

# Scaling Up CoolThink@JC

## Implementation Study Baseline Report



May 2021

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# EXECUTIVE SUMMARY

CoolThink@JC aims to nurture students' proactive use of technologies for social good from a young age, preparing them for a fast-changing digital future through hands-on, minds-on, and joyful learning experiences. After a successful pilot in 32 schools, CoolThink's co-creators, led by The Hong Kong Jockey Club Charities Trust (the Trust), have undertaken an ambitious initiative to take CoolThink@JC to scale within Hong Kong, supporting high-quality adoption in 200 primary schools and laying a foundation throughout the system for more widespread adoption. By demonstrating success at scale, CoolThink partners hope to create a new paradigm for CTE at the upper primary level that will serve as an international model for other cities and states.

To capture the lessons learned from this effort, the Trust has engaged SRI International to study the implementation of CoolThink@JC at scale. This implementation study will:

- Assess the extent to which schools' adoption of CoolThink@JC is consistent with the initiative's design principles and sustained over time,
- Identify the conditions that support or impede successful adoption at the classroom and school levels, and
- Validate an implementation model that will help interested stakeholders to learn from CoolThink@JC's scaling experience.

CoolThink partners began scaling CoolThink@JC in summer 2020, when a third cohort of 47 schools joined the first two pilot cohorts in teaching CoolThink lessons. Drawing on data from teacher and school

leader surveys administered between November 2020 and January 2021, this baseline report sets the context for the rollout of CoolThink@JC in Cohort 3 schools.

## Cohort 3 schools at baseline

Cohort 3 schools are a diverse cross-section of Hong Kong public sector primary schools, with student demographics matching those of this larger population, on average. About a third of Cohort 3 schools could be considered high need, based on the percentage of students qualifying for financial aid.

As CoolThink@JC scales beyond a relatively small group of early adopters, the partners anticipate that network schools will bring increasing diversity in prior experience with ICT instruction and in their capacity to adopt innovative computational thinking (CT) curriculum materials. Schools that have the following capacities in place before they adopt CoolThink@JC are expected to make faster progress toward strong implementation:

- **Prior experience with ICT instruction.** Most Cohort 3 schools have had long-standing experience with ICT. Two-thirds reported that they offered ICT as a stand-alone course to all Primary 4–6 students in 2019–20, with an average of 23 hours of instruction.
- **Adequate technology and infrastructure.** Large majorities of Cohort 3 schools were already well-equipped with the technology required to teach CoolThink lessons, including hardware, reliable internet access, and funding to purchase additional technology.

- **Existing school-based communities of practice (CoPs).** Many Cohort 3 schools have existing structures and practices in place to support CoPs. In some schools these teams will need to expand to include ICT teachers, and the frequency and focus of teacher team meetings may need to change to accommodate collaboration around CoolThink instruction.
- **Positive beliefs about the value of computational thinking education (CTE).** Most Cohort 3 school leaders agreed that CTE is critical for fostering problem-solving, creativity, and other 21st century skills, but teachers' initial beliefs about the value of CTE were more measured and varied across schools.
- **Openness to innovation and willingness to experiment.** About half of Cohort 3 school leaders described their schools as early adopters, among the first to try new teaching approaches and curricula. In other schools, teachers and school leaders expressed greater hesitancy about their colleagues' attitudes toward experimentation and risk.

## Cohort 3 classrooms and teachers at baseline

The character of CoolThink@JC at scale will also be strongly influenced by the wide variety of teachers who will be taking it up. For Cohort 3, teacher background and other attributes of teachers and classrooms that may be salient to implementation include:

- **Prior ICT experience and subject matter background.** The 246 teachers who were teaching CoolThink lessons for the first time in 2020-21 had an average of 7 years of prior ICT teaching experience teaching ICT,

although a significant minority (24%) were teaching ICT for the first time when they began teaching CoolThink@JC. Teachers' subject area backgrounds included math (a majority of CoolThink teachers), science, languages, and other non-STEM subjects.

- **Prior experience with “CoolThink-like” instructional practices.** In ICT instruction, many teachers reported that they “rarely” or “never” used instructional practices associated with student-centered problem-solving, including asking students to plan and design a computer program before coding it, to collaborate for problem solving, or to apply ICT skills to solve novel problems. CoolThink lessons will likely require many teachers to adopt unfamiliar instructional strategies.
- **Prior experience adapting instruction for equity among students with different needs.** Teachers reported making adaptations for students with lower academic ability (such as making materials more accessible or pairing high-ability and low-ability students in cooperative groups) more frequently than adaptations to ensure gender equity, such as attending to engagement for girls as well as boys.

## Early adoption of CoolThink lessons

This report is based on surveys conducted early in the 2020-21 school year, when CoolThink schools had just begun teaching CoolThink@JC. Early adoption findings include:

- **CoolThink’s professional development offerings were an important driver of adoption decisions.** Many school leaders also cited the fit of its curriculum and pedagogical principles with the school’s goals.

- **Shortened school days in early 2020-21 were leading teachers to prioritize efficiency over problem-solving in CoolThink classes.**

Teachers commonly found themselves having to streamline lesson content or modify in ways that made learning activities more efficient, such as assigning individual student work rather than groupwork, allowing less time for unstructured student exploration, and providing more scaffolding at the expense of student problem-solving.

- **Teachers' ratings of CoolThink professional development were generally positive.** Most teachers who responded to the end-of-session survey reported that it had given them important resources, hands-on experience, and confidence toward their adoption of CoolThink@JC and their ability to teach students to code, although some were still hesitant about their understanding of the difference between programming and computational thinking or their readiness to help students program for real-world problem-solving.

## Summary and conclusions

CoolThink@JC is taking a systemic approach to rollout, working both bottom up (by reaching a critical mass of teachers and schools) and top down (through system-level engagement) to promote territory-wide adoption. Looking ahead to achieving high-quality adoption in a critical mass of schools, the baseline findings reported here suggest that:

- Early adoption decisions have been primarily informed by the unique offerings of CoolThink@JC. It will also be important to continue to communicate clearly about CoolThink@JC alignment with EDB guidelines to broaden schools' motivations for adoption.

- After a challenging first year due to COVID-19, implementation of CoolThink@JC with integrity to its goals may require a re-emphasis on core design principles, including goals related to student exploration, creativity, and teamwork.
- With strong programmatic goals for equity, it will be important to ensure access to computational thinking classes for less advantaged students, and accessibility of the lessons to all students.

With regard to sector capacity-building goals, baseline findings suggest that:

- Cohort 3 schools, on average, have strong existing capacity related to ICT instruction. This priority afforded to ICT suggests fertile ground for CoolThink@JC as it is initiated.
- Many schools report that they are continuing to teach ICT subjects such as cybersecurity outside of the CoolThink curriculum, and many CoolThink teachers teach multiple subjects at multiple grade levels, placing additional demands on their time. Sustainability may require ongoing negotiations of priorities for attention and instructional time.
- Teachers come from a wide range of disciplinary backgrounds, including some from outside STEM fields. Those who teach humanities subjects may have a higher learning curve as they take on new ICT instructional assignments.

At the time of baseline data collection, the implementation of CoolThink@JC at scale was at its inception. The issues highlighted in this report are among a great many factors that will shape its adoption in schools and classrooms and its role in the larger system of CTE in Hong Kong. As this study continues, future reports will describe this progress, the experience of participants, and emerging models for the successful wide-scale adoption of CTE for primary-age students.

# INTRODUCTION

CoolThink@JC aims to nurture students' proactive use of technologies for social good from a young age, preparing them for a fast-changing digital future through a hands-on, minds-on, and joyful learning experiences. After a successful pilot in 32 schools, CoolThink's co-creators have undertaken an ambitious initiative to take CoolThink@JC to scale within Hong Kong.

This report is the first in a series from an implementation study being conducted by SRI International (SRI). The purpose of the study is to help stakeholders understand how CoolThink@JC is taking shape in classrooms, schools, and systems, and to offer models for other initiatives as they seek to go to scale. This baseline report, based on surveys of school leaders and teachers prior to their implementation of CoolThink@JC, focuses on conditions for success.

## CoolThink@JC

CoolThink@JC is a 3-year course sequence designed to introduce computational thinking to students in the upper primary grades and to support the development of their digital creativity, problem-solving, and other 21st century skills. Created and funded by The Hong Kong Jockey Club Charities Trust (the Trust), CoolThink@JC is a collaboration between the Education University of Hong Kong (EdUHK), Massachusetts Institute of Technology (MIT), and City University of Hong Kong (CityU). CoolThink partners developed comprehensive instructional materials, intensive teacher professional development (PD) to support effective

CoolThink instruction, and workshops to support public awareness of and parent engagement in computational thinking education (CTE). The lessons combine three essential elements of computational thinking (CT): CT concepts, CT practices, and CT perspectives (see box).

Over the course of a 3-year pilot, 32 Hong Kong primary schools adopted CoolThink lessons for more than 20,000 Primary 4–6 students. A rigorous evaluation of the impact of CoolThink@JC on students' CT skills found that CoolThink@JC had a large, statistically significant positive effect on CT practices and a smaller positive impact on CT concepts (Shear et al., 2020). In addition, CoolThink

**Computational thinking** encompasses the thought processes and strategies required to understand, formulate, and solve a problem in such a way that a computer can carry out the solution (Wing, 2006). Central to current conceptions of computational thinking is the idea that computing is a means of self-expression and creativity. Elements of computational thinking include:

- **CT Concepts:** Content knowledge required for developing computational artifacts
- **CT Practices:** Problem-solving and logical thinking skills characteristic of computational thinking
- **CT Perspectives:** Interest in and motivation for computational thinking, as well as perceptions of its nature and utility.



teachers reported that the lesson materials supported a shift toward more student-centered pedagogy, greater student autonomy, and greater opportunities to express creativity as students learned to define and solve novel problems without a single correct answer.

Building on these results, CoolThink partners began scaling CoolThink@JC to additional primary schools in summer 2020. A third cohort of 47 schools joined the first two cohorts of pilot schools in summer 2020. A fourth cohort of schools has already been recruited and will join CoolThink@JC in summer 2021, with additional cohorts of schools to be recruited in 2022 and 2023. Ultimately, the partners intend to support the adoption of CoolThink lessons in a large majority of Hong Kong's 475 public sector primary schools and create a self-sustaining territory-wide ecosystem that will support the continued growth and sustainability of CTE after the Trust's funding ends. By demonstrating success at scale, CoolThink partners hope to create a new paradigm

for CTE at the upper primary level that will serve as an international model for other cities and states as they seek to extend CTE to the primary grades.

CoolThink partners have developed a range of scaling strategies designed to make the CoolThink@JC program less resource-intensive, to lower barriers to adoption, and to build capacities for success and sustainability within the system (see box). Marshalling these resources, the CoolThink partners have set out to create: (A) a critical mass of CoolThink@JC adoption among primary schools, (B) system-level capacity to train and support CoolThink teachers, (C) public awareness and support for CTE, (D) upgraded tools and infrastructure, and (E) intellectual leadership for CTE. A robust CTE ecosystem with these five elements then supports strong, sustained implementation of CoolThink materials. Implementation with integrity then leads, in turn, to improved student outcomes, including CT and problem-solving skills, digital creativity, and other 21st century skills.

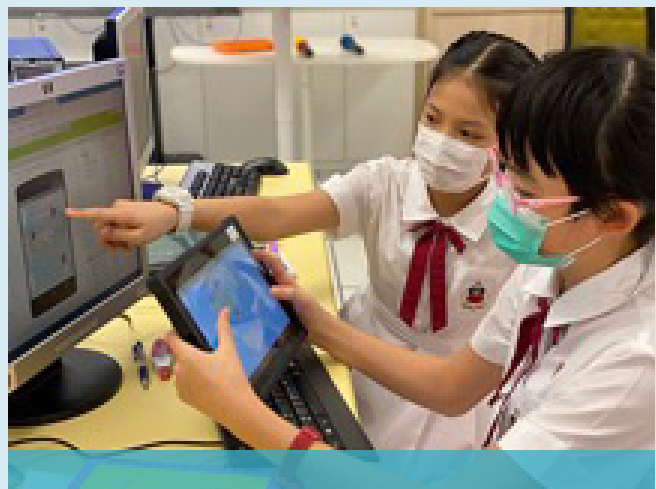




## CoolThink@JC Key Components

Key components of the CoolThink@JC program as it was designed for scaling include:

- Three 14-hour lesson sequences and accompanying instructional materials that reflect CoolThink@JC's key design principles (e.g., to play, to think, to code, to reflect pedagogy) and incorporate cutting edge technology (e.g., artificial intelligence and robotics).
- Support for school-level tailoring of the CoolThink curriculum, with options for designing specialized course pathways, streamlining lesson sequences, and/or supplementing/enriching lessons.
- Modular foundational teacher development courses that require substantially fewer hours in training compared with teacher PD offered during the pilot phase.
- Mentor teachers who conduct peer observations and provide feedback to teachers who are participating in foundational training.
- Cluster-level communities of practice (CoPs) that convene CoolThink teachers within a geographic region to collaborate, share resources, discuss problems of practice, and observe their peers. CoPs are facilitated by CoolThink mentor teachers.
- Instructional resources, including teaching assistants to support CoolThink instruction during teachers' first year in the program, and subsidies to purchase mobile devices to support instruction using MIT App Inventor.
- An InnoCommunity network of innovative teachers designed to disseminate CoolThink materials and support schools that want to carry out a more limited adoption of CoolThink materials.
- A wide range of additional teacher PD opportunities available to all schools and offered by multiple providers (for example, workshops sponsored by the Hong Kong Education Bureau (EDB) and InnoCommunity workshops led by pilot phase mentor teachers).
- Parent engagement workshops, coding fairs, and student competitions.
- Validated annual assessments of students' CT concepts, practices, and perspectives aligned with CoolThink instructional objectives.
- Strategic partnerships with the EDB, school sponsoring bodies (SSBs), and non-governmental organizations to develop a territory-wide ecosystem in support of CTE.



## CoolThink@JC implementation study

Even after a successful pilot, success at scale is often an elusive goal and brings with it a myriad of new considerations and challenges. The Trust has engaged SRI International to study the implementation of the CoolThink@JC program at scale to capture lessons learned and support fine-tuning of the scaling strategies over time. SRI's study is designed to track the uptake of CoolThink@JC's key components, the "how" and "why" of progress toward scaling goals, and the conditions that support or impede successful CoolThink@JC adoption at the classroom and school levels. The evaluation addresses six study questions (see box).

Implementation study results will also support communication about CoolThink@JC with stakeholders in other countries who want to learn from CoolThink@JC's scaling experience. As part of the CoolThink@JC implementation study, SRI will benchmark key elements of CoolThink@JC's design and implementation against CTE models implemented in other regional and national contexts. This benchmarking exercise will consider: (1) key features of CTE curriculum materials, teacher PD, and student assessments; (2) national or state curriculum policies to support scaling; (3) strategies for developing school capacity to sustain implementation; and (4) initiative ownership/governance.

## Implementation model

To launch the implementation study, SRI developed an implementation model to elaborate the roadmap underlying CoolThink@JC's theory of change. The model included in Appendix A shows how CoolThink resources and scaling activities carried out by the CoolThink partners will lead to changes at the classroom, school, and system levels.

## Implementation Study Questions

1. What does a CoolThink classroom look like at scale? How much, and by what factors, does it vary?
2. What are the essential characteristics of CoolThink@JC teacher PD at scale? How do teacher perceptions and self-reported outcomes vary in response to scalable models of PD?
3. What implementation factors are associated with stronger student outcomes?
4. How do CoolThink@JC classrooms, schools, and teacher PD support equitable access to CTE for all students?
5. What school-level policies and practices are common among schools that successfully sustain the CoolThink@JC model over time? What elements of the system-level context appear to support scaling and sustainability of CoolThink?
6. To what degree is a sustainable territory-wide ecosystem in support of CTE in evidence in Hong Kong?

This systematic picture is an important tool to navigate the scaling process, guiding ongoing partner activities and course corrections. It is also an important basis for the documentation of why and how CoolThink@JC works for those who may want to emulate its various components. Finally, the model serves as the starting point for an implementation study design: It specifies the topics, constructs, measures, and samples that the implementation evaluation will address over the course of the initiative. It also describes the proximal outcomes that are expected to lead to longer-term

impacts, including students' future-ready skills, a critical mass of schools with sustainable CTE programs and of skilled, experienced CoolThink teachers, and ultimately the creation of a self-sustaining territory-wide ecosystem that will support CTE after CoolThink funding ends.

## Implementation study data sources and methods

Data collection for the implementation study combines broad-scope surveys of representative samples of CoolThink teachers and school leaders with more in-depth data collection in small, purposive samples (e.g., educator interviews, classroom observations, classroom logs, PD observations, system-level interviews and out-of-network surveys) to understand how the CoolThink@JC vision is being understood and enacted throughout the various levels of the primary school system. This report focuses on school leader and teacher surveys conducted at baseline, early in the 2020-21 school year. The full set of data sources for the CoolThink@JC implementation study are described in Appendix B.

## Key questions for CoolThink schools at baseline

This baseline report sets the context for the rollout of CoolThink@JC: It describes the schools and teachers as they enter the initiative, as well as early participation in CoolThink activities and effects of COVID-19. An understanding of where the schools are starting from can help the CoolThink partners to identify assets to capitalize on, as well as areas in need of additional investment or focus.

Drawing on baseline data reported here, we identify some key issues that will guide analysis of data collected at follow-up, 1 or more years after

CoolThink@JC adoption. Future reports will describe the implementation and uptake of CoolThink@JC in Hong Kong schools as it scales, as well as the relationship between implementation success and school- and teacher-level conditions at baseline.

## Baseline data sources

Baseline measures of ICT instruction and of the school-level and classroom-level conditions supporting CTE are drawn from surveys of teachers and school leaders in the 47 Cohort 3 schools. These baseline surveys were designed by SRI and administered by Ipsos, the implementation study's local data collection partner. Surveys asked respondents to report on information and communication technology (ICT) instruction at their schools in the year before their school adopted CoolThink@JC, and before any COVID-19-related school closures. Surveys also asked teachers and school leaders to report on initial aspects of CoolThink instruction during 2020–21, including accommodations due to COVID-19. Each survey took about 20 minutes to complete.

Ipsos administered the surveys via Qualtrics between November 2020 and January 2021 to 47 Cohort 3 school leaders and all 246 Cohort 3 CoolThink teachers who were teaching CoolThink lessons in 2020-21. Of 47 schools, school leaders at 42 responded to the school leader survey (89% response rate). Half of the school leader surveys were completed by the principal only, 35% by both the principal and an ICT instructional leader or coach, and 15% exclusively by someone in an ICT instructional leadership or curriculum director role. Out of 246 CoolThink teachers in 47 schools, 194 teachers in 46 schools responded to the teacher survey (a response rate of 79%).

# COHORT 3 SCHOOLS AT BASELINE

Cohort 3 schools embarked on their adoption of CoolThink@JC curriculum materials with varying levels of prior experience with ICT instruction and computational thinking education. This section describes Cohort 3 schools and the school-level characteristics that are expected to shape CoolThink@JC implementation in the first year of the program. Data are drawn from the school leader survey with triangulation from the teacher survey, where appropriate.

## School characteristics

The 47 Cohort 3 schools together enroll more than 17,000 students in Primary 4–6. They represent a diverse cross-section of public sector primary schools<sup>1</sup> and are operated by at least 21 different school sponsoring bodies (SSBs), each reflecting a particular vision and mission for primary education and specific priorities for school-level staffing and curriculum decisions. To support recruitment and outreach efforts, the CoolThink@JC Central Coordinating Team (CCT) established partnerships with three of the largest SSBs in Hong Kong (Catholic Diocese of Hong Kong, Po Leung Kuk, and Tung Wah Group of Hospitals). More than half of the 41 Cohort 3 schools that responded to the school leader survey are operated by these three SSBs, with the Catholic Diocese of Hong Kong accounting for the largest number (10 schools). The remaining schools are operated by 18 different SSBs, with 16 contributing just one school to the cohort. As a result, Cohort 3 schools operate in a wide range of school-level policy contexts.

As shown in [Exhibit 1](#), Cohort 3 schools are broadly representative of Hong Kong primary schools across the territory. They are geographically well distributed and represent 17 of the territory's 18 districts. Almost all of the 40 schools that responded to demographic questions on the school leader survey serve both boys and girls; one school enrolls all boys. Four schools use English as the primary language of instruction, while the rest teach primarily in Chinese.



<sup>1</sup> Four of the 47 Cohort 3 schools are funded under the direct subsidy scheme. The remainder are aided primary schools.

Exhibit 1. Cohort 3 schools are broadly representative of all Hong Kong public sector primary schools

	Cohort 3 schools (n = 40)	Hong Kong primary schools (n = 476)
<b>Region</b>		
Hong Kong	15%	15%
Kowloon	33%	29%
New Territories East	13%	24%
New Territories West	40%	32%
<b>Enrollment by gender</b>		
Single gender (all boys/all girls)	10%	4%
Coeducational	90%	96%
<b>Primary language of instruction</b>		
Chinese	90%	95%
English	10%	5%
<b>Student demographics</b>		
% boys	53%	52%
% receiving financial aid	35%	34%
% special educational needs	14%	8%
% non-native Chinese speakers	5%	3%
% commuting from mainland China	6%	5%

Sources: Cohort 3 baseline school leader survey, 2020. Hong Kong Education Bureau, Student Enrollment Statistics ([edb.gov.hk](http://edb.gov.hk)).

Note: Cohort 3 means are based on the 40 schools that responded to demographic questions on the baseline school leader survey. Hong Kong primary school statistics include public sector aided and Direct Subsidy Scheme (DSS) schools only.

On average, 35% of students in Cohort 3 schools receive financial aid, consistent with the average for all primary students in Hong Kong's public sector schools (34%). Reflecting the partners' commitment to equity and promoting computational thinking education (CTE) for all students, including those that have traditionally not had access to high-quality CTE instruction, Cohort 3 also includes some schools that serve high proportions of traditionally underserved students. About a third of Cohort 3 schools could be considered "high need", with 50% of students or more qualifying for financial aid.

Similarly, 14% of students in Cohort 3 schools have special education needs (SEN), somewhat higher than the territory average of 8%. Five Cohort 3 schools have particularly high rates of special needs students, with SEN rates of 20% or more.

Small but significant numbers of schools reported unusual demographic profiles that could potentially impact CoolThink@JC implementation:

- Gender ratios in co-educational schools that favor boys (e.g., 4 schools with a boy-girl ratio of 3:2)



- Large numbers of students with special educational needs (e.g., 4 schools with 20% SEN students, 1 school with 50% SEN students)
- High incidence of students who cross the border from the mainland each day to attend school (e.g., 4 schools with 33–48% of students who live in mainland China)

## ICT instruction prior to CoolThink@JC

Schools that have extensive prior experience with ICT instruction may find the adoption of CoolThink materials to be a lighter lift than in schools attempting ICT instruction for the first time. Most Cohort 3 schools have had long-standing prior experience with ICT instruction, both during the regular school day and in afterschool and extracurricular activities. The ICT lessons offered by Cohort 3 schools at baseline addressed computational thinking and related topics, in addition to other traditional ICT priorities.

## ICT lessons offered during the regular school day

Most Cohort 3 schools reported that they offered ICT lessons to students in Primary 4–6 during the regular school day in the year before they adopted CoolThink@JC either as a stand-alone course (67% of schools), integrated into STEM lessons (17%), or in some other format (5%).

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**89%** Cohort 3 schools that offered ICT lessons during the regular school day in 2019–20, the year before adopting CoolThink@JC

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CoolThink curriculum materials are designed to be offered as a stand-alone course, with 35-minute

lessons that can be offered in a single period of instruction or back-to-back in a double period. Baseline surveys suggest that most Cohort 3 schools had already mainstreamed ICT instruction in the upper primary grades in this way: 67% of schools reported that they offered ICT as a stand-alone course to all Primary 4–6 students in 2019–20. For most Cohort 3 schools, ICT has been part of the regular school day curriculum for Primary 6 students for many years.

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**67%** Cohort 3 schools that offered ICT as a **stand-alone course to ALL students** in Primary 4, 5, and 6 at baseline

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**85%** Cohort 3 schools that offered ICT lessons to Primary 6 students for **4 or more years** before adopting CoolThink@JC

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CoolThink lessons require at least 14 hours of instruction for each level if taught as designed. Cohort 3 schools reported many more hours devoted to ICT lessons during the baseline year: an average of 23 hours of ICT instruction in 2019–20, although estimates of instructional time varied significantly by schools. Half of the schools that responded to this survey question reported that they had allocated between 14 and 23 hours to ICT instruction in 2019–20. A quarter of schools reported spending 14 hours or less. At the other end of the continuum, a quarter of schools reported spending more than 23 hours, with two schools allocating more than 80 hours to ICT instruction during their baseline school year.

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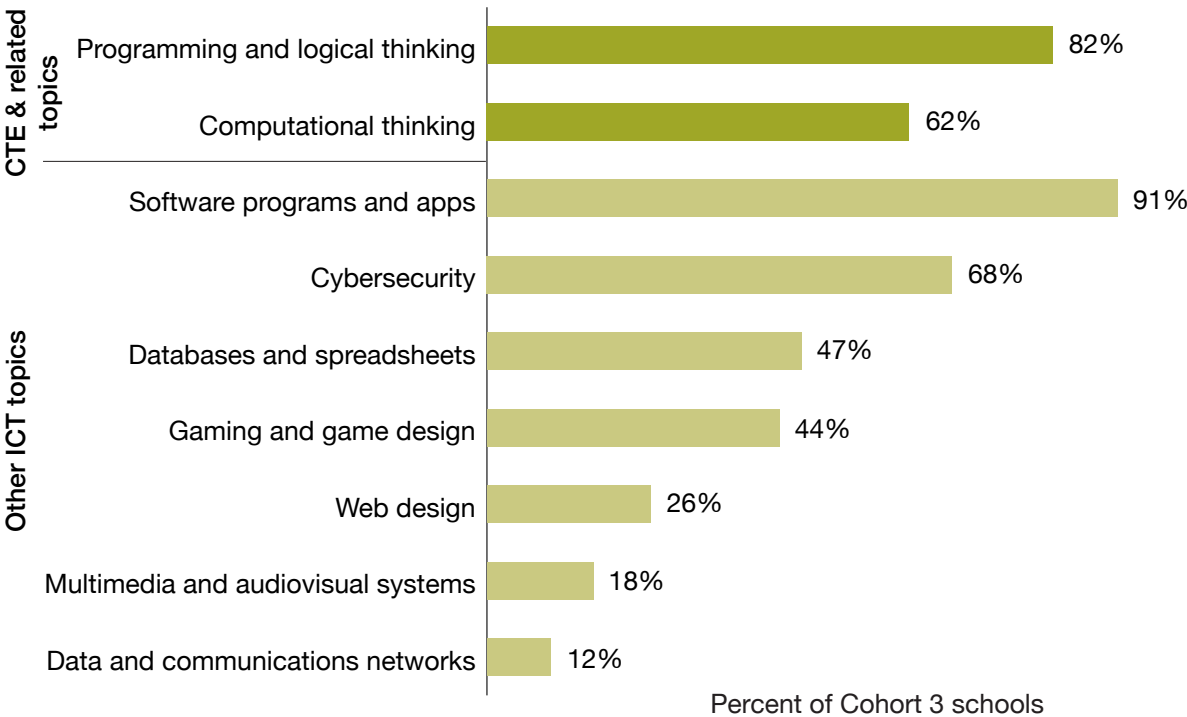
**23** Hours of ICT instruction for Primary 6 students, on average, at baseline

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In the year prior to CoolThink@JC adoption, most schools offered ICT lessons that addressed at least some CT topics. In more than 4 out of 5 schools, school leaders reported that students had had the opportunity to explore programming and logical thinking in ICT lessons; school leaders in

the majority of schools also reported that students had studied CT, although it is not clear how school leaders understood that term on the survey. Common ICT topics also include software programs and apps, cybersecurity, and databases and spreadsheets ([Exhibit 2](#)).

Exhibit 2. ICT lessons in the majority of Cohort 3 schools addressed computational thinking and closely related topics, although these were not the only focus



*n* = 34  
 Source: Cohort 3 baseline school leader survey, 2020

### Related extracurricular activities

In addition to ICT lessons during the school day, extracurricular activities and afterschool programming provided students with additional exposure to CTE and coding. In the year before they adopted CoolThink@JC, 76% of Cohort 3 schools reported that their students participated in CTE-related afterschool or extracurricular activities,

including computer clubs (37% of schools), robotics clubs (37% of schools), afterschool programming classes (15% of schools), and coding competitions, fairs, and special events (not including CoolThink events) (17% of schools). About a quarter of Cohort 3 schools (24%) reported that their students had participated in a CoolThink competition or coding fair during the baseline year.

Cohort 3 schools' interest in CT and coding education is reflected in the fact that nearly all (93%) offered some form of ICT programming to their students in the year before they joined CoolThink@JC, either in the form of ICT lessons during the school day or in the form of extracurricular activities, or both. Only three schools reported that their students did not participate in CT or coding activities of any kind. Most schools offered afterschool and extracurricular opportunities as a supplement to school-day ICT lessons, not a substitute: Of the 37 schools reporting that they offered ICT lessons in 2019–20, only 7 reported that their students did not participate in any CTE-related extracurricular activities in addition to lessons offered during the school day.

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**76%**

**Cohort 3 schools with students participating in extracurricular ICT activities (computer club, robotics club, competitions, and fairs)**

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**93%**

**Cohort 3 schools that offered *either* ICT lessons during the day or extracurricular ICT opportunities**

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## School-level infrastructure and support for ICT instruction

Successful adoption of CoolThink curriculum materials requires substantial tangible resources in the form of technology, staffing, time allocated in the master class schedule, and teacher time for planning and collaboration. Successful adoption also depends on intangible resources, including school leaders'

commitment to CoolThink@JC goals, staff's belief in the value of CTE, and teachers' willingness to innovate by experimenting with new pedagogies and instructional approaches. Schools that have these resources in place before they adopt CoolThink@JC are positioned to make faster progress toward strong implementation of the model.

## Technology

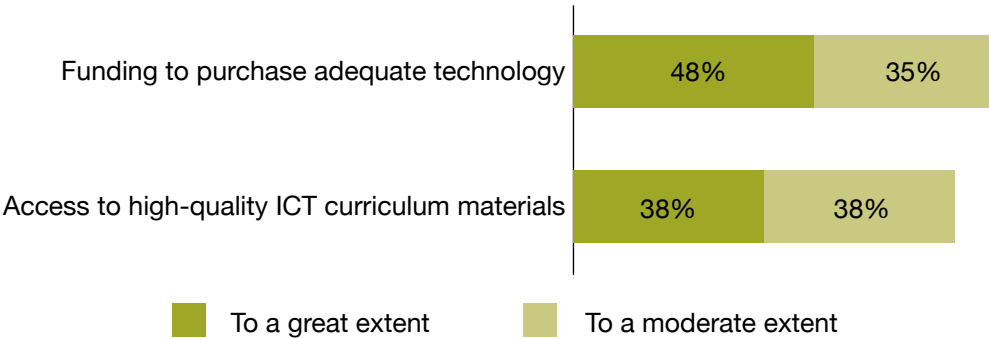
Schools adopting CoolThink@JC may apply for subsidies to purchase the mobile devices required to teach lessons employing MIT App Inventor. CoolThink partners also offer consultation on the technology, configurations, and infrastructure required to teach all CoolThink course levels. Before they adopted CoolThink@JC, however, most Cohort 3 schools reported that they were well-equipped with the required technology. For example, more than 90% of teachers and school leaders reported that each student had a desktop computer in the year before CoolThink@JC adoption,<sup>2</sup> more than 90% reported that each student had access to a wireless tablet (preferred for testing apps built-in App Inventor), and nearly all teachers (97%) reported that their school had reliable internet access under normal circumstances. The vast majority of school leaders reported that they had the funding that they needed to purchase adequate technology to support strong ICT instruction ([Exhibit 3](#)). Three of four school leaders also reported that they had access to high-quality curriculum materials to support strong ICT instruction, suggesting that CoolThink@JC adoption was not driven by dissatisfaction with the curriculum materials in use during the baseline year.

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<sup>2</sup> CoolThink teachers reported using PCs more often than MacBooks (82% of CoolThink teachers use PCs in instruction compared with 7% who use MacBooks) and iPads more often than Windows-based tablet computers (62% vs. 8%).

Exhibit 3. Most Cohort 3 schools had adequate funding to purchase technology and access to high-quality ICT curriculum materials before adopting CoolThink

*Extent to which supports for strong ICT instruction were present in schools at baseline*



*n* = 40

Source: Cohort 3 baseline school leader survey, 2020

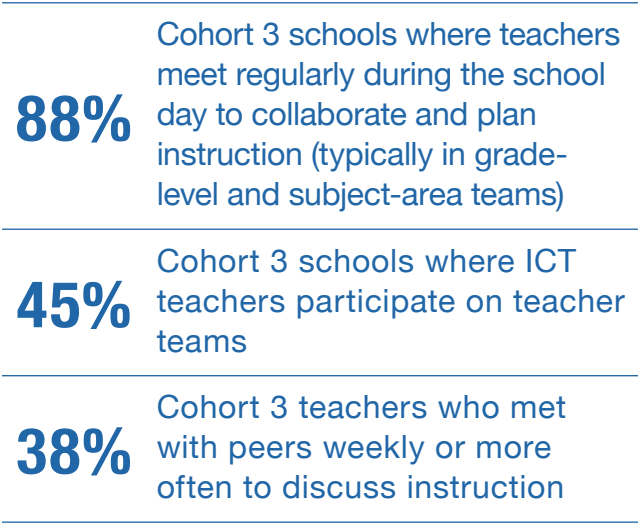
Teacher collaboration

CoolThink@JC scaling strategies include the establishment of both cluster-level (regional) and school-based communities of practice (CoPs). CoolThink CoPs include all CoolThink teachers (that is, those teaching CoolThink lessons, in addition to any other teaching assignments) and are facilitated in part by CoolThink mentor teachers. These CoPs are intended to support teachers as they try new CoolThink lessons, adjust their pedagogy to support the needs of diverse learners, and support students who are having difficulty engaging in CoolThink activities as designed. In future years, some school-based CoPs will tailor CoolThink curriculum by modifying or adding to the CoolThink courses, creating a specialized “school-based curriculum” consisting of tailored sequences of CoolThink courses and lessons. CoPs may also provide additional professional learning and support for new teachers who may not have had a chance to enroll in a CoolThink teacher development course.

At baseline, fewer than half of school leaders reported that ICT teachers (45%) met regularly in teacher teams to discuss instruction, although nearly all schools (88%) reported that at least some teachers (usually core subject teachers) met in grade-level or subject-area teams. In the majority of schools, these teacher teams did not meet often (once a month or less frequently in 54% of schools). According to school leaders, the highest priority of these teacher meetings was discussing pedagogical strategies (51% of schools reported this focus was “extremely important”). Providing teachers with opportunities for practice and feedback and supporting diverse learners were lower priorities for these teacher teams (20% and 9% of schools reported that these CoP objectives were “extremely important,” respectively).

Although Cohort 3 schools have structures and practices in place to support regular teacher team meetings, in some schools these structures will need to be expanded to include ICT teachers who

are now teaching CoolThink lessons. Also, the frequency and focus of teacher team meetings may need to change if the CoolThink partners' vision for school-based CoPs is to be realized.

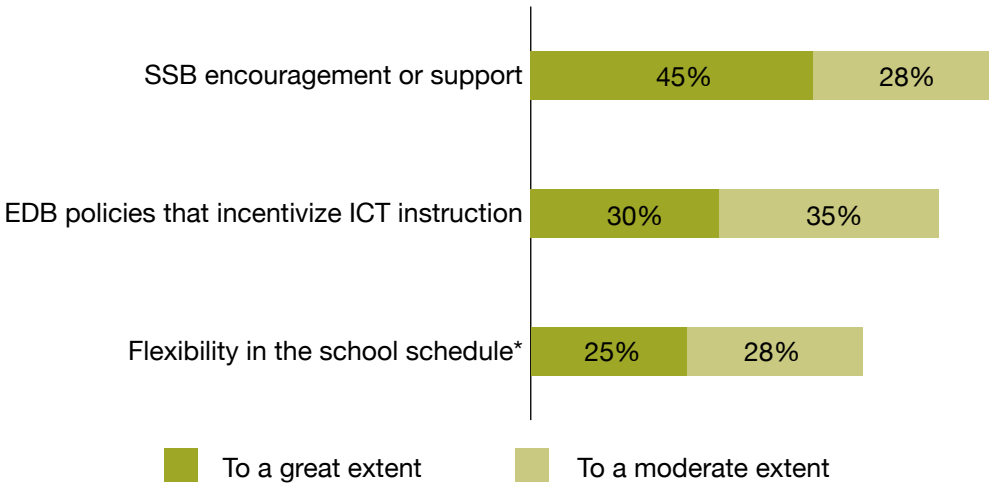


### Curriculum policy and guidance from supervising bodies

Instructional time is a finite resource, and many subjects in the primary school curriculum must be accommodated within the limits of the existing school day. For this reason, expanded instructional time may be the least readily available of all the school resources required for the adoption of CoolThink materials. Nevertheless, as noted above, most Cohort 3 schools were already providing students with more than 14 hours of ICT lessons before they adopted CoolThink@JC. In addition, half of Cohort 3 school leaders reported that they had sufficient flexibility during the school day to offer a strong ICT instruction, at least to a moderate extent (another 20% of school leaders reported that scheduling flexibility was not required to support a strong ICT program) ([Exhibit 4](#)).

Exhibit 4. Existing policies and guidance supported strong ICT instruction prior to adoption of CoolThink

*Extent to which supports for strong ICT instruction were present in schools at baseline*



\* An additional 20% of school leaders reported that flexibility in the school schedule was not necessary to support strong ICT instruction.

n = 40

Source: Baseline school leader survey, 2020





These positive reports about the availability of instructional time for ICT lessons at baseline may reflect the existing policy context and guidance from both the Education Bureau (EDB) and school sponsoring bodies (SSB) that support ICT instruction. About two-thirds of Cohort 3 schools reported that at baseline, EDB policies designed to incentivize ICT instruction (for example, STEM+C curriculum requirements that can be satisfied by ICT courses or lessons) had supported strong ICT instruction at their schools ([Exhibit 3](#)). Similarly, most school leaders reported that SSBs had supported or encouraged strong ICT instruction during the baseline year, with no significant differences between schools supervised by CoolThink partner SSBs (Catholic Diocese of Hong Kong, Po Leung Kuk, and Tung Wah Group of Hospitals) and schools supervised by other SSBs. Among their other functions, SSBs are responsible for setting priorities and offering guidance on curriculum decisions and

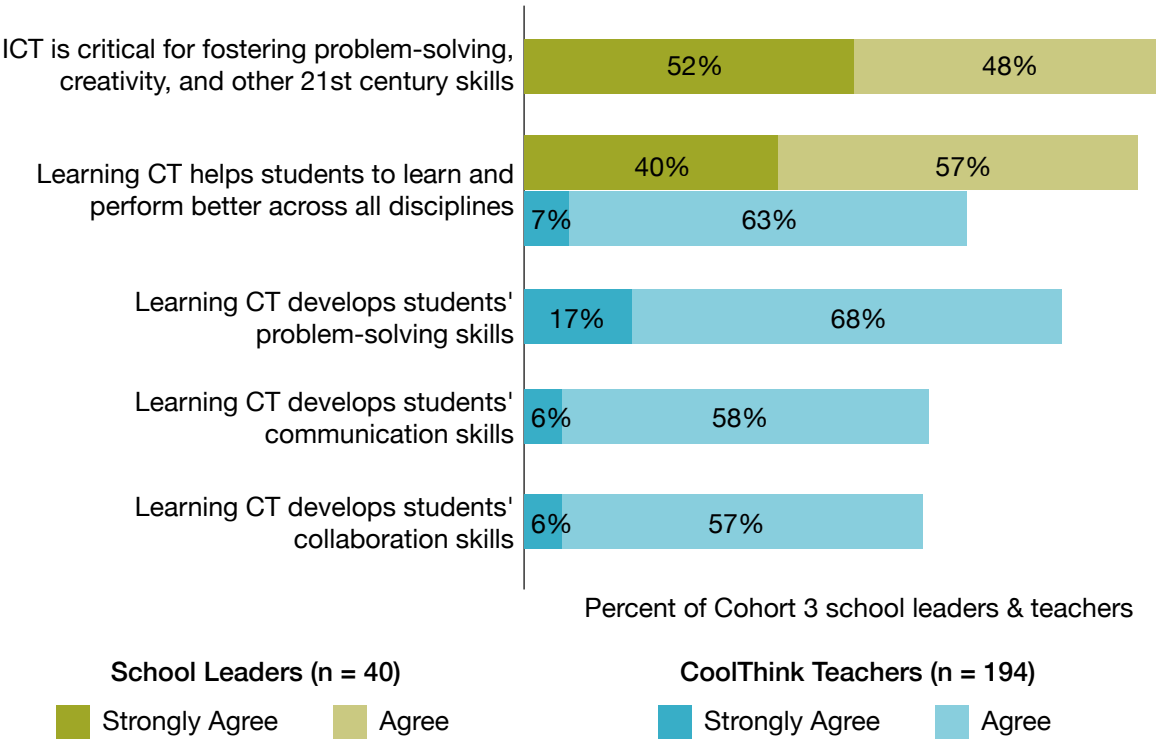
adoption; as such, SSBs can play an important role in helping schools navigate trade-offs to find time for ICT instruction in crowded school schedules. Taken together, these survey data suggest that school leaders believe that the external policy context and the guidance they have received from EDB and their SSBs generally support strong ICT instruction, at least to a moderate extent.

### Teacher and school leader beliefs about the value of CTE

At baseline, Cohort 3 school leaders expressed strong agreement with some key elements of the CoolThink@JC mission statement. For example, 100% of school leaders agreed that (a) all Primary 4–6 students should be required to take ICT lessons, (b) ICT lessons should be offered during the regular school day, and (c) ICT is critical for fostering problem-solving, creativity, and other 21st century skills. Of these, approximately half of all school leaders reported that they “strongly agreed” with these basic CoolThink@JC tenants.

At the same time, school leaders appeared to hold stronger beliefs about the value of CTE than their teachers. School leaders were more likely than teachers to agree that learning CT helps students across disciplines ([Exhibit 5](#)). All school leaders agreed that ICT education is critical for fostering problem solving and other 21st century skills, with half reporting that they “strongly agreed,” compared with fewer than 1 in 5 CoolThink teachers who reported similarly strong beliefs about the value of CTE for teaching problem solving, communication, and collaboration.

Exhibit 5. At baseline, school leaders believed more strongly in the value of computational thinking and ICT education than CoolThink teachers



Source: Baseline school leader and teacher surveys, 2020

This difference of perspectives between school leaders and teachers should perhaps not be surprising. If school leaders were primarily responsible for the decision to adopt CoolThink@JC, then strong beliefs about the value of CTE would be consistent with their decision to commit valuable instructional time, teacher PD time, and other school resources to CoolThink@JC. Teachers who were not part of this decision to adopt and are now facing the challenge of teaching CoolThink lessons to students may be expressing a more measured set of expectations. Whatever the reason for the discrepancy between Cohort 3 teachers and school leaders, in a strong implementation we would expect to see this gap close as teachers successfully adopt CoolThink@JC.

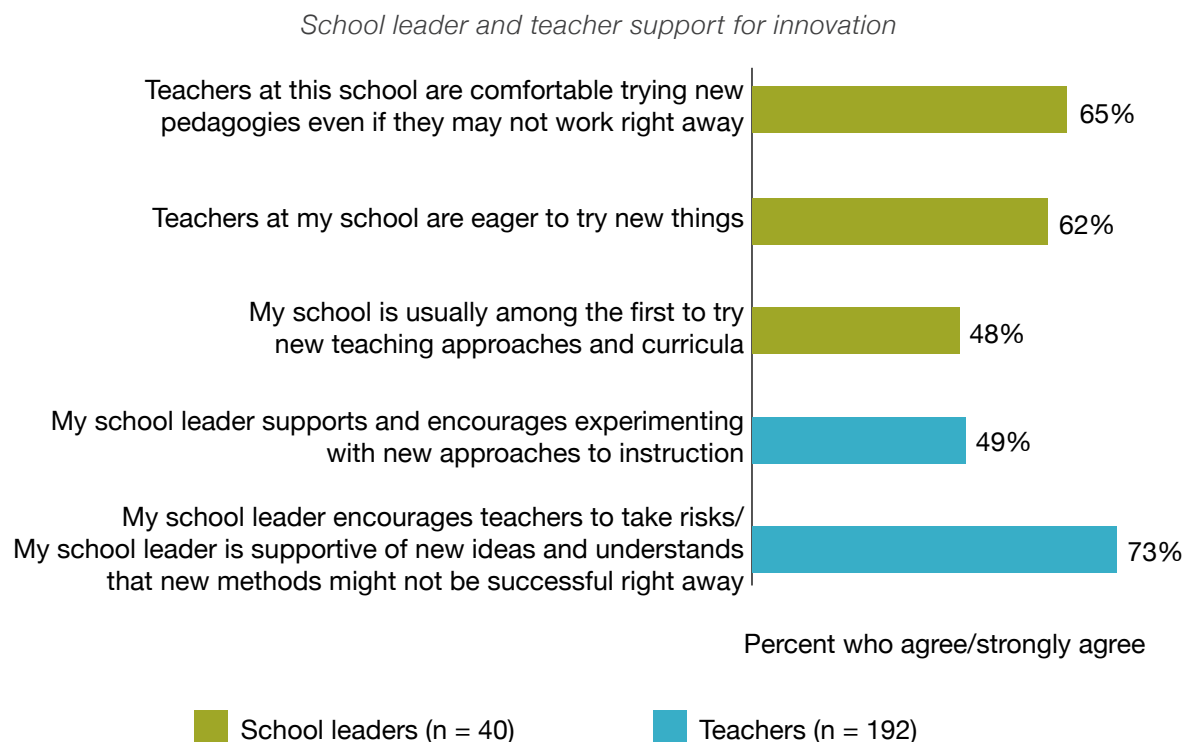
In addition to differences in perception between teachers and school leaders, baseline survey data also reflect significant differences between schools when it comes to teachers’ beliefs about CTE. Statistically, between one-quarter and one-third of the variation in teacher beliefs about CTE is accounted for by differences between schools, depending on the survey item. The variation in responses was large: On a five-point scale ranging from “strongly disagree” to “strongly agree” with statements about the value of CTE, some schools scored an average of 1.5 or less and others scored 3.0 or more. In future analyses, we will explore whether this school-level or teacher-level variation is associated with stronger implementation outcomes.

## Support for innovation

As demonstrated in the initiative’s pilot, successful CoolThink@JC adoption requires that teachers adopt new and sometimes unfamiliar pedagogical strategies. Many of the key features of CoolThink instruction (time devoted to unstructured exploration, student collaboration, and student-centered problem-solving) require classroom management and instructional skills that are different from more traditional approaches to

instruction. In just over half of Cohort 3 schools, school leaders reported that teachers were comfortable experimenting with new and unfamiliar pedagogies. About half of school leaders described their schools as early adopters, among the first to try new teaching approaches and curricula. For their part, half of teachers reported that their principal was extremely or very supportive of this kind of experimentation ([Exhibit 6](#)).

Exhibit 6. Just over half of school leaders report that teachers are comfortable trying new pedagogies, and half of teachers report that school leaders support this kind of experimentation



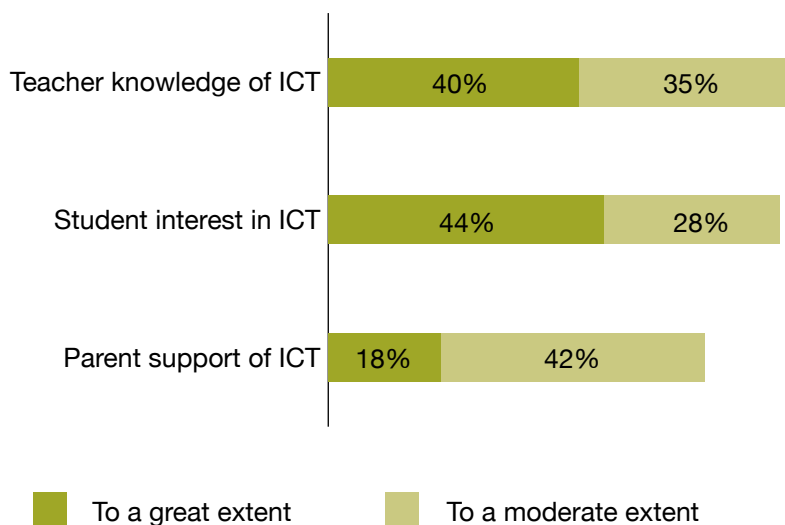
Source: Baseline school leader and teacher surveys, 2020

Together, these data suggest that about half of Cohort 3 schools can be described as “early adopters,” with a high degree of openness to experimentation and tolerance for strategies that might not work right away. This level of openness to engaging in innovation is a hopeful sign for future adoption of CoolThink@JC in these schools. In about half of Cohort 3 schools, however, both the school leaders and teachers expressed greater hesitancy about their colleagues’ attitudes towards experimentation and risk. As the CoolThink@JC scaling initiative progresses, we will explore the relationship between these attitudes at baseline and later progress toward sustained implementation of CoolThink@JC with integrity.

Close to half of school leaders indicated that teachers’ knowledge of ICT and student interest in the subject supported strong ICT instruction, reporting that they were present in their schools “to a great extent” as baseline ([Exhibit 7](#)). Most school leaders reported that they were present at least to a moderate extent. Parent support for ICT instruction is less robust, according to school leaders, with fewer than 1 in 5 reporting that parents supported ICT instruction “to a great extent.” As with other school-level resources and conditions that may influence sustained implementation of CoolThink@JC, we will explore whether this school-level variation is associated with stronger implementation outcomes as the scaling initiative progresses.

### Exhibit 7. Most school leaders reported at least moderate levels of knowledge, interest, and support for ICT at baseline

*Extent to which supports for strong ICT instruction were present in schools at baseline*



*n* = 40

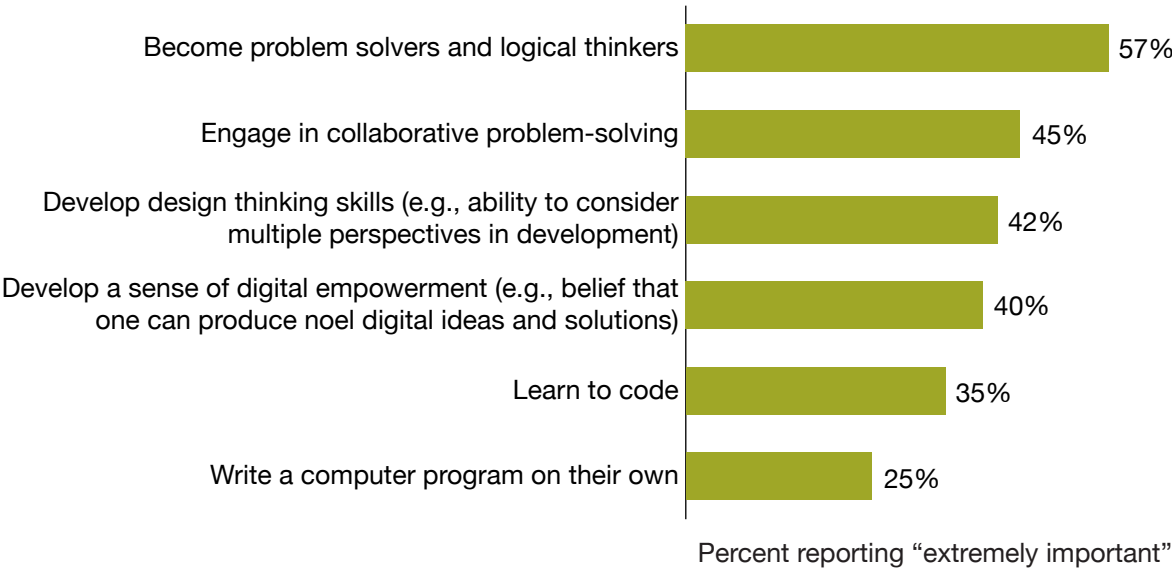
Source: Baseline school leader survey, 2020

# Expectations for CoolThink@JC

When asked at baseline about their priorities for CoolThink@JC adoption, school leaders were more likely to say that 21<sup>st</sup> century skills like problem solving, collaboration, and design thinking were “extremely important,” compared with simply learning to code or writing a computer program

on their own. These priorities suggest that school leaders place a high value on the approach to developing CT practices and perspectives that is a distinctive feature of the CoolThink courses, compared with other ICT curriculum materials ([Exhibit 8](#)).

Exhibit 8. School leaders prioritize 21st century skills (problem-solving, collaboration) over simply learning to code in their expectations for CoolThink



n = 40

Note: School leaders also reported that it was “extremely important” that CoolThink@JC help students: develop computational identity (e.g., feeling of belonging to a group of programmers) (25%); express creativity in creating games, apps, or other digital artifacts (28%); and design a computer program to solve a real-world problem (40%).

Source: Cohort 3 baseline school leader survey, 2020



# COHORT 3 CLASSROOMS AND TEACHERS AT BASELINE

When implementing a new curriculum in a classroom, the teacher's knowledge of the subject matter and beliefs about the nature of the curricular reform both have a strong influence on what actually happens in the classroom (Powell & Anderson, 2002). This section describes teachers' backgrounds and other baseline attributes of teachers and classrooms that may help explain later variation in CoolThink@JC implementation across classes within a school.

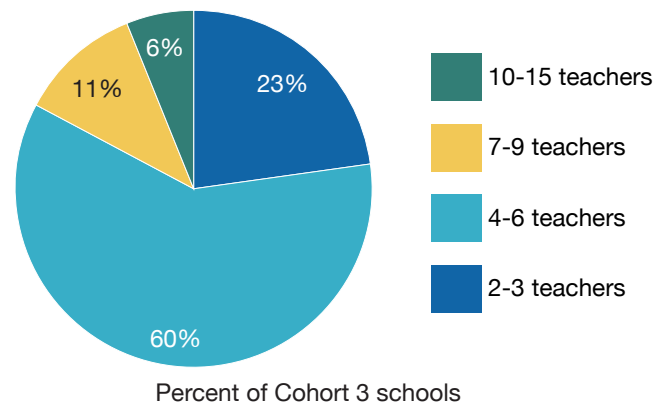
## Who are the CoolThink teachers?

A total of 246 teachers are teaching CoolThink@JC in the 2020–21 school year across the 47 Cohort 3 schools. As there is a range of school sizes across the cohort, the number of CoolThink teachers at each school varies substantially. An average of 5 teachers per school will teach CoolThink@JC during the 2020–21 school year, ranging from 2 to 15 at each

school. More than half of Cohort 3 schools (60%) have 4 to 6 CoolThink teachers, but 23% of schools have fewer than 4, 11% have 7 to 9, and 6% have 10 to 15 (Exhibit 9). This variation will affect the character of the teacher professional community and the management of the CoolThink@JC rollout at each school.

### Exhibit 9. Most Cohort 3 schools have 4–6 CoolThink teachers

*Number of CoolThink teachers in each Cohort 3 school*



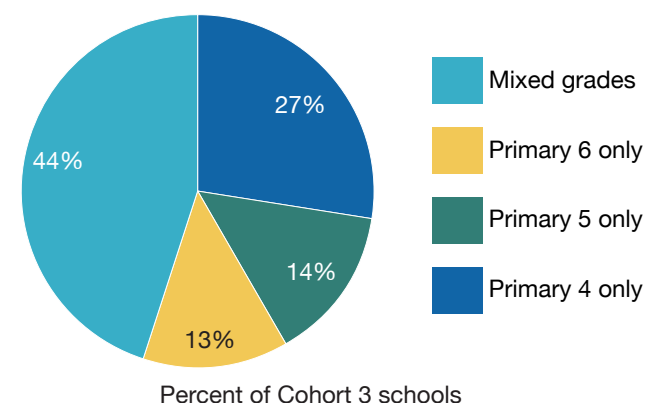
*n* = 47

*Source: Cohort 3 teacher development course rosters, 2020*



Among the teachers who responded to the survey, 61% teach Primary 4, 51% teach Primary 5, and 50% teach Primary 6. Close to half of the teachers (44%) teach mixed grade levels (Exhibit 10). Compared with those who teach single grades, teachers who teach mixed grades are more likely to have a bachelor's degree in ICT/computer science (CS) (34% versus 14%) and are more likely to have prior experience teaching ICT (55% versus 37%), indicating that they are more "specialized" ICT teachers who devote more time to teaching CoolThink@JC.

Exhibit 10. Close to half of CoolThink teachers teach across multiple grade levels



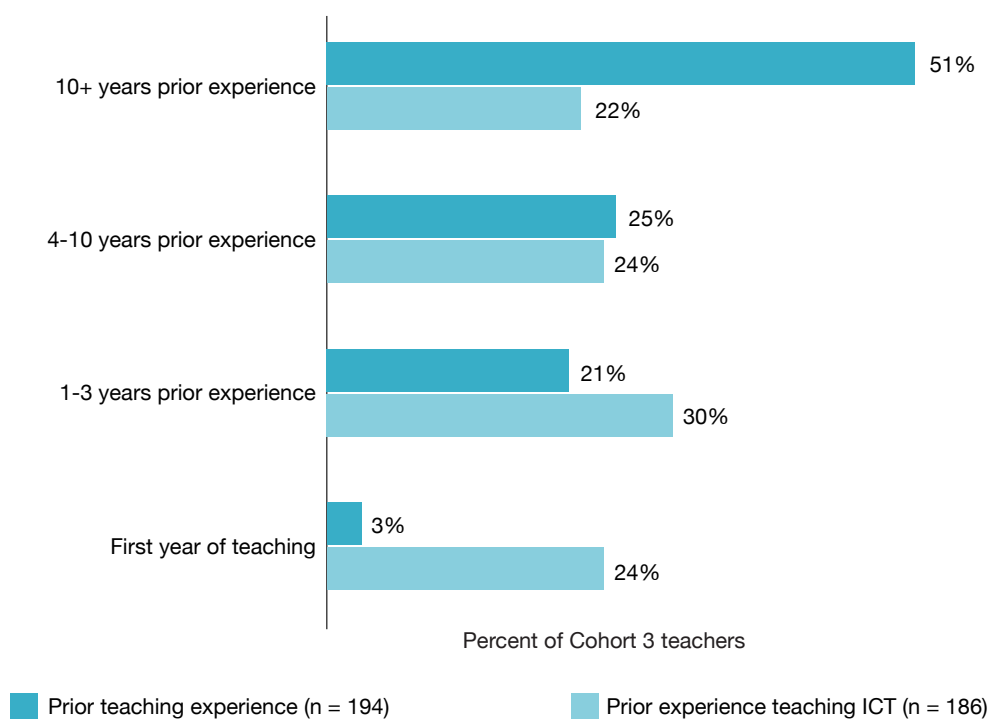
*n* = 194

Source: Cohort 3 baseline teacher survey, 2020

## Teacher background and experience

Like any ICT curriculum, CoolThink@JC comes with a substantial learning curve for teachers, and particularly for those who are new to ICT. Cohort 3 teachers have a range of prior experience, both in terms of overall teaching and teaching ICT. As they began teaching CoolThink@JC, teachers reported having taught an average of 11.8 years, with a majority (51%) of veteran teachers who had more than 10 years of teaching experience and just 3% of teachers in their first year of teaching (see [Exhibit 11](#)). Teachers reported an average of 6.9 years of prior experience teaching ICT in particular: a substantial experience base given the relative newness of the subject area in primary school. Some 22% of teachers had more than 10 years of ICT experience, and 24% were in their first year of teaching ICT.

Exhibit 11. Half of CoolThink teachers have at least 10 years teaching experience at baseline, but one quarter are in their first year of teaching ICT



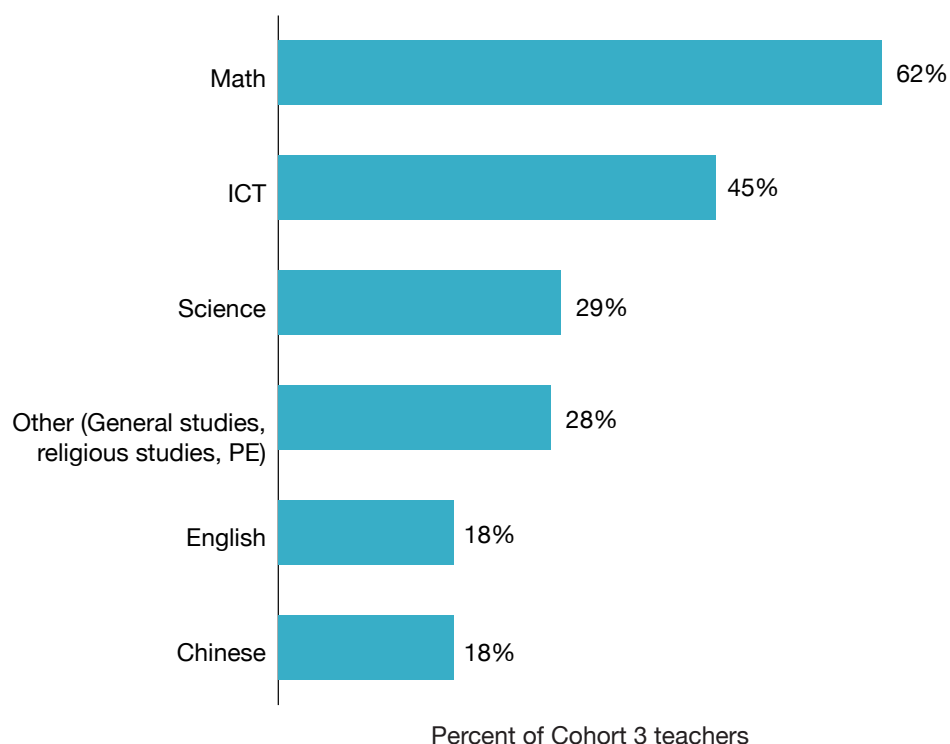
Source: Cohort 3 baseline teacher survey, 2020

Although 76% of teachers surveyed reported some prior experience with teaching ICT, only 45% taught ICT as their primary subject prior to teaching CoolThink@JC. A majority of Cohort 3 teachers (62%) previously taught math as their primary subject; other primary subjects include science (29%), languages (35%), or other subjects including general studies, physical education (PE), or religious studies (28%)

(Exhibit 12). Most teachers who reported previously teaching ICT as their primary subject also reported teaching another primary subject in the past. These varied teacher backgrounds have implications for teacher practices in the CoolThink@JC implementation. Teachers are likely to bring disciplinary norms and practices they are familiar with to their teaching of the CoolThink@JC program.

## Exhibit 12. CoolThink teachers have experience teaching a variety of subjects

*Primary subjects previously taught by CoolThink teachers*



*n* = 194

*Note: Teachers could select two or more primary subjects, so the percentages do not add to 100.*

*Source: Cohort 3 baseline teacher survey, 2020*

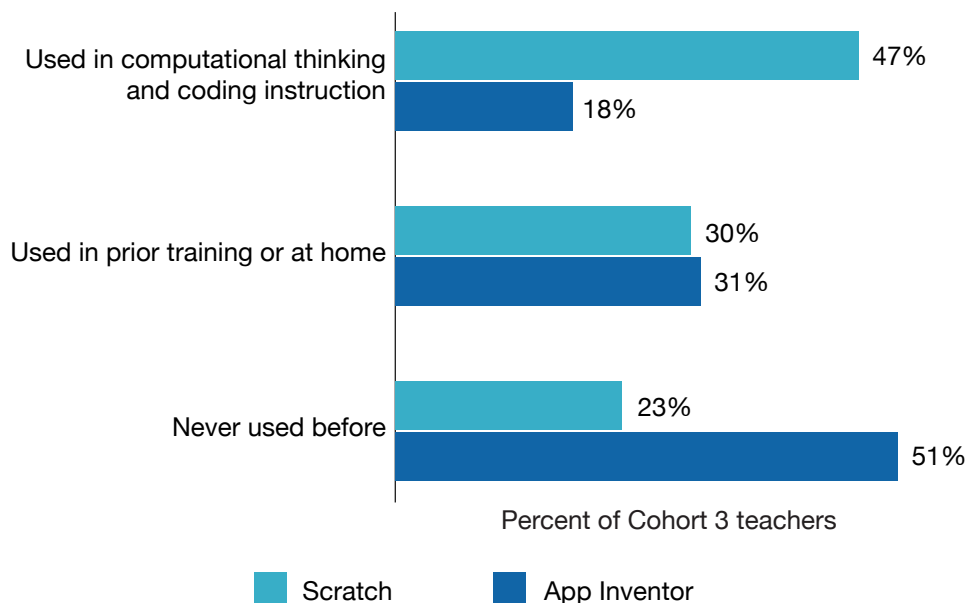
In addition to variations in teaching experience, the Cohort 3 teachers also have varied backgrounds in terms of their academic preparation and experience with programming languages. Only 23% of Cohort 3 CoolThink teachers have an undergraduate degree in ICT: 36% of teachers have a degree in math or

science, 26% have a degree in a language such as Chinese or English, and 26% have degrees in a range of other subjects including education, social sciences, general studies, PE, visual arts, and business administration.

Of those teachers who had previously taught ICT, only 36% had an undergraduate or graduate degree in CS or ICT, but most (94%) had access to some form of formal ICT professional development (PD) or training. About 62% of the teachers attended EDB workshops; 72% received formal ICT training through undergraduate degrees, preservice training, university-sponsored workshops, and formal coaching; and 40% of teachers received less formal ICT support through conferences and informal coaching. The majority of teachers participated in more than one kind of ICT support.

Most CoolThink teachers (79%) had experience with at least one of the block-based programming languages used in the CoolThink@JC program (see [Exhibit 13](#)). Teachers had more instructional experience with Scratch than MIT App Inventor: 47% of teachers reported having taught with Scratch, whereas only 18% of teachers reported having taught with App Inventor. Teachers reported similar amounts of prior training or home use with the two languages (approximately 30% each).

**Exhibit 13. More teachers have prior experience teaching with Scratch than MIT App Inventor**



*n* = 191

Source: Cohort 3 baseline teacher survey, 2020

## ICT instruction prior to CoolThink@JC

Commensurate with the teaching assignments described above, many CoolThink teachers who had taught ICT courses in the past reported prior experience with instructional activities that are typically employed in coding instruction ([Exhibit 14](#)). For example, activities that were “often” or “always”

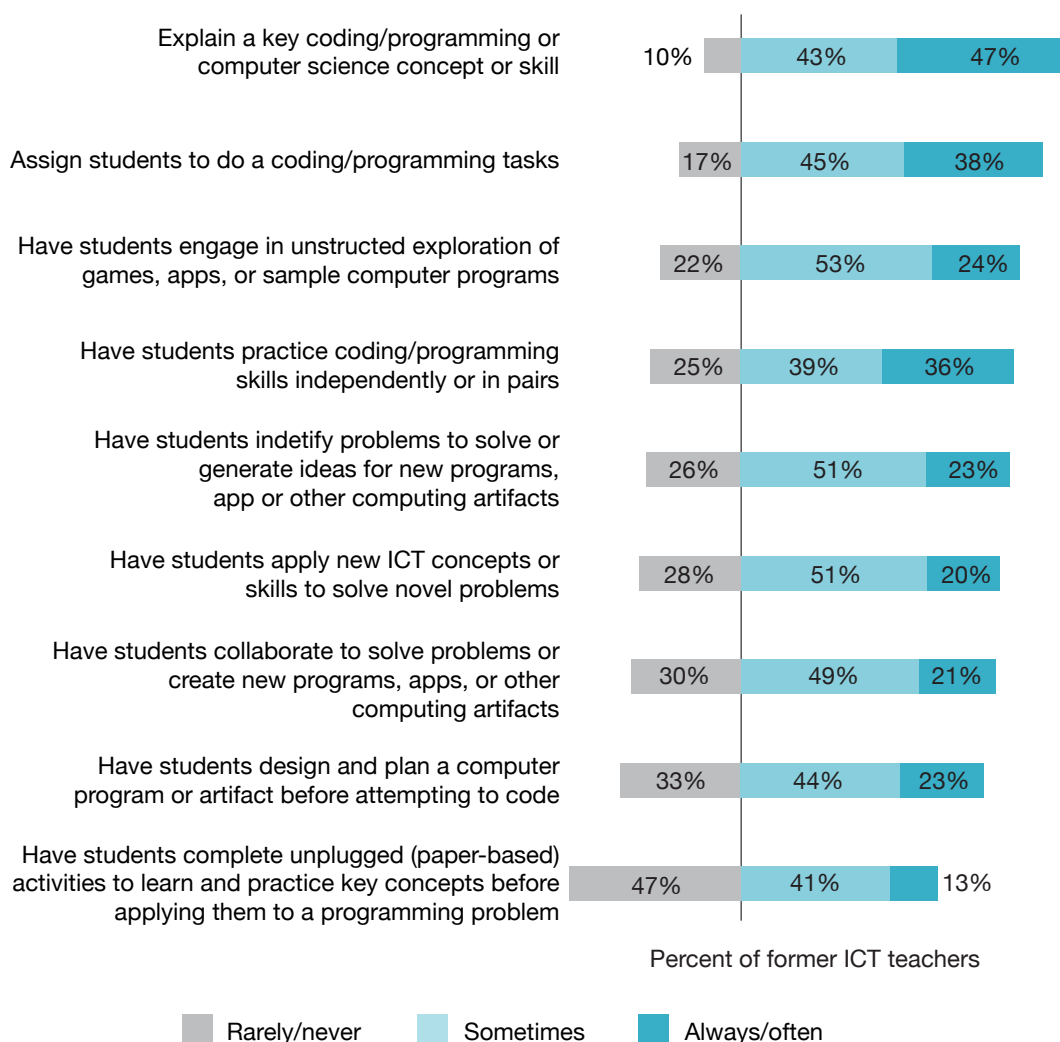
used as part of prior ICT instruction included explaining a key coding or CS concept or skill (47% of teachers), assigning students to programming tasks (38%), and having students practice programming individually or in pairs (36%).

However, CoolThink@JC's emphasis on active student problem-solving requires a range of instructional activities that fewer teachers have used in the past. For example, many previous ICT teachers reported that they "rarely" or "never" asked their students to engage in unplugged activities (47%), plan and design a computer program before coding it (33%), collaborate for problem solving (30%), or apply ICT skills to solve

novel problems (28%). These more "CoolThink-like" instructional activities were more likely to have been used among experienced ICT teachers who had also previously taught a STEM discipline (math or science) than those who came from a non-STEM discipline. This suggests that as teachers adopt CoolThink@JC, their disciplinary background may affect their learning curve not only for content but also for pedagogy.

#### Exhibit 14. Some hallmarks of CoolThink instruction will be new to teachers

*Frequency of instructional practices employed by teachers in ICT lessons*



*n* = 88

Note: This item was presented to the 45% of teachers who reported that ICT was one of their primary subjects during the baseline year.

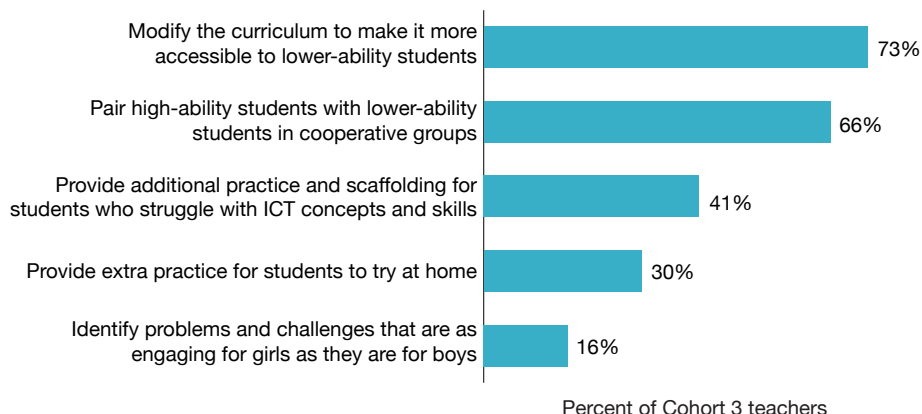
Source: Cohort 3 baseline teacher survey, 2020



One of CoolThink@JC's main priorities for the initiative is equity: Sponsors have a goal of making computational learning activities accessible to all students. Achieving this goal will rely in part on teachers' ability to engage students with differing learning needs or backgrounds. Many teachers reported that they already had a certain degree of experience with a variety of strategies toward adapting their instruction for students with different needs ([Exhibit 15](#)). Common strategies included modifying the curriculum to make it more accessible to lower-ability students (73%), pairing high-ability and low-ability students in cooperative groups (66%), and providing extra scaffolding

and practice for students who struggle with ICT concepts and skills (41%). Only 16% of teachers have previously used strategies to engage girls as well as boys; since previous research has found gender differences in student outcomes in the CoolThink@JC pilot (Shear et al., 2020), this may be an important focus for teacher PD. Teachers who previously taught STEM (math or science), or both ICT and STEM, as their primary subjects reported greater familiarity with these strategies to engage diverse learners, which again suggests that the prior discipline taught may shape teacher learning curves during initial CoolThink@JC adoption.

**Exhibit 15. Teachers report a variety of experience using strategies to engage diverse learners**



*n* = 193

Source: Cohort 3 baseline teacher survey, 2020

Given that CoolThink@JC is a novel instructional initiative in Hong Kong, its content is relatively new for most teachers. At the beginning of the school year, 28% of teachers said they were “confident” or “extremely confident” about computational thinking (CT) concepts, while just 18% selected these ratings for CT practices and 16% for (CT) perspectives. Teachers’ relatively low ratings of their own confidence in teaching CTE held for the experienced ICT teachers as well as for teachers

who were new to the subject.<sup>3</sup> The fact that a majority of experienced teachers expressed some hesitation in teaching CT concepts, practices, and perspectives reflects the novelty of CoolThink@JC compared with other existing ICT curricula. Teachers’ somewhat higher initial confidence in CT concepts may reflect the fact that CT practices and CT perspectives are unique areas of emphasis in CoolThink instruction relative to other ICT curricula that teachers may have used before.

<sup>3</sup> The 24% of teachers who were teaching ICT for the first time during the baseline year were slightly less likely to report that they were “confident” or “extremely confident” teaching CT. These ratings were low for all teachers, not only first-year ICT teachers.

# EARLY ADOPTION OF COOLTHINK LESSONS

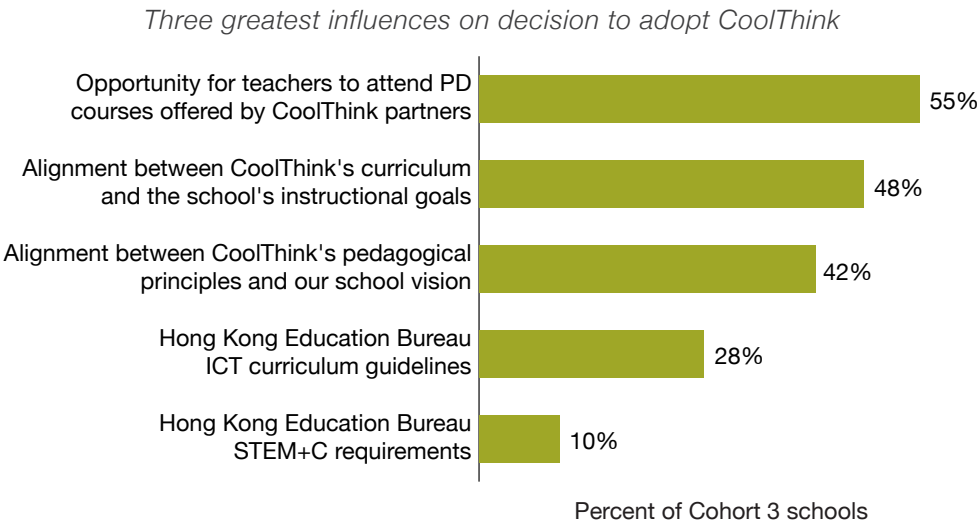
This section explores schools' adoption decisions and early engagement with the initiative, using reports from school leader and teacher surveys early in Cohort 3 schools' first year teaching CoolThink@JC. Surveys were administered from November 2020 to January 2021 when school conditions were unstable due to the changing pandemic situation. Nevertheless, responses from school staff still provide an overview of CoolThink adoption and early engagement during this time.

## Decision to adopt

An important requirement of successful scaling is that a large number of schools choose to adopt the innovation. On the school leader survey, Cohort

3 school leaders were asked to select the three greatest influences for their decision to adopt CoolThink@JC. Adoption decisions were mainly based on CoolThink@JC's PD course offerings (56%) and the fit of its curriculum and pedagogical principles with the school's goals (48% and 43% respectively) ([Exhibit 16](#)). The decision was only somewhat influenced by the Hong Kong Education Bureau's ICT curriculum guidelines (28%) and requirements (10%). This result suggests that CoolThink's features, such as extensive professional learning opportunities, are anticipated by school leaders as comparing favorably to other ICT offerings and may suggest an intention to implement the program in ways that are consistent with its designs.

Exhibit 16. CoolThink adoption was based on its own features more than national guidelines



*n* = 37

Source: Cohort 3 baseline school leader survey, 2020

Note: The following categories are omitted from the graph: school sponsoring body guidelines or recommendations (22%), testimonials from other schools that have used CoolThink@JC (22%), teacher's own review of CoolThink curriculum materials (5%), opportunity to share resources with other CoolThink schools and teachers (30%), access to CoolThink mentor teachers (12%), and opportunity for teachers to become CoolThink mentor teachers (2%).

## An early glimpse of CoolThink instruction

The 2020–21 school year began with a great deal of uncertainty, with expectations of schedule changes and periods of online learning due to COVID-19. To help navigate these challenges, early in the year the CoolThink@JC team offered a variety of support to teachers, students, schools, and families for online as well as face-to-face learning. These included online resources such as animated videos of CoolThink topics and online parent-child workshops where parents and children can create games together, detailed presentations and seminars for teachers on how to teach CoolThink@JC interactively both online and face-to-face, and back-to-school support before schools opened in August.

Despite the unstable conditions, CoolThink@JC was widely adopted in Cohort 3 schools in their first year.

The vast majority of school leaders reported that their schools were teaching CoolThink lessons at the time of the survey.

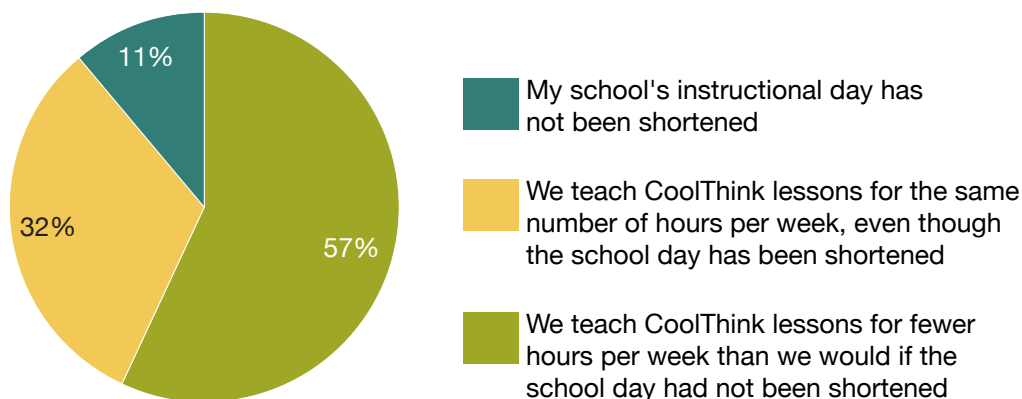
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**88%** School leaders who reported that their schools were teaching CoolThink lessons at the time of survey administration

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However, the majority of schools were teaching CoolThink lessons for fewer hours because of a shortened school day ([Exhibit 17](#)). Among 37 school leaders who said their schools were offering CoolThink@JC at the time of the survey, 57% reported that they taught CoolThink lessons for fewer hours per week because of a shortened school day, while 32% reported that they had found a way to teach CoolThink@JC for the same number of hours per week despite the shortened school day.

Exhibit 17. More than half of schools that offered CoolThink lessons were teaching them for fewer hours



Percent of Cohort 3 schools

$n = 37$

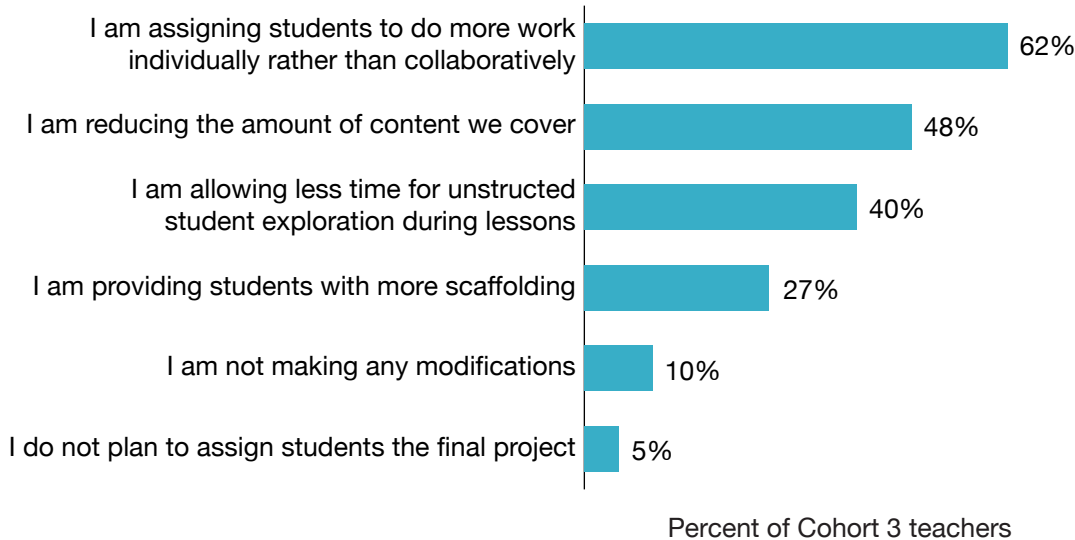
Source: Cohort 3 baseline school leader survey, 2020

To address the shortened instructional time, the majority of schools and teachers were making modifications to CoolThink lessons. In 21 schools where CT lessons were taught for fewer hours, 81% of school leaders reported that teachers were streamlining the content or modifying the learning activities to be more time-efficient ([Exhibit 18](#)).

This practice of streamlining and modifying lessons was consistently reported in the teacher survey. Among teachers who taught CoolThink@JC for fewer hours, strategies included assigning students to do

more work individually rather than collaboratively (62%), reducing the amount of content covered (48%), allowing less time for unstructured student exploration during lessons (39%), and providing students with more scaffolding (27%). These efficiency-driven practices to make use of limited time may compromise students' opportunities for open-ended exploration, collaboration, and problem-solving activities that are essential components of CoolThink@JC.

Exhibit 18. 90% of teachers modified CoolThink lessons to adapt to shortened instruction time



*n* = 131

Source: Cohort 3 baseline teacher survey, 2020

In addition to CoolThink@JC, the majority (59%) of school leaders reported that their schools still offer ICT topics not covered by CoolThink@JC in the current year, such as network infrastructure, enterprise software, or cybersecurity. These additional offerings reflect the overall commitment of these schools to well-rounded ICT instruction but also have the potential to put additional pressure on the school schedule for ICT.

## Early participation in CoolThink professional development

Strong and intensive professional development (PD) is a hallmark of CoolThink@JC's package. Beginning in the first year of a school's CoolThink@JC adoption, each teacher has access to a total of four courses that introduce both the CoolThink lesson materials and the pedagogical knowledge and pedagogies that are

essential to a CoolThink classroom. In the modular design of this program each course includes 12 hours of instruction (delivered as two 6-hour workshops), with the space of a month in between the two sessions to allow for classroom experimentation and reflection.

Given that school leaders mentioned the opportunity to participate in CoolThink@JC's PD offerings as the top driver of their participation in the initiative, it is not surprising that the actual initial attendance for CoolThink teacher development courses was very high. Our survey sample consisted of teachers who had registered for Course 1, Understanding CTE and Scratch Programming, and 100% of these teachers reported attending the course by March 2021. Initiative leaders believe that this number is very close to the full number of Cohort 3 CoolThink teachers in 2020-21. The vast majority of teachers who attended Course 1 (78%) had also attended or registered for Course 2, Understanding CTE and MIT App Inventor Programming. The high participation rate was enabled by the necessity of conducting trainings virtually in 2020-21 since it opened unlimited seats and may have been more accessible for some teachers.

Most teachers who responded to the Course 1 end-of-course survey (n = 176) agreed that the professional development provided was relevant to their teaching needs (87%), and provided them with relevant resources to use while teaching CoolThink@JC (85%). Three-quarters of teachers felt they received enough hands-on experience during the PD to feel ready to use the CoolThink curriculum with their students and adapt the lessons to the needs of their diverse students. A majority of teachers reported that the PD helped deepen their understanding of programming (78%) and computational thinking (86%), but fewer teachers (66%) believed that they had a

deeper understanding of the difference between programming and computational thinking due to the PD received, although supporting computational thinking and not just programming is an essential goal of CoolThink instruction. Similarly, 81% teachers reported that the PD made them feel confident in teaching students how to code, while fewer teachers (64%) reported feeling confident in helping students design a computer program to solve a real-world problem (that is, engage in computational thinking). After attending the PD, about 75% of teachers felt confident about helping their students develop a computational identity and sense of digital empowerment.



In addition to CoolThink teacher development courses, CoolThink partners made significant progress developing an array of PD opportunities for upper primary teachers from schools outside of the CoolThink@JC network. For example, between October 2020 and March 2021, EDB engaged CoolThink InnoCommunity teachers to offer six workshops through the EDB PD catalog on teaching computational thinking skills to upper primary students. Most of these workshops were tailored for teachers of specific subjects, including mathematics, English, general studies, and STEM (see box for workshop titles). Across multiple sessions, each of these 3-hour EDB workshops enrolled between 15 and 89 teachers between October and March, meaning that they approached the scale of the CoolThink teacher development courses in terms of numbers of teachers served, although they were not as intensive in terms of time. Teachers gave EDB workshops offered by InnoCommunity teachers very high ratings on exit surveys, with average ratings above 4.0 on a five-point scale on all items.

In addition, a smaller number of teachers attended four workshops offered by CoolThink InnoCommunity teachers to out-of-network schools, separate from those sponsored by the EDB. These 2-session workshops were on the topics of teaching CTE using Scratch (beginner level) and teaching CTE using App Inventor, and each enrolled between 9 and 14 teachers per session. On exit surveys, teachers gave InnoCommunity workshops, especially workshops on Scratch, slightly higher ratings than the CoolThink teacher development

### EDB workshops offered by InnoCommunity teachers

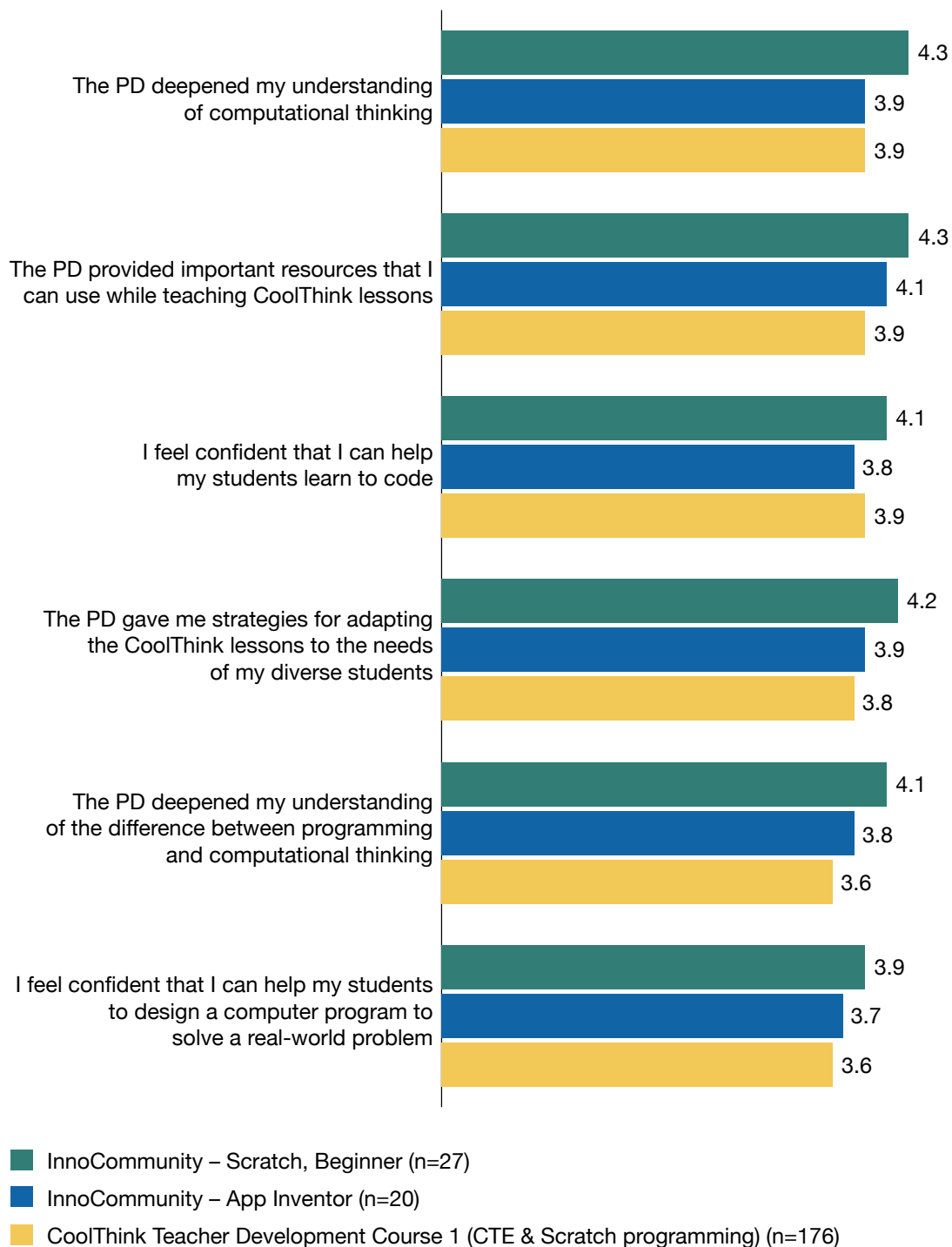
- STEM Education Learning, Teaching and Assessment Series: Using App Inventor to Develop Computational Thinking Among Upper Primary Students
- STEM Education Learning, Teaching and Assessment Series: Advanced Workshop on Implementing Coding Education to Develop Upper Primary Students' Computational Thinking (General Studies)
- Implementing Coding Education to Develop Upper Primary Students' Computational Thinking (Mathematics)
- Implementing Coding Education to Develop Upper Primary School Students' Computational Thinking (English Language Subject)
- Implementing Coding Education to Develop Upper Primary School Students' Computational Thinking (General Studies)
- Using App Inventor to Develop Computational Thinking among Upper Primary Students

courses ([Exhibit 19](#)). However, these differences were not large enough to be substantively significant, and teachers may have had higher expectations for the teacher development courses, which spanned 12 hours, compared with 3 hours required for InnoCommunity workshops.



Exhibit 19. InnoCommunity workshops on teaching CTE with Scratch received slightly higher ratings from teachers than other PD offerings

*Extent to which teachers agree with statements about the relevance and usefulness of PD*



*Note: Teachers rated their agreement with each statement on a 5-point scale, where 1 = “Strongly disagree” and 5 = “Strongly agree.”*

*Source: CoolThink PD exit surveys, 2020–21.*

# SUMMARY AND CONCLUSIONS

After a successful 32-school pilot, CoolThink@JC has begun a 4-year initiative to scale its computational thinking (CT) lessons to 168 additional primary schools in Hong Kong, with additional dissemination activities both territory-wide and internationally. Through these efforts, the CoolThink@JC program aims to bring hands-on, minds-on, and joyful computational thinking education (CTE) to a large number of students both within and beyond Hong Kong and establish a self-sustaining ecosystem to sustain these opportunities into the future. At baseline, this report paints a picture of the context into which this scaling effort is being introduced. Following an implementation model developed at the inception of the initiative ([Appendix A](#)), we describe factors at the system, school, and classroom levels that may influence the character of adoption going forward and the strategies that the CoolThink@JC team may wish to adopt to promote strong outcomes.

The initiative began with a framework of five components, as referenced in the implementation model. Of these five, baseline conditions at the schools speak most directly to components A (Critical Mass of Adoption) and B (Sector Capacity Building). Implications of the baseline data for the broader-scale adoption of CoolThink@JC in each of these areas include the following:

## *Component A: Critical Mass of Adoption*

- Building critical mass depends substantially on school-level decisions to join the growing CoolThink@JC community and adopt the lessons. For Cohort 3, school leaders point to PD resources as the most important driver of their decision to adopt CoolThink@JC: much more so than policies or guidance developed by the EDB and/or SSBs. This early recognition among

school leaders of the value and uniqueness of CoolThink@JC's PD resources is a strong positive for the initiative. To achieve system goals for rollout, it will also be important to continue to work towards strong alignment with EDB guidelines and to communicate clearly about that alignment to broaden motivations for adoption.

- Another important aspect of the adoption component is adoption with integrity: ensuring that CoolThink classrooms are aligned with CoolThink@JC's instructional vision to increase expectations that student outcomes at scale will replicate earlier successes. In this first year of implementation at scale, instructional time for CoolThink@JC was lost due to COVID-19-related school closures and schedule changes. In turn, this led teachers to make modifications that stressed efficiencies over some of the important goals of the initiative (for example, student exploration, creativity, and teamwork). In addition to predicted sacrifices of coverage that will need to be adjusted for as some students move to the next level of content in the coming year, it will be important for the CoolThink@JC team to work with teachers to make sure these instructional elements are re-emphasized once classes are back to a new normal.
- CoolThink@JC's goals of equity have two dimensions: ensuring that students from less advantaged backgrounds have the opportunity to enroll in CoolThink classes and making those classes accessible for all students. Programmatically, the CoolThink@JC team is recruiting schools to meet the first condition. The second condition requires that teachers be prepared with the skills to engage students with a variety of abilities and make the content

accessible to all. Baseline data show that some teachers—particularly those that have experience in STEM disciplines—have some initial experience using particular strategies to support students with different academic needs. It will be important for professional learning to focus explicitly on equity as it relates to computational thinking and to offer effective strategies and coaching to ensure that opportunities for exploration and problem solving are made accessible for all students, rather than left out for students who are deemed not ready.

### *Component B: Sector Capacity Building*

- Several pieces of evidence point to a picture of the Cohort 3 schools as having strong existing capacity related to ICT instruction. Prior instruction in ICT was extensive in these schools, both in the percentage of schools that already had ICT classes and in the hours they were, on average, able to allocate in the curriculum. The high priority afforded to ICT instruction in these schools suggests fertile ground for CoolThink@JC as it is initiated.
- At the same time, several factors point to the potential for conflicting priorities. Many of these schools report that they are continuing to teach ICT subjects, such as cybersecurity, outside the CoolThink curriculum. In addition, many of the recruited teachers taught multiple subjects at multiple grade levels at baseline; each of these subjects presumably places demands on teachers' time to attend ongoing PD and to collaborate with colleagues and peers from other schools. This may have implications for sustainability in the coming years, as schools and teachers continue to evolve their offerings. It will be important to pay attention to the school-level balance of the scarce resources of instructional time as well as teachers' time outside of the classroom.
- Teachers bring substantially more experience teaching with Scratch than with MIT App Inventor, as it is a more common tool in primary grades. The

team is already supplementing existing CoolThink teacher development offerings with programming language-specific workshops, which may be even more important in the coming year. When they take up App Inventor, teachers may also need additional support for instructional integration and pedagogical methods appropriate to that language.

- Teachers come from a wide range of disciplinary backgrounds, including some from outside STEM fields. Those who teach humanities subjects may have a higher learning curve as they take on new ICT instructional assignments and may bring different approaches to their teaching of CoolThink@JC. The CoolThink@JC team would do well to attend to these unique experiences as they consider tailored coaching needs and opportunities for a diversely talented population of teachers.
- Thanks in part to the online format of teacher development this year, all Cohort 3 CoolThink teachers have had the opportunity to participate in the teacher development courses offered by EdUHK. Because of the newness of many aspects of the CoolThink@JC model of student-centered instruction, and the later addition of new teachers, it will be important to have strong mechanisms for ongoing learning and sharing. The CoolThink@JC team is currently facilitating communities of practice at the cluster level which may need to be reinforced within each school to enable day-to-day adoption of new practices.

At the time of baseline data collection, the implementation of CoolThink@JC at scale was at its inception. The issues highlighted in this report are among a great many factors that will shape its adoption in schools and classrooms and its role in the larger system of CTE in Hong Kong. As this study continues, future reports will describe this progress, the experience of participants, and emerging models for the successful wide-scale adoption of CTE for primary-age students.

# REFERENCES

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- Shear, L., Wang, H., Tate, C., Basu, S., Laguarda, K. (February 2020). CoolThink@JC Evaluation: Endline Report. Menlo Park, CA: SRI International.
- Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, 49(3), 33-35.

# APPENDIX A: COOLTHINK@JC IMPLEMENTATION MODEL

Exhibit A-1: Implementation Outcomes and CoolThink@JC Components

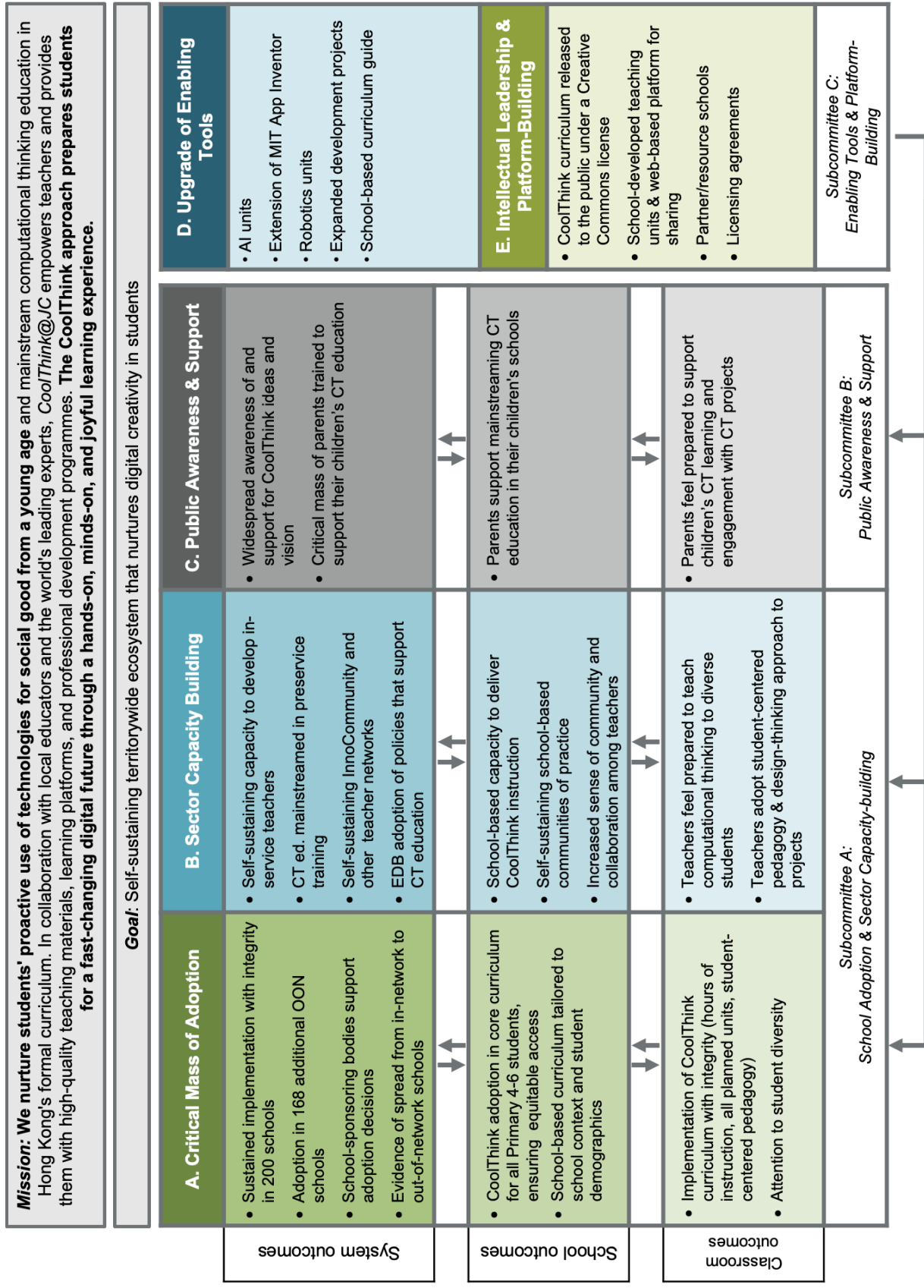


Exhibit A-2. Classroom-Level Implementation Model

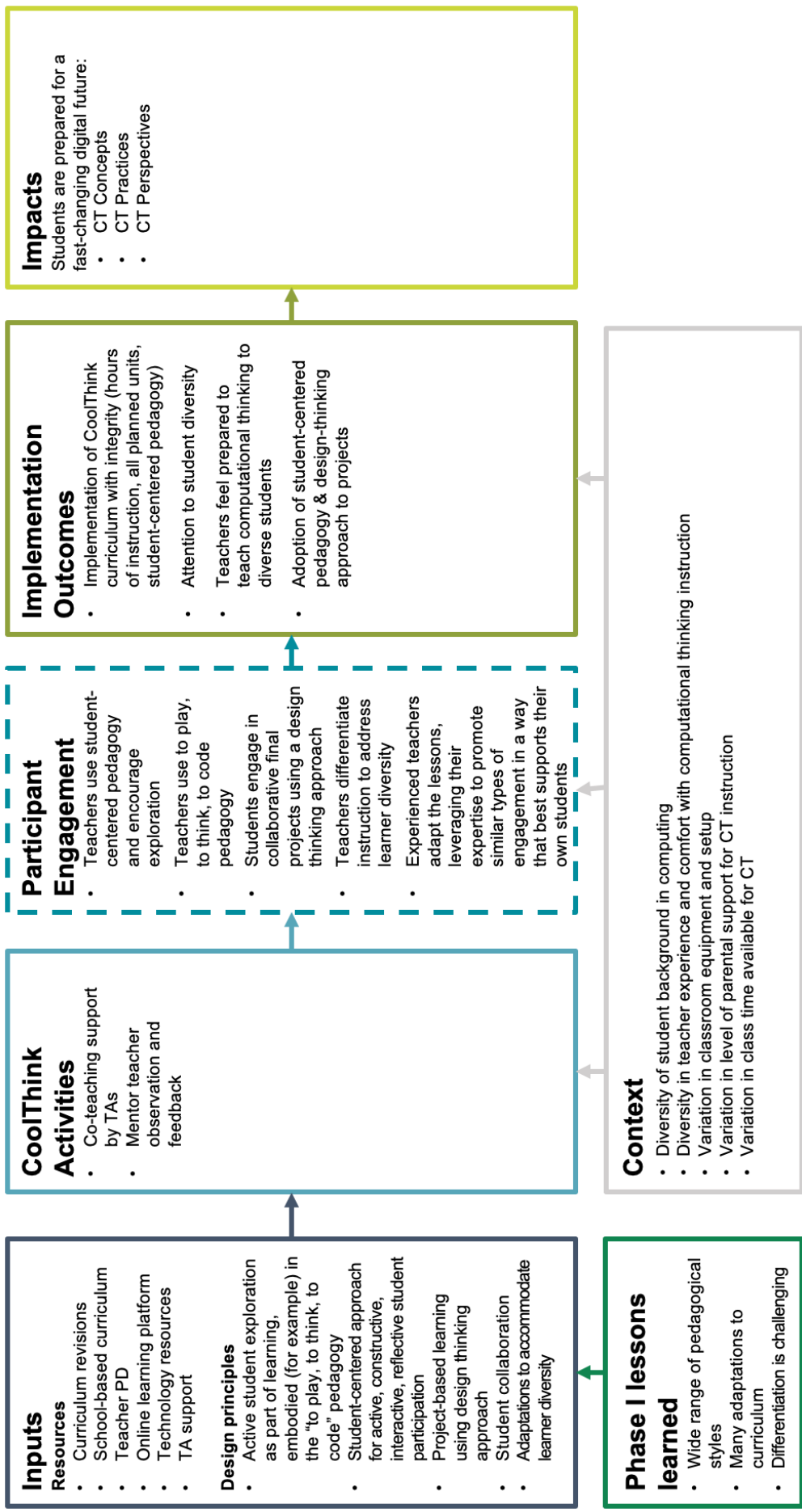




Exhibit A-3. School-Level Implementation Model

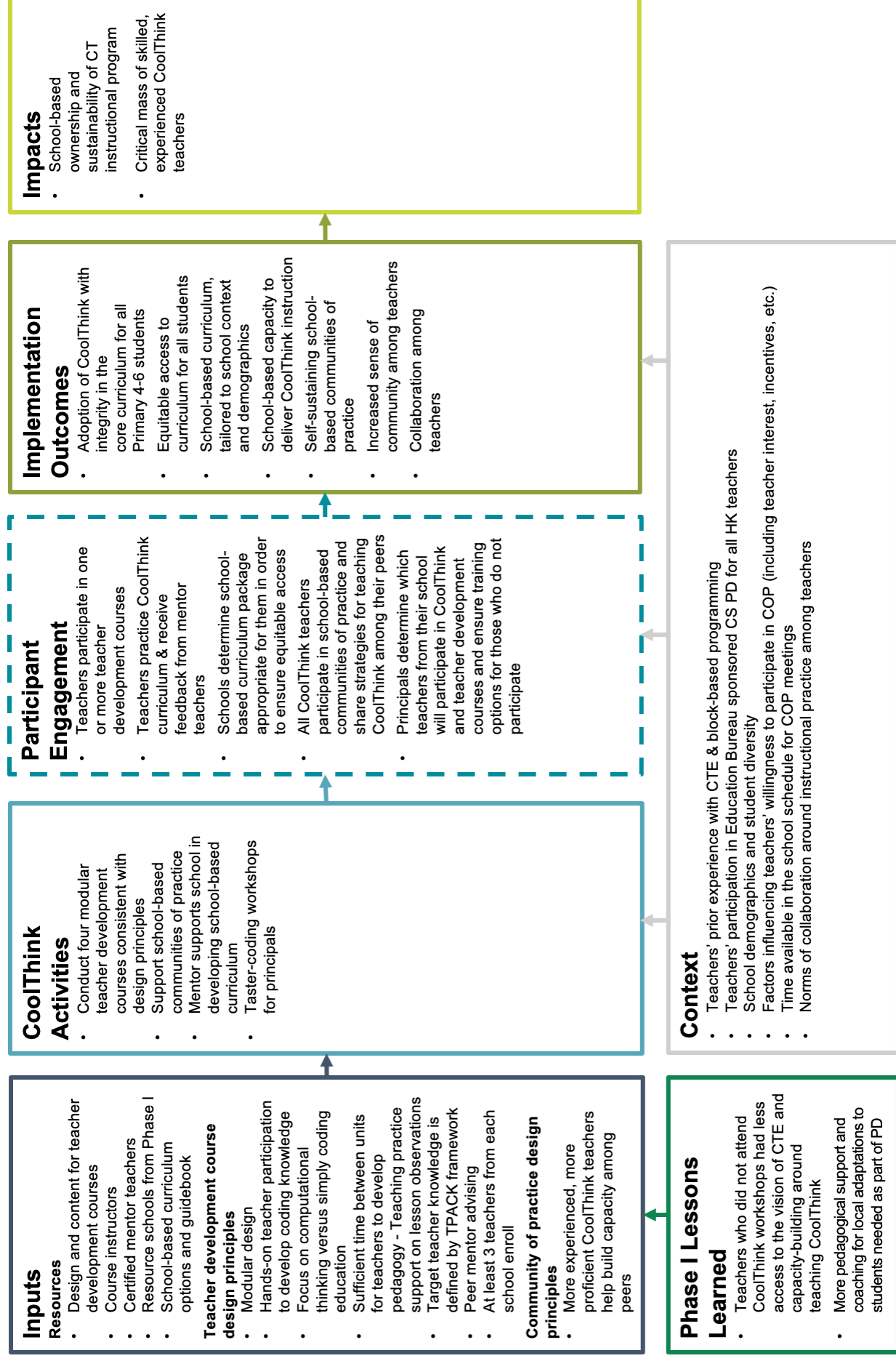
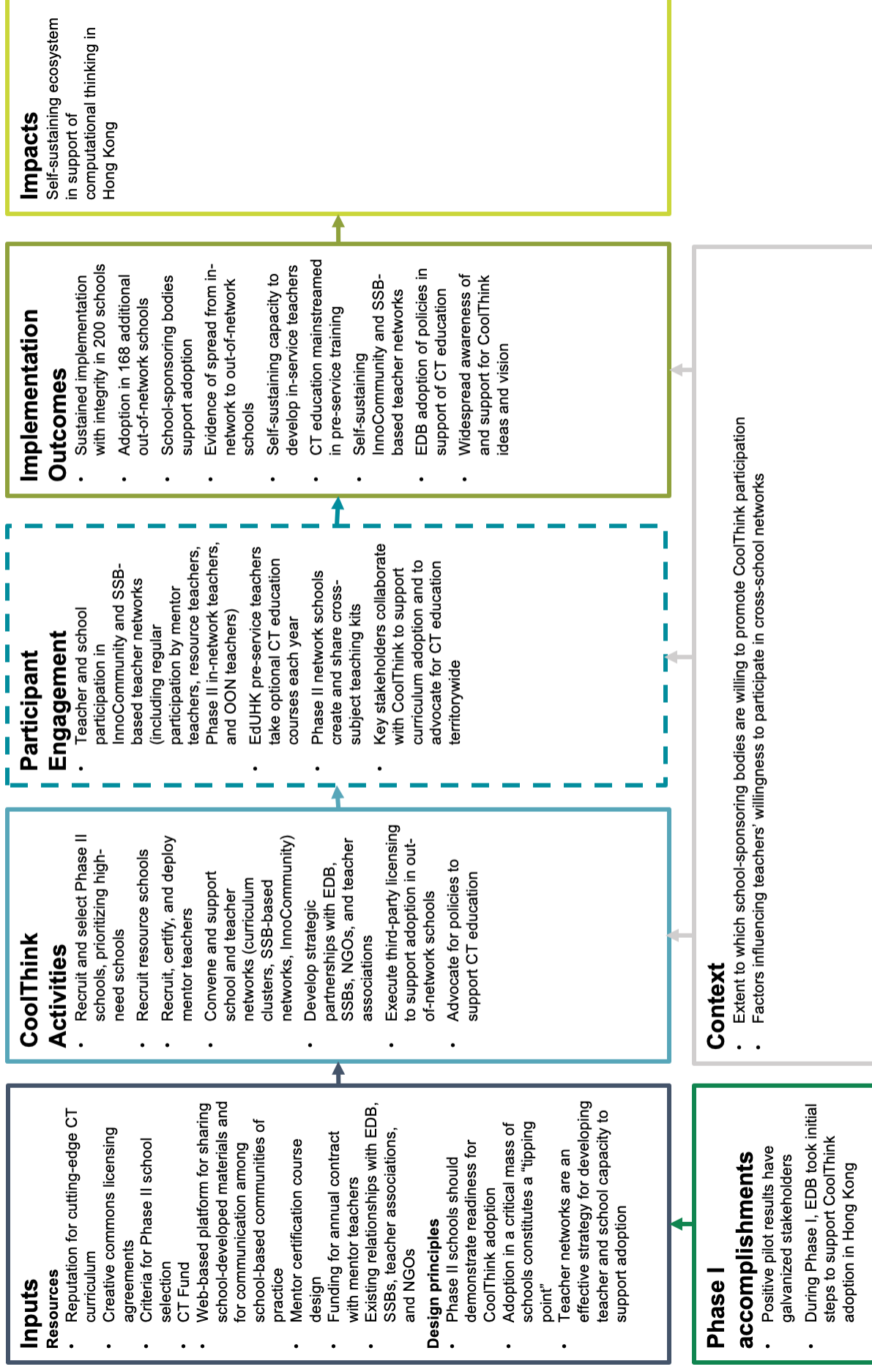


Exhibit A-4. System-Level Implementation Model



# APPENDIX B: IMPLEMENTATION STUDY DATA SOURCES AND TIMELINE

With the exception of out-of-network surveys, which will be administered just once to school leaders at baseline and then once to teachers in the third year of the initiative, all data sources for the implementation study will be collected annually, in the 2020–21, 2021–22, 2022–23, and 2023–24 school years.

- **Teacher and school leader surveys.** Surveys are administered to all CoolThink teachers and school leaders at baseline (before schools begin teaching CoolThink@JC) and again at the end of each of the four years of the initiative.
- **Classroom logs.** A sample of up to five CoolThink teachers in each school will log five CoolThink lessons annually, documenting the instructional activities and key pedagogies employed in each lesson.
- **School visits.** Site visits to a purposeful sample of 12 schools each year will include interviews with CoolThink teachers and school leaders, classroom observations, student focus groups, and interviews with mentor teachers.
- **Professional development observations.** Observations of a purposeful sample of CoolThink teacher development course sessions, EDB workshops, and other PD sessions offered by CoolThink InnoCommunity teachers will document the variation in PD offerings provided by various CoolThink partners.
- **Out-of-network (OON) surveys.** School leaders at all Hong Kong public sector primary schools were surveyed at baseline, to document existing CTE practices and adoption of ICT curriculum materials in primary schools across the territory. This baseline OON survey sample provides an important comparison point for CoolThink schools before the initiative began. In the third year of the initiative, ICT teachers at the same OON schools, serving as a comparison group for CoolThink teachers after several years of implementation.
- **System-level interviews.** Interviews with key systems-level actors at EDB, SSBs, and NGOs will describe those aspects of the system-level context with the greatest influence on schools' capacity to implement and sustain CoolThink@JC. Interviews will also assess how stakeholders view the initiative's progress, what they conclude about lessons learned and relevance for their own work, and specific actions taken as a result, in order to identify any impacts of CoolThink@JC beyond the participating schools and classrooms.

Exhibit B-1 describes the timelines of these various data collections along with the number of schools included at each data collection timepoint. The exhibit begins with a look at CoolThink implementation across the years for each cohort of schools. According to the phased rollout plans for CoolThink, each successive cohort will begin adoption in a different year, beginning with Cohort 3 in 2020–21. As a result, as the figure describes, at the time of any given data collection schools in different cohorts will be at different stages of CoolThink adoption.

Exhibit B-1. CoolThink Cohorts and Implementation Study Data Collection Timeline

	Implementation Year			
	2020-21	2021-22	2022-23	2023-24
	1st term	2nd term	2nd term	1st term
Cohort 1 (12 schools)		Year 7		
Cohort 2 (20 schools)		Year 6		
Cohort 3 (47 schools)	Baseline	Year 2	Year 3	
Cohort 4 (54 schools)	CoolThink Year 1	CoolThink Year 1	Year 2	
Cohort 5 (TBD, ~50)	Baseline	Baseline	CoolThink Year 1	
Cohort 6 (TBD, ~17)			Baseline	CoolThink Year 1
School Sample				
Teacher & School Leader Surveys				
Cohort 1		12		
Cohort 2		20		
Cohort 3	47	47	47	
Cohort 4		54	54	
Cohort 5		50	50	
Classroom Logs	47	60	60	
PD Exit Surveys	47	101	151	
Site Visits	12	12	12	
PD Observations	TBD	TBD	TBD	
OON SL Surveys	341		341**	
OON T Surveys			✓	
Systems Interviews	✓	✓	✓	✓

\*teacher only

\*\*this number will be reduced to exclude cohort 4-6 schools

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