


CLIx

CONNECTED LEARNING INITIATIVE

CHHATTISGARH | MIZORAM | RAJASTHAN | TELANGANA

# Making EdTech Work for Secondary School Students & their Teachers

## Research Findings from CLIx Phase I


CLIx Research Team


**2020**

*Winner of* ***OER Collaboration Awards for Excellence 2019*** *from Open Education Consortium*

Winner of the UNESCO - King Hamad Bin Isa Al-Khalifa Prize
for its outstanding contribution to the theme
*"Use of ICT to Increase Access to Quality Education"*

An initiative seeded by

TATA TRUSTS

Led by

Massachusetts Institute of Technology

TISS/CEI&AR/CLIx/2020/Rp/18Dec2020/12

The Connected Learning Initiative (CLIx) is a technology-enabled initiative at scale for high school students. The initiative was seeded by Tata Trusts, Mumbai with Tata Institute of Social Sciences, Mumbai and Massachusetts Institute of Technology, Cambridge, U.S.A. as founding partners. It offers a scalable and sustainable model of open education and is a bold effort to bring innovation and global best practices, adapted to the Indian context, to meet the educational needs of students and teachers.

CLIx incorporates thoughtful pedagogical design and leverages contemporary technology and online capabilities. Resources for students in the areas of mathematics, sciences, communicative English and digital literacy are designed to be interactive and to foster collaboration and integrate values and 21st century skills. These are being offered to students of government secondary schools in Chhattisgarh, Mizoram, Rajasthan and Telangana in their regional languages and are also released as open educational resources (OERs).

Teacher professional development is available through professional communities of practice and the blended programme Postgraduate Certificate in Reflective Teaching with ICT. Through research and collaborations, CLIx seeks to nurture a vibrant ecosystem of partnerships and innovation to improve schooling for underserved communities.

CLIx was awarded the UNESCO King Hamad Bin Isa Al-Khalifa Prize for the Use of ICTs in Education for its outstanding contribution to the theme Use of ICT to Increase Access to Quality Education (March 2018). CLIx won the OER Collaboration award for Excellence 2019, under the category resources, tools and practices from Open Education Consortium. (http://clixoer.tiss.edu).

Collaborators: Centre for Education Research and Practice, Jaipur; Department of Education, Mizoram University, Aizawl; Eklavya, Bhopal; Homi Bhabha Centre for Science Education, TIFR, Mumbai; National Institute of Advanced Studies, Bengaluru; State Council of Educational Research and Training (SCERT) of Telangana, Hyderabad; State Council of Educational Research and Training, Chhattisgarh; Tata ClassEdge, Mumbai; Inter-University Centre for Astronomy and Astrophysics, Pune; Government of Chhattisgarh; Government of Mizoram; Government of Rajasthan; Government of Telangana



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The CLIx partnership and wider ecosystem participated and contributed to all aspects of the intervention as well as design and data gathering, interpretation, analysis and reflection. We are grateful for their sustained interest and support.

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# Abbreviations

| | |
|---|---|
| AY | Academic Year |
| BC | Backward Castes |
| CBAM | Concerns Based Adoption Model |
| CG | Chhattisgarh |
| CLIx | Connected Learning Initiative |
| CMOS | Complementary Metal Oxide Semiconductor |
| CoP | Communities of Practice |
| COUHES | Committee on the Use of Humans as Experimental Subjects |
| CR | Classroom |
| CRO | Classroom observation |
| DISE | District Information System for Education |
| DS | Digital Skill |
| ES | Endline Survey/Endline Study |
| FGD | Focus Group Discussion |
| FRC | Field Resource Coordinators |
| HDD | Hard Disk Drive |
| ICT | Information and Communication Technology |
| IDPD | Innovation Diffusion and Process Documentation Study |
| IMT | Intervention Monitoring Tool |
| IRB | Institutional Review Board |
| KAP | Knowledge, Attitudes, Practices |
| LAN | Local Area Network |
| LO | Learning Outcomes |
| MIT | Massachusetts Institute of Technology |
| MOOC | Massive Online Open source Course |
| MZ | Mizoram |
| OBC | Other Backward Castes |
| OER | Open Educational Resources |
| PUC | Pre University College |
| RJ | Rajasthan |
| RMSA | Rashtriya Madhyamik Shiksha Abhiyan |
| RTICT | Post Graduate Certificate in Reflective Teaching with ICT |
| SC | Scheduled Castes |
| SCERT | State Council of Educational Research and Training |
| ST | Scheduled Tribes |
| TISS | Tata Institute of Social Sciences |
| TPD | Teacher Professional Development |
| TS | Telangana |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| VGA | Video Graphics Array |


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# Executive Summary

The Connected Learning Initiative (CLIx) is a technology-enabled initiative at scale for high school students. The initiative was seeded by Tata Trusts, Mumbai, and is led by Tata Institute of Social Sciences, Mumbai, and Massachusetts Institute of Technology, Cambridge, MA, USA. CLIx offers a scalable and sustainable model of open education to meet the educational needs of students and teachers. In March 2018, the initiative won UNESCO's prestigious King Hamad Bin Isa Al-Khalifa Prize for the Use of Information and Communication Technology (ICT) in the field of Education. CLIx incorporates thoughtful pedagogical design and leverages contemporary technology and online capabilities. Resources for students are in the areas of communicative English, mathematics, sciences, and digital literacy. They are designed to be interactive and to foster collaboration and integrate values and 21st century skills. These are being offered to students of government secondary schools in Chhattisgarh, Mizoram, Rajasthan and Telangana in their regional languages and are also released as open educational resources (OER) (clixoer.tiss.edu). Teacher professional development (TPD) is available through professional communities of practice established over the Telegram application on mobile phones, workshops and modular courses which are a part of the blended Postgraduate Certificate in Reflective Teaching with ICT (offered on tissx.tiss.edu). Through research and collaborations, CLIx seeks to nurture a vibrant ecosystem of partnerships and innovation to improve schooling for underserved communities.

CLIx was conceptualised as an action research programme. Research has been integral to the ongoing activities of CLIx, from design and implementation at scale to questions about adoption and impact of the programme. In terms of its total outreach, as of November 2019, CLIx has reached 398 schools, 385 of them with functional labs, 76,226 students, 3,509 teachers and 244 teacher educators across the four states. In 2015–16, districts were selected - 1 district in Chhattisgarh (CG), 1 district in Mizoram (MZ), 2 districts in Rajasthan (RJ) and 3 (later reorganised into 13) districts in Telangana (TS). In these districts, CLIx Intervention schools were selected from among those schools that had received ICT labs under the ICT@Schools phase 3 or later. This research report is drawn from research studies across CLIx schools that inquired into aspects of student cognitive and non-cognitive learning, TPD, curricular and technology integration, extent and quality of implementation of CLIx offerings in schools, monitoring and evaluation of its design and intervention, and diffusion of the innovation at the micro, meso and macro levels.

The research objectives of CLIx were achieved through studies conducted throughout the period of CLIx initiative, from the design phase to the implementation phase between 2015 and 2019. Specific studies were designed to answer research questions to inform the programme objectives including the design and development of CLIx, the dynamic processes and constituents of the programme and evaluation of its impact: (1) the Baseline-Endline study conducted at the beginning of the intervention between August and October 2016 and at the end of the intervention between January to March 2019; (2) two midline reviews conducted in April-May 2017 and January-February 2018 of select schools in CG, MZ, RJ and TS where the implementation had been rolled out; (3) the monitoring and evaluation study of CLIx design and intervention conducted during the academic year of 2018–19, including a study on student learning outcomes with respect to CLIx student modules in English, mathematics and science; (4) the Innovation Diffusion Process Documentation study conducted in two separate rounds in 2017 and 2019. Each of these studies involved collection of data from multiple sources, viz., students, teachers, principals, officials, parents and key members of CLIx, and using a variety of tools such as surveys, interviews, observations and digital platforms. This report presents findings from the major research studies listed above, conducted across CLIx to answer questions relating to the quality of CLIx implementation and its impact.

**CLIx research is guided by the following theory of change.**

1. Students' interest and engagement in communicative English, mathematics and science will improve when they have an opportunity to engage firsthand with interesting activities built on technological affordances mediated by teachers.
2. Teachers' ability to use technology in classrooms will improve when they receive professional development offerings and have access to continuous interaction with subject experts and peers in their communities of practice.
3. Quality of classroom processes will improve when teachers and students are provided with resource-rich technological affordances that provide scaffolding and space for exercising autonomy and when they are enabled to use these offerings with provision of adequate infrastructure and active support of school leadership, local ecosystem and government agencies.

This report is divided into nine sections. The first section provides an outline of the report. Section two gives details of the key research studies this report draws upon, including the data sources, sample size and methodology. Sections three, four, five, six, seven and eight, report findings pertaining to conditions for implementation, adoption and impact on teachers and students, and section nine provides the conclusions.

'Were conditions for effective implementation met in CLIx?' is the question answered in section three. A high percentage of CLIx schools were located in rural areas and in underserved regions of the country (85% of schools in CG & TS and 83% in RJ were in rural areas; 93% of schools in MZ were urban), the status of power supply, lab infrastructure, and availability of functional equipment are examined. Based on data from the intervention monitoring tool (IMT) used during field visits by field resource coordinators (FRCs) throughout the year, it is concluded that these conditions were met and at satisfactory or above satisfactory level in the intervention schools. Power outages were reported, and this was found to affect implementation in 20–25% of schools visited. Systems were in place to ensure a high level of functionality of ICT labs in all schools. Data from the CLIx platform which was uploaded on school servers showed that it was stable and trouble-free. Over 2,423 teachers from CLIx schools had received TPD and reported 90% level of satisfaction on the quality of training. About 67% of teachers who were in the baseline study were not a part of the endline study. This was largely on account of transfers that took place, especially in Rajasthan and Telangana, during the period of the intervention. Furthermore, in the same school, not all students taught by a CLIx-trained teacher had the opportunity to use CLIx resources in the ICT lab. Especially in cases of schools with large class size, students were batched and selected for lab classes on account of the limitations in lab size. Survey data from students, teachers and principals showed that these key stakeholders were positively disposed towards CLIx. Evidence gathered from the field thus establishes that, to a great extent, pre-conditions for ICT-based integration into schools was satisfied in the CLIx schools, although there was considerable variation in the extent of teachers' exposure to CLIx and overall functionality of school ICT labs.

Section four discusses findings from the Monitoring and Evaluation of CLIx Design and Intervention study and examines the process, and extent, of CLIx usage in schools. This section draws on data from school observations using IMT and student data from the CLIx platform on use of CLIx resources. The observational findings from IMT show that, in over 40% of CLIx schools at least 50% of CLIx student modules in all three subjects were used by students in ICT labs, in the states of Chhattisgarh, Mizoram and Rajasthan. Data from the CLIx student platform available for 218 schools showed an average of 40 unique logins per school, and over all, in 52% of CLIx schools 50% or more of the modules had been accessed.

Section five of the report presents research findings from the CLIx intervention at the level of teachers. The role of the teacher is central in the CLIx intervention design, with TPD aimed at developing teacher capacity for ICT use and integration into subject teaching, influencing their beliefs towards ICT use in education and using a practice-based approach. It was found that 162 ‘panel’ teachers (i.e., teachers who were part of the baseline as well as the endline surveys) from all four states reported a statistically significant increase in their advanced digital skills such as use of digital tools, applications and the internet (0.35 points on a scale of 1–5); online ICT skills (0.21 points on a scale of 1–4); and improved perception of challenges associated with teaching with computers (extrinsic) (0.20 points on a scale of 1-5). Teachers’ responses to the survey question on their concerns regarding CLIx showed that 45.42% of teachers were at stage 01 of concerns (on a scale of 0 to 6) about adoption, suggesting that they still needed to know more about the programme. Across stages 0–3, panel and non-panel teachers were equally represented. However, a larger proportion of panel teachers were found to be in stage 4 (23%) as compared to the non-panel teachers (12%). This suggests that with greater experience with CLIx (3 years as opposed to 1–2 years), there is a higher level of adoption.

Section six reports findings pertaining to student learning from two distinct studies, the learning outcomes study and the endline study. The learning outcomes study used a quasi-experimental research design to assess student learning on select CLIx modules, where implementation by existing teachers, followed high fidelity to design. CLIx modules were found to result in statistically significant learning gains (t-tests at 95% significance or higher), thus providing evidence of the quality and efficacy of CLIx learning resources in English, mathematics and science. English elementary was tested in schools in Mizoram, and students showed significant gains in listening skills. Geometric Reasoning was tested in Chhattisgarh, and Basic Astronomy was tested in Rajasthan.

The endline study was conducted with the same sample set of CLIx (165) and control (55) schools as used in the baseline (AY-2016) across all four intervention states. Surveys were done at the level of students, teachers and school heads. The student survey had two tools: the student general tool gathered data regarding background, self-reporting of ICT skills and perceptions regarding ICT in education, and a section on feedback for CLIx schools. The student learning assessment tool tested overall competencies and concepts from English, mathematics and science at the 9th grade level. The teacher survey had two tools. The teacher tool collected data on teacher backgrounds, their attitudes and perceptions regarding ICT integration. The teacher feedback tool obtained feedback on CLIx resources. The principals’ survey consisted of the school principal tool that captured data on the school heads’ perceptions regarding ICT in school and a principal feedback tool that gathered feedback on CLIx resources. On assessing the extent of ‘CLIx treatment’ received by student groups, it was found that there was variation in teachers (wrt TPD received and years of experience of using CLIx) and opportunity to use CLIx modules in lab (whether having ICT lab classes or not). Accordingly, an analysis plan was adopted for comparisons between six types of CLIx treatment. Results are based on comparisons between Group I students who were taught by teachers having maximum TPD and had experience of using CLIx resources in ICT lab, Group II students who were taught by teachers with maximum TPD but did not have experience of using the CLIx resources in ICT lab, Group VI which was an internal control group and Group VII, the external control.

In the endline survey, English test scores of students in full CLIx treatment (Group I) were better than the external control (Group VII). The group with only high TPD input (Group II) also scored better than internal and external control groups (VI and VII), significant with a small effect size in the case of the latter. Science scores of Group I were significantly better with a small effect size than those in the group that had the teacher with high TPD but not the access to CLIx lab (GII). Science scores of girl students with full CLIx inputs (GI) were significantly better than those in internal control (GVI) with a small effect size as well as in comparison with those of Group II . Maths scores of students from Group II were better than Group I. The endline survey generally suggests that there are positive gains in English and science while in the case of maths, CLIx TPD was effective in improving learning gains for students in general as well as for the girls and SC/ST in particular.

Comparing the findings on student learning from the learning outcomes and endline study, it can be noted that the student learning scores were better in the topics for which CLIx modules were made available while a similar outcome was seen for English and science across grade level topics as assessed during the endline survey. Taking into account state level variations in CLIx subject module implementation, a sample test of student learning of Geometric Reasoning in Chhattisgarh (where implementation of GR module was in 83% schools), showed that the students in the high CLIx input group performed significantly better than the external control and the group that had teachers with high TPD but without the benefit of CLIx resources.

Among girl students those in Group I (i.e. receiving high CLIx inputs in terms of teachers with TPD and usage of CLIx resources in ICT lab) performed significantly better with effect size as compared to Groups VI (internal control) and II (only high TPD) in the case of science. Significantly better performance in English was noted for the high CLIx input group (GI) as compared to the external control in the case of girls and SC/ST students. With regards to a range of ICT skills, there was a positive effect of using CLIx resources in the ICT lab. The opportunity to use ICT-based resources benefited girls and students from SC and ST communities in particular.

Comparison of the classroom practices and student behaviours of CLIx and control classrooms did not show differences. However, in CLIx ICT labs, teachers were observed to be engaging in practices that were more supportive of student learning and students were seen exhibiting active learning behaviours. In the student learning outcome study, comparison of CLIx and control classroom observations showed positive gains in CLIx classrooms. In English classrooms, students were observed taking ownership of their learning, engaging in peer collaborations to discuss and produce language. In the case of Geometric Reasoning, observations showed classroom discussions took up 60% of classroom time in CLIx schools while teacher talk took up 70% of the time in non-CLIx schools. Students from CLIx intervention groups also reported having more active learning opportunities and more opportunities to use ICT for learning.

The innovation diffusion and process documentation (IDPD) study provided insights regarding perceptions of key stakeholders through in-depth qualitative interviews and focus group discussions. Students said CLIx helped them understand concepts better and it was appealing and enjoyable to learn through games and other activities. It gave them confidence to work on the computer. They mentioned that at times, it was challenging and frustrating to learn when the teacher was not present in the lab. Teachers reported that their TPD was useful when it was based on the implementation and practical aspects and that they found CLIx field members' support helpful in rolling out lab sessions. They felt that the hands-on aspect of CLIx modules were useful for some topics for their students and those who were not participative in regular classes were active in CLIx classes. Unsuccessful roll-out experiences, low student–computer ratios and pressure to complete syllabus were some of the inhibitors. Principals, on the other hand, agreed that CLIx modules were enjoyable for students, helped them learn concepts better and would enable them to 'compete' with private school children. However, the small lab space and smaller number of computers made student batching for ICT-based learning a challenge, particularly as the same teachers were focused on Class 10 board examinations. District officials expressed satisfaction with the quality of CLIx resources and field support to schools but felt that CLIx outreach was small, which made it challenging to give it due attention.

In conclusion, we return briefly to the theory of change guiding CLIx research: improvement in student learning both in cognitive and non-cognitive terms, change in teachers' skills and disposition towards the use ICT and change in pedagogic processes with the provision of necessary infrastructure and support from the leadership and ecosystem.

(i) At the level of student learning and engagement, findings from the two major studies, the endline study (ES) and learning outcomes (LO) study, show that CLIx students perform better when provided the necessary conditions in terms of CLIx-trained teachers and access to CLIx ICT resources in English speaking and listening (from LO and ES), science (from LO and ES), and mathematics (LO). Girls and students from SC, ST and OBC also benefit more from the use of ICT in addition to having a CLIx trained teacher.

Findings from the learning assessment of students in the endline survey indicate that those who received high levels of CLIx inputs in the form of highly trained CLIx teachers and use of CLIx resources had significantly better learning compared to students who did not have these inputs. This was true for CLIx students in English and science, but not for mathematics. For English, having a highly trained CLIx teacher seemed to benefit students even in the absence of CLIx resources, they performed significantly better with small effect sizes compared to those in the external control group. For science, the results were significantly improved with a small effect size in the high CLIx input group compared with the group who had the same teachers but no access to the lab resources. Girl students did significantly better in science when they received high CLIx inputs compared to the internal control and the group who only had a highly trained teacher but not the lab.

(ii) Teachers' advanced digital skills and engagement with professional development online improved significantly with longer engagement with the programme and on receiving the full extent of TPD. Findings from the endline study showed that CLIx teachers who constituted a panel improved in their advanced digital skills, online ICT engagement skills, their perception of challenge associated with teaching with computers and in English and maths, their self-reported active learning and student-centred practices. A similar finding was made for teachers with higher levels of TPD (3 years) from CLIx panel that seems to have contributed to their gain in skills and perceptions of challenge in using ICT. There was, however, a significant decrease in the self-reported practice of student-centred teaching–learning practices in Science. Critical examination of one's own practice emerges as an important factor in interpreting some of the results, for example, all CLIx teachers were found to rate themselves lower in terms of their pedagogic practice in comparison to the non-CLIx teachers. In panel group, teachers with high-TPD (3 years) reporting significantly negative change in levels of student-centred pedagogic practice in Science overtime. This too suggests increased ability to reflect on their practice which is at the core of CLIx TPD.

(iii) In terms of pedagogic change, student reports, observational records of teachers' and students' behaviours in the classrooms, particularly when using CLIx resources, showed better engagement, interest and peer learning on the part of students. Teachers relating to real life, promoting collaborative learning and supporting student learning from mistakes, behaviours aligned with CLIx pedagogic pillars, were evident in CLIx classroom observations.

The learning outcomes study clearly points towards the importance of high fidelity as a factor in obtaining improved learning outcomes in specific areas of CLIx curricular intervention in English, mathematics and science. Positive gains were found for English and science grade level learning for all students with high CLIx inputs and in the case for girls and students of SC and ST categories. For teachers, their extent of TPD seems to be a critical factor in improving their positive attitudes and digital skills and ICT use. Positive gains at student and teacher levels are directly linked to the adoption of CLIx across the CLIx schools as seen in the specific case of student outcomes in Geometric Reasoning in Chhattisgarh. In terms of further areas of inquiry, precise lines of inquiry on student learning based on the extent of use of CLIx resources is needed. Teacher perceptions of their student-centred pedagogic practice need to be examined in relation to their improved ability for reflective practice. Similarly, factors such as teacher transfers that affected effective implementation by trained teachers and low observational data for Telangana schools need to be included for further analysis and interpretation of CLIx impact.

# 1. Introduction

The Connected Learning Initiative (CLIx) is a technology-enabled initiative at scale for high school students. The initiative was seeded by Tata Trusts, Mumbai, in 2015, and is led by Tata Institute of Social Sciences, Mumbai, and Massachusetts Institute of Technology, Cambridge, MA, USA. CLIx offers a scalable and sustainable model of open education to meet the educational needs of students and teachers (clix.tiss.edu). The initiative won UNESCO's prestigious UNESCO-King Hamad Bin Isa Al-Khalifa Prize for the Use of Information and Communication Technology (ICT) in the Field of Education in March 2018 for its outstanding contribution to the theme Use of ICT to Increase Access to Quality Education, with a view to promote innovations in leveraging ICTs for achieving SDG4.[1] In November 2019, the Initiative won the Open Education Consortium OER Collaboration Award for Excellence.[2]

CLIx incorporates thoughtful pedagogical design and leverages contemporary technology and online capabilities. Resources for high school students are offered in the areas of digital literacy, communicative English, mathematics and sciences and are designed to be interactive, foster collaboration and integrate values and 21st century skills with the subject teacher's active involvement. These resources have been developed through a design-based research (DBR) process. They are offered on the CLIx platform that fosters collaboration and creates an off-line internet experience in the school ICT lab. These resources are being offered to students of government secondary schools in Chhattisgarh (CG), Mizoram (MZ), Rajasthan (RJ) and Telangana (TS) in their regional languages or medium of instruction in school (Hindi, Telugu and English). They have also been released as open educational resources (OER) (clixoer.tiss.edu). Teachers in CLIx intervention schools have been provided with teacher professional development (TPD) in the form of workshops, modular courses, and support through professional communities of practice (CoP) established over the Telegram application on mobile phones. The modular courses are a part of the blended Postgraduate Certificate in Reflective Teaching with ICT (RTICT).

Through development, research and collaborations, CLIx seeks to nurture a vibrant ecosystem of partnerships and innovation to improve schooling for underserved communities. This includes six development partners: Eklavya, Bhopal; Homi Bhabha Centre for Science Education, TIFR, Mumbai; National Institute of Advanced Studies, Bengaluru; Tata ClassEdge, Mumbai; Inter-University Centre for Astronomy and Astrophysics, Pune. The four implementation partners are: Centre for Education Research and Practice, Jaipur; State Council of Educational Research and Training, Raipur; State Council of Educational Research and Training, Hyderabad; Department of Education, Mizoram University, Aizawl. Four state partners with whom MOUs have been signed are, Government of Rajasthan, Government of Chhattisgarh, Government of Mizoram and Government of Telangana.

## 1.1 The CLIx Intervention

Between 2015 and 2018, interactive modules were designed, developed and made available on the CLIx platform. The modules were designed on the three pedagogical pillars of (i) authentic learning,

[1] https://en.unesco.org/themes/ict-education/ict-education-prize/previous-laureates,
https://en.unesco.org news/2017-unesco-laureate-clix-shows-how-educational-technology-benefits-underserved-communities
[2] https://www.oeconsortium.org/projects/open-education-awards-for-excellence/2019-winners-of-oe-awards/tools-and-practices-awards/

(ii) learning from mistakes and (iii) collaboration. They were available in English (in Mizoram), Telugu (in Telangana) and Hindi (Chhattisgarh and Mizoram). Each module was designed to run for approximately three weeks, involving work in the ICT lab, classroom activities and field and science lab activities (based on the modules). The ICT lab experiences were designed to be collaborative, interactive exercises, involving two or three students at a terminal, with teachers interacting and guiding them.

The process of intervention roughly followed the following stages and processes in each state, in close collaboration with the relevant state department (SCERT in the case of Chhattisgarh and Telangana and RMSA in the case of Mizoram and Rajasthan).

1. Selecting schools, surveying and readying the school lab by the field implementation team, including field resource coordinators and field technologists (FRCs and FT) ensuring the hardware was in place, the server and LAN were established, and the platform and resources were loaded
2. TPD workshops to introduce teachers first to digital literacy and second to subject pedagogy, followed by teachers being enrolled into the online CoP (in their subject groups) on mobile phones and being enrolled into the Reflective Teaching with ICT course (online component) with an emphasis on the principles of active learning
3. Working with the school head and teachers on scheduling ICT labs into subject teaching and the school timetable, which involved batching in case of large classrooms
4. 'Roll out' involving teachers using the modules and resources, an enabling system for continuous lab maintenance, onsite teacher orientation on CLIx modules by FRCs, monitoring and reporting based on visits by the field team, and data from the server 'syncing' with the main server at TISS.

**2015-16:** In this period, the initial conditions for the intervention were established, including signing of MOUs, assessing ICT and science lab infrastructure conditions in schools, and understanding the kinds of inputs that teachers had received in the past for ICT integration. The CLIx modules' design process began.

**2016-17:** In this period, CLIx module development and pilots were done. Computer labs were readied based on the infrastructure mapping study. Professional development of teachers was done on ICT and digital skills. A few CLIx resources were made available to schools through an 'unplatform'.

**2017-18:** In this period, CLIx platform with most of the modules was available to schools. Professional development of teachers was done through a postgraduate certificate course in the blended mode. The intervention monitoring tool was developed and piloted.

**2018-19:** In this period, all issues pertaining to the platform were addressed and all modules were made available to states. The intervention monitoring tool and practices of field technology support were stabilised. However, there were significant teacher transfers, particularly in Rajasthan and Telangana, requiring extensive reorientation of teachers. This year has been taken as a year of full-fledged implementation of CLIx.

There were notable variations in the manner in which the implementation unfolded in the four CLIx states of Chhattisgarh, Mizoram, Rajasthan and Telangana.

(i) Government partner: Government institutions anchoring the programme varied. In Chhattisgarh, State Council of Educational Research and Training (SCERT) anchored CLIx implementation. In Mizoram and Rajasthan, it was the Directorate of School Education and Rashtriya Madhyamik Shiksha Abhiyan (RMSA). In Telangana, it was SCERT in coordination with Directorate of School Education and RMSA.

(ii) Implementation partner: The implementation in each state was carried out by different institutions and partners. In Mizoram, it was done by the education department of Mizoram University. In Chhattisgarh, it was a direct involvement of TISS. In Rajasthan, CERP, a non-government agency working in education and research, was the implementation partner. The TISS team included field resource coordinators for CG, MZ and RJ, and in Telangana, the SCERT was supported by a small TISS project management team including three FRCs.

(iii) Lab readiness: CLIx schools were chosen on the basis of their lab readiness, for which ICT phase III was taken as the primary indicator. The ground conditions of ICT lab infrastructure within ICT phase III varied considerably in terms of hardware and software capability, which affected lab conditions, platform efficacy, etc. Lab maintenance was contracted out to an external vendor in CG and RJ, and maintaining the labs required close coordination with them.

(iv) The ratio of FRCs to schools varied widely across states, from a ratio of 1:10 in CG, MZ and RJ and overall 3 for 300 schools in TS.

(v) Teacher transfers affected implementation and increased demands for retraining in RJ and TS, but this was not an issue in CG and MZ.

(vi) Class sizes varied considerably across states, posing constraints of timetabling and batching in Rajasthan and Chhattisgarh, but this was not an issue in MZ and TS.

## 1.2 Theory of Change

CLIx intervention and research are guided by the following theory of change.

1. Students' interest and engagement in communicative English, maths and science will improve when they have an opportunity to engage firsthand with interesting activities built on technological affordances mediated by teachers.
2. Teachers' ability to use technology in classrooms will improve when they receive professional development offerings and have access to continuous interaction with subject experts and peers in their CoP.
3. Quality of classroom processes will improve when teachers and students are provided with resource-rich technological affordances that provide scaffolding and space for exercising autonomy and when they are enabled to use these offerings with provision of adequate infrastructure and active support of school leadership, local ecosystem and government agencies.

## 1.3 Overview of the Research Report

This report presents research findings from implementation of CLIx during the year 2018-19 in 461 government schools across the four states of Chhattisgarh (30 schools), Mizoram (30), Rajasthan (101) and Telangana (300). The sample of schools in the baseline and endline studies[3] was drawn from these 461 schools.

Field support and monitoring of CLIx schools was actively conducted in 311 schools. However, 150 schools in Telangana were dropped from active field support when it was determined that in

[3]Descriptions of the baseline and endline studies and intervention monitoring are provided in Section 2 of this report.

these schools, although teachers had received professional development and efforts had gone into lab readiness, the conditions of ICT infrastructure did not reach satisfactory level to enable CLIx ICT lab usage implementation.

As CLIx is an action research project, research is an integral part of all its activities, from design to implementation. This report consolidates findings from the major research studies[4] conducted across CLIx states to answer critical research questions on a range of aspects including:

- Were preconditions for satisfactory implementation of an ICT-based intervention met in the schools included in the intervention?
- What was the extent of usage of CLIx by students?
- What were the changes and impact of CLIx on teachers, their beliefs and practices, and students' cognitive and non-cognitive learning?

The findings reported are drawn from a range of quantitative and qualitative data sources using diverse tools including surveys of students, teachers and principals of schools, observational data from the implementation and monitoring tool, digital data from CLIx student learning platform, interviews with key stakeholders and classroom observations.[5]

This report is organised into five sections. Section two, which follows this introduction, provides a brief overview of the key studies designed and tools of process documentation and sources of data while sections three, four and five present findings along with evidence related to the three sets of premises following the theory of change outlined above.

Section three examines the extent to which the preconditions for a technology-based intervention obtained on the field. CLIx implementation process includes establishing and putting into place mechanisms to ensure that ICT labs are equipped with functioning computers, servers and headphones with audio recording, and that these are maintained. Schools also need to put into place timetables to ensure that students can use the ICT lab with their subject teacher. The implementation process ensures that English, mathematics and science teachers receive professional development and continuous support through the mobile-based CoP and visits of FRC.

Section four pertains to the extent and process of 'adoption' of CLIx by the system comprising schools, teachers and students. Data for this is obtained from the intervention monitoring tool (IMT) used by FRCs to record observations of their school visits and from CLIx platform on students' use of CLIx modules. Teachers' survey recorded their concerns regarding CLIx intervention which were coded in accordance with the stages of concern, a dimension of the concerns based adoption model (CBAM).

Section five presents findings on outcomes at the level of teachers. Teachers who were part of the baseline and endline surveys constitute a panel, and their characteristics and change over time in their ICT use, beliefs, perception of challenges in ICT integration and classroom pedagogic practice are reported. Section six reports findings from the learning outcomes study which was a part of the monitoring and evaluation of Design and Intervention study. It used a quasi-experimental design to examine student learning gains in contexts where teachers were able to teach with high fidelity to the intended design. Section seven relates to comparison of outcomes in student learning among groups based on extent of intervention, gender and social categories.

Section seven pertains to the changes observed in the pedagogic practices and classroom behaviours

[4]All research studies referred to in this report have ethical clearance from the TISS-IRB and MIT-COUHES. Also see fn 6.

[5]Link to the reports of CLIx research studies: https://clix.tiss.edu/research/publications/.

reported by teachers and experienced by students in CLIx and non-CLIx classrooms and CLIx sessions. Initial trends from interviews of key stakeholders on their perceptions about CLIx, its purpose, affordances, constraints, implementation and potential impact are presented in section eight. Conclusions and way forward are discussed in the final section.

# 2. Key Research Studies and Sources of Data

This section provides an overview of four key sources of data that are drawn upon in this report, which are the process documentation in CLIx monitoring and three studies: (1) Monitoring and Evaluation of CLIx Design and Intervention study (that included an LO study), (2) Baseline-Endline study and (3) Innovation Diffusion Process Documentation study. All of these have received relevant institutional ethical clearances.[6] Details on coverage and sampling are also provided.

## 2.1 Monitoring and Evaluation of CLIx Design and Intervention Study

This study focused on the quality of CLIx implementation and use across the 311 schools where it was implemented against the maximum adoption that was possible to achieve given the necessary conditions. This objective was met through examination of secondary data that was gathered in the course of the final year of CLIx implementation - monitoring and process documentation and data from the platform - and supplemented by feedback gathered during the endline survey (see below).

### A. Process documentation in CLIx monitoring

(i) The intervention monitoring tool (IMT) was used by the field implementing groups to track progress of the implementation and involved both quantitative and qualitative observations made by FRCs on their scheduled visits to schools. The tool had 64 questions on various parameters of implementation including status of labs, activities of teachers, and extent of usage of the modules. It was to be filled based on direct observations and interviews with teachers for the period between the previous visit and the current one. During the 2018-19 period, a total of 1,198 school visits were made to 255 schools (average of 4.70 visits per school), and 512 observations were recorded using the IMT during the academic session 2018-19.

(ii) The CLIx platform is designed to gather data on various aspects of usage of CLIx resources.[7] Digital data was available regularly through regular 'syncing' of the servers of about 174 schools with the main TISS CLIx server (referred to as 'thin data'), which provided information on aspects of usage. CLIx modules included a number of lessons, units and multiple tools such as games and interactive activities, which were accessed by students when they logged into the CLIx platform. The platform is designed to enable modules to be accessed via login. However, they can also be accessed without login, in which case the students' module history is not available to them.[8] A student who has logged in can also include collaborators as 'buddies' through a feature called buddy login. Some tools are designed to log data such

[6]Following were the studies approved by Institutional Review Board (IRB) of TISS (dates of approval): Connected Learning Initiative (CLIx) a baseline study to analyse the impact of the intervention on students, teachers, classroom processes and school officials (08.04.2015), Monitoring and Evaluation Study of CLIx Design and Intervention (13.09.2016), Innovation Diffusion Process Documentation: A Study of Connected Learning Initiative (CLIx) (08.07.2016).

[7]For details of the CLIx platform design, see: Mulla, S., Aitawdekar, K., KRD, K., & Nagarjuna, G. (2018). Not a walled garden but a Lego board! Experiments, innovations and experiences of CLIx Platform. Working paper presented as poster at Connected Learning at Scale: An International Symposium. Mumbai, India. August 8-9, 2018.https://gstudio-docs.readthedocs.io/en/latest/data-collection.html

[8]Platform module usage data is captured for only those students who have logged in. The actual number of users, according to field reports, might be 25-30% higher. Further, CLIx modules were designed for students to work in pairs or trios using the same login.

as the number of logins and time spent captured in the thin data. In-depth data from various tools and interactives which are a part of the CLIx modules record information that provides insights into student interactions, such as number of attempts made, actions taken in each attempt and outcomes of these actions. These data are also received as a part of the thin data gathered via syncthing. The CLIx platform further gathers digital records of the pathways of usage (like activities visited, time of visit and 'out-action' before stepping into third-party tools plugged in the platform). This data is not shared via syncthing and remains on the CLIx server as a part of the 'data dump', to be downloaded manually from each server. The entire data dump has been gathered from CLIx school servers at the end of the academic year (2018-19). This includes students' non-cognitive gains, all the student artefacts, file uploads and assessment data. The analysis of this data is not a part of this report.

(iii) Feedback on CLIx experience was gathered from teachers, students and school heads from a sample of 165 CLIx schools and 317 teachers who participated in the endline survey (see section 2.2.4).

### B. Learning Outcomes Study

The learning outcomes study was designed to assess whether, *in contexts of implementatio*n *where there is high fidelity to intended design of CLIx modules*, there are significant learning gains for students. Between May and October 2018, three separate studies of two modules in English and one module each in maths and science were conducted, using a quasi-experimental research design. The English Beginner 1 and English Elementary 1 modules were studied in six CLIx experimental schools and six non-CLIx control schools in Aizawl, Mizoram. The Geometric Reasoning module was studied in ten CLIx and nine non-CLIx schools of Dhamtari, Chhattisgarh. The Basic Astronomy module was studied in seven CLIx schools and seven non-CLIx schools in Jaipur, Rajasthan. High fidelity to intended pedagogy and use of CLIx resources was ensured by providing specific inputs to the teachers in the CLIx schools. This was over and above the inputs they had already received in the form of TPD workshops, FRC support and interactions on their mobile CoPs. Teacher inputs also included a one-day workshop to discuss and orient on ideal implementation design and regular interactions, feedback and support from members of the design team during the four weeks of implementation. Control schools were selected from an existing sample of control schools from the baseline study and willingness of the respective school heads to be a part of the study. Student learning outcomes data from the District Information System for Education (DISE), Government of India, was used to further establish comparability of the intervention and control schools sampled. The results of the study are reported based on pre- and post-test scores of students in CLIx and non-CLIx schools and observations of classrooms and computer labs. Quantitative analyses of pre- and post-test scores were done to determine gains in student scores and differences in cognitive gains between the treatment and control groups. Non-cognitive gains in terms of skills and change in student and teacher behaviours were also studied using qualitative observational data.[9]

## 2.2 Baseline-Endline Study

A. A **Baseline Study** was conducted between July and August 2016 in Chhattisgarh, Mizoram, Rajasthan and Telangana, with a sample of 165 schools selected for CLIx intervention and 55

[9] The detailed report of the Learning Outcomes Study may be acceessed at https://clix.tiss.edu/wp-content/uploads/2015/09/LO_Report-2019.pdf

non-CLIx schools. The same sample of schools was retained for the endline study (see below). The same set of tools[10] was used. Two midline studies with purposive selection (19 and 88 respectively) were conducted in April-May 2017 and January-February 2018 to understand aspects of the ongoing rollout.[11]

B. The **CLIx Endline Study** was conducted between January and March 2019 in Chhattisgarh, Mizoram, Rajasthan and Telangana.

### *2.2.1 Sample*

A total of 165 CLIx intervention schools and 55 non-CLIx schools were sampled. The sample was constructed during the baseline study in 2015 and followed a two-stage process of random selection from all intervention schools.[12] The non-CLIx schools were also selected based on the availability of an ICT lab through the ICT@Schools scheme. The baseline schools surveyed were retained in the endline study.

All English, maths and science teachers who taught grade 9, all school heads, and students of Grade 9 in the sample schools were part of the baseline and endline studies. The classrooms and ICT lab practices of 31 CLIx teachers and the classroom practices of 32 non-CLIx teachers (of English, mathematics and science) were also observed. The sample of teachers in the endline study included 372 CLIx teachers (137 female, 235 male)[13] and 109 non-CLIx teachers (32 female, 77 male). A total of 162, i.e., about 36% of the original 452 CLIx baseline participant teachers were a part of the endline sample. This reduction is largely attributed to transfers in Telangana and Rajasthan. Grade 9 students, the focus grade for CLIx intervention, were surveyed. The number of school head teachers were 88 in CLIx (24 female, 64 male) and 33 in non-CLIx schools (7 female, 26 male).

The student sample consisted of 3960 students in CLIx schools (2105 girls, 1855 boys) and 1409 non-CLIx students (757 girls, 652boys); In cases where the class size was more than 45, 40 of the students were randomly selected, taking care that this sample reflected the gender ratio of the class[14].

[10]There were a few additions made in the endline study tools to include items specific to CLIx intervention on experience of pedagogic practice. To obtain feedback on CLIx, an additional survey tool for teachers, students and principals was designed in the endline study. Some questions that were deemed not relevant in the baseline analysis were dropped in the interest of reducing time of administration. Though items pertaining to outcome indicators were identical to the baseline study tool, a few items were added under select indicators in both teacher and student tools to include CLIx-specific items. Based on domain objectives, a few questions in the learning assessment tool were modified (English: 4 and Science: 8). Nine questions were dropped from the principal tool. In the interest of reducing time for tool administration, only specific questions found relevant in baseline analysis were retained.

[11]The research outputs based on the baseline study included learning assessment reports for Chhattisgarh, Mizoram, Rajasthan and Telangana and a working paper on in-service teacher education and ICT. The consolidated Midline 1 report involving select schools from Chhattisgarh, Mizoram and Rajasthan and Midline 2 study reports for these three states can be accessed online from the CLIx publications webpage: https://clix.tiss.edu/research/publications/

[12]Random sampling of schools was done at the time of baseline survey in 2015, based on rural-urban location and enrolment in grade 9. Schools belonging to ICT phase-3 were considered for the sampling of CLIx schools. The rest were considered for the sampling of non-CLIx schools.

[13]For 15 CLIx and 9 non-CLIx schools, only student data is available. Teachers' data from these schools is either unavailable or dropped due to lack of consent.

[14] Data cleaning and missing value treatments: A total of 6934 data got generated from the survey. 87 data points were dropped on account of occurrence of lack of response in more than 80% of the tool, inconsistent responses and unidentified students. Presence of blanks in the data was on account of either lack of knowledge or lack of experience of the item asked in a given question. Such missing values are not at random (MNAR). Hence these missing values were replaced with the minimum response value for a given question. Such types of missing values which resulted from improper scanning, occured at random (MAR) and were treated wth pairwise elimination. Dropping data on account of MAR resulted in a total observation of 5369. For pairwise elimination of data, only the question used for the reporting, has been considered. In case of profiling of students (section 6.2.1), case-specific treatment of MAR has been done.

Table 2.1 provides a detailed description of the sample.

**Table 2.1: Sample Description**

| | Chhattisgarh | | Mizoram | | Rajasthan | | Telangana | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CLIx | Control | CLIx | Control | CLIx | Control | CLIx | Control | CLIx | Control |
| CLIx intervention schools | 30 | 10 | 30 | - | 101 | 20 | 300 | 25 | 461 | NA |
| Endline sample schools[1] | 20 | 10 | 29 | - | 41 | 20 | 74 | 25 | 164 | 55 |
| Rural | 85% | 90% | 7% (Aizawl) | | 83% | 72% | 81% | 72% | 68% | 75% |
| PTR (Range) | 28 (18-44) | 32 (12-45) | 10 (3-26) | - | 26 (14-41) | 28 (8-51) | 16 (4-35) | 19 (7-92) | 19 (3-44) | 25 (7-92) |
| No. of Teachers (Panel, Total) | 33, 54 | 0, 29 | 62, 89 | - | 31, 76 | 0, 34 | 36, 153 | 0, 46 | 162, 372 | 0, 109 |
| Teachers in total (male, female) | 25, 29 | 20, 9 | 54, 35 | - | 60, 16 | 25, 9 | 96, 57 | 32, 14 | 235, 137 | 77, 32 |
| Panel CLIx teachers (male, female) | 17, 16 | - | 34, 28 | - | 23, 8 | - | 18, 18 | - | 92, 70 | - |
| Average experience in years (SD) | 9.6 (7.2) | 6.9 (6) | 19.5 (7.9) | - | 10.7 (7.4) | 9.6 (7.5) | 12.7 (5.3) | 12.1 (4.6) | 13.5 (7.6) | 9.9 (6.3) |
| Panel teachers' average experience in years (SD) | 10.8 (6.8) | - | 20 (7.2) | - | 10.1 (6.3) | - | 12.7 (6.4) | - | 14.6 (8) | - |
| School students (boys, girls) | 618 (279, 339) | 320 (132, 188) | 320 (132, 188) | - | 1130 (589, 541) | 494 (238, 256) | 1558 (672, 886) | 595 (282, 313) | 3960 (1855, 2105) | 1409 (652, 757) |
| ST (boys, girls) | 42, 53 | 12, 30 | 304,326 | | 118,65 | 16,11 | 87,88 | 38,21 | 551,532 | 66,62 |
| SC (boys, girls) | 22,42 | 20,16 | 2,1 | | 136,124 | 35,41 | 158,154 | 59,71 | 318,321 | 114,128 |
| BC+OBC (boys, girls) | 160,203 | 77,116 | 3, 0 | | 259,255 | 134,148 | 399,593 | 165,195 | 821,1051 | 376,459 |
| General (boys, girls) | 10,13 | 8,4 | 3,0 | | 52,77 | 40,33 | 14,22 | 11,10 | 79,112 | 59,47 |
| Other (boys, girls) | 3, 3 | 0,1 | 1, 1 | | 8,5 | 6,2 | 6,11 | 8,8 | 18,20 | 14,11 |
| Classroom observations (incl. CLIx lab) | 10 | 6 | 12 | 6[2] | 22 | 12 | 16 | 8 | 60 | 32 |
| Schools in LO study[3] | 10 | 9 | 6 | 6 | 7 | 7 | - | - | - | - |

**Notes:**

1. The actual CLIx schools planned was 30 in Mizoram. But 1 school dropped out from the intervention. In Rajasthan 1 school got included and in Telangana, 1 school could not be surveyed.
2. The non-CLIx schools identified as control schools for the learning outcomes study were considered for endline classroom observations only in Mizoram.
3. The three Learning Ooutcome sub-studies were Mizoram English, Chhattisgarh mathematics, Rajasthan science.
4. BC- Backward Castes, OBC- Other Backward Castes, SC- Scheduled Castes and ST- Scheduled Tribe

### 2.2.2 Tools

The endline study included surveys of students, teachers and principals and classroom observations carried out in the intervention and control schools.

A. **The student general tool** comprised nine sections: (a) identification details (b)individual details, (c) access to and use of technology and digital citizenship, (d, e, f) students' self-reports of the pedagogy experienced in their English, mathematics and science classrooms respectively, (g) assessment of students' epistemic values and perception (e.g., collaboration with peers, persistence in learning), which the CLIx modules were designed to foster, (h) feedback on CLIx (administered only in the CLIx intervention schools), (i) items to establish the modules used by students.

B. **The student learning assessment tool** included three sections, each corresponding to learning assessment questions in English, mathematics and science. There were approximately 13 questions in each domain. The questions were designed to gauge students' knowledge, inference and application in mathematics and science. Learning assessment questions for English were designed to evaluate students' ability to use syntax to read, write and speak in English. Student survey tools were translated from English to Hindi and Telugu in the endline study. (Translation into Mizo was done only during the baseline study).

C. **The teachers general tool** comprised nine sections: identification, demographic details, pedagogical methods, technology access and use, technology-related competence, professional development, beliefs about use and effects of technology, challenges in integrating technology in teaching and domain[15] pedagogy. The teacher feedback tool comprised two sections, namely, identification and feedback.

D. **The questionnaire for school principals** comprised nine sections, namely, identification, usage of digital tools, usage of applications, usage of email, usage of internet, beliefs about use of technology in education, concerns related to integration of technology in school education, position with regard to technology integration in schools and demographics. Principal feedback tool comprised two sections, namely, identification and feedback for CLIx implementation and usefulness. Endline surveys for teachers and principals were conducted in English.[16]

E. **The questionnaire for officials** comprised eight sections, namely, preliminary, usage of digital tools, usage of applications, usage of email, use of technology devices in government high schools, beliefs about use of technology in education, concerns related to implementation of technology in school education and feedback for CLIx implementation and usefulness.

F. A small sample of **classroom observations** of English, maths and science teachers from CLIx and non-CLIx endline samples was conducted using quantitative checklists. In addition, there were qualitative observations of the same CLIx teachers conducting the CLIx lab sessions.

### 2.2.3 Period of survey

Endline survey data collection was carried out by CLIx field teams in Chhattisgarh, Mizoram and Rajasthan and by a contracted field team in Telangana between February and March 2019.

### 2.2.4 Analysis

**Key constructs:** Factor analysis was done to identify the key constructs in the teacher and student data[17]. The reliability of the indices was checked using Cronbach alpha. In the case of teachers,

[15]In the baseline study, there was a separate tool for domain questions for each of the three domains.
[16]In the baseline study, the survey was conducted in English, Hindi, Mizo and Telugu.
[17]The details of the factors, indices and item discrimination can be found in the CLIx Documentation on Analysis.

factors were identified and used in the analysis of (i) teachers' beliefs about use of technology, (ii) ICT engagement, (iii) digital skills, (iv) challenges perceived in ICT integration and (v) domain pedagogy. Some factors (latent variables) from the resultant model were dropped from the analysis of teachers' outcome if they had either less than 3 items or had Cronbach alpha less than 0.67.

In the case of students' digital skills and pedagogies experienced by them in classrooms an exploratory factor analysis did not result in any reliable and interpretable factor. The indexing for these constructs has been guided by expert judgement of the results from exploratory factor analysis followed by that of confirmatory factor analysis. With regard to learning outcomes, item discrimination was used on the endline student data to identify questions that successfully differentiate learners within each domain.[18]

**Comparisons**

**Teachers:** The analysis of endline survey data followed a quasi-experimental design, that is, a comparison of the treatment and control groups in the endline survey. Teachers' survey data was analysed by comparing responses of CLIx teachers with non-CLIx teachers. In the case of 162 teachers who were part of the baseline and endline samples, designated as a panel, a comparative analysis of change over time was also carried out. The CLIx teachers' survey included one open-ended question regarding their concerns about CLIx, the responses to which were mapped to the stages of concerns of the concerns based adoption model (CBAM)[19] to help study the extent of adoption at the level of teachers.

**Students:** In the case of students, 'difference in differences' between baseline and endline *was not* carried out as the student cohorts were not the same. The scenarios of implementation varied across schools in a state, leading to six different treatment groups. Students' learning outcomes were analysed by grouping CLIx students from all four states based on the extent of CLIx inputs they received along two major dimensions:

1. extent of TPD received by their teachers which varied from 3 years, 1-2 years or 0 inputs
2. opportunity to use CLIx resources in the ICT lab (yes or no)

It may be noted that in several schools, teachers batched their students and gave only some of them the opportunity to work with CLIx resources in the ICT lab. Thus, students of the same teacher could be found in both groups - those who did and who did not receive CLIx ICT lab resource treatment. Of the six groups, Group 1, comprising 546-819 students, represents the highest level of CLIx treatment (having teachers with maximum TPD and usage of CLIx ICT resources). Group 2, comprising 266-483 students, represents those who had the same teachers as in Group 1, with maximum TPD inputs, but did not have opportunities to use the CLIx ICT resources. Group 6, comprising 120-230students, was effectively an internal control as their teachers had not received TPD and they did not use the CLIx ICT resources either. Group 7, comprising 1,409 students, were from the external control schools.[20] Table 2.2 provides an overview of the five treatment groups and one internal and one external control.

[18] Goodness of fit for a model in factor analysis was decided based on RMSEA, CFI, TLI and SRMR.

[19] https://www.air.org/resource/stages-concern

[20] Group 5 comprising 805 students represents those schools in which the teacher did not receive any TPD, but students visited the lab and used CLIx resources. In many cases this was facilitated by the FRC.

**Table 2.2: Grouping Structure and Sample for Analysis for Students' Scholastic Outcomes**

| Did students use CLIx modules? | Duration of TPD from CLIx | | | Non-CLIx External control (109 Teachers) |
|---|---|---|---|---|
| | 3 years (128 Teachers) | 1 to 2 years (195 Teachers) | 0 years (47 Teachers) | |
| Yes | Group 1 (High CLIx input) E=819, M=760, S=546[1] | Group 3 E=929, M=842, S=1050 | Group 5 E=150, M=254, S=248 | Group 7 E=1409, M=1409, S=1409 |
| No | Group 2 E=266, M=287, S=483 | Group 4 E=467, M=583, S=568 | Group 6 (No CLIx input - internal control) E=120, M=135, S=230 | |

**Notes:**
1. Number of students who took the English test (E), mathematics test (M) and science test (S)
2. Owing to differences in student responses to specific items, the N will be different for non-scholastic outcomes and experience of classroom practices.

Non-scholastic outcomes on student digital skills, based on their self-reports in the student general survey (19 items including basic, advanced and online digital skills and CLIx-specific ones) were analysed on the basis of student grouping (Table 2.2) and are presented in section 6. The survey included responses on students' experiences of classroom pedagogies (6-7 items including learning through application and activities) for each of the three subject areas which are analysed on the basis of student grouping (Table 2.2) and reported under pedagogic practices (section 7 of this report).

## 2.3 Innovation Diffusion Process Documentation Study

The purpose of the innovation diffusion and process documentation study (IDPD)[21] was to understand the changes over time of the perspectives from the stakeholders involved in the innovation - namely, CLIx - regarding their perceptions about its purpose, affordances, constraints, implementation, and potential impact. The key research questions of the study were:

1. What was the process of innovation diffusion across the life cycle of the intervention?
2. What were the key shifts and continuities in the concerns, expectations, roles and ideas about the innovation among various stakeholders?
3. What were the similarities and differences amongst the stakeholders' views and ideas about the innovation?

The first round (R1) of this study was conducted in mid-2017 and the second round (R2) was conducted in January - March 2019. Structured interviews and focus group discussions were conducted, with a cross-section of stakeholders who have been categorised into three levels based on their functions, roles and locations. Macro level consisted of donors, three principal investigators of CLIx, leads of all the domain teams, TPD team, and technology teams. Meso comprised field team leads of all four states and all field team members including FRCs, field action research fellows (FARFs) and FTs from each state. Micro comprised one school from each of the eight districts covered (8 schools). There were two rounds of the study, the first one conducted during the baseline and the second at the time of the endline survey. At the micro level, data collection was done for both rounds through interviews with teachers, principals and district-level officials using a semi-structured tool and through FGDs with students and their parents.

In case of principals, teachers, students and parents, the sampling of respondents for R1 and R2 was done at the school level; a subsection of schools from R1 were selected for R2. Individual

[21] Innovation Diffusion Process Documentation: A case of Connected Learning Initiative (CLIx) https://clix.tiss.edu/wp-content/uploads/2020/06/MehendaleA-et-al-2018.pdf

respondents would, however, vary from one round to the next. At the school level, in-depth interviews were conducted with principals, and teachers of English, maths and science and for Grade 9. Focus group interviews were done with students in groups of 4-5 boys and girls, and 2-3 parents per school selected based on their availability.

The findings reported here are from micro level data from Round 2 consisting of 52 in-depth interviews and focus group interviews conducted using semi-structured questionnaires (CG-11, MZ-10, RJ-17, TS-14). The data analysed for this report include 8 focus group interviews with students, and 8 interviews with parents, in-depth interviews with 12 teachers, 4 head teachers, and 4 state or district officials. Qualitative data from across states were translated (from Hindi in Chhattisgarh and Rajasthan and from Telugu in Telangana) and transcribed. A preliminary thematic analysis of the data has been carried out to identify changes in stakeholder perceptions on factors that promote or inhibit the adoption of CLIx.

## 2.4 Other data sources

The process of implementation was continuously monitored and supported by the use of various tools for feedback and monitoring. This included:

- **Technological issue tracker:** This tracker tool was used and maintained by the CLIx Field Technologists to document on an ongoing basis the technology issues reported from the field and to address their resolution. Each technological issue reported from the field was documented along with date, nature of issue and school, and its resolution was also documented on a spreadsheet.

**Table 2.3: Overview of Aspects of CLIx Implementation for which Data was Collected**

| | Data Sources (CLIx Schools covered) | Infrastructure and Tech Stability | Lab Mainte-nance and Ownership | Students Access to Modules | Teacher Beliefs | Teacher ICT Capability | Classroom Practices | Student Beliefs | Student Learning |
|---|---|---|---|---|---|---|---|---|---|
| **1** | Intervention monitoring tool (245 of 311 schools) | Y | Y | | | Y | Y | | |
| **2** | Platform (syncthing) (174 of 311 schools) | Y | | Y | | | | | Y |
| **3** | Platform (data dump) (234 of 311 schools)[1] | Y | | Y | | | | Y | Y |
| **4** | Endline survey (165 of 461 schools) | Y | Y | Y | Y | Y | Y | Y | Y |
| **5** | Learning Outcome study (23 schools) | | | | Y | | Y | | Y |
| **6** | IDPD interviews and FGDs (micro study: 8 schools) | Y | | | Y | Y | | Y | Y |

**Note:** Data has been collected and is available for 28 out of 30 schools in Chhattisgarh, 85 out of 101 schools in Rajasthan and 121 out of 150 schools in Telangana. Data from 26 out of 30 schools in Mizoram is available but not yet delivered on account of the pandemic lockdown and earlier communication problems.

- **Telegram group discussions:** All teachers were organised in subject groups by state on Telegram (total of 12 groups). Discussions in Telegram groups provided insights into ongoing CLIx implementation by teachers.
- **TPD workshop feedback:** TPD workshop feedback collected through mudcards during

workshops provided insights into teachers' learning.

- **RTICT** course registration of teachers, their course engagement and completion status and grade earned were tracked on the platform TISSx and the academic records maintained at TISS.
- **TPD training attendance data:** Training data of teachers surveyed during endline was collected from the field teams separately. Teachers who participated in all years of training as provided by the state were coded as category 3 teachers. Those who had not participated at all were in the category 0 and the teachers who belonged to the intermediary category were coded as 1.

# 3. Pre-conditions for Effective Implementation of CLIx

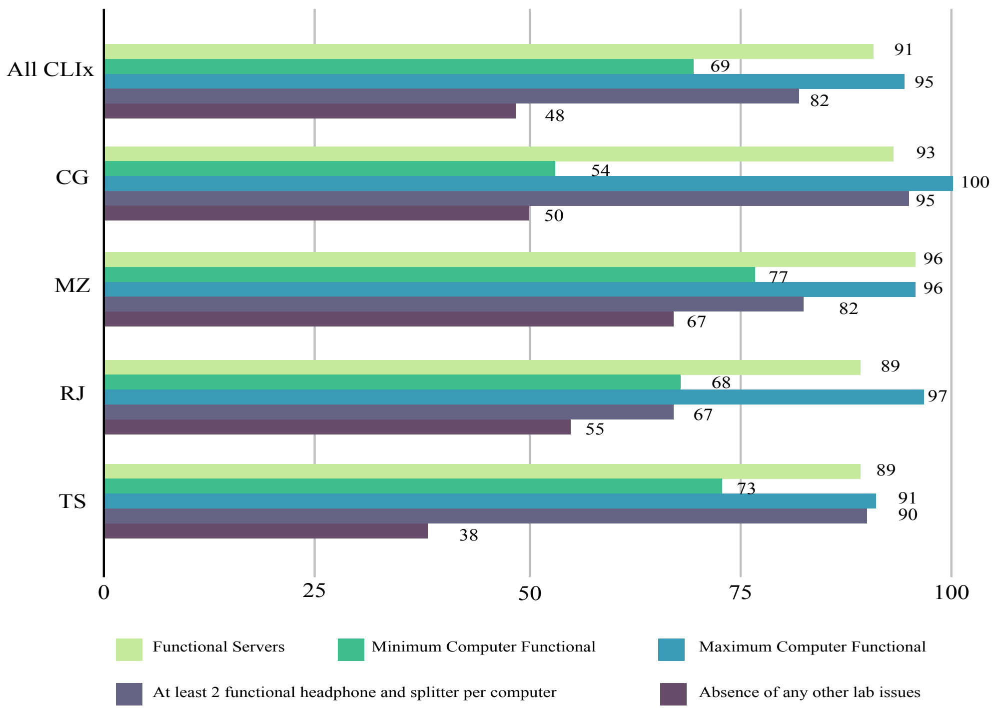
**'Were conditions for effective implementation of CLIx met in schools during the year 2018-19?'**

This section answers this question and looks into matters pertaining to adequacy of infrastructure such as functioning labs, power supply, provision of CLIx offerings and teacher availability. Data to make this assessment is drawn mainly from (1) 1,198 school visits and 512 observations recorded through the IMT from 255 schools during the period July 2018-Mar 2019; (2) CLIx platform data collected from 174 schools through syncthing and additionally the data dump from 234 schools and (3) responses from key stakeholders to relevant questions in the endline surveys.

## 3.1 Lab Functionality

Computer lab functionality is a precondition for implementation of CLIx. This includes a set of at least ten computers or terminals connected with a server via LAN and each computer equipped with a splitter and two headphones (earphones with microphones).

**Figure 3.1: Status of Lab Functionality in CLIx Schools (IMT: Jul-Mar 2019)**




**Source:** Data from Implementation Monitoring Tool (2018-2019).
**Note:** Figures for Telangana have been computed over 150 functional schools, leaving out the150 schools where this condition was not satisfied (see explanation in the body)

In Telangana, a lab readiness drive conducted in AY 2017-18 found that labs in about 150 of the 300 schools originally chosen for CLIx implementation had severe technical issues due to legacy systems, i.e., older configurations of server machines and N-computing as well as hardware issues.[22] Although all 300 schools were engaged with for readying ICT lab and TPD, 150 of them

[22]For instance, with respect to software, the CLIx platform is best run on Chrome 53 and Chrome 49+ at the least.

had these severe hardware issues, leading to a situation in which CLIx ICT resources could not be offered to students. The implementation teams focused on ongoing lab functionality in the other 150 schools, and these were regularly visited and monitored.

Based on the IMT observations, in most ICT labs across all four states the server functioned without problems (89% in RJ and TS, 93% in CG and 96% in MZ). This finding is significant as there was concern whether a server-based model of providing access to resources would function unproblematically in the conditions that prevail in government school settings. (See annexure Table 1 for status of lab functionality by state.)

Level of functionality of computers varied across the states, as shown in Figure 3.1. ICT lab functionality in CLIx schools was maintained at a reasonably high level such that, by AY 2018-19, labs across the schools and states were largely functional. In Chhattisgarh, the proportion of functional computers varied through the academic year from 54% to 100%. The variation was 77% to 96% in Mizoram, 68% to 97% in Rajasthan and 73% to 91% in Telangana. Overall, the average proportion of functional servers was 91%, at least 2 functional headphones and splitter per computer were present in 82% cases and there were no other lab issues in 48% of the visits. The occurrence of the other lab issues was high in Telangana due to old hardware that was provided in 2010-11.

## 3.2 Power Supply

IMT observations showed that about 17% of the 255 schools reported that issues of power supply affected implementation of CLIx. In the endline survey, in 40% of schools (67 out of 165), 50% of teachers reported that power was ‘extremely challenging’ for ICT integration. Higher reports of power supply affecting CLIx implementation were reported from Telangana (22%) and Rajasthan (16%). The overall assessment is that power supply problems were present and disrupted ICT lab usage in about 15-25% instances, but not so high that the intervention plan of going to scale with ICT integration in curriculum was unfounded.

## 3.3 Ongoing Lab Maintenance

At the start of the year, an average of 5 hours per school was spent by an FRC on lab preparation. This was to install the new CLIx platform, collect data from previous years’ activities, check and reconnect computer accessories and LAN network.

A system for addressing and resolving ongoing problems pertaining to maintaining lab functionality was a part of the CLIx implementation strategy. The technology issue tracker was put in place as a system of reporting problems to be addressed by FTs. Teachers and FRCs reported and resolved problems. FTs reported a significant reduction of issues from 2016-17, to 2017-18 and to 2018-19. These could be attributed to bugs being resolved and more skills being developed by teachers to resolve issues. FTs reported significant reduction in problems reported from the field.

Infrastructure issues that were reported included issues related to UPS, power switches and importantly, power failures that caused motherboard issues, HDD and OS corruption. Hardware issues included those of N-computing devices, RAM, motherboard and peripherals. Software issues included those of OS, drivers and N-computing software. Platform issues included problems

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However, N-computing devices in schools could not support any operating system other than Windows XP (the last version of Chrome supported by Windows XP is 49). In case of hardware, while 2 GB RAMs were provided to the schools, the school systems were only able to handle up to 1 GB.

faced in activities involving audio recording and limited functionality of applications like Turtle Logo due to hardware limitations.

Rajasthan reported a high level of platform issues which seems to be because only one server machine was used in the lab rather than two (as the second machine was often appropriated for school official work). Further, as an external vendor was responsible for maintenance, timely support was often not provided to resolve issues, leading to their frequent reporting. Both Rajasthan and Telangana also experienced software problems on account of N-computing which led to incompatibilities in running applications in regional languages (Hindi and Telugu respectively).

The distribution of issues reported by different categories is given in Table 3.1. [See annexure Table 2 for further details.]

**Table 3.1: State-Level Distribution of Issues by Category as per Issue Tracker (AY 2018-19)**

| State | Total Schools | Hardware | Software | Infrastructure | Platform | Total Issues |
|---|---|---|---|---|---|---|
| CG | 30 | 75% | 15% | 5% | 5% | 200 |
| MZ | 30 | 79% | 16% | 5% | 0% | 19 |
| RJ | 101 | 47% | 17% | 10% | 27% | 300 |
| TS | 150 | 65% | 19% | 8% | 8% | 260 |
| Total | 311 | 475 | 133 | 61 | 110 | 779 |
| Issue total as % of all issues reported (779) | | 61% | 17% | 8% | 14% | |

## 3.4 CLIx Resources

A. The CLIx platform, customised from G-studio, was deployed in schools through the school server. The platform included a ‘login’ and ‘buddy login’ to enable student groups collaborating with each other to be recorded on the platform. A simplified login and ‘buddy login’ was available in the version used in 2018-19. The platform was found to be stable.

B. CLIx modules: In 2018-19, 16 CLIx student modules - 2 in English, 4 in maths, 6 in science and 4 in I2C - amounting to approximately 190 hours of content were made available to schools. The modules included more than 20 different digital tools specifically designed for student activities and learning. Table 3.2 provides a detailed listing of the CLIx modules and tools that were deployed. As can be noted, based on the topics of the school syllabus in each state, some modules in mathematics (Proportional Reasoning and Linear Equations in Chhattisgarh) and science (Basic Astronomy in Mizoram) were not used.

**Table 3.2: CLIx Resources by Subject and Module**

(https://clixoer.tiss.edu/home/e-library/)

| Subject | CLIx Module Name | Total Lessons[1] (Activities[2]) | Tools[3] | Approx hours of content | MZ | CG | RJ | TS |
|---|---|---|---|---|---|---|---|---|
| I2C (digital literacy) | Introduction and Indic typing | 1 (4) | - | 6 | Y | Y | Y | Y |
| | Analysis with Spreadsheets | 1 (6) | LibreOffice calc | 9 | Y | Y | Y | Y |
| | Drawing with Inkscape | 1 (4) | Inkscape | 6 | Y | Y | Y | Y |
| | Mindmapping | 1 (4) | Freeplane | 6 | Y | Y | Y | Y |
| | Fun with Geogebra | 1 (4) | Geogebra | 6 | Y | Y | Y | Y |
| English | English Beginner | 25 (196) | Story Time, Let's Talk, Word Play, Open Story Tool, Think and Write | 20 | Y | Y | Y | Y |
| | English Elementary | 25 (188) | | 20 | Y | Y | Y | Y |
| Maths | Geometric Reasoning Part I | 15 (65) | Geogebra, Policequad, Turtle block | 15 | Y | Y | Y | Y |
| | Geometric Reasoning Part II | 13 (53) | | 11 | Y | Y | Y | Y |
| | Linear Equations | 7 (55) | Ages puzzle, Coins tool, Factorisation tool | 11 | Y | N | Y | Y |
| | Proportional Reasoning | 22 (22) | Ratio patterns, Food sharing tool, Ice cubes tool | 12 | Y | N | Y | Y |
| Science | Atomic Structure | 9 (49) | Atom factory, molecule factory | 12 | Y | Y | Y | Y |
| | Basic Astronomy | 5 (16) | Astroamer element hunt, Astroamer moon track, Astroamer planet trek, Rotation of the earth | 9 | N | N | Y | Y |
| | Ecosystem | 11 (52) | Fish Farm Tool | 8 | Y | Y | Y | Y |
| | Health and Disease | 8 (68) | Population Tool | 12 | Y | Y | Y | Y |
| | Sound | 10 (56) | Audacity | 12 | Y | Y | Y | Y |
| | Understanding Motion | 12 (69) | Run Kitty Run, Video Analysis Tool | 15 | Y | Y | Y | Y |

**Notes:**

1. **Lesson:** Many activities for a particular topic or theme together make up a lesson.
2. **Activity:** An activity is what a student can "do" on and off the CLIx platform, such as reading text, watching a video, listening to a story, working on a quiz, writing a note, taking part in a discussion, playing a game, conducting a field survey, engaging in hands-on activity.
3. **Tool:** A tool is a digital resource integrated in a lesson as an activity that is performed using a computing device. A tool may include simulations or games.

## 3.5 Access to CLIx Resources in ICT Lab

In all four states, the size of the lab was limited to 10 machines (maximum) and by adding a splitter with two headphone-microphone sets, its capacity was extended to 20 students for active learning. Resources were also designed to facilitate collaborative work on modules in groups of two or three, and buddy login was provided to enable all participants to be registered on the platform. Nevertheless, schools had to batch their students in order to give them access to the ICT lab.

**Table 3.3: Scheduling and Timetabled Access to ICT Labs**

| | Chhattisgarh | Mizoram | Rajasthan | Telangana | Overall |
|---|---|---|---|---|---|
| Government circular/guidelines to schedule CLIx and ICT lab usage[1] | Yes | Yes | No | Yes | |
| Timetabling[1] | Every day, last two periods | Two periods per subject per week per section | Teachers advised during training to use at least one subject period per week | Two periods per subject per week per section | |
| Students sent in batches to ensure all students in cohort access and use ICT labs[2] | 23 out of 27 schools<br>85% | 12 out of 24 schools<br>50% | 71 out of 71 schools<br>100% | 25 out of 42 schools<br>60% | 131 out of 164 schools<br>80% |

**Notes:**

1. The government circulars were issued by each state to its CLIx schools and included advisories on timetabling, except in the case of Rajasthan.
2. From IMT data collected during school visits by FRCs: "Did the teacher use batching to make sure all students have access to the lab?"

State governments of Chhattisgarh, Mizoram and Telangana issued circulars directing schools to include the lab session into the timetable. In Rajasthan, this advice was given to teachers during TPD. In 80% of schools, the school made arrangements by batching students to provide lab access. Table 3.3 provides state-wise details of government guidelines provided in each state for timetabled access and batching of students to ICT labs. (Average classroom size of CLIx schools was 34.22.)

Data from the endline survey suggests that, in the course of batching, not all batches received an opportunity to use the lab. Data on student access to labs revealed statistically significant gender difference in CLIx lab access by domain and by state as shown in Table 3.4. In the case of English, higher percentages of boys and girls attended CLIx lab sessions (72% and 66%, respectively). Students from SC/ST (81%) category were more likely to attend CLIx English lab than the category, "non-SC/ST" (71%) in Chhattisgarh. Students from the "non-SC/ST" category (94%) were more likely to attend CLIx English lab in Rajasthan. In the case of maths, boys in Chhattisgarh and students from the "non-SC/ST" category in Telangana were more likely to attend CLIx lab sessions (75% and 61% respectively). In case of science, gender wise differences were not significant. However, in Telangana, students from SC/ST categories were less likely to attend CLIx lab sessions in science (54%).(Refer to annexure Table 4 for details.)

**Table 3.4: Gender and Caste Comparison of Student Access to ICT Lab**

**Table 3.4a: Gender Comparison of Student Access to ICT Lab**

| | All CLIx | Chhattisgarh | Mizoram | Rajasthan | Telangana |
|---|---|---|---|---|---|
| English | Boy>Girls* | no difference | Girls>Boys* | no difference | Boys>Girls* |
| Mathematics | Boys>Girls* | Boys>Girls* | no difference | no difference | no difference |
| Science | no difference | no difference | no difference | no difference | no difference |

**Table 3.4b: Caste Comparison of Student Access to ICT Lab**

| | All CLIx | Chhattisgarh | Mizoram | Rajasthan | Telangana |
|---|---|---|---|---|---|
| English | no difference | SC/ST>Non-SC/ST * | no difference | SC/ST<Non-SC/ST* | no difference |
| Mathematics | SC/ST<Non-SC/ST* | no difference | no difference | no difference | SC/ST <Non-SC/ST* |
| Science | SC/ST<Non-SC/ST* | no difference | no difference | no difference | SC/ST<Non-SC/ST* |

* Significance at 0.05 level

## 3.6 Perceptions of Key Stakeholders Regarding Quality of CLIx Resources

Responses from feedback surveys indicate the perceptions of students, teachers and principals with respect to the quality and usefulness of CLIx resources. Over 90% of teachers were of the view that CLIx modules support higher order learning such as thinking, reasoning, application, conceptual understanding and skills such as collaborative learning. As many as 93% of teachers felt CLIx modules helped them to understand their content better. Of the 73 principals surveyed for feedback, 95% said CLIx supported students' ability for thinking, reasoning and application and improved their conceptual understanding. Further, 81% teachers and 88% principals felt that CLIx should be a part of regular curricular offerings. Finally, 94% of the teachers said they would continue to use CLIx offerings in part or fully. These responses indicate that teachers and school heads were positively disposed towards CLIx resources and their usefulness (see annexure Table 3 for details). Among 3958 CLIx students, 55% considered CLIx to be interesting and 56% were of the view that it is helpful to learn the topics better. 49 % found the activities in the CLIx modules easy to learn.

## 3.7 Teachers' Access to Technology

Given the nature of the intervention, teachers' access to devices and their ability to engage with ICT was a critical precondition for CLIx TPD and support during implementation at school. Almost all (99%) of the CLIx teachers had access to mobile or smartphones (endline survey data; 97% of teachers from non-CLIx schools had access to mobile or smartphones). Among those with access to a mobile or smartphone, 93% of CLIx teachers and 95% of non-CLIx teachers had access to the internet. Only 57% of CLIx teachers had access to desktop or laptop computers or tablets outside the school (46% of non-CLIx teachers). The assumption made in CLIx that teachers own mobile phones and a 'Bring Your Own Device' approach would work for TPD was confirmed in the case of mobile phone-based CoP. However, access to personal computer devices on which they could engage with online professional learning was more limited. Based on the 169 CLIx teachers who completed one or more RTICT courses, their assignment submission patterns in 2017-19 showed that teachers were predominantly using their smartphones to access and do the course. The availability of the mobile app (TISSx) seems to have contributed to enhancing their engagement with the course and their ability to complete coursework.

## 3.8 Professional Development of Teachers

Professional development of teachers was a critical lever in the CLIx intervention given the teachers' central role in achieving ICT integration and meaningful student engagement. Rigorous and regular state- and district-level training and refresher workshops were offered to all CLIx teachers throughout the project period from 2015 to 2019, including orientation for those transferred into CLIx schools. This included their digital literacy as well as understanding and skills related to ICT-integrated resources and CLIx modules. Teachers were offered the opportunity to enrol and complete courses in the RTICT modules relating to digital literacy and their subject pedagogy. They were also all included into CoP via the Telegram mobile app (TISSx) through which peers and experts provided continuous professional support and motivation.

### *3.8.1 Workshops*

In each CLIx school, a minimum of three subject teachers assigned for Grade 9 English, maths and science were invited to the training. As per training attendance records maintained by state teams, the number of teachers who attended workshops for CLIx training on digital literacy and subject-based ICT integration between 2015-19 were as follows:

In Chhattisgarh, 83% of English, 82% of maths and 90% of science teachers were trained out of the total that were planned to be trained. In Mizoram, the proportion of teachers trained versus planned were 53% for English, 55% for maths and 54% for science. This low proportion was on account of the state's decision to send only one subject teacher per school for CLIx training although the CLIx team had planned for all teachers to attend. In Rajasthan, where there was relatively low attendance of teachers in Jaipur and Sirohi, the percentages of trained to planned was 78% for English, 65% for maths and 85% for science. Reasons cited for the low attendance included distances to commute, lack of clarity of information and also lack of interest among teachers. In Telangana, 84% of English, 89% of maths and 90% of science teachers were provided training.

According to teachers' feedback (317 respondents) during the endline survey on the usefulness and relevance of CLIx TPD, 80% said[23] that they found the workshops helpful to understand the importance of the use of ICT in education. Similarly, 81% of the teachers found these workshops helpful to gain confidence in using ICT in teaching and 74% said that these workshops helped them to take up new responsibilities within the school.

### 3.8.2 Communities of Practice (CoP)[24]

A total of 2,500 CLIx school teachers belonged to subject and state CoPs formed on the Telegram application on mobile phones. The endline survey indicates that 78% of CLIx teachers found interactions on the Telegram-based online CoP interactions useful to resolve doubts and get relevant information.

### 3.8.3 Reflective Teaching with ICT (RTICT)

A practice-based MOOC programme titled Reflective Teaching with ICT (RTICT) was offered to CLIx teachers. It had one compulsory basic introduction to ICT course followed by subject-based pedagogy courses and other electives.[25] By the end of 2018, a total of 3,463 enrolments were made for various courses as a part of RTICT (ICT compulsory course - 1,723, pedagogy of English SO1 - 443, pedagogy of science SO2 - 600, pedagogy of mathematics SO3 -697). Qualitative feedback from teachers on the RTICT courses obtained as part of programme review showed that teachers found the course content to be satisfactory and particularly appreciated the interactive pedagogies adopted in workshops. Teachers expressed a need for more time on computer-based activities. Their feedback showed their increased confidence in use of technology. In the endline survey, 62% of teachers found the course offering of RTICT useful. At the end of 2019, a total of 169 teachers (5% of enrolments) had completed one or two courses offered and earned completion certificates.

## 3.9 School-Based Support by CLIx FRCs

Based on recorded IMT observations, in 2018-19, FRCs were able to make a total of 1,198 visits to 255 of the 311 schools that were the focus of monitoring for implementation. That means, 82% of the schools were visited for monitoring and support, which includes 100% of schools in Chhattisgarh, 93%

[23]Rating scale: 1. strongly disagree, 2. disagree, 3. agree, 4. strongly agree, 5. N.A./Not attended. Percentages expressed refer to overall agreement, i.e., sum of options 3 and 4.

[24]This section draws on the data and analysis in Thirumalai, B et.al., (2019). Designing for technology-enabled reflective practice: Teachers' voices on participating in a connected learning practice, in R. Setty et al. (eds.), Teaching and Teacher Education, South Asian Education Policy, Research, and Practice, https://doi.org/10.1007/978-3-030-26879-4_11

[25] This was designed as a 17 credit 2-year long Certificate programme, accredited by Tata Institute of Social Sciences (TISS),

in Mizoram, 86% in Rajasthan and 73% in Telangana. (For data on the 150 schools where lab functionality was average or above average see Table 3.1.) It may be noted that in Telangana, there were only 3 FRCs for 150 schools (1:50 ratio), in keeping with the implementation partnership for scaling with SCERT Telangana. In the other states, the ratio was 1 FRC to 10 schools. The overall average was 4.7 visits per school. During these visits, the FRCs interacted with teachers on implementation and addressed their issues, attended to ICT issues in the lab, and interacted with the school head. In some schools, particularly in Mizoram, the implementation of I2C was largely driven by the FRCs during their school visits as the subject teachers did not seem to be comfortable or confident to deal with basic digital literacy.

Survey responses of teachers showed that they found many aspects of support and inputs from the CLIx team and the school ecosystem to be quite valuable. For example, 85% teachers found support from CLIx technologists (in person or via phone) to ensure lab functioning to be useful; 61% reported having received support by CLIx staff reasonably useful;[26] 71% reported having received reasonable support by the CLIx staff and 90% found the support from CLIx staff reasonably useful. 38% of teachers reported receiving reasonable support[27] in the form of visits by state officials and state teacher educators from CLIx, and 68% of teachers found these visits reasonably useful. A high 91% found the principal's or school head's active support useful, and 81% of the teachers found government circulars regarding CLIx reasonably useful.

## 3.10 Overview of Findings

**Table 3.5: Summary of Preconditions for CLIx**

| S No | Dimension | Status |
|---|---|---|
| 1 | Lab functionality | It was largely in place in all states, except in Telangana where satisfactory level was reached for 50% schools.<br>Functional servers in 91% of school visits<br>At least 2 functional headphone and splitter per computer in 82% of the schools<br>Functional computers across the academic year 69% to 95%<br>No other lab issues in 48% of instances |
| 2 | Power supply | 75%-85% schools had reasonably stable power supply. |
| 3 | Ongoing lab maintenance | A significant reduction of issues between 2016–17 and 2018–19. Hardware issues (61%) were the biggest challenge followed by those of software (17%), platform (14%) and infrastructure (8%). |
| 4 | CLIx resources | Full complement of CLIx resources were provided to states in the relevant medium of instruction of students. |
| 5 | Access to CLIx resources | All states included lab sessions in timetables. 86% of schools batched students for lab access. Overall, boys had greater opportunity to use the ICT lab as compared to girls, particularly in the case of Telangana for English and Chhattisgarh for maths. SC / ST students had less lab access compared to others in Rajasthan in the case of English and in Telangana for maths and science. |
| 6 | Quality of CLIx resources | CLIx resources were found to be generally of high quality (appeal and concepts). Most teachers found resources to have curriculum relevance. |
| 7 | Teachers' access to technology | Smartphone was the predominant form of device access (93–95% of teachers). About 57% CLIx teachers had access to laptops or computers outside school. |
| 8 | Professional development | TPD attendance in workshops was high, and a high level of satisfaction was reported regarding quality.<br>Mobile CoP was found to be generally useful by about 75% of teachers.<br>Of all MOOC-TPD enrolments, 5% teachers completed with certification. |
| 9 | School-based support | FRCs visited 82% of CLIx schools, with 4.8 visits per school on average - 100% in CG, 93% in MZ, 86% in RJ and 73% in TS (given the implementation model and much larger proportion of schools). Among teachers, 85% found tech field support useful, 71% found visits reasonably supportive and 90% found support useful. |

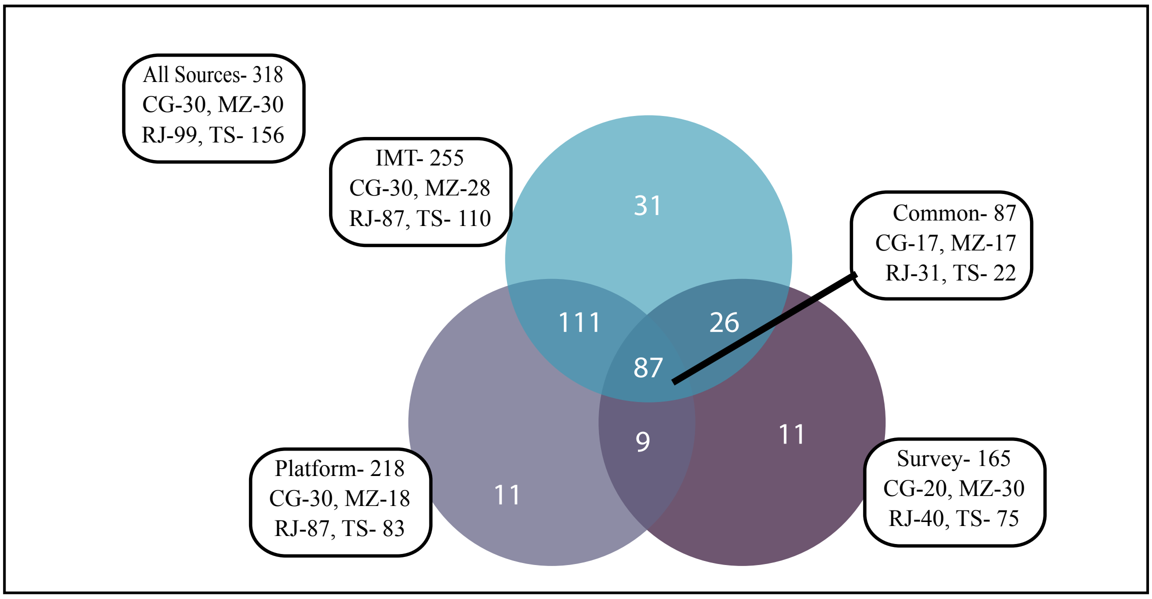
[26]rating scale: 1: not at all useful, 2: somewhat useful, 3: very useful, 4: N.A./not attended
[27]rating scale: 1: Never, 2: Rarely, 3. Sometime, 4: Often, 5: Don't Know/N.A.

# 4. Extent of CLIx Adoption

By CLIx 'adoption' we mean the extent of opportunity and actual usage of CLIx resources by students. Several CLIx modules involved blended design: classroom, science lab and playground activities as well as the ICT lab. In this section, Implementation and Monitoring Tool (IMT) observation data from 512 observations of CLIx schools (including observations of lab usage) from 1,198 visits across 255 schools over the academic session 2018-'19 are used to report findings on the extent of such adoption at the school level (30 schools in CG, 28 MZ, 87 RJ, 110 TS). Extent of adoption at the level of teachers is presented based on analysis of CLIx teachers' responses to the endline survey question on their concerns about CLIx.

Understanding adoption at student level requires interpreting data gathered on the CLIx platform. This along with other observations pertaining to adoption are interpreted and presented based on platform data for the period July 2018-March 2019 (approximating to the school academic year) from across 218 schools for which data is available.

**Figure. 4.1: Number of CLIx Schools Covered by Different Data Sources**




## 4.1 Adoption at School Level based on the Intervention Monitoring Tool (IMT)

The extent of CLIx adoption at the school level can be seen from IMT data from 512 school observations made by FRCs during 1,198 visits to 255 schools over the 2018-'19 academic session. This data is presented in Table 4.1 and Figure 4.2. Across the states, 12 modules in English (2), mathematics (4) and science (6) were made available to CLIx schools.[28] The average of all modules used per school across all states was 3.73. The average module varied by state. Usage in CG, MZ and RJ was over 4.5, while for TS it was only 2.19 (CG 4.6, MZ 4.71, RJ 4.62, TS 2.19). It must also be noted that the total observations of usage in TS (78) was low relative to the total school visits (295) in that state (data from the platform shows a higher level of access in Telangana as discussed in section 4.4.). There was also variation between subject module usage among states. In English,

[28]In Chhattisgarh, in maths, only Geometric Reasoning was officially rolled out and data for it is included here. In science, Basic Astronomy was not officially rolled out, nevertheless instances of usage are high and hence have also been included.

the highest usage was seen in Mizoram (52%), followed by Chhattisgarh (45%), while the overall average was 31%. In mathematics, Chhattisgarh usage was 83%, followed by Mizoram (48%), while overall usage was about 33%. In the case of science, Chhattisgarh and Rajasthan usage was at 41%, followed by Mizoram at 32%. On the whole, levels of module usage were much higher in Mizoram and Chhattisgarh and lower in Telangana.

**Table 4.1: School Visits, Lab Observations and Module Usage by State (Jul 2018–Mar 2019, IMT)**

| CLIx state | Total schools visited | Total visits made | Total school observations | Range of modules used and (median)[1] | Average of all modules used [1] / modules rolled out officially | % schools in which 50% or more modules used (N) | % of English modules used per school (out of max 2 modules) | % of maths modules used per school (out of max 3 modules) | % of science modules used per school (out of max 6 modules) |
|---|---|---|---|---|---|---|---|---|---|
| CG | 30 | 291 | 101 | 1-10 (4.80) | 4.60/10 | 46.7% (14) | 45% | 83%[2] | 41%[1] |
| MZ | 28 | 192 | 102 | 0-11 (5.45) | 4.71/11 | 42.9% (12) | 52% | 48% | 32% |
| RJ | 87 | 420 | 231 | 0-11(4.00) | 4.62/12 | 42.5% (37) | 28% | 32% | 41% |
| TS | 110 | 295 | 78 | 0-10 (1.00) | 2.19/12 | 12.7% (14) | 25% | 16% | 15% |
| All CLIx | 255 | 1198 | 512 | 0-11(3.00) | 3.73/12 | 29% (74) | 31% | 33% | 29% |

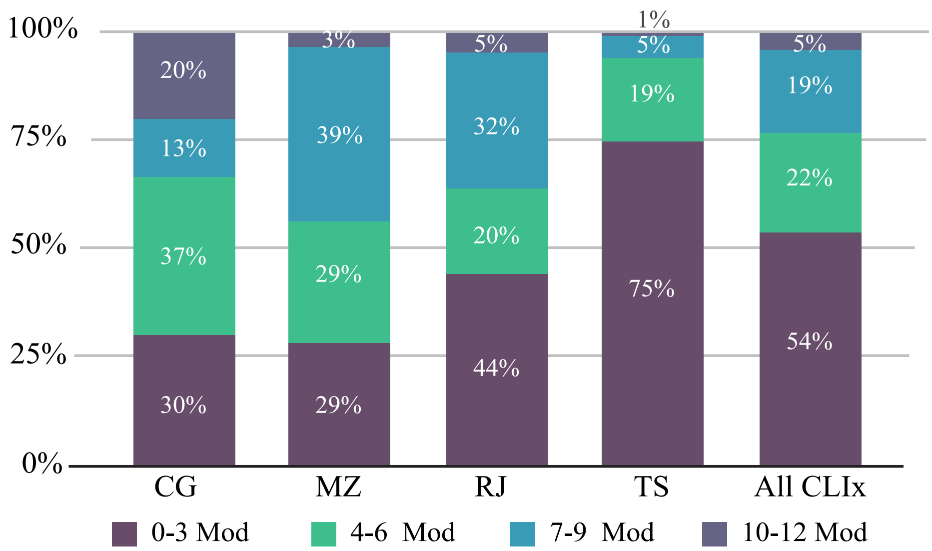
**Source:** IMT Data

**Notes:**

1. This is out of the maximum modules officially rolled out in the state across the three subjects. Refer to Table 3.3 for details of the modules in the state roll-out.
2. In Chhattisgarh, two modules of Geometric Reasoning were rolled out as 'one' and this was the officially mandated roll out. Hence, maximum modules = 1.

Table 4.1 gives the pattern distribution of average module usage per school per state. Overall, in 29% of schools, about 50% or more modules had been used by students. There was considerable state level variation, where a higher proportion of schools in Chhattisgarh (46.7% of schools), Mizoram (42.9% schools) and Rajasthan (42.5% schools) used 50% or more modules and in Telangana only 12.7% schools used 50% or more of the modules.

**Figure 4.2: Distribution of Average CLIx Module Usage per School based on IMT data (State-wise and All CLIx)[1]**




**Note:** Based on IMT observations of module usage: Chhattisgarh: 291 observations over 30 schools, Mizoram: 102 observations over 28 schools, Rajasthan: 231 observations over 87 schools, 78 observations from 110 schools

Figure 4.2 shows us the spread with reference to extent of module usage state wise. We note that overall CLIx schools, about 5% showed a high level of adoption, and were found to have used between 10 to 12 of modules (20% of schools in Chhattisgarh were in this group). An average of 19% of schools had an adoption level of about 7 to 9 modules, across all CLIX schools (13% of schools in Chhattisgarh, 39% of schools in Mizoram and 32% of schools in Rajasthan). We also found that overall in CLIx, low level of module usage was noted in 54% of schools (44% of RJ and 75% in TS). Majority of the schools Chhattisgarh (70%), Mizoram (72%) and Rajasthan (57%) rolled out at least four or more modules.

## 4.2 Adoption at Teacher Level

Adoption of CLIx by teachers is assessed using both the IMT data on teachers and their responses to the CBAM items in which they reported their concerns.

### *4.2.1. Engagement during lab sessions from IMT*

Of the 512 IMT observations made, 500 were of CLIx lab sessions. In 354 sessions (71% of all sessions), teachers were present for the entire session (Figure 4.3). Of those who were present for the entire session, 73% also used discussion with students (Table 4.2). These teachers were also found to be far more actively engaged with students either taking initiative themselves (53%) or responding to requests from students (41%). In the case of teachers who did not remain in the lab for the entire session (29%), a majority were not responsive to students at all (62%) and did not discuss with students much (82%).

**Figure 4.3: Teacher Engagement During Lab Session**

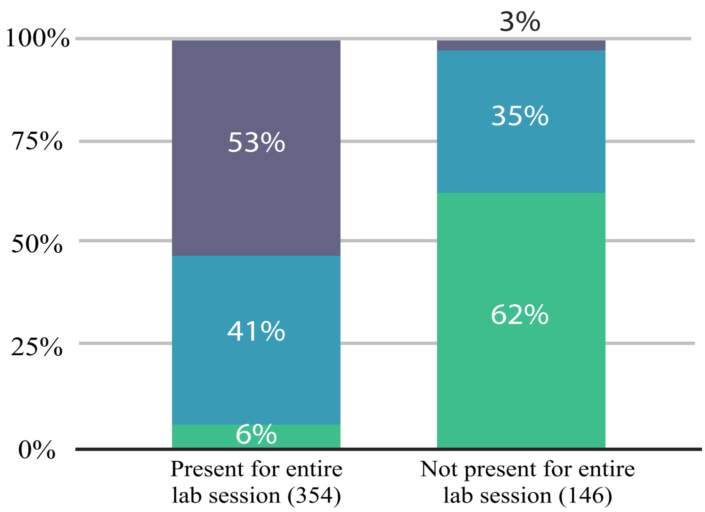



**Table 4.2: Use of Discussion by Teachers During Lab Session**

| Teacher Presemce | Initiated discussion with whole lab | Did not initiate discussion with whole lab | Total |
|---|---|---|---|
| Teachers who were present for entire lab session (71% of total) | 73% | 27% | 354 |
| Teachers who were not present for entire lab session (29% of total) | 18% | 82% | 146 |

### 4.2.2 Concerns based adoption model analysis

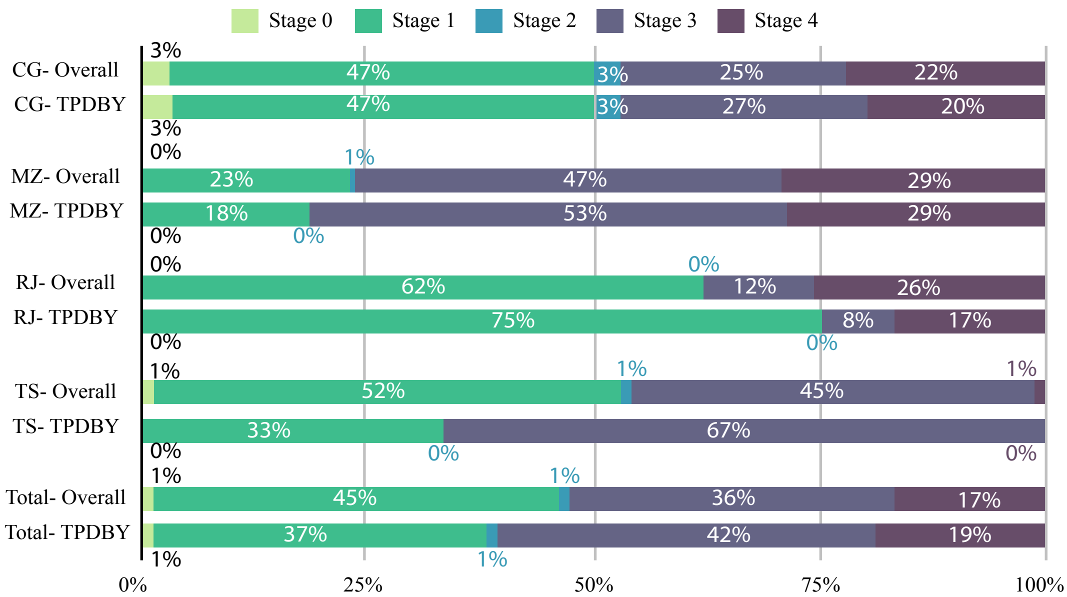
The CBAM proposes that the kinds of concerns teachers express are indicative of the extent of their engagement with the innovation. Across the four states, 273 CLIx teachers responded to the open-ended survey question on their concerns with regard to CLIx. Teachers' responses were coded based on the CBAM stages of concerns, stages 0 to 6.[29] CLIx teachers' concerns could be mapped onto stages 1 to 4; there were very few responses at stage 0 and none at stages 5 or 6 (Table 4.3).

A majority of teachers were concerned with issues pertaining to stage 1 (45% overall, with TS 52%, RJ 62% and CG 47%) indicating that teachers needed to know more about the innovation. Overall, 36% teachers were in stage 3 concerns, predominantly teachers from Mizoram (47%), followed by Telangana (45%), Chhattisgarh (25%) and Rajasthan (12%). There were about 22-29% teachers in CG, MZ and RJ whose responses were categorised under stage 4 which pertains to higher levels of concerns and thereby adoption, such as the consequences of the innovation for their students. The absence of teachers from Telangana in this Stage 4 of concerns suggests a lower level of adoption (Figure 4.4).

**Table 4.3: Stages of Teachers' Concerns About CLIx (Number of Teachers)**

| Stages of Concerns | CG | MZ | RJ | TS | Total | Stage total as % of total |
|---|---|---|---|---|---|---|
| Stage 0 (Unconcerned) | 1 | 0 | 0 | 1 | 2 | 1% |
| Stage 1 (Informational) | 17 | 17 | 36 | 54 | 124 | 45% |
| Stage 2 (Personal) | 1 | 1 | 0 | 1 | 3 | 1% |
| Stage 3 (Management) | 9 | 35 | 7 | 47 | 98 | 36% |
| Stage 4 (Consequences) | 8 | 22 | 15 | 1 | 46 | 17% |
| Total | 36 | 75 | 58 | 104 | 273 | |

**Figure 4.4: Stages of Concern Overall and Teachers with TPD for 3 Years**




**Note:** Total number of respondents: Overall :CG-36, MZ-75, RJ-58, TS-104; TPD3Y: CG-30, MZ-34,RJ-12,TS-21

[29] CBAM stages of concerns: 0 - Unconcerned; 1 - Informational; 2 - Personal; 3 - Management; 4 - Consequence; 5 - Collaboration; 6 - Refocusing (https://www.air.org/resource/stages-concern)

### 4.2.3 Changes in concerns over time

We investigated concerns of teachers who received the maximum extent of TPD for up to three years in comparison with concerns of all teachers. A relatively higher proportion of panel teachers were in Stage 4 (19% vs. 17%). In the case of Mizoram and Telangana, a larger proportion of teachers with TPD 3 years were in stage 3 (53% vs. 47% for Mizoram and 67% vs. 45% for Telangana). Longer exposure to the CLIx intervention did seem to have either no change (CG and RJ) or improvement in adoption (MZ, TS and overall).

## 4.3 Interpreting adoption from platform data: school and student level

The platform usage is based on student login data. CLIx platform was designed to enable students to use it with or without logging in. The main motivation to use login was to have continuous access to their earlier work. However this was made optional to reduce login related barriers to access. Moreover CLIx modules are designed for collaboration and one student login may represent a group working on the resource. Hence the data of usage from the platform is either less than or equal to the actual usage. *It may under-represent the overall access and usage,* and in no case represents the higher side of the picture. Login data also *may over-represent engagement or quality of engagement* as login data does not tell us about time spent in a given session. In spite of these limitations, the data from platform logins is drawn upon and used, as it is an proxy of student access and usage. Based on this data we analyse and present findings pertaining to student users and usage of CLIx.

Each student module is organised in the form of units which include lessons and activities. When students logged into the platform in order to use resources, this created a record of 'logins' of students.

Table 4.4 provides the overall picture of student usage of modules.The average unique logins per school was an average of 41.59 across CLIx schools, which compares well with the average class size of CLIx schools. This indicates a reasonable level of access by individual students of all intervention schools. With regards to the level of access of resources over all CLIx schools, 52% of all schools were found to have accessed more than 50% of the available resources. The average of units accessed per login in English was 1.58 (overall maximum of 4), in Mathematics, 2.02 (overall maximum of 13) and in Science 2.33 (overall maximum of 8).

**Table 4.4 : Student module usage by subject and state (Jul 2018–Mar 2019, Platform data)**

| CLIx state | No. of schools with platform data | Unique Logins (per s chool average) | Avg. of English Units accessed per login (Max) | Avg. of Maths Units accessed per login (Max) | Avg. of Science Units accessed per login (Max) | % of schools with >=50% Eng. units accessed (N) | % of schools with >=50% Maths units accessed (N) | % of schools with >=50% Sci. units accessed (N) | % of schools with >=50% all units accessed (N) |
|---|---|---|---|---|---|---|---|---|---|
| CG | 30 | 1645 (54.83) | 1.61 (4) | 1.56 (5) | 2.61 (8) | 70% (21) | 53% (16) | 70% (21) | 53% (16) |
| MZ | 18 | 671 (37.27) | 1.4 (4) | 1.8 (13) | 1.53 (5) | 61% (11) | 17% (3) | 39% (7) | 28% (5) |
| RJ | 87 | 4147 (47.67) | 1.35 (4) | 1.9 (13) | 2.25 (8) | 67% (58) | 37% (32) | 78% (68) | 56% (49) |
| TS | 83 | 2604 (31.37) | 1.82 (4) | 2.61 (13) | 2.49 (8) | 75% (62) | 30% (25) | 67% (56) | 52% (43) |
| All CLIx | 218 | 9067 (41.59) | 1.58 (4) | 2.02 (13) | 2.33 (8) | 70% (152) | 35% (76) | 70% (152) | 52% (113) |

**Note:** CLIx subject content is divided into modules, units, lessons and activities

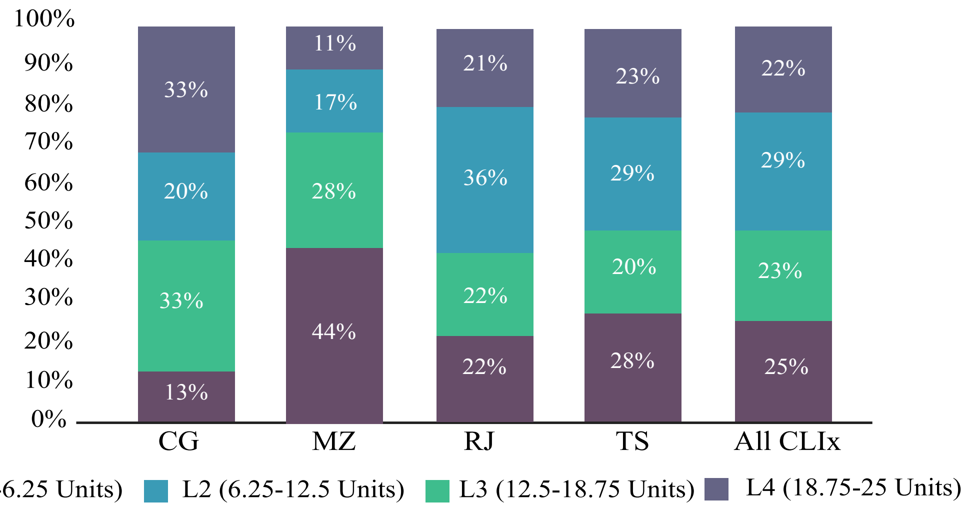
We examined the percentage of schools which had accessed 50% or more units, subject wise, to get a sense of level of adoption in schools. 70% of all CLIx schools were found to have accessed 50%

or more English units, 35% had accessed 50% or more mathematics units and 70% had accessed 50% or more science units. This suggests that in general the extent of adoption of English and science across all CLIx schools was much higher than that of mathematics.

The module with maximum usage in English was English Elementary, in Mathematics it was Geometric Reasoning-1 and in Science it was Atomic Structure and Sound.

The figure 4.5 examines module usage based on platform logins which was also discussed under section 4.1, based on IMT observations. Based on platform data we note that in at least 51% of schools, at least about 50% of the CLIx module-units were accessed by students (24% schools used more than 50% of modules). There is variation between states: in the case of Chhattisgarh, at least 53% of schools used 50% or more of the CLIx module-units (33% as per IMT), in Mizoram this was 29% (42% as per IMT), in Rajasthan this was at least 57% (37% as per IMT) and in Telangana it was 52% (6% as per IMT) of schools. In general we note higher levels shown by the platform data (except in the case of Rajasthan). The differences between the platform unit-access data and IMT module usage observations range from -13% in case of Mizoram, +20% for Rajasthan, +20% for Chhattisgarh and +46% in case of Telangana. In general this suggests that the results from direct observation were an underestimate at best. The difference in the case of Telangana could tell us that in a situation where direct observation was very limited, the platform access data tells us that the level of usage was likely much higher than the estimate provided by the IMT. In case of Mizoram, the fact of higher level of usage observed on the IMT as opposed to logged on the platform could be attributed to lesser usage of login by students.

**Figure 4.5: Distribution of Average CLIx Module-units Usage per School based on Platform Data (All CLIx and States)**




**Note:** The student module content is divided into modules, units, lessons and activities

## 4.4 Discussion

Evidence of adoption and levels of adoption of CLIx modules is generated through complementary sources of data. Primarily from the Intervention monitoring tool we find that more than 50% of modules were used by over 42% of schools in Chhattisgarh (46.7%), Mizoram (42.9%) and Rajasthan (42.5%), and was at 12.7% in the case of Telangana. Overall 29% of CLIx schools used more than 50% of modules. Usage based on platform login data shows that at least 50% of module-units were accessed in 52% of schools in Chhattisgarh (53%), Rajasthan (56%) and Telangana (52%), and was at 28% in case of Mizoram. Over all in CLIx this was 52% of schools. We may attribute these differences to the nature of data being collected as well as the possibility that many students in Mizoram were using CLIx modules without logging in.

Overall level of module usage was observed to be higher in Chhattisgarh across all subjects. The extent of module usage varied across subjects and in different states. Mathematics was found to be used highest in Chhattisgarh (83% of schools as per IMT and 70% of schools according to platform data, used more than 50% of the modules and contents). In the case of Science, more than 50% usage of resources was noted in Rajasthan and Chhattisgarh (78% in RJ as per IMT and 41% as per platform for RJ and CG). For English, Mizoram and Telangana emerged as high usage states (52% in MZ according to IMT and 75% in TS as per platform).

Data shows that 71% of teachers remained in the lab for CLIx ICT usage sessions and of them, 73% actively discussed and either themselves took initiative or responded to students when asked. Concerns Based Adoption Model (CBAM) shows that 45.4% of teachers were still in stage 1 (need to know about the initiative) and 35.9% were in stage 3. Higher levels of adoption (stage4) were seen in about 22-29% of teachers, especially from Mizoram, Chhattisgarh and Rajasthan. Longer exposure to CLIx seems to have led to greater improvement in adoption in Mizoram and Telangana.

# 5. Teachers

In this section, findings from endline surveys pertaining to teachers across the four states are presented. Findings from teachers' endline surveys were analysed for comparison of (i) All CLIx and non-CLIx teachers (ii) teachers who were a part of the baseline and endline surveys (panel) and (iii) teachers in the panel who have received maximum TPD over 3 years or 1-2 years in a few cases.

This section is divided into three parts. In the first part, findings from the endline survey of teachers are discussed. The second part evaluates the extent of change witnessed in knowledge, attitudes and practices (KAP) of teachers over the period of CLIx intervention. For this purpose, all the panel teachers (162) were considered. The third part examines the impact of TPD on teacher KAP.

In the case of panel teachers, findings are reported as changes during 2016-19 in their perceptions, beliefs and practices pertaining to technology access and use, technology related competence, professional development, beliefs about use and effects of technology, challenges in integrating technology in teaching and domain pedagogy.

## 5.1 Profile of Teachers[30]

A sample of 481 teachers was surveyed in the endline survey, including 372 from CLIx intervention schools and 109 from non-CLIx schools. From the CLIx teacher sample, 128 teachers reported having received 3 years of CLIx TPD, 195 teachers had received 1-2 years of TPD and 47 teachers had not received any training.[31] The 109 teachers from non-CLIx schools comprised the external control group.

For 162[32] of the 372 CLIx teachers surveyed, there was also data from the baseline survey (i.e. panel data of 2016 baseline and 2019 endline surveys). Of this 'panel teachers' group, 76 had received all training over the three-year period of implementation, and 79 teachers had received one or two years of TPD, while 7 teachers had not attended any CLIx training. These differences in TPD treatment are drawn upon while making comparative analyses in change over time in KAP of teachers and their response to question of concerns about CLIx in the CBAM survey (section 4.3)

Male teachers constituted 63% of all CLIx teachers, 57% of the panel subgroup of CLIx teachers and 71% of non-CLIx teachers. Teachers' average experience across all groups was 10 years (non-CLIx) to 14.6 years (CLIx-panel). It was found across all states that a relatively high proportion of teachers teaching English did not have a graduate degree in this subject. 53, 79 and 85 percent of English, maths and science teachers in CLIx schools had similar subjects in graduation. In case of non-CLIx the proportion was 53, 81 and 81 percent respectively.

[30]Refer Annexure Tables 5-8 for detailed tables pertaining to teacher characteristics (gender, age, caste, years of experience, age and educational background).

[31]Please refer to section 2 on methodology for the relevance of the extent of TPD received to the seven-group analysis plan adopted, particularly in section 6 of the report. The 128 teachers with 3 years of CLIx TPD were in groups 1 and 2 of student sample, i.e., teachers having received maximum TPD. The 195 teachers with 1-2 years of TPD were in groups 3 and 4. The 47 teachers with no training were in groups 5 and 6, group 6 represented the internal control for analysis. Two CLIx teachers had missing data for the extent of TPD received. The 109 teachers from non-CLIx schools comprised the external control group.

[32] The total number of teachers in the panel group was 162. Among them one one teacher had only subject tool data and not general tool data from the baseline. With reference to panel group analysis, please refer to N mentioned in the tables for each of the constructs there.

## 5.2 Teacher Attributes: Knowledge, Attitude and Practices

Changes in teachers were observed based on attributes relating to their skills and practices pertaining to ICT usage, their perceptions and beliefs pertaining to ICT integration into education and their practices favouring active, student-centred learning. These attributes were reported separately for teachers of English, mathematics and science. The attributes were arrived at by factor analysis (see section 2.2.4). Table 5.1 provides a description of these attributes.

**Table 5.1: Description of Knowledge Attitude and Practices (KAP) Constructs or Attributes**

| | | |
|---|---|---|
| ICT skills | | |
| (i) | Basic ICT skills | Ability to start a computer; handle a mouse device; save files; use word processing software, spreadsheet; type in English, type in Hindi, Telugu, Mizo (7 items) |
| (ii) | Advanced ICTskills | Ability to download/upload files; photograph and record audio/video clips on phone/digital camera; use online maps, simulations; download and use apps on mobile phone; use video conferencing; program (10 items) |
| (iii) | Online ICT engagement | Experience of searching internet for personal or professional work; experience of interacting with online community (4 items) |
| Use of ICT in education and teaching learning | | |
| (iv) | Positive beliefs about role of ICT in teaching-learning process | Use of technology in teacher learning process improves student learning, helps students grasp difficult curricular concepts, enables them to do better projects, helps them apply and relate concepts, improves curricular transaction, enables students to collaborate and interact more, increases healthy competition, reduces students fear of failure, Takes more time (with students) but is worth it, is more effective when teachers collaborate with peers or experts (10 items) |
| (v) | Perception of challenges in accessing computers and accessing training to use computers | Not enough computers in computer lab, not enough training for teachers on use of computers, not enough opportunity to practice (3 items) |
| (vi) | Perception of problems of devices, power and access to internet (hardware, data, power) | Unstable and intermittent power supply, frequent crashing of computers or outdated computers, internet is slow (3 items) |
| (vii) | Perception of challenges associated with teaching with computers (extrinsic) | (Extrinsic) leadership is not supportive. Students are at different levels, and it is difficult to manage when students have poor computer skills. Computer teacher is not available. It takes time away from completing the syllabus<br>(intrinsic) lack of know-how on integrating ICT for subject teaching (6 items) |
| Active learning and student-centred teacher learning practices | | |
| (viii) | Student-centred teaching learning practices in English | Relate what is being learnt to students' daily life, use textbooks and other resources in class, prepare additional information for next days' lesson, ask open-ended questions to students; give students opportunities to explain their answers and to decide on their own how they will carry out tasks; organise students to work in small groups (7 items) |
| (ix) | Student-centred teaching learning practices in maths | Relate what is being learnt to students' daily life, ask open-ended questions to Students, let them decide on their own how they will solve (complex) problems, organise students to work in small groups (4 items) |
| (x) | Student-centred teaching practices in science | Ask students to observe natural phenomena, ask them to design, plan and conduct investigations and describe what they observe, organise students to work in small groups, do demonstrations and experiments for students to observe (6 items) |

## 5.3 CLIx-Non-CLIx Teacher Comparison of Changes in Knowledge, Attitude and Practice

Comparisons of CLIx and non-CLIx teachers were carried out with reference to their self-reported skills, perceptions and beliefs pertaining to ICT and use of ICT in education and their student-centred teaching practices (Table 5.2). With reference to advanced and online ICT engagement and perception of challenges of using ICT in education, CLIx teachers had slightly higher scores as compared to non-CLIx teachers. With regards to self-reported student-centred teaching practices, CLIx teachers had lower scores compared to non-CLIx teachers. However, none of these differences was significant.

**Table 5.2: Average Score of CLIx and Non-CLIx Teachers on KAP**

| Category | KAP | Scoring Range | CLIx N=372[1] | Non-CLIx N=109[1] |
|---|---|---|---|---|
| ICT skills | Basic ICT skills | 1-5 | 2.28 | 3.59 |
| | Advanced ICT skills | 1-5 | 3.74 | 3.14 |
| | Online ICT engagement | 1-4 | 3.08 | 2.33 |
| Use of ICT in education | Positive beliefs about role of ICT in teaching-learning | 1-4 | 3.23 | 3.23 |
| | Perception of challenges in accessing computers and accessing training to use computers | 1-5 | 4.11 | 4 |
| | Perception of problems of devices, power and access to internet (hardware, data, power) | 1-5 | 4.13 | 4.06 |
| | Perception of challenges associated with teaching with computers (extrinsic) | 1-5 | 3.71 | 3.69 |
| Active learning and student-centred teaching practices | Student-centred teaching practices in English | 1-4 | 2.86 (118) | 3.06 (30) |
| | Student-centred teaching practices in maths | 1-4 | 2.65 (122) | 2.75 (42) |
| | Student-centred teaching practices in science | 1-4 | 2.40 (132) | 2.57 (37) |

**Note:** Where the N value for a row differs from the total, this is indicated in parentheses.

## 5.4 Change over Time: Knowledge, Attitude and Practices of CLIx-Panel Teacher Group

Responses of the CLIx panel teacher group were analysed to understand if their reported skills, perceptions, beliefs, and practices had changed over time between the baseline and the endline surveys (Table 5.3). For the test of significance, paired t-test has been used.

### *5.4.1 ICT skills*

All CLIx-panel teachers reported an improvement in their advanced digital skills (0.35 points, statistically significant) and online ICT engagement (0.21 points, statistically significant). However there was a decline in their self-reported basic ICT skills (0.10 points, not statistically significant). The finding on decline in basic skills self-reporting can be understood in the context of field experiences, wherein teachers' basic digital skills were found to be at a much lower level during the TPD training than what the data from baseline survey suggested. It can be interpreted as a case of teachers overestimating their digital skills during the baseline survey and having a more realistic assessment of their abilities after having had the opportunity to engage with digital skills during the course of their trainings. However, the advanced digital skills and online ICT engagement for all categories of teachers improved significantly overtime[33].

### *5.4.2 Use of ICT in education*

There was a decrease in positive beliefs about the role of ICT in education (0.02 points, not statistically significant). There was no change in the teachers' perception of challenges pertaining to computer access and training. Perception of challenges with regard to functioning of devices, power and internet declined over time (0.05 points, though not significant statistically). Perception of challenge of teaching with computers increased (0.20 points, and statistically significant).

[33] Refer toTable 9 in annexure.

While comparing 3-year TPD teachers with the 1-2 years TPD teacher group[34] in the endline survey, the former reported greater level of agreement with positive beliefs about the role of ICT in education (average score 3.24 vs. 3.13) and lower level of challenges regarding computer access and training (average score 3.96 vs. 4.22) and teaching with computers (average score 3.52 vs. 3.76). All these differences are statistically significant. This finding suggests that higher level of TPD has contributed to the development of teachers' confidence in their own ability to use ICT and also their beliefs regarding the use of ICT in education.

### *5.4.3 Active learning and student-centred practices*

Improvements were seen in self-reported student-centred teaching practices for English teachers (0.11 points) and mathematics teachers (0.10 points), and a decrease for science teachers (0.14 points, and statistically significant).

**Table 5.3: Average Scores of CLIx Panel Teachers Based on Extent of TPD Received**

| S. No. | Criteria | KAP | Scoring Range | All CLIx panel | | CLIx Panel with TPD= 3y | |
|---|---|---|---|---|---|---|---|
| | | | | N | Change @ EL - BL | N | Change @ EL - BL |
| i | ICT Skills | Basic ICT skills | 1-5 | 161 | -0.10 | 75 | -0.06 |
| ii | | Advanced ICT skills | 1-5 | 161 | 0.35* | 75 | 0.33* |
| iii | | Online ICT engagement | 1-4 | 161 | 0.21* | 75 | 0.25* |
| iv | Use of ICT in education | Positive beliefs about role of ICT in teaching-learning | 1-4 | 161 | -0.02 | 75 | -0.03 |
| v | | Perception of challenges in accessing computers and accessing training to use computers | 1-5 | 161 | 0 | 75 | -0.14 |
| vi | | Perception of problems of devices, power and access to internet (hardware, data, power) | 1-5 | 161 | -0.05 | 75 | -0.09 |
| vii | | Perception of challenges associated with teaching with computers (extrinsic) | 1-5 | 161 | 0.20* | 75 | 0.09 |
| viii | Active and Stdent-centred practices | Student-centred teaching practices in English | 1-4 | 56 | 0.11 | 27 | 0.04 |
| ix | | Student-centred teaching practices in maths | 1-4 | 52 | 0.10 | 25 | 0.27 |
| x | | Experiential learning practices in science | 1-4 | 52 | -0.14* | 23 | -0.29* |

**Notes:**
@ EL-BL: Endline score - Baseline score
+,- indicates positive or negative change.
* Change from BL to EL is significant at 0.05 level.

## 5.5 Variations in CLIx-panel teachers with extent of TPD

Panel teachers were further segregated by the extent of TPD they had received over the 3 years of CLIx intervention. Further analysis was carried out comparing the groups that had received 3 full years of TPD with those who had received only 1 to 2 years of TPD (Table 9 in annexure).

### *5.5.1 ICT skills*

With reference to their ICT skills, teachers with the full 3 years of TPD reported significant improvement in their advanced ICT skills (0.33 points.) and online ICT engagement (0.25 points). The improvement in the outcomes was also significant for those with 1 to 2 years of TPD.

[34] For detailed analysis table, please see Table 9 in annexure.

### *5.5.2 Use of ICT in education*

With reference to use of ICT in education, teachers with 3 years of TPD reported a lower level of challenge in accessing computers and training (-0.14 units) and challenge of functioning devices, power and internet (-0.09 units). They saw an increase in their own perception of challenge regarding teaching with computers (0.09 units). There was also a similar change witnessed in those teachers who had 1 to 2 years of TPD (0.08, -0.07 and 0.16 units respectively). This suggests that more training has contributed to teachers' ability or confidence to handle challenges or perception of problematic conditions as being challenging.

## 5.6 Discussion

No notable differences were seen between CLIx teachers (all taken together) and non-CLIx teachers in their ICT skills, positive beliefs about use of ICT in teaching learning or perception of challenge, and in their self-reported active learning and student-centred practices. However, disaggregated analysis of CLIx panel teachers showed that they improved in their advanced digital skills and online ICT engagement skills over time. Among the panel, higher levels of TPD seems to have contributed to their perception on the usefulness of ICT in education and feeling less challenged in using ICT. In the case of science teachers, a significant decrease in the self-reported practice of student-centred teaching-learning practices was also noted.

# 6. Students

Students are the ultimate beneficiaries of the CLIx intervention. In this section, outcomes at the student level are reported from two studies carried out to investigate scholastic and non-scholastic changes: the learning outcomes study and the endline study.

Scholastic outcomes: The learning outcomes study answers the question, ‘Do CLIx modules produce significant learning gains when implemented with fidelity to the intended design?’ This question was studied through a quasi-experimental research study across three states where, in CLIx intervention schools, specific CLIx modules were used, and in the non-intervention, control schools, the same topics were taught by teachers using the prescribed resources. The teaching and learning outcomes of the same topics were measured and compared.

The learning assessment tests in the endline study examined grade-appropriate English, mathematics and science content through paper pencil tests, with the addition of listening and speaking in English. The scope of the assessment was not restricted to CLIx module content, although there were items included from those topics as well.

Non-scholastic outcomes were assessed in both the learning outcomes study and the endline study. In the learning outcomes study, the test measured attitudes and beliefs of students. Student behaviours in the classroom were also observed, and students were interviewed. In the endline study, the student survey tool gathered information from students, self-reported on their level of knowledge and skills of ICT and their beliefs regarding ICT use in education.

The learning outcomes study followed a difference in difference approach for analysis between treatment and control groups. In the endline study analysis, as in the case of the teacher responses, the analysis was carried out based on the factors that emerged as significant. The analysis plan adopted for comparisons is based on grouping students based on the extent of treatment received (teachers with higher vs. low levels of professional development and level of usage of CLIx resources in ICT lab) discussed in section 2.2.4 of this report.

The two studies (learning outcomes and endline study) inform us on two distinct dimensions of student learning from CLIx interventions. The learning outcomes study informs our understanding of student learning of concepts that the CLIx modules were designed to achieve. The endline study provides assessment of student learning of a range of grade specific concepts and competencies (knowledge, skills, application and higher order reasoning), in the respective domains of English, maths and science.

## 6.1 Learning Outcomes in Contexts of Higher Fidelity to Design

The learning outcome study was conducted to study learning outcome gains in 9th grade, using three subject modules of CLIx: English (studied in Mizoram), mathematics (studied in Chhattisgarh) and science (studied in Rajasthan). The specific modules selected were Basic Astronomy in science, Geometric Reasoning in mathematics and English Beginner and English Elementary for English listening and speaking. These modules were implemented under near- optimal conditions, involving teaching spread over 3 to 4 weeks and following the prescribed classroom experiences and lab-based work for the ICT components of the modules. In the non-CLIx schools, over the similar period, the related textbook topic was taught by their teachers. In both contexts, the module or topic was completed. Higher fidelity of CLIx implementation was mostly attributed to the extent to which CLIx teachers had understood the objectives of the module and used resources as per recommendation, enabled desired learning behaviours of the students and facilitated the discussion and digital activities with students while incorporating feedback from the research group collaborating in the classrooms. Pre- and post-tests of students were conducted. The average scores of students and analysis of the changes is presented in Table 6.1

**Table 6.1: Pretest–Post-test Average Scores (in percentage) and Analysis in Learning Outcomes Study**

| Subject-Topic | CLIx | | | Non-CLIx | | | Difference between CLIx and non-CLIx | Significance |
|---|---|---|---|---|---|---|---|---|
| | Pretest | Posttest | Gain | Pretest | Posttest | Gain | | |
| English - Listening (N: CLIx=100; Non-CLIx=75) | 40.0 | 61.0 | 21.0 | 57.3 | 69.2 | 11.9 | 9.1 | *p = .0036* |
| English - Speaking (N: CLIx=99; Non-CLIx=77) | 43.0 | 53.9 | 10.9 | 55.7 | 73.3 | 17.6 | -6.7 | p = .0301 |
| English - Speaking for 3 of 6 CLIx schools (N: CLIx = 56) (average scores) | 16.03 (max:40) | 23.9 (max:40) | 7.86 | | | | | p<.01 |
| Maths - Geometric Reasoning (N: CLIx=466; Non-CLIx=499) | 29.77 | 43.19 | 13.42 | 33.92 | 36.73 | 2.81 | 10.61 | *p< .001* |
| Maths - Gender wise data (N: CLIx- F = 251, M = 215 Non-CLIx F = 290, M = 209) | F: 29.8 M: 29.63 | F: 39.44 M: 47.57 | F: 9.6 | F: 35.46 M: 38.48 | F: 32.80 M: 35.47 | F: 2.66 | 7 | *p=.002* |
| Science - Astronomy (N: CLIx = 169; Non-CLIx = 118) | 33.31 | 46.58 | 13.27 | 32.07 | 32.98 | 0.91 | 12.36 | *p< .001* |

### 6.1.1 English Learning Outcomes

Student participants in the six CLIx intervention schools showed increased improvement (21 points) in listening skills that was statistically significant (p < .03), indicating that their ability to listen closely to audios and speech in English and comprehend meaning improved during the course of the intervention. When comparing the gains of students in intervention schools with the gains of their counterparts in non-intervention schools, there was a significant difference between the two groups, p = .0036. This confirms that students' listening skills improved during the period of study. For speaking skills, both intervention (n=99) and control groups (n=77) gained alike in their outcomes (10.9 points, and 17.6points respectively).

Students from non-intervention schools showed a significantly greater gain (p = .0301) than those from intervention schools in speaking skills. When a second level of analysis was carried out by disaggregating intervention schools, it was noted that in 3 out of the 6 intervention schools, there was an improvement in speaking scores for students which was seen to be statistically significant (average gain by 7.86 points, p<.01). Since CLIx was the only intervention present at the time of the study in these schools, we can attribute the difference in scores to the program. From the perspective of language learning practises, classroom observations in the intervention schools showed that students gained confidence, initiated discussions amongst peers and collaborated with their peers in task completion increasingly over the weeks. A reduction in teacher involvement intervention from their teachers was also noted over time. The control schools, by contrast, demonstrated primarily teacher-led classrooms with fewer opportunities for students to produce and use language meaningfully.

### *6.1.2 Mathematics Learning Outcomes*

Students in the intervention schools showed higher gains from pretest to posttest by 13.42 percentage points which was statistically significant ($p < .0001$). The gain of CLIx students (466) from pretest to posttest was statistically significant ($p < .001$) compared to that of non-CLIx students (499). This points to the effectiveness of the module and its implementation.

A gender analysis of student performance revealed that girls in the intervention group scored significantly higher than girls in the non-intervention group ($p = .0002$). This suggests that the use of the CLIx modules (classroom teaching and use of ICT lab resources) was particularly beneficial in supporting learning of girls.

Qualitative analysis was carried out of student responses and also of levels of fidelity within the CLIx intervention schools. It was found, based on the responses of students to open-ended items in the pretests and posttests, that students gained in their ability to use more properties to describe the shapes correctly. More cognitive gains were evidenced in classrooms where there was a relatively higher level of fidelity, with reference to the students' concepts of shape, understanding of properties of plane shapes and hierarchical class relations and engagement with the process of mathematical reasoning.

### *6.1.3 Science Learning Outcomes*

Scores of students in the intervention schools (n=169) improved significantly from 33% to 47% after the intervention ($p < .001$), whereas the scores of those in the non-intervention group (118 students) did not improve ($p = .10$). There was a significant difference between posttest scores of students in the intervention (47%) and non-intervention groups (33%), as well as in their pre- to posttest gains (both $p < .001$), with the intervention group scoring higher in the posttest and showing greater improvement.

Post test results showed significant increase (almost 5 percentage points) in interest and positive attitudes towards learning astronomy and science in the intervention group compared to the control group. However, students' beliefs in astronomy remained unchanged after the intervention. This shows that the module was effective in improving students' conceptual understanding and interest in astronomy but it did not result in critically questioning their own beliefs related to it.

## 6.2 Endline Study, Profile of Respondents and Analysis Plan

The endline test of learning outcomes in English, mathematics and science, ICT skills, and beliefs and perceptions in CLIx intervention and non-CLIx schools was carried out to assess overall grade level content and competencies pertaining to the subject areas. A total of 3960 students in CLIx and 1409 students in non-CLIx schools were surveyed across the four states.

### *6.2.1 Profile*

The gender distribution across CLIx and non-CLIx schools was similar, with approximately 53% girls and 46% boys respectively. In terms of caste, ST (27%) were in majority followed by BC (26%) and OBC (22%) in CLIx. In case of non-CLIx schools OBC were in majority (33%) followed by BC (26%) and SC (17%). The difference in percentage of ST category students between CLIx and non-CLIx schools is due to the absence of non-CLIx schools in Mizoram, which has a large ST population. (Detailed profiling of students and their parents can be found in Annexure Tables 10-13.) Students' access to devices at home showed similar distribution in CLIx and non-CLIx samples  access to internet was about 35-36% and computers was about 15% for both the categories..

### *6.2.2 Analysis*

Student outcomes in scholastic and non-scholastic areas are presented under student groupings in terms of two types of treatment they received: being taught by teachers with CLIx TPD and having the opportunity to use the CLIx resources. This analysis plan was devised to recognise variations in implementation scenarios across CLIx states and schools, and to account for the fact that not all students taught by a given teacher were batched for ICT lab access or given the opportunity to use CLIx modules in the ICT lab. (See section 2.2.4 for detailed description of analysis plan.) Note that, although there was variation between states in the extent of modules used (see Table 4.1), this has not been taken into account in the present analysis, which treats opportunity to use CLIx ICT resources in lab as a binary variable (yes, no). This seven-group analysis (5 CLIx treatment, 1 internal control and 1 non-CLIx external control) is used in the findings presented here. Comparisons are made with reference to specific groups of interest: *High CLIx input*- group 1 students who were taught by the most experienced and trained teachers, *Only High TPD input*- group 2 who were also taught by this group of teachers but who did not use CLIx ICT resources, *Internal control*-Group 6 which was taught by untrained teachers with no experience of CLIx and no ICT lab usage and *External control*-group 7 from non-CLIx schools.

It may be noted that there are caste and gender based differences in access to lab. Students from SC, ST categories are less likely to access lab for science and mathematics. Boys are more likely to attend English and mathematics lab sessions. (See section 3.5 for the state-specific variations on batching and also Table 4 in annexure.)

## 6.3 Overall Student Scholastic Outcomes from Endline Study

The average test scores of students are presented in Table 6.2 following the 7-group analysis plan for English, mathematics and science. Table 6.3 presents the results of comparisons between the specific groups of interest, which are further discussed below.

**Table 6.2: Average Endline Test Scores of Students in English, Mathematics and Science**

| Use of CLIx modules in ICT lab | CLIx TPD received by Teacher | | | |
|---|---|---|---|---|
| | 3 years | 1-2 years | 0 years | External Control |
| Yes | Group 1<br>(Full CLIx input = CLIx TPD + CLIx modules)<br>English Score 43.20 (N-819)<br>Maths Score 40.77 (N- 761 )<br>Science Score 46.25 (N- 547) | Group 3<br><br>English Score 44.08 (N-929)<br>Maths Score 40.71 (N-843)<br>Science Score 46.54 (N-1051) | Group 5<br><br>English score 43.68 (N- 150)<br>Maths score 51.18 (N-254)<br>Science score 45.31 (N- 248) | Group 7<br>(External Control)<br><br>English score 41.81 (N-1411)<br>Maths score 43.91 (N- 1411)<br>Science score 45.71 (N-1411) |
| No | Group 2<br>(Only Full CLIx TPD input w/o CLIx modules)<br>English Score 47.68 (N-267)<br>Maths 46.84 (N-287)<br>Science score 42.16 (N- 483) | Group 4<br><br>English score 52.25 (N-467)<br>Maths Score 39.14 (N- 583)<br>Science score 44.97 (N- 568) | Group 6<br>(No CLIx input: Internal control)<br><br>English score 46.5 (N-120)<br>Maths score 43.92 (N- 135)<br>Science score 42.69 (N- 230) | |

**Table 6.3: Summary Results from Comparison of Differences in Student Average Scholastic Scores**

| | Full CLIx input group vs internal control | Full CLIx input group vs external control | Full CLIx input group vs Only CLIx TPD group | Only CLIx TPD group vs internal control | Only CLIx TPD group vs external control |
|---|---|---|---|---|---|
| | I vs VI | I vs VII | I vs II | II vs VI | II vs VII |
| English | (-) | (+) | (-), * | (+) | (+), *, # |
| Maths | (-) | (-), * | (-), *, # | (+) | (+), * |
| Science | (+), * | (+) | (+), *, # | (-) | (-), * |

**Notes:**
(+), (-) indicates if there was a positive or negative effect.
* is used to denote where there is significance at 0.05 level, using independent group t-test.
Effect size is denoted by Cohen's d: small effect (#), medium effect (##).

**English**: Group II scored significantly[35] higher than Group VII. This suggests that having a teacher who has received a higher level of TPD results in better English scores. (There was no significant difference observed in relation to the internal control group.) Group I also scored higher than Group VII but the results were not significant. Students in the high CLIx input group (Group I) scored significantly lower than those of the only high TPD input (Group II). This suggests that students who had teachers with high TPD inputs were able to score better than those who could also access CLIx resources.

**Maths**: The scores of students from the external and internal control groups (GVII and GVI) were better than those of the CLIx full intervention group (GI). Group II students, those with teachers who had received full CLIx TPD but who did not have an opportunity to use ICT CLIx resources in the lab, were found to score better than the internal control (GVI) and significantly better than the external control group (GVII). Group II was also found to have gained significantly more than Group I, suggesting that there is a benefit (small effect size) of professionally developed teachers for student learning.

**Science**: The students from Group I who received full CLIx inputs scored higher than the external control (Group VII[36]) and also the internal control (group VI, significant). They also scored significantly higher than Group II (t with small effect size) suggesting that in the case of science, the use of ICT modules positively benefited learning. It was also noted that the external control group (VII) performed significantly better than group II (with only CLIx TPD). Overall, in the case of Science, the results suggest that having teachers with high TPD and use of CLIx resources was important in student learning.

## 6.4 Comparison of Student Scholastic Outcomes from Endline and Learning Outcomes Study

The learning outcomes study focused on student learning from CLIx modules under conditions of high fidelity to design and assessed learning on specific concepts in English, maths and science. Whereas the Endline study focused on a much larger student sample and assessed their learning in a wider range of grade-specific concepts. Table 6.4 provides a comparison of student performance across the two studies. A comparison of scholastic learning of CLIx students based on their grouping

[35] These differences were tested using independent group t-test and found significant at 0.05 level. Effect size was measured using Cohen's d.
[36] See fn 6.

from these two studies is done based on the level of CLIx input. The treatment and control groups of the learning outcomes study are comparable with the 'High CLIx Input' Group I and external control Group VII of the endline study.

### 6.4.1 Group I vs. Group VII

*Endline Study:* Group I students performed better than Group VII, the external control group in English and science (these results were not significant.)

*Learning Outcomes Study:* Group I CLIx treatment students had significantly outperformed the Group VII external control in English listening skills. Group I students significantly outperformed Group VII external control in Geometric Reasoning. Group I students significantly outperformed the Group VII external control in Basic Astronomy.

### 6.4.2 Group I vs. Group II (Endline Study)

Group I students performed better than Group II in Science and these results were significant with a small effect size. In Maths and English Group II performed significantly better than Group I.

### 6.4.3 Group II vs. Group VII (Endline Study)

Group II students performed better in comparison with students in the external control, Group VII in the case of English. These results were significant with a small effect size.Group II students performed better in maths too in comparison with students in external control, Group VII. This result too was significant. Group II students scored significantly less than Group VII, the external control group, in science.

**Table 6.4: Summary of Student Learning from Learning Outcome(LO) and Endline Survey (ES)**

| Grouping | | I vs VII | I vs II | II vs VII |
|---|---|---|---|---|
| Subjects | Studies | Results | | |
| English | English Listening (LO) | **(+), *** | | |
| | English Speaking (LO) | (-), * | | |
| | English (LO) | (-) | | |
| | English (ES) | (+) | (-), * | (+), *, # |
| Mathematics | Maths Geometric Reasoning (LO) | **(+), *** | | |
| | Maths (ES) | (-), * | (-), *, # | (+), * |
| Science | Science Astronomy (LO) | (+),* | | |
| | Science (ES) | (+) | (+), *, # | (-), * |

**Notes:**
(+), (-) indicates if there was a positive or negative effect.
* is used to denote where there is significance at 0.05 level, using independent group t-test.
Effect size is denoted by Cohen's d: small effect (#), medium effect (##).
Comparison of I & III (not shown in this table) showed students did significantly better with full 3 years TPD than those with 1-2 years of TPD.

The scholastic outcomes from the endline study are reported for all states combined. Table 6.5 reports the findings from an investigation of maths learning from the endline study was further undertaken for Chhattisgarh which had the overall highest level of mathematics module usage (83% of schools used more than 50% of maths modules as shown in Table 4.1). We find that the high CLIx input group (Group I) performed better than the external control group as well as better than the group with only high TPD (Group II). Group II scored better than the external group in overall maths learning. (See Table 14 in annexure for the detailed scores).

**Table 6.5: Summary of Student Learning from Chhattisgarh in Mathematics and Geometric Reasoning**

| | Full CLIx input group vs internal control | Full CLIx input group vs external control | Full CLIx input group vs Only CLIx TPD group | Only CLIx TPD group vs internal control | Only CLIx TPD group vs external control |
|---|---|---|---|---|---|
| | I vs VI | I vs VII | I vs II | II vs VI | II vs VII |
| **CG (GR)** | N.A. | (+), * | (+),* | N.A. | (+) |
| **CG (Maths)** | N.A. | (+) | (+) | N.A. | (+) |

**Notes:**
(+), (-) indicates if there was a positive or negative effect.
* is used to denote where there is significance at 0.05 level, using independent group t-test.
Effect size is denoted by Cohen's d: small effect (#), medium effect (##).

Specifically with regards to Geometric Reasoning which was consistently rolled out across the state, we find Group I did significantly better than the external control. This suggests that while overall mathematical learning was not impacted by CLIx in the entire CLIx population, there was an impact on mathematical learning seen in Chhattisgarh where the level of mathematics implementation was higher. Further, impact is seen in relation to geometric reasoning, which was the focus of CLIx mathematics module which was implemented there.

This analysis and the noted state level variations in the extent of adoption (See Section 4), suggest the relevance of further investigating the relationship of state level implementation level metrics and in relation to student learning outcomes subject wise.

## 6.5 Scholastic Outcomes Analysed for Gender and Caste

**Gender:** The comparison of girls' performance and of students from SC/ST categories is presented in Table 6.6. (See annexure Tables 15 and 16 for data on average scores.)

**Table 6.6: Summary Results from Comparison of Differences in Girls' and SC/ST Students' Average Scholastic Scores**

| | Full CLIx input group vs internal control | Full CLIx input group vs external control | Full CLIx input group vs only CLIx TPD input group (w/o CLIx ICT resources) |
|---|---|---|---|
| | I vs VI | I vs VII | I vs II |
| Girls | | | |
| English | (+) | (+), * | (+) |
| Maths | (-) | (-) | (-), *,# |
| Science | (+), *, # | (+) | (+), *, # |
| SC/ST students | | | |
| English | (+) | (+), * | (-), *, # |
| Maths | (-), *, # | (-) | (-), *, # |
| Science | (+) | (+) | (+) |

**Notes:**
(+), (–) indicates if there was a positive or negative effect.
* is used to denote where there is significance at 0.05 level, using independent group t-test.
Effect size is denoted by Cohen's d: small effect (#), medium effect (##).

Girl students in CLIx schools who had access to the full inputs performed better than the external control group in English (significant) and science. The performance of this group in science in particular was significantly higher than the internal control group (GVI) and Group II (high TPD but no access to CLIx lab). In both cases the results were significant with a small effect size. In the case of students from SC/ST, their performance in English, and science were better when they had a teacher with high TPD and access to the computer lab (GI). The results were significant in the case of English compared with external control.

## 6.6 Overall Student Digital Skills

Students' digital skills were assessed on their scores in four constructs.

**Table 6.7: Student ICT Skills Constructss**

| | | |
|---|---|---|
| (i) | Basic digital skills | Ability to start a computer, handle a mouse device, use paint or inkscape (3 items) |
| (ii) | Advanced digital skills | Ability to use hyperlinks, program a task, use simulation, book ticket, fill online form, use mind maps (6 items) |
| (iii) | Online and mobile skills | Ability to type in Hindi/Mizo/Telugu, use internet browser, chat online, download and upload files, record audio and video, download and use apps on mobile phone (6 items) |
| (iv) | CLIx module-specific digital skills | Ability to log into platform and use buddy login, use rating feature and write comments on platform (4 items) |

The opportunity to use the ICT lab in the course of using CLIx modules (Table 6.9) overwhelmingly produced significant shifts in student knowledge and skills relating to basic digital skills (including turning on a computer) and CLIx specific digital skills (Table 6.7). There was significant improvement with respect to online and mobile digital skills in the case of the high input Group I in comparison with external control (GVII) and Group II that did not access the CLIx lab resources.

**Table 6.8: Digital Skill Scores of Students (max 5) Across CLIx and Non-CLIx Schools**

| Grouping | Duration of TPD from CLIx | | | |
|---|---|---|---|---|
| | 3 years | 1-2 years | 0 years | External control |
| CLIx modules<br>Yes | Group 1<br>Basic 3.95<br>Advanced 2.62<br>Online 3.53<br>CLIx-specific 2.70<br>(N – 1493) | Group 3<br>Basic 3.81<br>Advanced 2.63<br>Online 3.42<br>CLIx-specific 2.69<br>(N –1562) | Group 5<br>Basic 4.17<br>Advanced 3.93<br>Online 4.12<br>CLIx-specific 3.75<br>(N –35) | **Group 7**<br>Basic 3.58<br>Advanced 2.60<br>Online 3.30<br>CLIx Specific N.A.<br>(N- 1409) |
| CLIx modules<br>No | Group 2<br>Basic 3.64<br>Advanced 2.40<br>Online 3.29<br>CLIx-specific 2.33<br>(N –298) | Group 4<br>Basic 3.49<br>Advanced 2.40<br>Online 3.18<br>CLIx Specific 2.29<br>(N –520) | Group 6<br>Basic 3.99<br>Advanced 2.83<br>Online 3.49<br>CLIx Specific 2.64<br>(N –52) | |

**Table 6.9: Summary Results from Comparison of Differences of Students' Digital Skills**

| | Full CLIx input group vs internal control | Full CLIx input group vs external control | Full CLIx input group vs Only CLIx TPD group | Only CLIx TPD group vs internal control | Only CLIx TPD group vs external control |
|---|---|---|---|---|---|
| | I vs VI | I vs VII | I vs II | II vs VI | II vs VII |
| Basic Digital Skills | (-) | (+), *, # | (+), *, # | (-), *,# | (+) |
| Advanced Digital Skills | (-) | (+) | (+), * | (-), *,# | (-), * |
| Online and Mobile Digital Skills | (+) | (+), * | (+), * | (-) | (-) |
| CLIx Specific Digital Skills | (+) | N.A. | (+), *, # | (-) | N.A. |

**Notes:**
(+), (-) indicates if there was a positive or negative effect.
* is used to denote where there is significance at 0.05 level, using independent group t-test.
Effect size is denoted by Cohen's d: small effect (#), medium effect (##).

Analysis of girls' digital skills (Table 6.10)[37] showed that there were gains (also significant and with small effect size) for basic digital skills and online and mobile digital skills for the full CLIx treatment group in comparison with the external control group. This was not so for the 'advanced' and CLIx specific digital skills. For all the four types of digital skills, the full CLIx treatment group gained significantly with small effect sizes (except advanced digital skills, significant but no effect size) more than students who did not have the opportunity to use CLIx resources in the lab. In the case of students from SC/ST groups, the full CLIx treatment group, GI, did significantly better with effect sizes across three types of digital skills (basic skills was better but not significant) compared to the group which did not have access to CLIx resources but had a high input CLIx teacher (GII). Further for SC/ST students, GI (high CLIx input) did significantly better compared to the external control in basic and online digital skills with effect size for the former.

**Table 6.10: Summary Results from Comparison of Differences in Girls' and SC/ST Students' Average Digital Skill Scores**

| | Full CLIx input group vs internal control | Full CLIx input group vs external control | Full CLIx input group vs only CLIx TPD input group (w/o CLIx ICT resources) |
|---|---|---|---|
| | I vs VI | I vs VII | I vs II |
| Girls | | | |
| Basic Digital Skills | (+) | (+),*, # | (+), *, # |
| Advanced Digital Skills | (-), *, # | (-) | (+), * |
| Online and Mobile Digital Skills | (-) | (+), *, # | (+), *, # |
| CLIx Specific Digital Skills | (-) | N.A. | (+), *, # |
| SC/ST students | | | |
| Basic Digital Skills | (-) | (+),*, # | (+) |
| Advanced Digital Skills | (-) | (-), * | (+), *, # |
| Online and Mobile Digital Skills | (+) | (+),* | (+),*, # |
| CLIx Specific Digital Skills | (-) | N.A. | (+),*, # |

**Notes:**
(+), (-) indicates if there was a positive or negative effect.
* is used to denote where there is significance at 0.05 level, using independent group t-test.
Effect size is denoted by Cohen's d: small effect (#), medium effect (##).

[37] See annexure Tables 17 and 18 for data on average scores in digital skills of girls and SC/ST students.

## 6.7 Discussion

The learning outcomes study provided strong evidence of statistically significant gains in student scores when using CLIx modules with high fidelity to intended design in mathematics, science and English. Positive gains were also noted in student learning behaviours of collaboration and discussion and in science beliefs. *These findings are specific to the content areas such as English speaking and listening, Geometric Reasoning and Basic Astronomy for which the CLIx modules were used.*

In the endline survey, English test scores of students in full CLIx treatment (Group I) was better than Group VII. Group II also scored better than group VI and VII, significant with a small effect size in the case of the latter. Science scores of Group I were significantly better with effect size than those in the group that had the teacher with high TPD but not the access to CLIx lab GII). Science scores of girl students with full CLIx inputs (GI) were significantly better than those in internal control (GVI) with a small effect size as well as in comparison with those of Group II. Maths scores of students from Group II were better than Group I. The endline survey generally suggests that there are positive gains in English and science in areas of focus of the CLIx modules. In the case of maths, CLIx TPD was effective in improving learning gains for students in general as well as for the girls and SC/ST in particular. With regards to a range of ICT skills, there was a positive effect of using CLIx resources in the ICT lab for all students. The opportunity to use ICT-based resources benefited girls and students from SC and ST communities.

Comparing the findings on student learning from these two studies, viz., learning outcomes and endline study, it can be noted that the student learning scores were better in the topics for which CLIx modules were made available. Positive gains across all grade level topics were found for English and science but not in maths as assessed during the endline survey. Taking into account state level variations in CLIx subject module implementation, a sample test of student learning of Geometric Reasoning in Chhattisgarh (where implementation of GR module was 83%), showed that the students in the high CLIx input group performed significantly better than the external control and the group that had teacher with high TPD but without the benefit of CLIx resources. This is a line of inquiry that can be pursued for other subjects and states.

The endline analysis was largely based on the 7 groups formed based on the CLIx treatments received. However, as has been shown in section 4, the extent of adoption of the modules in the school level and across states varied. Further analysis may give us a better understanding of the impact of CLIx on student learning given field realities, particularly in the case of mathematics. The opportunity to use the ICT lab in the course of using CLIx modules (Table 6.10) produced significant shifts in student knowledge and skills relating to basic digital skills (including turning on a computer), online and mobile digital skills such as use of internet browsers, as well as CLIx specific digital skills (use of CLIx platform features).

# 7. Pedagogic Practice

CLIx student learning and TPD are designed to achieve pedagogic change in classrooms through the pedagogic pillars of authentic learning, learning from mistakes and collaborative learning. Students' survey responses on their experiences in English, maths and science classrooms during the endline survey provided the student perspectives of their pedagogic experiences, reported here for CLIx students (grouped based on inputs as described in section 2.2.4) in comparison with non-CLIx students. The classroom observations were carried out for a small subset of the sample CLIx schools and non-CLIx schools of the endline survey across the four states between January and April 2019. In CLIx schools, 31 observations of teachers conducting English, mathematics and science classes (10, 12 and 9 respectively) and a total of 29 observations of teachers conducting ICT lab classes in English, mathematics and science (10, 11 and 8 respectively) were conducted. A total of 32 classroom observations in non-CLIx schools of teachers conducting English, mathematics and science (11, 11 and 10) were observed.[38] Classroom teaching was observed using a quantitative checklist. CLIx ICT lab sessions were observed using qualitative tools such as freewrites and tally sheets focusing on student and teacher behaviours and use of pedagogic pillars in CLIx sessions.

## 7.1 Students' Experience of Pedagogic Practices

Students' self-reports of their experience of classroom pedagogies for English, maths and science emerged significant for one factor - active learning, where students reported on whether they had opportunities to learn through activities, experiments, collaboration etc.

**Table 7.1: Students' Experiences of Classroom Pedagogies (Endline Survey)**

| Subject/constructs | Items / Student Responses |
|---|---|
| Active Learning (English) | We speak in English with each other. We play word games like crossword and word building. We participate in English dramas or role-plays. We work together in small groups. We use radio/audio tapes to listen to English programmes. We try to apply what we learn in English class with our daily lives. (6 items) |
| Active Learning (Maths) | We memorize formulas and procedures. We explain our answers. We relate what we are learning in mathematics to our daily lives. We decide on our own procedures for solving complex problems. We listen to the teacher give a lecture-style presentation. We work problems on our own. (6 items) |
| Active Learning (Science) | We make observations and describe what we see. We watch the teacher demonstrate an experiment or investigation. We do an experiment or investigation. We work in small groups on an experiment or investigation. We use scientific formulas and laws to solve problems. We give explanations about what we are studying. We relate what we are learning in science to our daily lives. (7 items) |

As shown in the summary results in table 7.2,[39] students in the CLIx treatment groups (I) , i.e., being taught by teachers having received CLIx 3 years of TPD and opportunities to use the lab, reported having fewer opportunities for active learning, as compared to the internal and external groups (comparisons of I & VI and I & VII). In contrast, students with the full CLIx treatment (teachers with full TPD and using ICT lab) consistently reported higher levels of active learning in subject teaching as against group II. All three comparisons of difference were significant and in addition there was a small effect size reported in all cases.

[38]The observations were carried out for teachers teaching English, maths and science, and in the case of lab observation in CLIx schools, for the same teacher conducting the lab session. This was convenience sampling, and the CLIx observations were distributed across different schools so as to minimise the demand on the same school lab for multiple subjects. In Chhattisgarh, a total of 6 CLIx CR, 4 CLIx-Lab and 6 non-CLIx classrooms; 6, 6 and 6 respectively for Mizoram; 11, 11 and 12 for Rajasthan and 8, 8 and 8 for Telangana were observed: English: 10 CLIx CR, 10 CLIx lab and 10 non-CLIx, mathematics: 12 CLIx CR, 11CLIx-Lab and 11 non-CLIx; science: 9 CLIx CR, 8 CLIx lab and 11 non-CLIx were observed.

[39]See annexure Tables 19, 20 and 21 for data on average scores on students' classroom experiences.

We attribute this to CLIx students answering these items with greater knowledge and discrimination as compared to students from Group II. It may be noted that in section 5.4, teachers of English and mathematics self-reported higher levels of student-centred practices, while teachers of science self-reported a decrease.

**Table 7.2: Summary Results from Comparison of Students' Classroom Experiences of Active Learning and Learning with ICT**

| Student Grouping | Full CLIx input group vs internal control | Full CLIx input group vs external control | Full CLIx input group vs Only CLIx TPD group |
|---|---|---|---|
| Comparison | I vs VI | I vs VII | I vs II |
| Active learning (English) | (-), *, ## | (-), * | (+), *, # |
| Active learning (mathematics) | (+) | (-), * | (+), *, # |
| Active learning (science) | (-), *,# | (-), *, # | (+),*,# |

**Notes:**
(+), (–) indicates if there was a positive or negative effect.
* significance at 0.05 level using independent group t-test.
#: small effect size, ##: medium effect size denoted by Cohen's d.

## 7.2 Classroom Observations

Across subject areas, teachers in CLIx classrooms for English, mathematics and science more frequently used practices that involved authentic learning, relating to real life (48% vs. 16%) and checking for conceptual knowledge of students (23% vs. 13%). 'Getting students to speak' was observed more frequently in non-CLIx schools (19% vs. 16%) compared to CLIx schools (16%). However, a relatively high proportion of teachers in CLIx classrooms were not found to check for conceptual knowledge (42%) or get students to speak (42%). This suggests that while there was a strong transfer of the practice of 'connecting to real life', which was a CLIx pedagogical pillar, other epistemic values promoted in the CLIx modules, such as providing students opportunity for higher order thinking and getting students to speak, were less in evidence.

**Table 7.3: Regular Classroom Pedagogies (figures in %)**

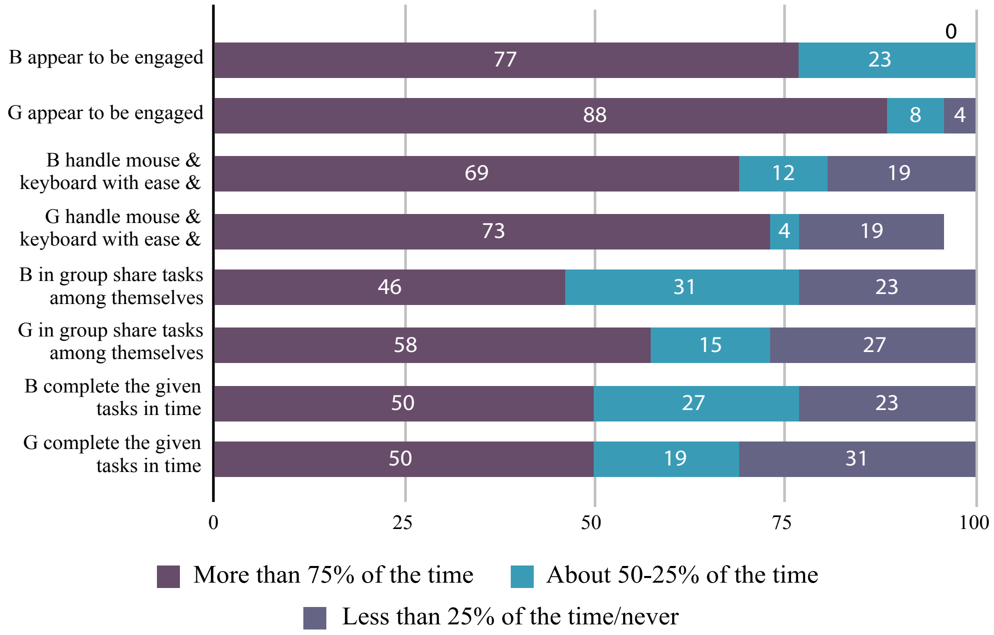
| Frequencies of observations | Relating to real life | | Checking conceptual knowledge | | Getting students to speak | |
|---|---|---|---|---|---|---|
| | CLIx | Non-CLIx | CLIx | Non-CLIx | CLIx | Non-CLIx |
| Frequently (Frequently = > 5 times) | 48 | 16 | 23 | 13 | 16 | 19 |
| Occasionally (Occasionally =1-2 times) | 23 | 47 | 35 | 50 | 42 | 44 |
| Never | 29 | 38 | 42 | 38 | 42 | 38 |
| Total observations | 31 | 32 | 31 | 32 | 31 | 32 |

## 7.3 CLIx Lab Observations

**Student behaviours**: In contrast to observations of regular classroom teaching, the 29 CLIx lab observations indicated a high level of student engagement. Students were observed to demonstrate confidence in handling computer operations, sharing and completing tasks. In 82% of sessions observed, students appeared to be engaged for more than 75% of the lab duration (girls 88%; boys

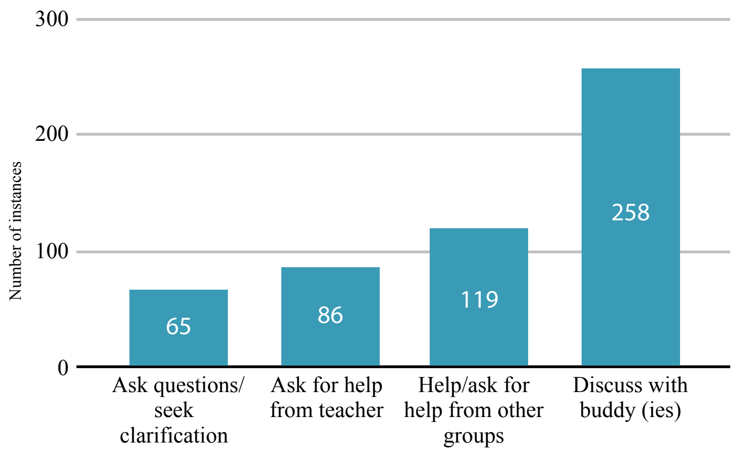
77%). They were observed to handle the computer operations confidently more than 75% of the time (girls 73%, boys 69%) and in terms of sharing of tasks among themselves 58% of girls and 46% of boys did so over 75% of the time. Half (50%) of girls and boys completed the given tasks in time in the observations made more than 75% of the time (Figure 7.1).

**Figure 7.1: Students' Engagement in CLIx Lab (26 Girls and 26 Boys)**




The qualitative data from the 29 freewrites of lab observations was analysed for behaviours exhibited by students (Figure 7.2). Students were observed to discuss with peers (258 instances) and ask for help from their peers (119 instances), ask for help from their teachers (86 instances) and ask questions or clarifications (65 instances).

**Figure 7.2: Student Behaviours: CLIx Lab Sessions**




**Teacher behaviours**: In over 43% of the 29 lab sessions observed (Figure 7.3), teachers were providing clear instructions, explaining the tasks and checking for student engagement more than 75% of the time. Teachers were seen providing extra support (72 instances), praising students and valuing their inputs (23 instances) and using students' mistakes as teachable moments (21 instances) (Figure 7.4).

Figure 7.3: Teacher Behaviours during CLIx Lab Sessions by Duration

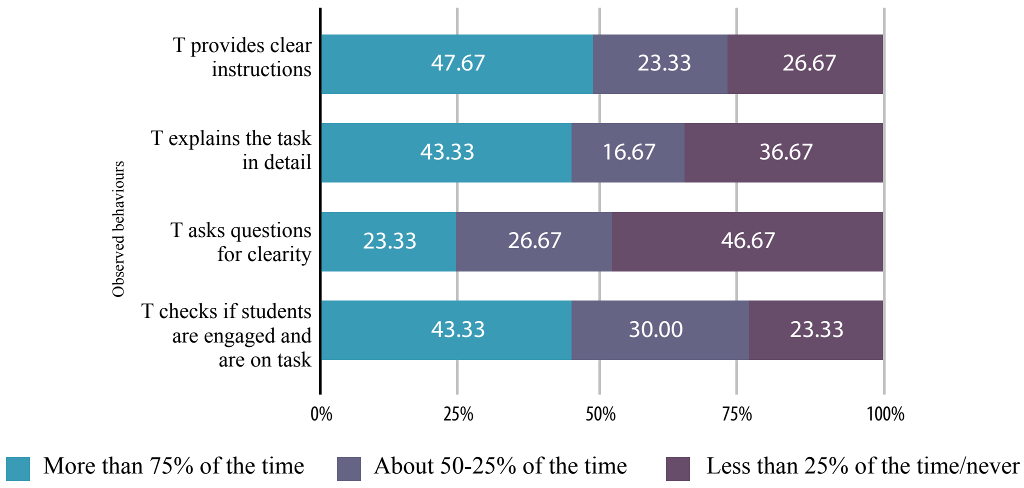
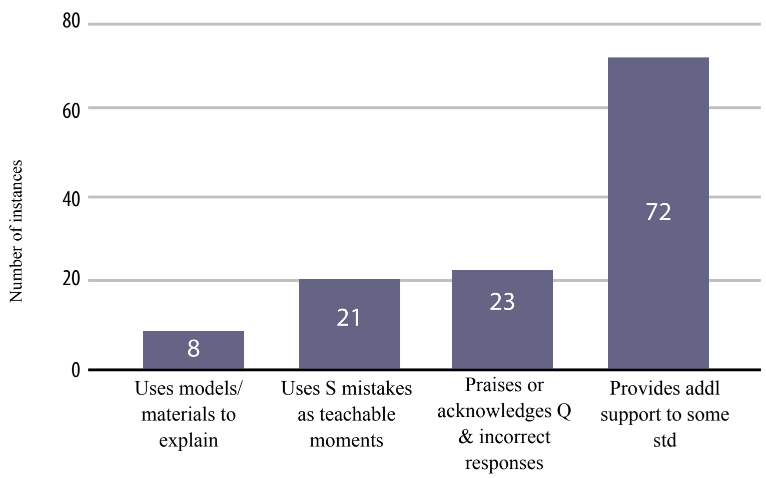



Figure 7.4: Teacher Behaviours During CLIx Lab Sessions by Frequency




## 7.4 Classroom Observations from Learning Outcomes Studies[40]

The learning outcomes study for select modules in English, maths and science had a strong qualitative component that studied classroom behaviours of teachers and students as they implemented the CLIx modules. Each domain had specifically designed tools to capture the specific behaviours aligned with their learning objectives in addition to freewrites of classroom transactions. Qualitative analysis of student and teacher behaviours across the three domains are summarised here.

**English**: Classroom observations in the English domain showed that students' ability to produce language in the English classroom corresponded to the high inputs they received in the intervention schools compared to the non-intervention schools. Student behaviours such as discussions among students and positive engagement, initiatives taken by students, collaboration in language tasks were found to increase with increase in their production of content. Observations showed correlation between active implementation and intervention by the teachers and the students'

[40]This section is from the Report on the Learning Outcomes of the CLIx Student Modules, 2019. https://clix.tiss.edu/wp-content/uploads/2015/09/LO_Report-2019.pdf

comfort with the course and task completion. Teachers were observed to provide students with the opportunity to tackle a task independently leading to greater engagement with the modules and correspondingly higher language production over a period of time. This was reflected in students' increased confidence levels, increase in number of instances of student initiatives, peer collaboration in listening and speaking tasks, and positive engagement with the modules.

**Maths**: The general observations of intervention schools indicated that students were highly engaged in digital activities in the lab, especially the PoliceQuad game. Even when they sat in large groups or had infrastructure issues, students could read the clues and engage actively in discussion without having active control of the mouse. Intervention schools spent close to 60% of the observed time on classroom discussions, with the teacher facilitating meaningful 'maths talk' between two or more students or between the teacher and (one or more) students. There was a marked difference in the number of short and extended responses supported by reasons by the students in the intervention schools as compared to students in the non-intervention schools. This corresponded with the larger number of questions asked by the intervention school teachers to students to explain their reasoning and attempting to build on incorrect student responses, thereby providing a safe space to make mistakes. The students in the intervention schools also spent more time on individual work which included working on student workbook tasks, specifically designed to bring out students' existing ideas and help articulate their reasoning.

**Science**: Classroom and computer lab observations in intervention schools revealed that students enthusiastically engaged in role-plays and digital activities. Some students spontaneously used novel gestures to communicate spatial information which is difficult to communicate through diagrams such as the angle between the orbit of the moon and that of the earth. They collaborated during role-play and digital activities as expected. Most students took charge of their learning in the computer lab and played the digital game multiple times which indicated they were learning from mistakes. Teachers felt happy and more confident when students responded positively to their new teaching style. Alongside students, teachers' attitudes and beliefs too changed with respect to content and pedagogy of astronomy.

## 7.5 Discussion

It seems that there was a reasonably high incidence of teachers' use of real life contexts in CLIx classrooms as compared to non-CLIx classrooms, which is aligned to the CLIx pedagogical pillar of authentic learning emphasised in TPD. However, incidence of pedagogical practices aligned to other epistemic values such as engagement for higher order thinking or concept learning and student voice were not noted by a fairly large percentage of observations.

However, a significant difference was noted between classroom teaching and ICT lab teaching pedagogical practices of teachers (by and large the same group of teachers). In the ICT lab, while they continued to not ask too many questions relating to the content (46.7%), they were seen to be active, supporting students and checking to ensure their engagement. Students' level of active engagement was seen to be consistently high in the lab sessions. A high level of collaborative behaviours, aligned to the CLIx pedagogical pillar of collaboration, were noted, both among boys and girls. Help extended by teachers to specific groups of students was a significant observation, suggesting that in the lab teachers had time to address individual needs, unlike the classroom where they were engaged with the whole cohort.

Classroom observations from the learning outcomes study indicate a high level of engagement with content in CLIx classrooms on the part of teachers and students in all three subjects where the modules were being implemented. There were increased instances of peer interactions, teacher student interactions and greater time spent on tasks, students exhibiting independent learning, confidence and positive attitudes towards the specific topics.

# 8. Innovation Diffusion: *Trends*

The perceptions of stakeholders regarding CLIx innovation is discussed based on 52 in-depth structured interviews and focus group discussions held with students (boys and girls), teachers, principals, parents and officials from across the four states. These responses were collected during the endline survey (2019).[41] These interviews were transcribed for analysis. Emerging trends from the data are discussed in this report under the broad categories of factors that served to promote or inhibit innovation at the micro levels. In-depth comparative analysis of the data across rounds 1 and 2 from baseline to endline surveys is ongoing.

## 8.1 Students

**Promoters:**

*Content:* Student responses regarding the CLIx resources they used showed that they valued the content that promoted their understanding at a conceptual level. They found the presentation of the CLIx modules in terms of their audio-visual content appealing and engaging. They reported that it helped to sustain their interest and improve concentration.

*Pedagogy:* Students reported that the hands-on nature of CLIx learning made it more enjoyable. They particularly noted the motivational aspects of CLIx resources such as gamification, winning points.

*ICT:* The use of ICT and learning of computers made students feel confident about themselves and their ability to learn.

**Inhibitors:**

*Pedagogy:* Students noted that the modules were sometimes done repetitively and they found it taxing. Use of CLIx resources in the ICT lab, in the absence of the teacher, was not found to be satisfying and produced frustration.

## 8.2 Teachers

**Promoters:**

*TPD:* TPD workshops and regular refresher training helped teachers get well acquainted with CLIx modules and adopt them in school. The workshops focused on the nature of CLIx offerings for students, which was useful from an implementation perspective.

*School-based support:* Teachers found the accessibility of FRC or FT of CLIx to be a positive factor. Many were able to draw support from their students in maintaining the labs and fixing basic issues.

*Content and pedagogy:* CLIx modules had engaging audio-visual presentation of content that made the topic accessible. The hands-on pedagogies of CLIx helped students understand some of the topics better.

*Student engagement:* Students who were passive in a regular class based on blackboard teaching were found to be actively engaged and understood lessons better in the CLIx lab lessons. This seems to have been a factor that weighed in favour of adoption.

[41] sample details can be found in section 2.4 of this report.

**Inhibitors:**

*Lab conditions:* The low student-computer ratio in schools where classroom size was particularly high posed constraints for teachers. In terms of ICT usage, unsuccessful attempts in rolling out left strong impressions that became an inhibiting factor. Due to small lab size, operational difficulties of batching students and CLIx covering only select topics, the classroom cannot be wholly transferred to labs. So, operationalisation (assembling a batch of students in lab and engaging the rest elsewhere) became challenging.

*Content and pedagogy:* Teachers mentioned that some of the CLIx modules had a lower relevance to their school curriculum, given that they were required to complete the syllabus within a given timeframe. CLIx modules covered only a small section of the syllabus and may not in teachers' view lead to better results in the board exams.

*TPD:* Some teachers were required to attend TPD workshops that were residential, which was a challenge.

## 8.3 Principals

**Promoters:**

*Programmatic:* The orientation for head teachers held for CLIx head teachers at the state level was helpful in understanding the approach of CLIx and its benefits.

*Importance of ICT:* Head teachers were of the view that ICT is a critical skill for students to learn to prepare them for the future. They were of the view that their students would be able to compete better with students from private schools.

*Content and pedagogy:* Head teachers expressed satisfaction that their school children enjoyed CLIx offerings and gave positive feedback about learning with computers.

**Inhibitors:**

*Lab maintenance:* Head teachers did not have sufficient funds to address maintenance and repairs in the ICT labs.

*Programmatic:* Due to transfers, some head teachers reported not having an understanding of the programme. Teachers were common across class 9 and 10 in the secondary schools and their time and energies were directed towards preparation of students for boards. Some head teachers were of the view that lack of monitoring by government officials was an inhibiting factor.

## 8.4 Parents

**Promoters:**

For parents, the main factor in favour of CLIx which they noted was that their children were being exposed to learning with technology which would help them in their future education and employment.

They did not report any factors that could be considered inhibitors.

## 8.5 Officials

**Promoters:**

*Programmatic:* Officials were convinced about the quality of content and the sound principles of learning on which CLIx offerings were based, given that the programme was led by a premier, respected institution like TISS.

*TPD:* Officials received positive feedback from teachers on the quality of the trainings.

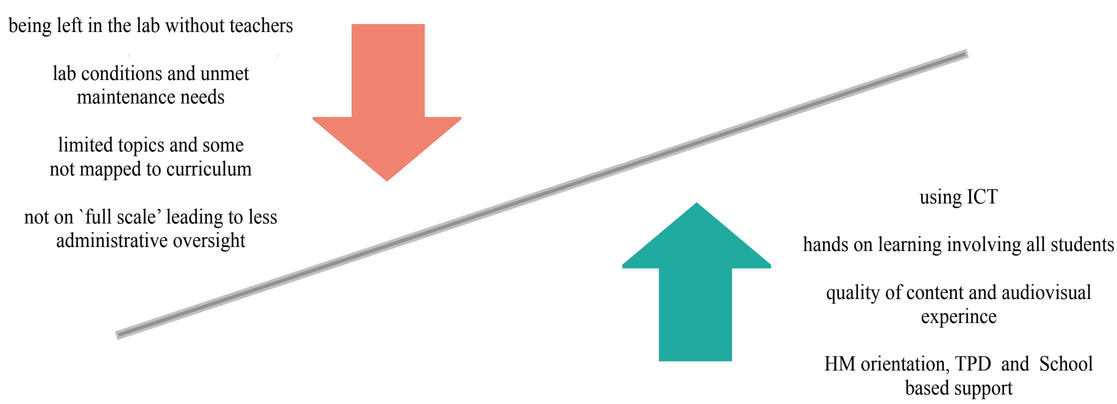
**Inhibitors:**

*Programmatic:* From the officials' perspective, the current scale of CLIx was not large enough to warrant administrative attention. The number of topics covered in CLIx was low.

## 8.6. Discussion

The interviews of stakeholders indicate the nested nature of interests, involvements, expectations and concerns with respect to the innovation that corresponds to their position within the school ecosystem (Fig. 8.1). Students' responses indicate the importance of teacher pedagogies and engagement in the process. Teachers' responses indicate the challenges with regards to managing the practical aspects of implementation and the importance of systemic adoption of the innovation. Principals' perspectives point to the need for institutional monitoring of the processes whereas for the officials, the issue was one of scale and outreach.

**Figure 8.1: Factors that promote or inhibit innovation diffusion**



# 9. Conclusion

## 9.1 Preconditions for Effective Implementation of CLIx

Apart from 150 schools in Telangana, where the basic hardware did not improve sufficiently, in all CLIx schools, a fairly high level of functional labs were maintained throughout the year. Between 75-85% schools had reasonably good power supply to support the ICT-based classes. A full complement of CLIx resources in digital literacy and subject areas were available. About 86% of schools batched students to enable access to the lab, and in Telangana in particular, a significant gender bias was noted in providing lab access. A high percentage of teachers in CLIx schools had received TPD and were enrolled on the CLIx CoPs - 75% reported high level of satisfaction with the quality of support received. Only 5% of teachers completed certification which was provided to them. About 82% of CLIx schools were visited, with an average of 4.8 visits per schools. As many as 85% teachers reported satisfaction with the quality of tech support received and 71% with the usefulness of the resource support they received.

## 9.2 CLIx Adoption

Over 42% of CLIx schools were observed to have used over 50% of the modules in Chhattisgarh, Mizoram and Rajasthan while in Telangana only about 12% of schools had done so (all states 29%). Overall level of module usage was observed to be higher in Chhattisgarh across all subjects. State and subject-wise variations were noted in module usage. Compared across data sources from IMT and CLIx Platform, the pattern of module usage was found to be highest in Chhattisgarh for mathematics (83% of schools as per IMT and 70% of schools according to platform data, used more than 50% of the modules and contents). In the case of Science, more than 50% usage of resources was noted in Rajasthan and Chhattisgarh (78% schools in RJ and 41% in CG as per IMT and 41% as per platform for RJ and CG). For English, Mizoram and Telangana emerged as high usage states (52% in MZ according to IMT and 75% in TS as per platform).

About 71% of teachers were found to remain in the lab for CLIx ICT usage sessions and of them, 73% actively discussed and either themselves took initiative or responded to students when asked. CBAM showed that 45.4% of teachers were still in stage 1 (need to know about the initiative) and 35.9% were in stage 3. Higher levels of adoption (stage 4) were seen in about 20-25% of teachers especially from Mizoram, Chhattisgarh and Rajasthan. Longer exposure to CLIx seems to have led to greater improvement in adoption in Mizoram and Telangana.

Overall, the school level of adoption in Chhattisgarh was relatively higher with over 46% of schools using over 50% of modules across all subjects. In Rajasthan and Mizoram, over about 42% of schools had used 50% or more of the modules. In these three states, a relatively higher proportion of teachers (25%) reported higher levels of concerns (stage 4) indicating higher adoption. Student platform data showed a reasonable degree of student access to CLIx digital resources, with about 50% of all CLIx schools accessing over 50% of the modules.

The situation in Telangana was one of lower levels of adoption based on IMT observations, with lowest level of 50% or more module usage (in only 12% schools), and no teachers in stage 4 of concerns. However, it must be noted that adoption in Telangana was largely driven by the state's own initiatives to ensure infrastructure and maintenance and monitoring and support for teachers, with a much thinner level of field presence of FRCs and a much larger number of schools involved.

There is also need to examine the impact of large-scale teacher transfers seen in both Telangana and Rajasthan on level of adoption.

## 9.3 Reflecting on Evidence for the CLIx Theory of Change

(i) Students' interest and engagement in communicative English, maths and science will improve when they have an opportunity to engage first-hand with interesting activities built on technological affordances.

At the level of student learning and engagement, findings from the two major studies, endline study and learning outcomes study show that CLIx students perform better when provided the necessary conditions in terms of CLIx-trained teachers and access to CLIx ICT resources in English speaking and listening (from LO and ES), science (from LO and ES), and mathematics (LO). Girls and students from SC, ST and OBC categories also benefit more from use of ICT in addition to having a CLIx trained teacher.

Findings from the learning assessment of students' endline survey indicate that those who received high levels of CLIx inputs in the form of highly trained CLIx teachers and access to CLIx resources had improved learning. For English, having a highly trained CLIx teacher seemed to benefit students even in the absence of CLIx resources; they performed better than the external control group and the group with only the highly trained teacher performed significantly better with small effect sizes compared to those in the external control group. In science, students performed significantly better when they had teachers with high TPD with access to CLIx resources as compared to the internal control as well as the group that only had the teachers with high TPD but not CLIx lab. It was the reverse in the case of Mathematics.  In the case of girls in the case of science, improved performance was noted in the full CLIx input group in comparison to both the internal control and the group with high TPD but no CLIx resources. High CLIx input groups (GI) did significantly better on most of the digital skills compared to the external group and the group that only had high TPD teachers with no CLIx resources.

(ii) Teachers' ability to use technology in classrooms will improve when they receive professional development offerings and have access to continuous interaction with subject experts and peers in their CoPs.

Teachers' advanced digital skills and engagement with professional development online improved significantly with longer engagement with the programme and receiving full extent of TPD. Findings from the endline study showed that CLIx teachers who constituted the panel, improved in their advanced digital skills and online ICT engagement skills in terms of their positive beliefs about use of ICT in teaching-learning or their perception of challenge, and their self-reported active learning and student-centred practices. A similar finding was made for teachers with higher levels of TPD from CLIx that seems to have contributed to their gain in confidence as well as skills and perceptions of challenge in using ICT. There was, however, a significant decrease in the self-reported practice of student-centred teaching-learning practices. Critical examination of one's own practice emerges as an important factor in interpreting some of the results such as, where all CLIx teachers were found to rate themselves lower in terms of their ICT skills and pedagogic practice in comparison to the non-CLIx teachers. Teachers with high-TPD reporting lower level of student-centred pedagogic practice too suggests increased ability to reflect on their practice which is at the core of CLIx TPD.

(iii) Quality of classroom processes will improve when teachers and students are provided with resource-rich technological affordances that provide scaffolding and space for exercising autonomy and when they are enabled to use these offerings with provision of adequate infrastructure and active support of school leadership, local ecosystem and government agencies.

In terms of pedagogic change, student reports, observational records of teachers' and students' behaviours in the classrooms, particularly when using CLIx resources, showed better engagement, interest and peer learning on the part of students. Teachers relating to real life, promoting collaborative learning and supporting student learning from mistakes, behaviours aligned with CLIx pedagogic pillars, were evident in CLIx classroom observations.

## 9.4 Concluding Observations

Most of the pre-conditions including lab functionality, CLIx resources and Teacher Professional Development were in place for CLIx implementation. Observational data sources showed that over 40% of schools in the states of Chhattisgarh, Mizoram and Rajasthan implemented over 50% of the CLIx modules. The data also showed that for over 70% of the observations, teachers were present and involved in the module implementation. The learning outcomes study clearly points towards the importance of high fidelity as a factor in obtaining improved learning outcomes in specific areas of CLIx curricular intervention in English, mathematics and science. Positive gains were found for English and science grade level learning for all students with high CLIx inputs and in the case for girls and students of SC and ST categories. For teachers, their extent of TPD seems to be a critical factor in improving their positive attitudes and digital skills and ICT use. Positive gains at student and teacher levels are directly linked to the adoption of CLIx across the CLIx schools as seen in the specific case of student outcomes in Geometric Reasoning in Chhattisgarh. In terms of further areas of inquiry, precise lines of inquiry on student learning based on the extent of use of CLIx resources is needed. Teacher perceptions of their student-centred pedagogic practice need to be examined in relation to their improved ability for reflective practice. Similarly, factors such as teacher transfers that affected effective implementation by trained teachers and low observational data for Telangana schools need to be included for further analysis and interpretation of CLIx impact.

# ANNEXURES

**Table 1: Percentage of Schools by Lab Functionality Criteria (Jun - Dec, 2018)**

| Criteria for Lab Functionality | All CLIx | CG | MZ | RJ | TS |
|---|---|---|---|---|---|
| Functional servers | 92% | 93% | 96% | 89% | 93% |
| All computers being functional | 67% | 83% | 43% | 62% | 72% |
| At least 2 functional headphones and splitter for each computer | 87% | 100% | 86% | 71% | 96% |
| No other lab issues present | 49% | 47% | 71% | 55% | 39% |
| Total schools | 245 | 30 | 28 | 84 | 103 |

**Table 2: Key Lab Issues Reported**

| | Hardware | Software | Infrastructure | Platform |
|---|---|---|---|---|
| Chhattisgarh | UPS issues; motherboard, keyboard, mouse dysfunctionality; Dusty RAM causing machine boot issue; Damaged LAN cable and broken adaptor issues | Customised version of Turtle Logo not working on low configuration machines | Electricity issues caused OS corruption; Space issue; Machine replacements | Recording activities encountered issues; Full-featured Turtle Logo activity was not working due to hardware constraints; SSL certificate reading required in some schools due to machine exchange or formatting |
| Mizoram | Motherboard; keyboard, mouse issue | Client machine OS got corrupted in a school | Power failures caused motherboard issue | |
| Rajasthan | N-computing issues; LAN cabling and port; VGA cable connection videos playing with blurred display due to N-computing server low configuration | N-computing software issue, license renewal, Drivers issues OS reinstallation | Power failures caused HDD corruption for the installer and for internal HDD in 2-3 instance Inverter issues, Power switch issues | I2C course was not available in Hindi SSL certificate reading required in some schools due to machine exchange or formatting |
| Telangana | N-computing PCI-card issues,CMOS battery issue, RAM issues LAN cable and network setup issue | Drivers corruption; N-computing server OS reinstallation N-computing devices connectivity issue OS corruption issues | Power failures and non-working UPS; Sudden Power failures causing “initramfs” screen on the server machines | PoliceQuad and Turtle Logo not running on more than 2 machines in one unit of N-computing due to outdated hardware |

**Table 3: Teachers' Feedback on CLIx Field Inputs and Digital Modules- Usefulness of different Inputs and Factors for CLIx Implementation (%)**

| CLIx Inputs[1] | All CLIx (N=317) | CG (N=43) | MZ (N=82) | RJ (N=70) | TS (N=122) |
|---|---|---|---|---|---|
| CLIx workshop for teachers | 90 | 100 | 95 | 96 | 79 |
| CLIx teachers' CoP group on WhatsApp/Telegram group | 85 | 90 | 88 | 94 | 76 |
| RTICT course on TISSx for teachers | 62 | 76 | 50 | 57 | 66 |
| Ensuring functioning lab by CLIx technologists (in person or via phone) | 85 | 88 | 92 | 96 | 75 |
| Lab sessions conducted by CLIx staff | 89 | 93 | 96 | 99 | 77 |
| Support visits to teachers by CLIx staff | 90 | 93 | 98 | 96 | 79 |
| Support visits by state officials/ state teacher educator for CLIx | 68 | 74 | 57 | 69 | 73 |
| Support in classroom management and batching of students | 86 | 93 | 85 | 96 | 80 |
| Principal/school head's support | 91 | 96 | 96 | 97 | 82 |
| Government circulars regarding CLIx | 81 | 88 | 84 | 81 | 75 |

**Notes**
Figures here include combined percentages for the options of somewhat useful and very useful. Response options included - not at all useful, somewhat useful, very useful and not applicable/attended.

**Table 4: Gender and SC/ST Distribution of Students by Lab Access (%)**

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lab Access of Students in English** | | | | | | | | | | | | | | | | |
| | | CLIx | | | Chhattisgarh | | | Mizoram | | | Rajasthan | | | Telangana | | |
| | | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total |
| Gender | Boys | 72* | 28* | 1309 | 76 | 24 | 224 | 66* | 34* | 276 | 91 | 9 | 349 | 60* | 40* | 460 |
| | Girls | 66* | 34* | 1442 | 70 | 30 | 270 | 75* | 25* | 293 | 88 | 12 | 303 | 48* | 52* | 576 |
| Caste | Non-SC/ST | 68 | 32 | 1474 | 71* | 29* | 374 | 80 | 20 | 20 | 94* | 6* | 391 | 52 | 48 | 689 |
| | SC/ST | 70 | 30 | 1277 | 81* | 19* | 120 | 70 | 30 | 549 | 83* | 17* | 261 | 56 | 47 | 347 |
| **Lab Access of Students in Mathematics** | | | | | | | | | | | | | | | | |
| | | CLIx | | | Chhattisgarh | | | Mizoram | | | Rajasthan | | | Telangana | | |
| | | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total |
| Gender | Boys | 67* | 33* | 1336 | 75* | 25* | 247 | 54 | 46 | 233 | 76 | 24 | 407 | 62 | 38 | 449 |
| | Girls | 63* | 37* | 1525 | 61* | 39* | 307 | 53 | 47 | 234 | 79 | 21 | 401 | 56 | 44 | 583 |
| Caste | Non-SC/ST | 67* | 33* | 1615 | 66 | 34 | 418 | 56 | 44 | 9 | 77 | 23 | 491 | 61* | 39* | 697 |
| | SC/ST | 62* | 38* | 1246 | 72 | 28 | 136 | 53 | 47 | 458 | 79 | 21 | 317 | 54* | 46* | 335 |
| **Lab Access of Students in Science** | | | | | | | | | | | | | | | | |
| | | CLIx | | | Chhattisgarh | | | Mizoram | | | Rajasthan | | | Telangana | | |
| | | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total | Lab | No Lab | Total |
| Gender | Boys | 61 | 39 | 1486 | 51 | 49 | 279 | 40 | 60 | 304 | 82 | 18 | 393 | 62 | 38 | 510 |
| | Girls | 58 | 42 | 1639 | 45 | 55 | 339 | 42 | 58 | 317 | 82 | 18 | 351 | 59 | 41 | 632 |
| Caste | Non-SC/ST | 64* | 36* | 1725 | 48 | 52 | 459 | 19 | 81 | 21 | 81 | 19 | 472 | 63* | 37* | 773 |
| | SC/ST | 53* | 47* | 1400 | 45 | 55 | 159 | 42 | 59 | 600 | 83 | 17 | 272 | 54* | 46* | 369 |

* Significance at 0.05 level

**Tables 5-8: Background Characteristics of Teachers**

| | CLIx | Non-CLIx | Panel | Panel (1-3 years) |
|---|---|---|---|---|
| Total | 372 | 109 | 161 | 76 |

**Table 5: Gender Composition of Teachers**

| | | | | |
|---|---|---|---|---|
| Male | 235 | 77 | 91 | 43 |
| Female | 137 | 32 | 70 | 33 |

**Table 6: Caste Composition of Teachers**

| | | | | |
|---|---|---|---|---|
| ST | 105 | 7 | 69 | 27 |
| SC | 25 | 12 | 8 | 3 |
| OBC | 151 | 62 | 49 | 29 |
| General | 79 | 26 | 32 | 16 |
| Other | 6 | 0 | 2 | 1 |
| Do not wish to divulge | 6 | 2 | 1 | 0 |

**Table 7: Average Age and Years of Professional Experience of Teachers**

| | | | | |
|---|---|---|---|---|
| Average years of age (range) | 43.4 (23-60) | 40.3 (24-57) | 43.8 (27-58) | 42 (27-58) |
| Average years of experience (range) | 13.5 (1-33) | 9.9 (1-28) | 14.6 (2-33) | 13.42 (3-33) |
| Science (%) | 85%(132) | 81% (37) | 90% (52) | 87% (23) |

**Table 8: Proportion of Teachers with Bachelor's Degree in their Respective Subject of Teaching**

| | | | | |
|---|---|---|---|---|
| English (%) | 53% (118) | 53% (30) | 54% (56) | 56% (27) |
| Maths (%) | 79% (122) | 81% (42 ) | 70% (54) | 73% (26) |

**Table 9: Digital Skills and ICT Usage of Panel Teachers**

| | Panel Teachers | | | | TPD=3 Years | | | | TPD=1-2 Years | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BL | EL | No. of Teachers | Change | BL | EL | No. of Teachers | Change | BL | EL | Sample | Change |
| Online ICT engagement | 2.27 | 2.06 | 161 | 0.21* | 2.09 | 2.34 | 75 | 0.25* | 2.02 | 2.19 | 79 | 0.17* |
| Basic DS | 3.43 | 3.53 | 161 | -0.10 | 3.55 | 3.48 | 75 | -0.06 | 3.45 | 3.38 | 79 | -0.07 |
| Advanced DS | 3.08 | 2.73 | 161 | 0.35* | 2.77 | 3.11 | 75 | 0.33* | 2.64 | 3.01 | 79 | 0.37* |
| Positive belief ** | 3.19 | 3.20 | 161 | -0.02 | 3.27 | 3.24 | 75 | -0.03 | 3.14 | 3.13 | 79 | -0.01 |
| Computer access and training ** | 4.11 | 4.11 | 161 | 0 | 4.1 | 3.96 | 75 | -0.14 | 4.14 | 4.22 | 79 | 0.08 |
| Functioning of computer | 4.10 | 4.15 | 161 | -0.05 | 4.07 | 3.98 | 75 | -0.09 | 4.24 | 4.17 | 79 | -0.07 |
| Teaching with computer ** | 3.66 | 3.46 | 161 | 0.20* | 3.43 | 3.52 | 75 | 0.09 | 3.59 | 3.76 | 79 | 0.16 |
| Student-centred teaching in English | 2.87 | 2.76 | 56 | 0.11 | 2.84 | 2.88 | 27 | 0.04 | 2.69 | 2.87 | 28 | 0.18 |
| Student-centred teaching in maths | 2.63 | 2.53 | 52 | 0.10 | 2.55 | 2.82 | 25 | 0.27 | 2.55 | 2.51 | 24 | -0.04 |
| Experiential learning in science | 2.31 | 2.46 | 52 | -0.14* | 2.58 | 2.29 | 23 | -0.29* | 2.33 | 2.31 | 26 | -0.02 |

* Significant at 5% level of significance

**Table 10: Student Background Characteristics**

| | CLIx | Non-CLIx |
|---|---|---|
| Gender | | |
| Boys | 1855 | 652 |
| Girls | 2105 | 757 |
| Total | 3960 | 1409 |
| Caste | | |
| ST | 1083 | 128 |
| SC | 639 | 242 |
| OBC+BC | 1872 | 835 |
| General | 191 | 106 |
| Other | 38 | 25 |
| Do not wish to tell/Don't know | 137 | 73 |
| Total (N) | 3960 | 1409 |

**Tables 11-12: Parental Education and Occupation**

| | Father | | Mother | |
|---|---|---|---|---|
| | CLIx | Non-CLIx | CLIx | Non-CLIx |
| Parental Education (in %) | | | | |
| Never attended school | 15 | 16 | 32 | 35 |
| Grade 1-5 | 17 | 18 | 24 | 25 |
| Grades 6-8 | 20 | 19 | 17 | 17 |
| Grade 9-10 | 24 | 26 | 13 | 12 |
| Grade 12/ PUC/ Junior College | 9 | 12 | 4 | 4 |
| Polytechnic college (Diploma) | 1 | 1 | 1 | 1 |
| Graduate and above | 5 | 5 | 2 | 2 |
| Do not know | 9 | 3 | 7 | 3 |
| Total (N) | 3949 | 1405 | 3948 | 1401 |
| | 5354 | | 5349 | |
| Parental Occupation (in %) | | | | |
| Works only at home | 5 | 5 | 43 | 42 |
| Works as a farmer in own farm | 35 | 36 | 25 | 25 |
| Casual labour on farm/non-farm | 37 | 33 | 24 | 26 |
| Shopkeeper/sells vegetables/ animal husbandry | 8 | 11 | 4 | 3 |
| Regular pvt/govt employed | 16 | 15 | 4 | 3 |
| Total (N) | 3544 | 1278 | 3857 | 1380 |
| | 4822 | | 5237 | |

**Table 13: Ownership of Select Household Items (figures in %)**

| Item | CLIx | Non-CLIx |
|---|---|---|
| Calculator | 44 | 46 |
| Computer | 15 | 15 |
| TV | 83 | 80 |
| Mobile phone | 90 | 91 |
| Smartphone | 62 | 56 |
| Internet connection | 35 | 36 |
| Total (N) | 3938 | 1403 |

N includes count of records after deletion of observations related to missing values due to incomplete scanning

**Tables 14: Average Scores in Mathematics and Geometric Reasoning (GR) in Chhattisgarh**

<table>
<tr><th rowspan="2">Grouping</th><th colspan="4">Duration of TPD from CLIx</th></tr>
<tr><th>3 years</th><th>1 to 2 years</th><th>0 years</th><th>External Control</th></tr>
<tr><td>CLIx modules<br>Yes</td><td>GROUP 1<br>(High CLIx input)<br>Maths score 38.30<br>(N-315)<br>GR score 2.04<br>(N-241)</td><td>GROUP 3</td><td>GROUP 5</td><td rowspan="2">GROUP 7<br>Maths score 37.08<br>(N-320)<br>GR score 1.80<br>(N-320)</td></tr>
<tr><td>CLIx modules<br>No</td><td>GROUP 2<br>Maths score 37.85<br>(N-107)<br>GR score 1.80<br>(N-181)</td><td>GROUP 4</td><td>GROUP 6<br>(No Input)<br>N.A.</td></tr>
</table>

**Tables 15-16: Average Scores in Scholastic Outcomes of Girls and SC/ST Students**

<table>
<tr><th rowspan="2">Grouping</th><th colspan="4">Duration of TPD from CLIx</th></tr>
<tr><th>3 years</th><th>1 to 2 years</th><th>0 years</th><th>External Control</th></tr>
<tr><td colspan="5">Table 15: Girls</td></tr>
<tr><td>CLIx modules<br>Yes</td><td>GROUP 1<br>(High CLIx input)<br>English Score 44.49(N-423)<br>Maths Score 39.62 (N-408)<br>Science Score 47.23 (N-287)</td><td>Group 3</td><td>Group 5</td><td rowspan="2">GROUP 7<br>English score 40.90 (N757)<br>Maths score 40.85 (N-757)<br>Science score 45.45 (N-757)</td></tr>
<tr><td>CLIx modules<br>No</td><td>GROUP 2<br>English Score 43.12 (N-154)<br>Maths Score 46.35 (N-186)<br>Science Score 42.87 (N-253)</td><td>Group 4</td><td>GROUP 6<br>(No Input)<br>English score 43 (N-70)<br>Maths score 42.86 (N89)<br>Science score 41.40 (N-130)</td></tr>
<tr><td colspan="5">Table 16: SC/ST Students</td></tr>
<tr><td>CLIx modules<br>Yes</td><td>GROUP 1<br>(High CLIx input)<br>English Score 46.55 (N-383)<br>Maths Score 39.19 (N-329)<br>Science Score 44.21 (N-285)</td><td>GROUP 3</td><td>GROUP 5</td><td rowspan="2">GROUP 7<br>English score 42.16 (N-370)<br>Maths score 40.93 (N-370)<br>Science score 43.14 (N-370)</td></tr>
<tr><td>CLIx modules<br>No</td><td>GROUP 2<br>English Score 52 (N-85)<br>Maths Score 45.56 (N-103)<br>Science Score 43.75 (N-292)</td><td>GROUP 4</td><td>GROUP 6<br>(No Input)<br>English score 40.70 (N-43)<br>Maths score 45.43 (N-61)<br>Science score 42.33 (N-128)</td></tr>
</table>

**Tables 17 and 18: Average Scores in Digital Skill-Based Outcomes of Girls and SC/ST Students**

<table>
<tr><th rowspan="2">Grouping</th><th colspan="4">Duration of TPD from CLIx</th></tr>
<tr><th>3 years</th><th>1 to 2 years</th><th>0 years</th><th>External Control</th></tr>
<tr><td colspan="5">Table 17: Girls</td></tr>
<tr><td>CLIx Modules<br>Yes</td><td>GROUP 1<br>(High CLIx input)<br>Basic Digital Skill 3.80<br>Advanced Digital Skill 2.43<br>Online Digital Skill 3.35<br>CLIx-specific Digital Skill 2.53<br><br>(N-821)</td><td>GROUP 3</td><td>GROUP 5</td><td rowspan="2">GROUP 7<br>Basic Digital Skill 3.41<br>Advanced Digital Skill 2.48<br>Online Digital Skill 3.07<br>CLIx-specific Digital Skill N.A.<br><br>(N-757)</td></tr>
<tr><td>CLIx Modules<br>No</td><td>GROUP 2<br>Basic Digital Skill 3.28<br>Advanced Digital Skill 2.24<br>Online Digital Skill 3<br>CLIx Specific Digital Skill 2.21<br><br>(N-167)</td><td>GROUP 4</td><td>GROUP 6<br>(No Input)<br>Basic Digital Skill 3.79<br>Advanced Digital Skill 2.80<br>Online Digital Skill 3.38<br>CLIx Specific Digital skill 2.60<br><br>(N-33)</td></tr>
<tr><td colspan="5">Table 18: SC/ST students</td></tr>
<tr><td>CLIx Modules<br>Yes</td><td>GROUP 1<br>(High CLIx input)<br>Basic Digital Skill 3.98<br>Advanced Digital Skill 2.66<br>Online Digital Skill 3.65<br>CLIx Specific Digital Skill 2.82<br><br>(N-730)</td><td>GROUP 3</td><td>GROUP 5</td><td rowspan="2">GROUP 7<br>Basic Digital Skill 3.65<br>Advanced Digital Skill 2.86<br>Online Digital Skill 3.47<br>CLIx Specific Digital Skill N.A.<br><br>(N- 370)</td></tr>
<tr><td>CLIx Modules<br>No</td><td>GROUP 2<br>Basic Digital Skill 3.83<br>Advanced Digital Skill 2.41<br>Online Digital Skill 3.41<br>CLIx-specific Digital Skill 2.45<br><br>(N-157)</td><td>GROUP 4</td><td>GROUP 6<br>(No Input)<br>Basic Digital Skill 4.03<br>Advanced Digital Skill 3.07<br>Online Digital Skill 3.63<br>CLIx-specific Digital Skill 2.99<br><br>(N-25)</td></tr>
</table>

**Tables 19, 20 and 21: Average Scores in Experiences of CR Pedagogies in English, Maths and Science**

| Grouping | Duration of TPD from CLIx | | | |
|---|---|---|---|---|
| | 3 years | 1 to 2 years | 0 years | External Control |
| **Table 19: English** | | | | |
| CLIx Modules Yes | GROUP 1 Active Learning 1.83 (N-1493 ) | GROUP 3 Active Learning 1.89 (N-1562 ) | GROUP 5 Active Learning 2.28 (N-35) | GROUP 7 Active Learning 1.88 (N-1409 ) |
| CLIx Modules No | GROUP 2 Active Learning 1.73 (N-298 ) | GROUP 4 Active Learning 1.76 (N-520 ) | GROUP 6 Active Learning 2.10 (N-52 ) | |
| **Table 20: Maths** | | | | |
| CLIx Modules Yes | GROUP 1 Active Learning 2.90 (N-1493 ) | GROUP 3 Active Learning 2.98 (N- 1562 ) | GROUP 5 Active Learning 3.07 (N- 35) | GROUP 7 Active Learning 3 (N-1409 ) |
| CLIx Modules No | GROUP 2 Active Learning 2.63 (N-298 ) | GROUP 4 Active Learning 2.85 (N-520 ) | GROUP 6 Active Learning 2.88 (N-52) | |
| **Table 21: Science** | | | | |
| CLIx Modules Yes | GROUP 1 Active Learning 2.76 (N-1493 ) | GROUP 3 Active Learning 3 (N- 1562) | GROUP 5 Active Learning 3.19 (N-35 ) | GROUP 7 Active Learning 2.95 (N-1409 |
| CLIx Modules No | GROUP 2 Active Learning 2.50 (N-298) | GROUP 4 Active Learning 2.78 (N- 520) | GROUP 6 Active Learning 3.02 (N-52 ) | |

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