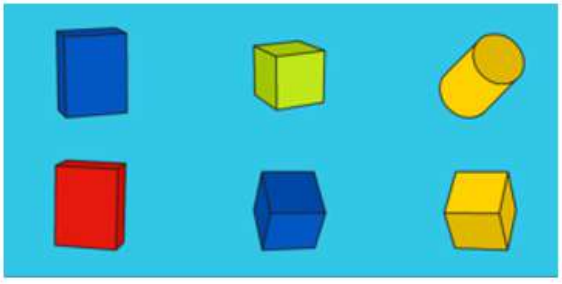
Please identify the following 3D shapes



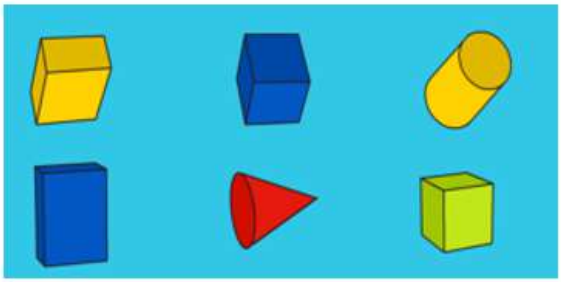
Level 4

Properties of 3D shapes:

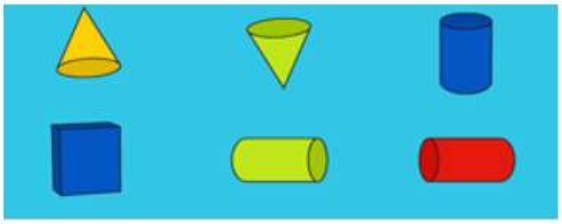
1. Select the shape with all flat surfaces



2. Identify all faces of the shape with all flat surfaces



3. Select the shape with a curved surface



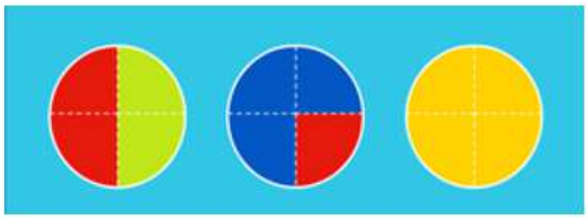
4. Select the shape with a circular top

Fractions and Decimals

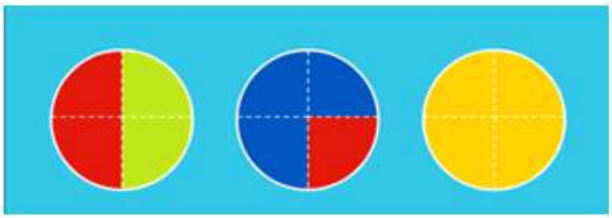
Level 1

Fraction identification

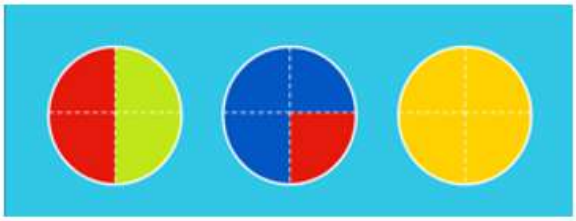
1. Select the object/parts divided in ½



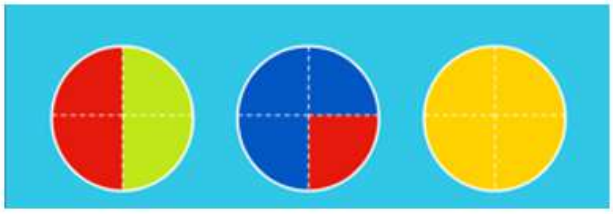
2. Select the object divided into ¼



3. Select the object divided into ¾



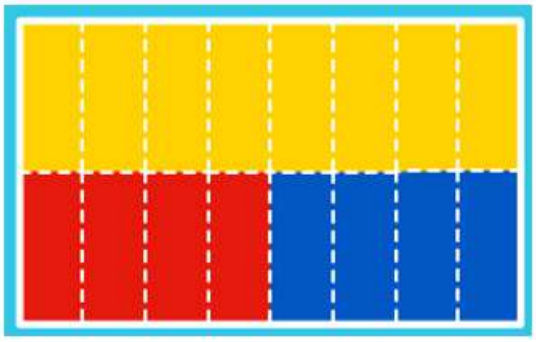
4. Select the object divided into 2/4



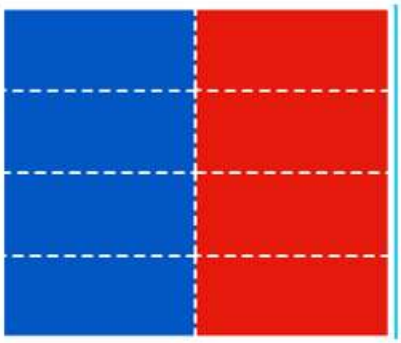
Level 2

Fraction representation

1. Represent the fraction in 'blue' in first Rectangle



2. Represent the red portion in fraction



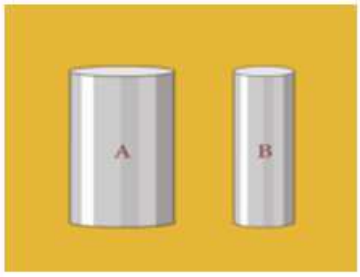
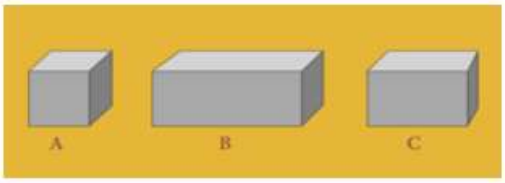
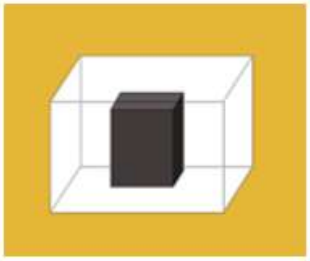
Level 3

Decimal to fraction conversion

A) Represent the following in Decimals	B) Represent the following in Fractions
1. ½	1. 0.25
2. ¼	2. 0.50
3 . ¾	3 . 0.75

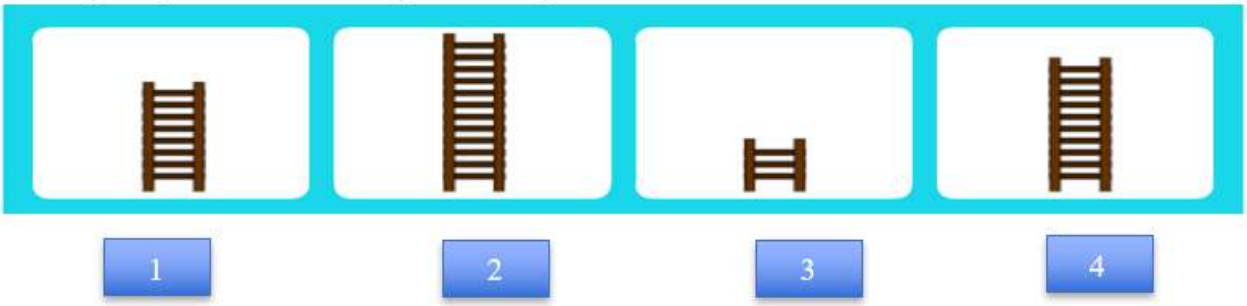
Measurement

Level 1

1.Which of the two is the thicker rod	2. Which cuboid is the longest	3.Which of the two is inside: White or Black
		

Level 2

1. Arrange the given rod in decreasing order of height



2. Arrange the given objects in increasing order of length

3. Which is thick/thin	4. Arrange the given objects in decreasing order of their width
	

Level 3

Time sequencing

1. What day comes after Wednesday?	3. What month comes after April?
2. Select the last Saturday of the month: 	4. What is the time denoted by the watch: 

Level 4

Height, weight and volume comparison:

1. Which of the two objects is heavier?

2. Which of the two objects is taller?

3. Which of the two objects is lighter

ABOUT SATTVA

Sattva (www.sattva.co.in) is a social impact strategy consulting and implementation firm. Sattva works closely at the intersection of business and impact, with multiple stakeholders including non-profits, social enterprises, corporations and the social investing ecosystem. Sattva's work pans across multiple states in India, multiple countries in Africa and South Asia, on the ground, and Sattva has engaged with leading organizations across the globe through its practice in strategic advisory, realizing operational outcomes, CSR knowledge assessments, and co-creation of sustainable models. Sattva works to realize inclusive developmental goals across themes in emerging markets, including education, skill development and livelihoods, health care and sanitation, digital and financial inclusion, energy access and environment, among others. Sattva has offices in Bangalore, Mumbai, Delhi and Paris