Learning and Assessment for
DIGITAL CITIZENSHIP

# Hong Kong Students' Digital Citizenship Development

## Initial Findings

Hong Kong
April 2020

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This publication is a report published by the Learning and Assessment for Digital Citizenship (e-Citizenship) Project, which is funded by the Research Grants Council of the Hong Kong Special Administrative Region, China, under its Theme-based Research Scheme [Project No. T44-707/16-N] and jointly conducted by researchers from The University of Hong Kong and The Hong Kong University of Science and Technology. The preparation of this report was overseen by the Project Coordinator, Nancy Law.

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## Website

Please visit the following website for more information about the project and current events: https://ecitizen.hk.

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# Foreword

The research project "Learning and Assessment for Digital Citizenship" (or eCitizenship for short) started in November 2016 with the aim of understanding the development of children and youth in a highly connected world wherein exposure to digital technology and social media are pervasive. In particular, we investigate their ability to live, learn, participate and achieve well-being, and how different family, school and social factors influence the development of these abilities among children and youth. This five-year longitudinal project includes four age cohorts at primary, secondary and tertiary education levels. The project brings together an interdisciplinary team of local researchers from The University of Hong Kong and from The Hong Kong University of Science and Technology as well as international experts, from the fields of education, human development, humanities, information science and computer engineering. This is the first education-focused project awarded under the Theme-based Research Scheme of the Research Grants Council of Hong Kong, an indication of the importance of this research.

This publication reports results from the assessments and surveys of the first round of data collection that was conducted in primary and secondary schools during the 2018/2019 academic year. During the 2020/2021 academic year, the eCitizenship project will augment the data reported in this publication with another round of data collection with the same students to facilitate understanding of their development as digital citizens. There are also more elements to the eCitizenship project than the assessment and survey components in this report, such as online collaborative problem-solving games and enhancing students' self-regulation and planning through self-tracking. Interested readers can find additional information about the project and research findings to-date on the eCitizenship project website (https://ecitizen.hk) and the video of our presentation at the Learning and Teaching Expo 2019 (https://www.hkedcity.net/goelearning/en/resource/5e15a3320da87e2242adf7c6).

It would not have been possible to conduct the studies that led to the findings reported here without the dedication and support from various groups and individuals. In particular, I would like to thank all the schools, teachers and students who have given their time to participate in this study. I would further like to acknowledge the invaluable support provided by the eCitizenship Advisory Committee, the Centre for Information Technology in Education at The University of Hong Kong, and Policy 21, all of whom helped us with advice and with support in reaching out to the sampled schools. Also, I would like to express my gratitude to Mr Zhengliang Sun and Miss Huanhuan Yin for the translation assistance she rendered, and to the members of the research team who contributed to the project at various stages of this project.

**Prof. Nancy Law** (Project Coordinator and Principal Investigator)
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The e-Citizenship team also comprises several PhD students and part-time student helpers who have made valuable contributions to the project.

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# 1. Introduction

Citizenship has traditionally been defined by membership of geopolitical entities such as nation states, and with rights and responsibilities as the common denominator of citizenship. The escalating speed of technological development points to the need to broaden the traditional definition of citizenship. Access to information and communication technology (ICT) has impacted our society in fundamental ways, bringing both opportunities and challenges, and has had marked influences on the well-being of children and youth who grow up in this digital era. People engage not only in physical and face-to-face interactions, but also increasingly via virtual spaces and communities mediated by digital communication tools. It is therefore unsurprising that interest in the notion of "digital citizenship" has burgeoned in recent years. It is in this context that the project "Learning and Assessment for Digital Citizenship" (eCitizenship for short) targets the grand challenge of understanding and improving the development of digital citizenship as a multifaceted human capacity within the varied educational, social, cultural and technological contexts in Hong Kong.

Ribble (2015, p.15) defines digital citizenship as "the norms of appropriate, responsible behavior with regard to technology use". He identified nine general areas of competence related to digital human activities: digital access, digital commerce, digital literacy, digital communication, digital etiquette, digital rights and responsibility, digital law, digital security, and digital health and wellness. On the other hand, Mossberger, Tolbert, and McNeal (2008, p.1) focus on the social participation aspect and define digital citizenship as "the ability to participate in society online". In a policy review published by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2016, p.15), digital citizenship is defined as the ability "to find, access, use and create information effectively; engage with other users and with content in an active, critical, sensitive and ethical manner; and navigate the online and ICT environment safely and responsibly, while being aware of one's own rights." Although these few examples illustrate differences in the scope of digital citizenship, the capacity to use digital technology safely, responsibly, and ethically is commonly considered as a core element in school curricula related to digital citizenship (Law, Chow, & Fu, 2018).

## 1.1. Study purpose

A major goal of the eCitizenship project is to understand how key aspects of digital citizenship develop from childhood to early adulthood and how contexts, such as school and home factors contribute to this development, through longitudinal cohort studies. Here, digital citizenship is conceptualized as comprising digital competences, well-being, and the awareness of and responsibility to engage and participate in the globally networked world.

## 1.2. Study design

The project adopts a cross-cohort longitudinal design (see Figure 1) to examine performance differences among students in three different age cohorts, including one cohort of primary school students (**Cohort 1: Primary 3** [P3]) and two cohorts of secondary students (**Cohort 2: Secondary 1** [S1], and **Cohort 3: Secondary 3** [S3]) in Hong Kong. Students of all three cohorts were tested in the 2018/19 school year (pretest), and the same students will be tested again two years later in the 2020/21 school year (posttest). Such a study design is suitable to observe intra-individual development of digital citizenship (longitudinal component) and to

understand inter-individual differences in students' digital citizenship across different age cohorts (cross-cohort component).

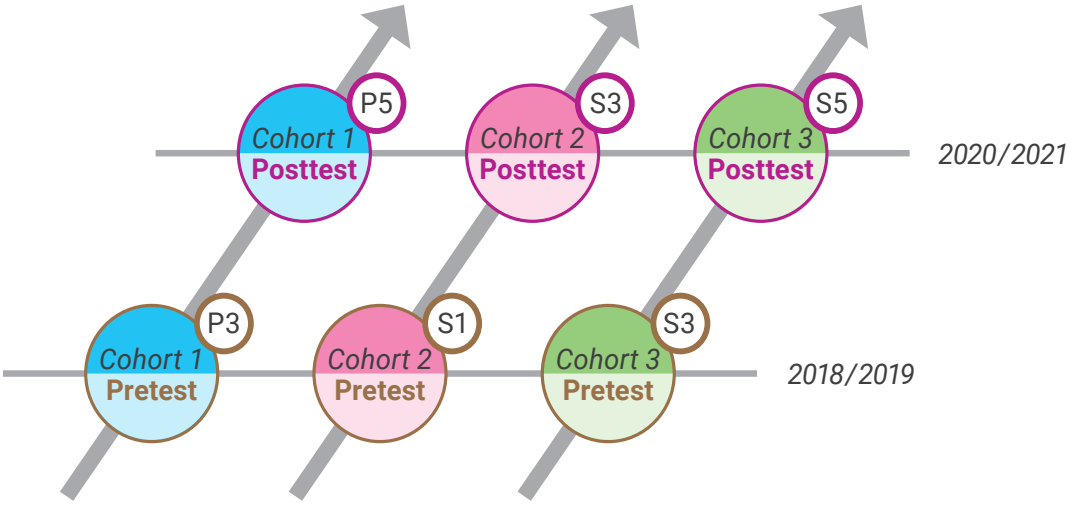


*Figure 1.* The Longitudinal Cross-cohort Study Design of the "eCitizenship" Project.

The current report focusses on cross-cohort differences in students' digital citizenship competence and other measures using data from the first wave data collection conducted in the 2018/2019 school year. Specifically, assessment data were collected to capture digital literacy and collaborative problem solving as crucial digital competences. Supplementary data were collected through online questionnaires to learn about students' digital access and usage, their digital health, online risks and digital safety, as well as their digital self-efficacy and civic engagement. Additional data were also gathered from teachers and principals, because school factors can influence students' digital citizenship development.

## 1.3. Sample

The sampling design used stratified random sampling with districts selected based on geography and socioeconomic status. For the current project, four districts were randomly selected: North (New Territories East Region), Tuen Mun (New Territories West Region), Sham Shui Po (Kowloon Region) and Wan Chai (Hong Kong Region). A few replacement schools that are not located in one of these four districts also participated in the study. In most of these schools, students from two classes of each cohort—either Primary 3 or Secondary 1 and Secondary 3 (at the same school)—were randomly selected to participate in the study. A total of 18 primary schools and 14 secondary schools took part in the study, with over 2,000 students completing the assessment and/or survey (Table 1). In addition, more than half of the teachers and principals of the sampled students responded to short questionnaires.

Table 1
*Number of Participating Schools, Classes, Students, Teachers and Principals*

| | | | Responses | | | | |
|---|---|---|---|---|---|---|---|
| Cohort | Schools | Classes | DLA | CPS | SVY | Teachers | Principals |
| Primary 3 | 18 | 39 | 750 | - | 736 | 169 | 9 |
| Secondary 1 | 14 | 27 | 715 | 705 | 711 | 88 | 9 |
| Secondary 3 | | 29 | 581 | 593 | 581 | 104 | |

*Note.* DLA = assessment of digital literacy, CPS = assessment of collaborative problem solving, SVY = student survey questionnaire.

# 2. Students' digital literacy performance

Sampled students completed an assessment designed to measure their digital literacy (DL), which is a crucial capacity for handling everyday tasks and to fully participate in today's networked societies. The digital literacy test was informed by a comprehensive assessment framework based on two most popular and authoritative DL frameworks: the International Computer and Information Literacy Study (ICILS; Fraillon, Ainley, Schulz, Duckworth, & Friedman, 2019; Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014) assessment framework and the European Commission developed Digital Competence Framework (DigComp; Carretero, Vuorikari, & Punie, 2017; Vuorikari, Punie, Carretero, & van den Brande, 2016). The assessment instrument accordingly measured students' digital literacy in five competence areas (Carretero et al., 2017):

- Information and data literacy: Gathering, evaluating and managing data and digital content.
- Communication and collaboration: Interacting, sharing and collaborating through digital technologies, engaging in citizenship through digital technologies, digital etiquette, and managing digital identity.
- Digital content creation: Developing and re-elaborating digital content, programming skills, and copyright knowledge.
- Safety: Protecting devices, privacy, well-being, and the environment.
- Problem solving: Solving technical problems, creatively using digital technologies, and identifying technological responses and digital competence gaps.

The DL assessment instrument developed in this study provides a comprehensive coverage of the above five dimensions. In addition, collaboration was measured separately through a test of collaborative problem solving discussed in Section 3.

A total of 80 test items was developed and distributed across three test forms to provide articulated age-appropriate test instruments, one for each student cohort. The three booklets comprised 45, 50, and 50 items for Primary 3, Secondary 1, and Secondary 3 students, respectively. There are some common items across the booklets in order to construct a common scale on which to place all students in order to compare students' performance across the three cohorts. Students' performances in the five competence areas were found to be highly correlated, and therefore only one general digital literacy score is reported here. The results and sample descriptions of some items for each competence area are presented in the Appendix to illustrate the nature of the performance achieved by different student cohorts.

## 2.1. Digital literacy performance better at higher grade levels

On the basis of the students' responses from all three cohorts, the digital literacy score was standardized to have a mean of 0 and a standard deviation (SD) of 1. The boxplots of the digital literacy scores for the three cohorts are presented in Figure 2. An inspection of the unscaled responses showed that the primary school students on average answered a third (33%) of the questions correctly while the secondary school students correctly answered an average of half the questions (S1: 51%; S3: 50%). The test instrument for S3 had a higher proportion of more

difficult questions, hence S3 students' overall performance after scaling was nevertheless slightly better than that of S1 students.

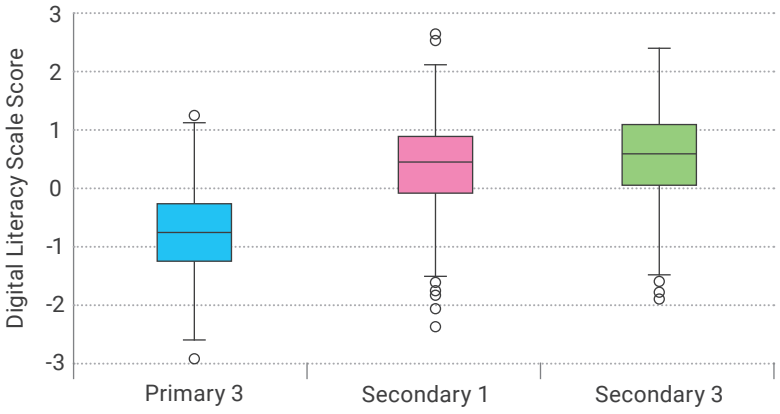


*Figure 2.* Boxplots of Students' Digital Literacy Scale Scores by Cohort.

The boxplots[1] in Figure 2 suggest that students in secondary schools outperformed primary school students. However, the large overlaps in score distributions across the three cohorts mean that some of the primary school students reached higher levels of digital literacy than some of the secondary students. The figure also shows that there is a wider diversity in S1 students' DL performance, as evidenced by the fact that a few S1 students performed better than any of the S3 students, and that there were more students below a reasonable low performance threshold in S1 when compared to the other two cohorts.

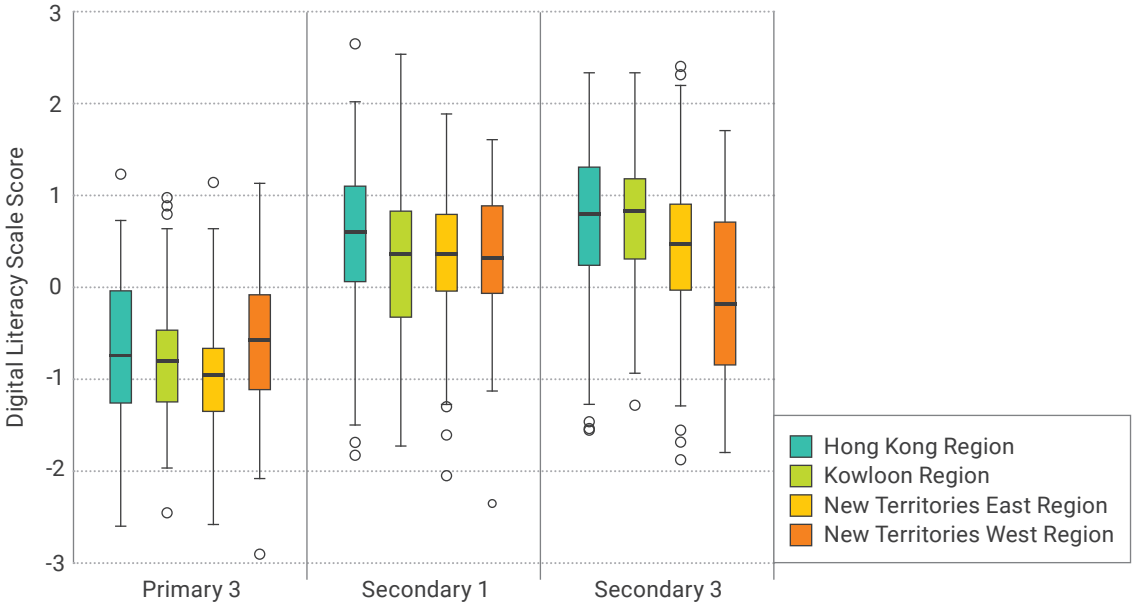


*Figure 3.* Boxplots of Students' Digital Literacy Scale Scores by District.

Furthermore, a comparison of the performance of the students in this study across the four sampled regions shows that for secondary students, those on Hong Kong Region on average

1 For an explanation of boxplot, refer to:
https://towardsdatascience.com/understanding-boxplots-5e2df7bcbd51

performed better, whereas those in New Territories West on average had the lowest scores (see Figure 3). However, the picture changes for the P3 cohort, which shows students from New Territories West outperformed the P3 students from the other three regions. This probably shows that there are large variations in student performance in schools within the same region and such variations are largely due to randomness in sampling. We also note that while S1 students' performance across the four regions are similar, there are much larger differences across regions for S3, with New Territories West registering much lower performance. As S1 and S3 students were sampled from the same schools, the differences in performance profile could also be due to sampling effects if schools have ability streaming for allocation of students to classes. Further investigation is needed to understand why there are much wider cross-district variations in performance in S3 compared to S1.

## 2.2. Digital literacy performance across gender and SES

Figure 4 shows the average overall digital literacy scores for male and female students separately for each cohort. Besides the higher levels of digital literacy among secondary school students (see Figure 2), the figure below indicates that girls in secondary schools significantly outperformed their male peers, while there was no noticeable gender difference among primary school students. This finding is particularly interesting because it stands in contrast to research that reported smaller gender differences among older cohorts of students (Siddiq & Scherer, 2019). This result raises questions about what might have happened during the later years of primary schooling that had led to this increasing gender gap, and how parents and schools may prevent this gap from emerging.

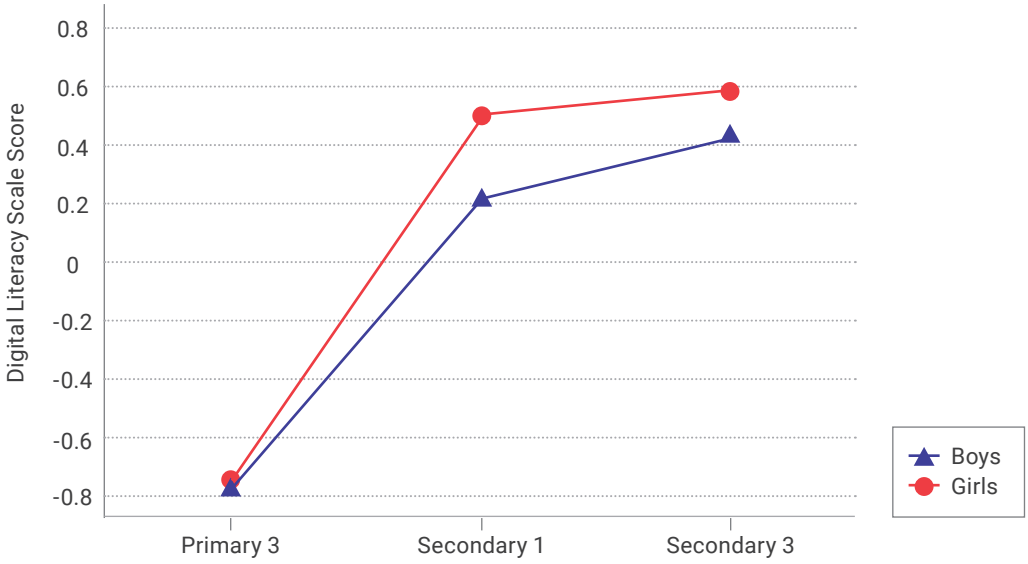


*Figure 4.* Students' Digital Literacy Scale Scores by Gender and Cohort.

Student reports of the number of books at home were used as a proxy for socio-economic status. Students from homes with more books performed slightly better in the digital literacy assessment than other students. No association was found between students' digital literacy and parents' levels of education, though it should be noted that many students (over 40% across the three cohorts) reported not knowing their parents' education background.

## 2.3. Significant performance divide in digital literacy between and within schools

In this section, we look at the performance of the students by school. Each boxplot in blue in Figure 5 represents the performance of students from one primary school, and the yellow boxplot on the right is the performance of the entire Primary 3 sample. The red dashed line is the median across all primary students. This figure shows that there are large differences in the median score across schools. For example, the top end of the box for School A is on the red line, indicating that about 75% of the P3 students in this school have scores at or below the sample median. This contrasts with another school (B) whose median score is above the purple dashed line (meaning that over half of the students from this school is above 75% of the entire student cohort), and another School (C) whose median is below the brown dashed line (25% quartile). Another observation is the large differences in performance across students within the same school. This is evident from the box length and the separation between whiskers in the boxplots. The larger these are, the greater the within-school differences in digital literacy competence among students. Such differences have implications for students' learning, particularly if schools were to implement e-learning extensively.

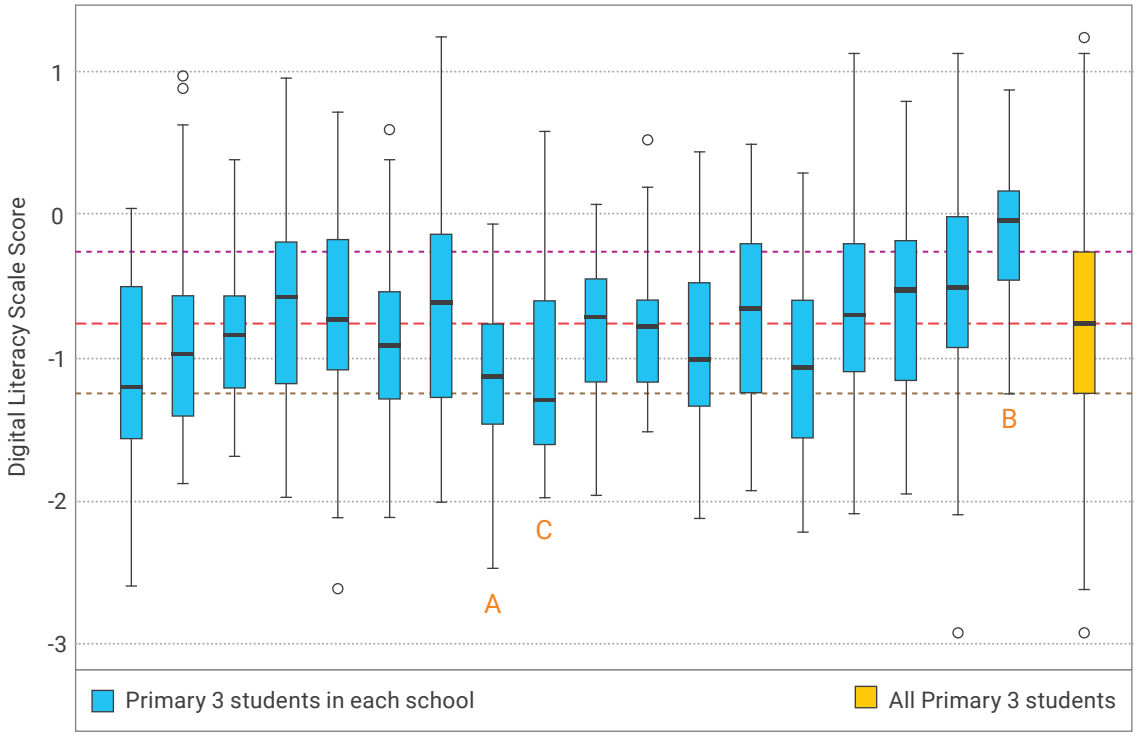


*Figure 5.* Boxplots of Primary School Students' Digital Literacy Performance by School.

Figure 6 below shows the results for secondary schools. Each pair of neighboring bars represents the performance distribution for S1 (in pink) and S3 (in green) in the same school, the boxplot on the right shows the performance of the entire secondary sample. There are several noteworthy observations from this figure. First, the wide diversities across schools as observed in the primary school cohort are observable in the secondary cohorts as well. For example, for School X in Figure 6, the medians for both S1 and S3 were above the 75% quartile for secondary school students, and above the medians of all other schools. Also, in most

schools, S3 students on average were more digitally literate than their younger schoolmates in S1. However, there were two schools where the younger cohort of students was more digitally literate than the older cohort (Schools Y and Z). This could be the result of a change in student intake profile or because these schools have recently made more focused efforts to enhance students' digital literacy. However, there may also be other reasons, such as classes within these schools were ability streamed, such that different segments of student ability spectrum within the same school were sampled for the two cohorts.

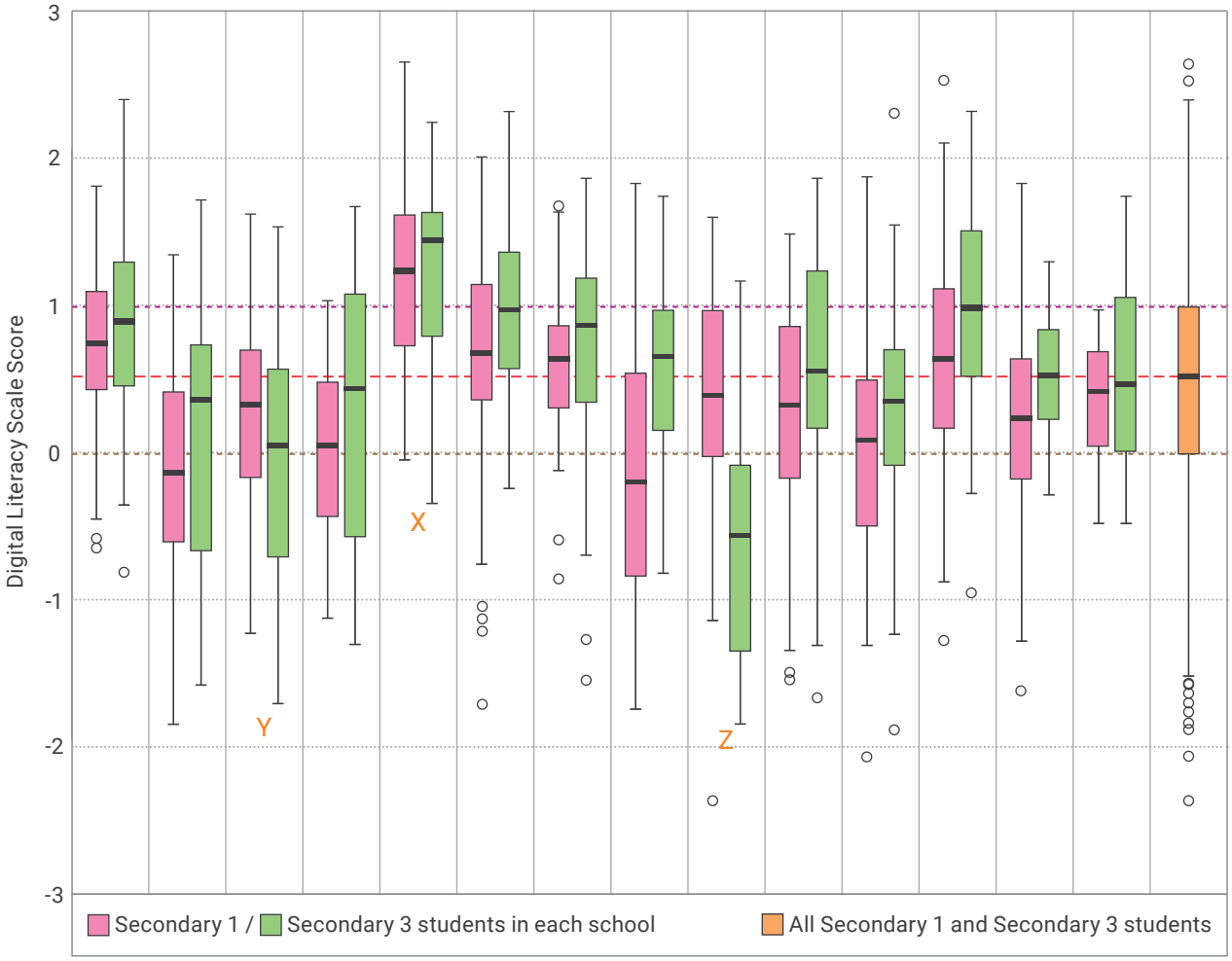


*Figure 6.* Boxplots of Secondary Students' Digital Literacy Performance by School.

In addition to interschool comparisons, we also noted significant intraschool differences in Figure 6. As indicated by the box length and whiskers length, most schools recorded differences of up to three standard deviations. This range was larger in S3 when compared with S1. It is also clear from the results that some of the secondary students are at risk of lagging behind in digital literacy.

Finally, the interschool variation among secondary schools appeared somewhat greater than it was among primary schools. In Figure 6 above we see relatively more school medians below the lower quartile (the brown dashed line) or above the upper quartile (the purple dashed line), respectively, when compared with these quartiles in Figure 5. In fact, the performance differences were smallest among P3 schools and largest among S3 cohorts in secondary schools, as indicated by the school-level variance.

# 3. Collaborative problem solving (secondary level only)

Collaborating to solve authentic problems is important for digital citizens because many workplace, social and political problems cannot be solved by individuals acting alone. To measure students' collaborative problem-solving (CPS) skills, the eCitizenship project adopted the assessment instrument developed by the Assessment Research Centre (ARC), University of Melbourne (Hesse, Care, Buder, Sassenberg, & Griffin, 2015). As this test is considered valid only for the assessment of students aged 11 or above, it was only administered to the two secondary student cohorts.

In this test, students were assigned to work in pairs on five online collaborative tasks. The instrument measured two aspects of CPS: Cognitive process skills (including task regulation and knowledge building), and social process skills (including participation, perspective taking, and social regulation) demonstrated by the students during the collaborative tasks. The test was scaled by the ARC based on calibrations conducted using international data collected during their instrument development stage. The ARC provided the assessed proficiency level for each participating student for each of the two skills aspects based on the performance levels shown in Table 2.

Table 2
*Proficiency Levels of Cognitive and Social CPS*

| | Cognitive Process Skills | Social Process Skills |
|---|---|---|
| Level 1 | Exploration | Independent working |
| Level 2 | Systematic trial and error | Supported working |
| Level 3 | Gathering and collecting information | Awareness of partnership |
| Level 4 | Strategic planning and executing | Mutual commitment |
| Level 5 | Efficient working | Valued partnership |
| Level 6 | Refined strategic application and problem solving | Cooperation and shared goals |

*Note.* 1 indicates the lowest and 6 the highest level of CPS.

## 3.1. Secondary students better in social than cognitive aspect of CPS

The summaries in Figure 7 and Figure 8 below show cognitive and social CPS performance of the two secondary cohorts. Although it was observed that the older cohort (S3) achieved slightly higher levels of competence overall, similar to digital literacy, the performance profile is largely comparable.

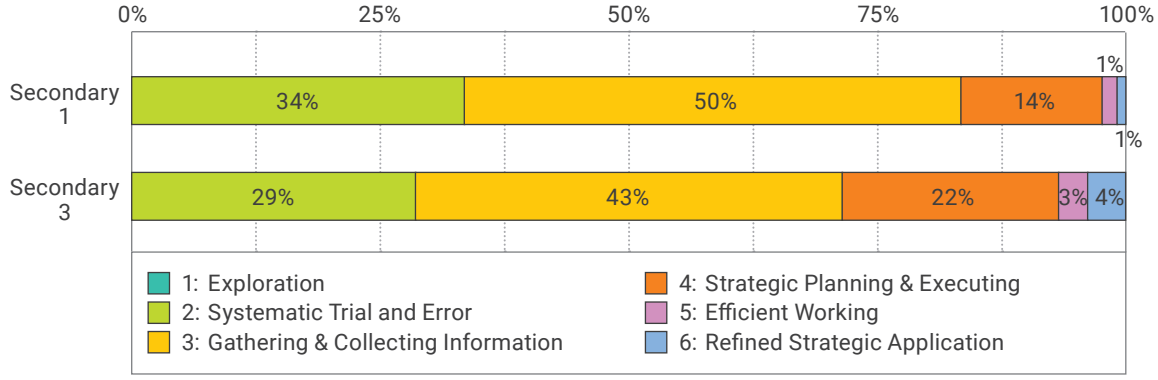


*Figure 7.* Percentages of Secondary Students Reaching Different Levels of CPS Cognitive Process Skills.

Most students reached Level 2 or Level 3 in the cognitive domain, and only very few students achieved either of the highest two performance levels in cognitive CPS process skills. This was true for both cohorts and both genders. Moreover, students in both cohorts demonstrated higher levels of social process skills when compared to the cognitive process skills. Over half the students assessed in both cohorts reached Level 5 in the social domain. Thus, it appears that there is a need for students to develop metacognitive skills in strategic planning, execution and enhanced work efficiency in problem solving.

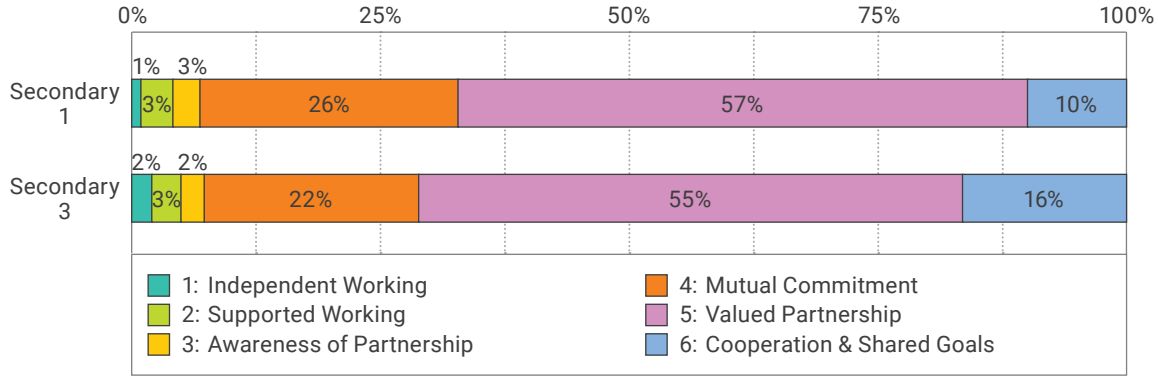


*Figure 8.* Percentages of Secondary Students Reaching Different Levels of CPS Social Process Skills.

Although male and female students had very similar performance profiles for both cognitive and social CPS process skills, female students on average slightly outperformed their male counterparts in both domains.

## 3.2. Collaborative problem-solving performance across schools

Similar to the performance comparison on digital literacy, Figure 9 and Figure 10 show the average student performance by school, with S1 in pink and S3 in green bars and two neighboring bars representing the two cohorts at the same school; the right is the performance of the entire secondary sample. Here we present boxplots of the performance scores (rather than the six performance levels), with zero being the mean calibrated by ARC (which is *not* the average score among Hong Kong students), and the vertical axis indicating how many standard deviations (SD) these scores differ from the ARC mean. This provides a more refined comparison than using performance levels. Higher scores mean better collaborative problem-solving skills in the respective skill domains.

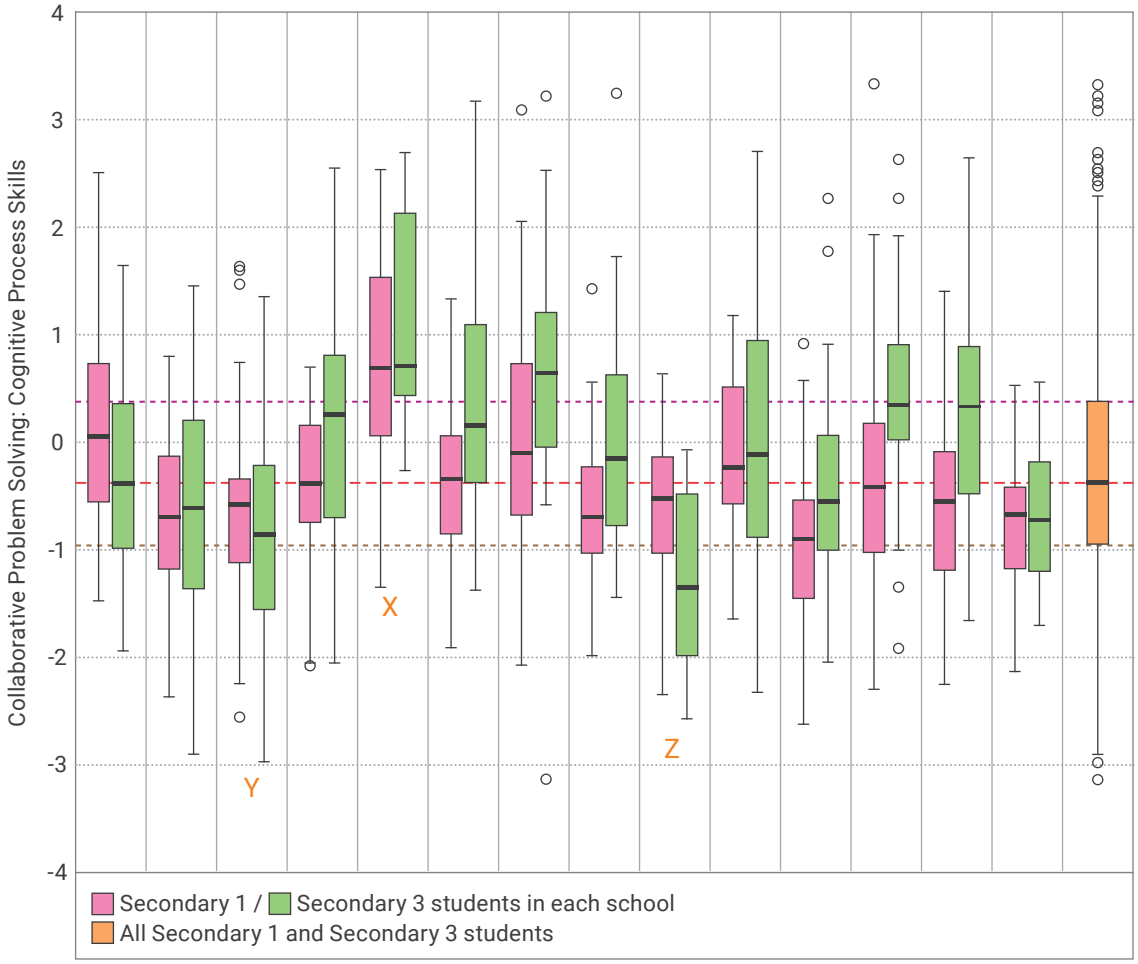


*Figure 9.* Boxplots of Secondary Students' Cognitive CPS Process Skills Performance by School (two extreme outliers not shown).

School X in Figure 9 has the highest medians for both cohorts, well-above the 75% quartile of all secondary schools (the purple dashed line). This is the same school with the highest average digital literacy performance. The median for S3 in School Z in Figure 9 is below the 25% quartile (the brown dashed line) and the top end of the boxplot is below the sample median (the red dashed line). This indicates that less than 25% of the assessed S3 students reached the sample average. Similar to the DL results, S3 cohorts in Schools Y and Z on average reached lower cognitive CPS process skills than their younger schoolmates in S1.

A very similar pattern was found for social CPS process skills for these two schools (see Figure 10).

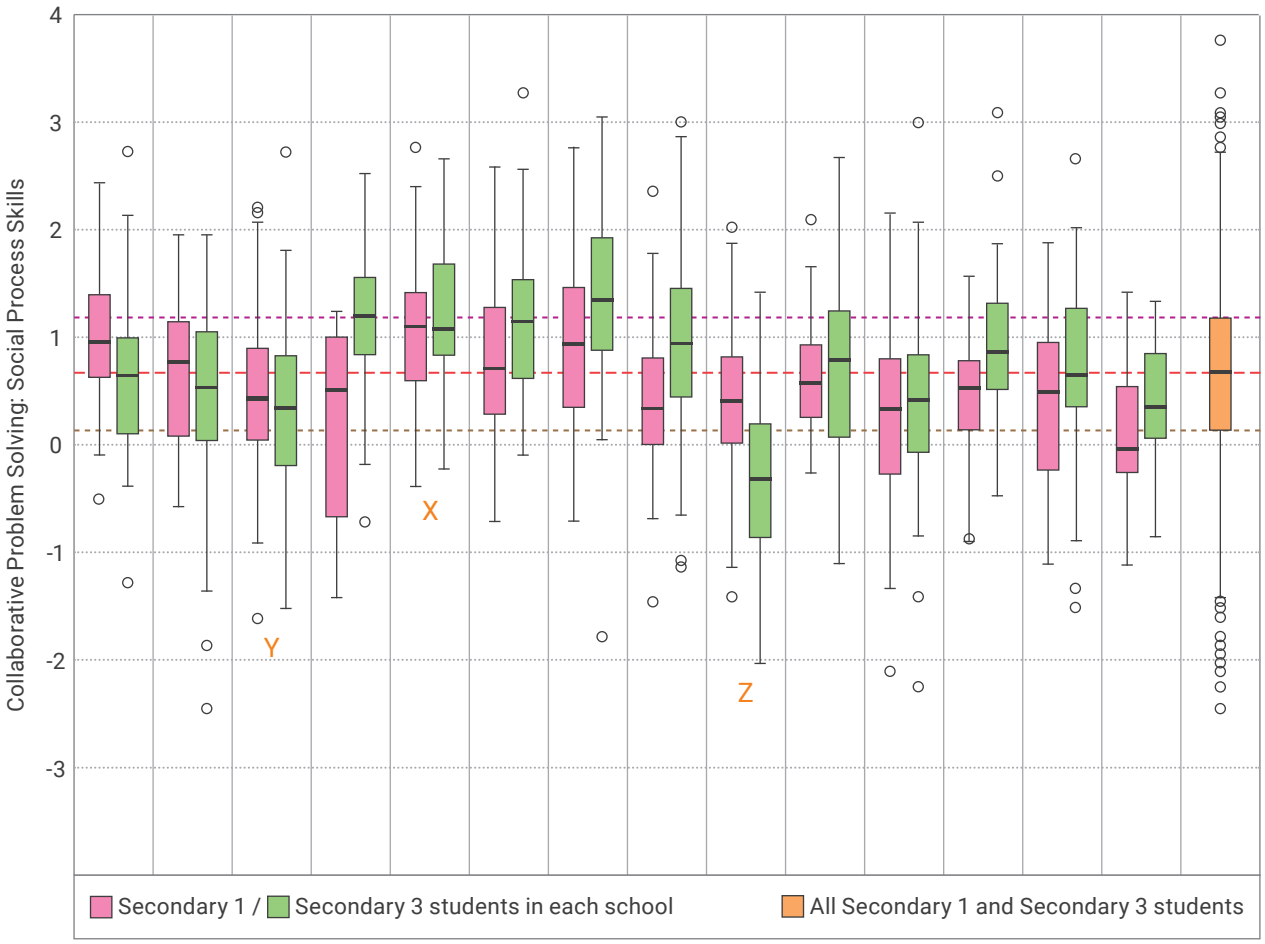


*Figure 10.* Boxplots of Secondary Students' Social CPS Process Skills Performance by School (three extreme outliers not shown).

## 3.3. Digital literacy and CPS are distinct competences

High performers in the collaborative problem-solving test usually also had higher digital literacy scores. However, statistical tests show that the strength of this association was moderate, suggesting that digital literacy and CPS are distinct competences. Hence, digital literacy and CPS may also require distinct educational support and training. Furthermore, digital literacy was found to be more strongly correlated with the cognitive process skills ($r$=.35 in S1 and respectively $r$=.40 in S3) than the social process skills ($r$=.19 in S1 and respectively $r$=.29 in S3).

# 4. Students' background and their digital competence

## 4.1. Digital access and usage

### 4.1.1. Digital divide: students without or very limited access to digital devices at home

The students responded to a range of questions about the availability and usage of digital devices. A majority of the students in all cohorts had access to desktop computers, laptops and tablets at home, but most of them had to share these devices with others. Almost all secondary students reported access to a smartphone, and in contrast to the primary students, most of them did not have to share their smartphones with others. Notably, 8% of the primary school students reported no access to any of the four devices; while the corresponding figures were only 2% and 1% for S1 and S3 students respectively.

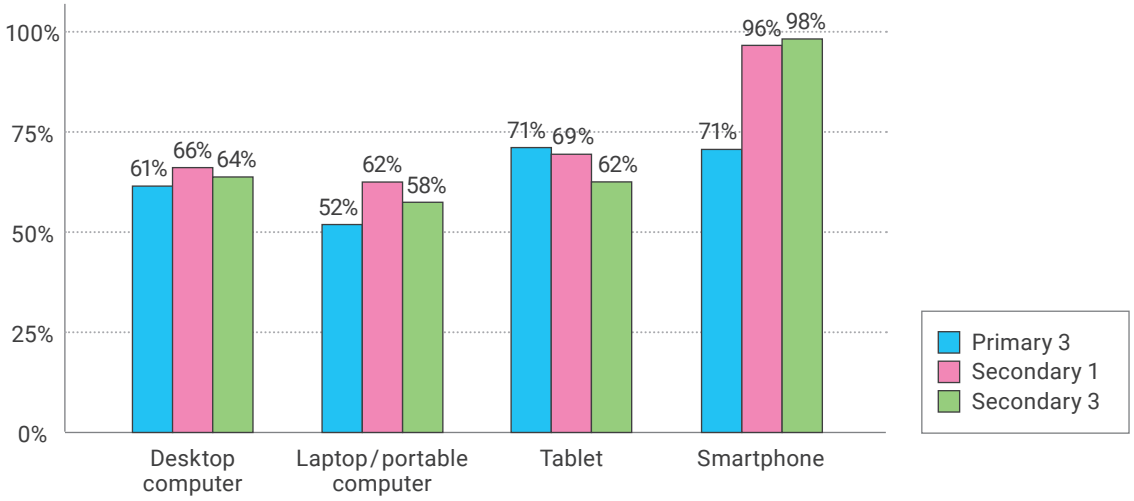


*Figure 11.* Percentages of Students with Access to Different Digital Devices at Home.

While smartphones are the preferred device for leisure, games and communication with family and friends, it is not easy to use them for serious work such as reading extended passages or doing homework. A total of 13% of the primary students, 10% of S1 and 8% of S3 students reported having no access at home to devices with a larger display (i.e., desktop computer, laptop, and/or tablet).

Even for those students who had access to devices with a larger display at home, they often have to share them with other family members (see Table 3). This becomes particularly challenging for students when they are forced to learn online at the same time with other siblings and may even have to compete for device use with work-at-home parents.

Table 3

*Percentages of Students with Access to Digital Devices with Large Displays at Home (e.g. Desktop Computer, Laptops, Tablets, etc.)*

| Cohort | No access to all three devices | Shared access to at least one device but no exclusive access | Access without sharing on at least one device |
|---|---|---|---|
| Primary 3 | 13% | 35% | 52% |
| Secondary 1 | 10% | 46% | 44% |
| Secondary 3 | 8% | 42% | 50% |

### 4.1.2. Digital devices primarily used for communication and leisure

Figure 12 summarizes students' daily usage of digital devices for five purposes. Students primarily used digital devices to communicate with others and at home for leisure activities that are unrelated to schoolwork.

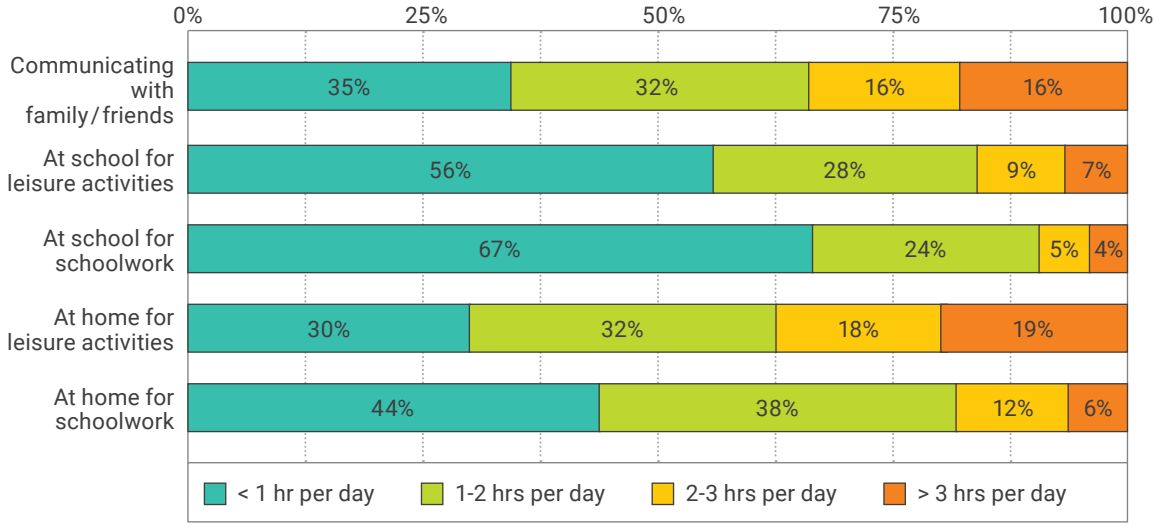


*Figure 12.* Students' Use of Digital Devices at Home and in School (all three cohorts).

The older student cohorts spent significantly more time on digital devices at home for leisure activities, as shown in Figure 13. There were also small differences in the time students reported spending at home for schoolwork, indicating that S3 students spent less time on this activity using digital devices.

We find that time spent on communicating with friends and/or family was not related to students' digital literacy in all three cohorts. On the other hand, secondary students reported better mental health[2] the more time they spent on such digital communication (mental health was not measured among primary school students).

2 Mental health was measured using the short general health questionnaire (Goldberg, 1978; Goldberg & Williams, 1988), which asks students 12 questions to assess their current mental state and if it differs from their usual state.

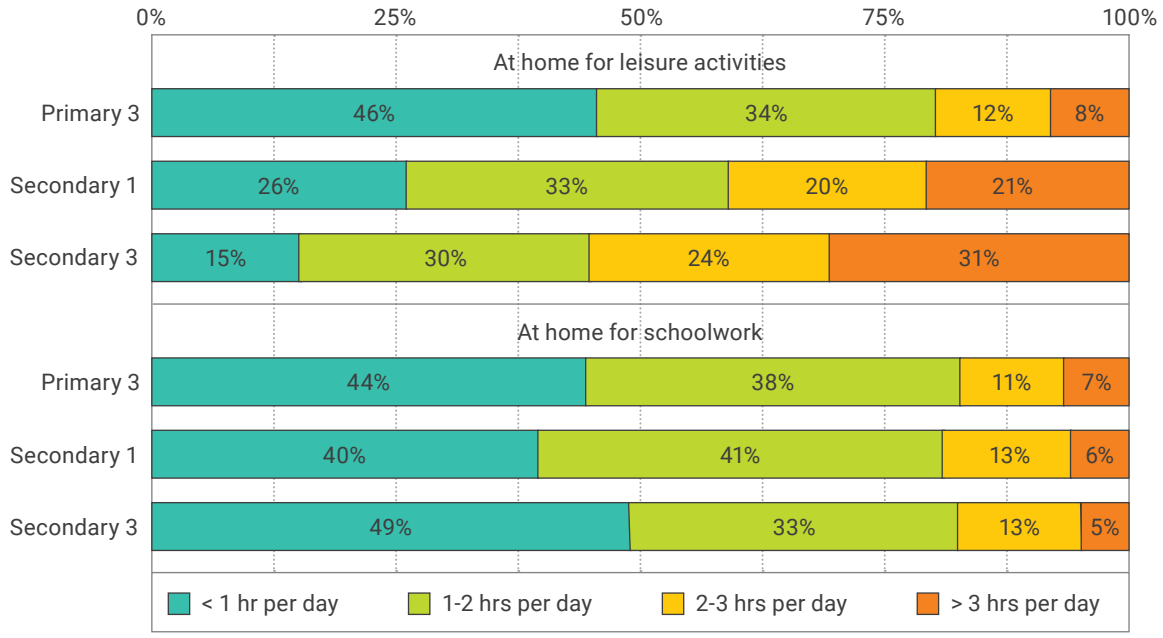


*Figure 13.* Students' Use of Digital Devices—Cohort Differences.

### 4.1.3. YouTube the most popular social media for students

Students further indicated whether they held accounts with different social media platforms and how often they accessed these. As shown in Table 4, YouTube was among the three most prevalent social media platforms for all three age cohorts. For secondary students, WhatsApp closely followed, and WeChat was also very popular. For S3 students, Facebook and Instagram were the third most popular social media platforms. Among primary school students, however, WeChat and Tik Tok took over as the next two most popular platforms. Finally, at least for the P3 and S1 students surveyed, those reporting more frequent social media usage had lower levels of digital literacy and CPS performance.

Table 4
*Percentages of Students with Social Media Accounts (by Cohort)*

| | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|
| YouTube | 62% | 84% | 93% |
| WhatsApp | 45% | 85% | 94% |
| WeChat | 50% | 77% | 76% |
| Facebook | 32% | 67% | 81% |
| Instagram | 24% | 64% | 81% |
| Tik Tok | 46% | 60% | 45% |
| Weibo | 27% | 23% | 41% |
| Snapchat | 24% | 28% | 46% |
| Others | 30% | 26% | 26% |

## 4.2. Online health

### 4.2.1. About one in ten secondary students may have Internet addiction

The student questionnaire included ten items to measure secondary school students' Internet addiction. Internet addiction refers to "the frequent and uncontrolled use of the Internet to the extent that other aspects of the user's life are negatively affected" (Teo & Kam, 2014, p.624). The questions in our survey captured students' levels of Internet involvement (e.g., failing to cut down time spent on the Internet, losing sleep due to nightly logons, schoolwork suffering because of the amount of time spent online). Students' responses are averaged to form one scale (0-4), with a mean higher than 2.5 indicating a risk of addiction. Figure 14 shows that about 9% of S1 respondents and 8% of S3 respondents show symptoms of Internet addiction.

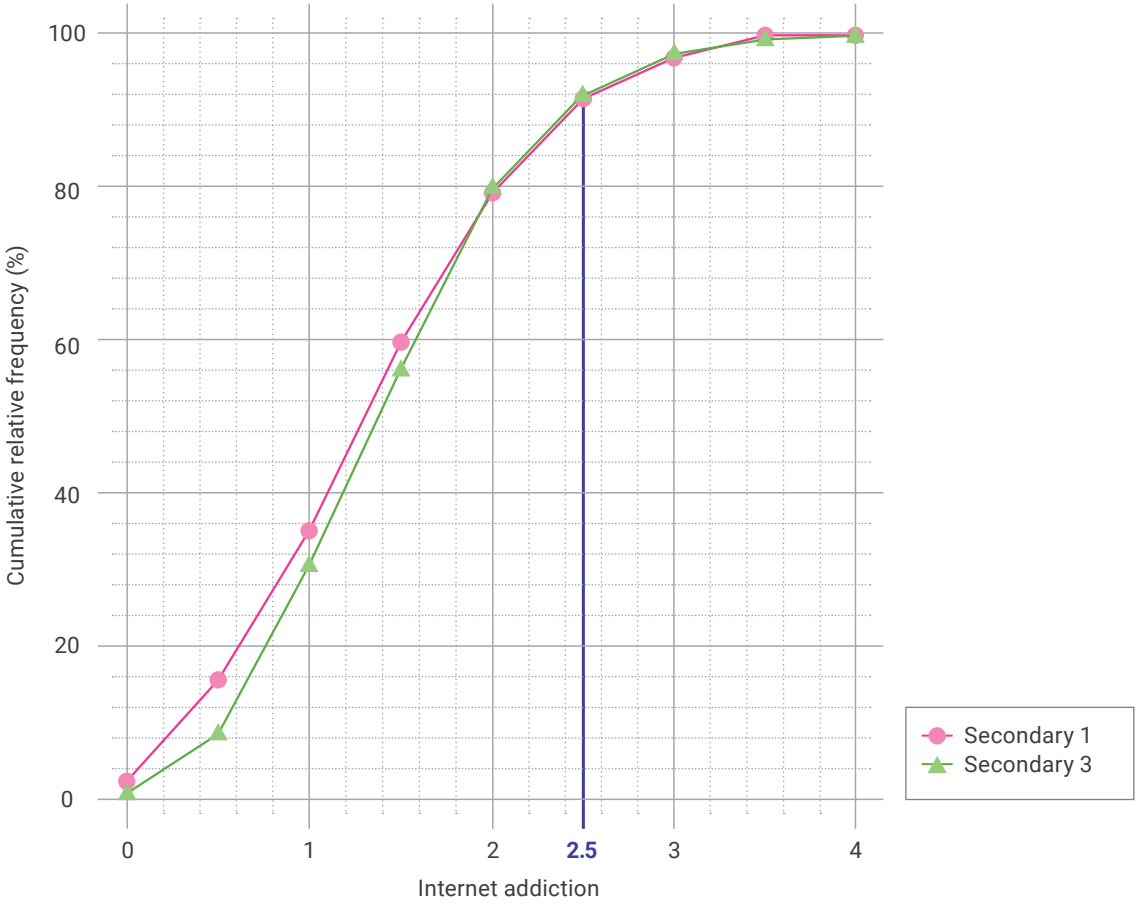


*Figure 14.* Cumulative Frequencies of Secondary Students' Levels of Internet Addiction.

### 4.2.2. Moderate digital gaming correlates with higher digital competences

Students in all three cohorts indicated how many times they had played games using digital devices in the two weeks prior to the survey. Primary school students, on average, reported less frequent game playing than secondary students. Notably, boys reported more frequent digital game playing than girls.

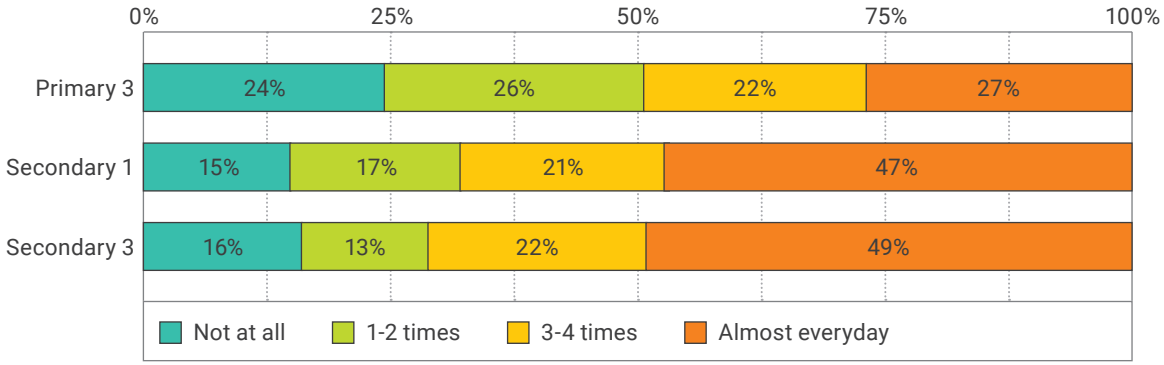


*Figure 15.* Time Spent Playing Games on Digital Devices.

Students also responded to nine questions designed to capture pathological gaming, or game addiction (e.g., only thinking about playing a game, feeling miserable when not playing, hiding how much one plays). The questions were adapted from the Short Internet Gaming Disorder Scale (Lemmens, Valkenburg, & Gentile, 2015). The responses were averaged to form one scale (0-4). Students in S3 reported significantly less game addiction than students' in P3, but the S1 students did not differ statistically from the other two cohorts. Again, boys showed higher levels of game addiction in all three cohorts, which is consistent with the gender gap in gaming frequency.

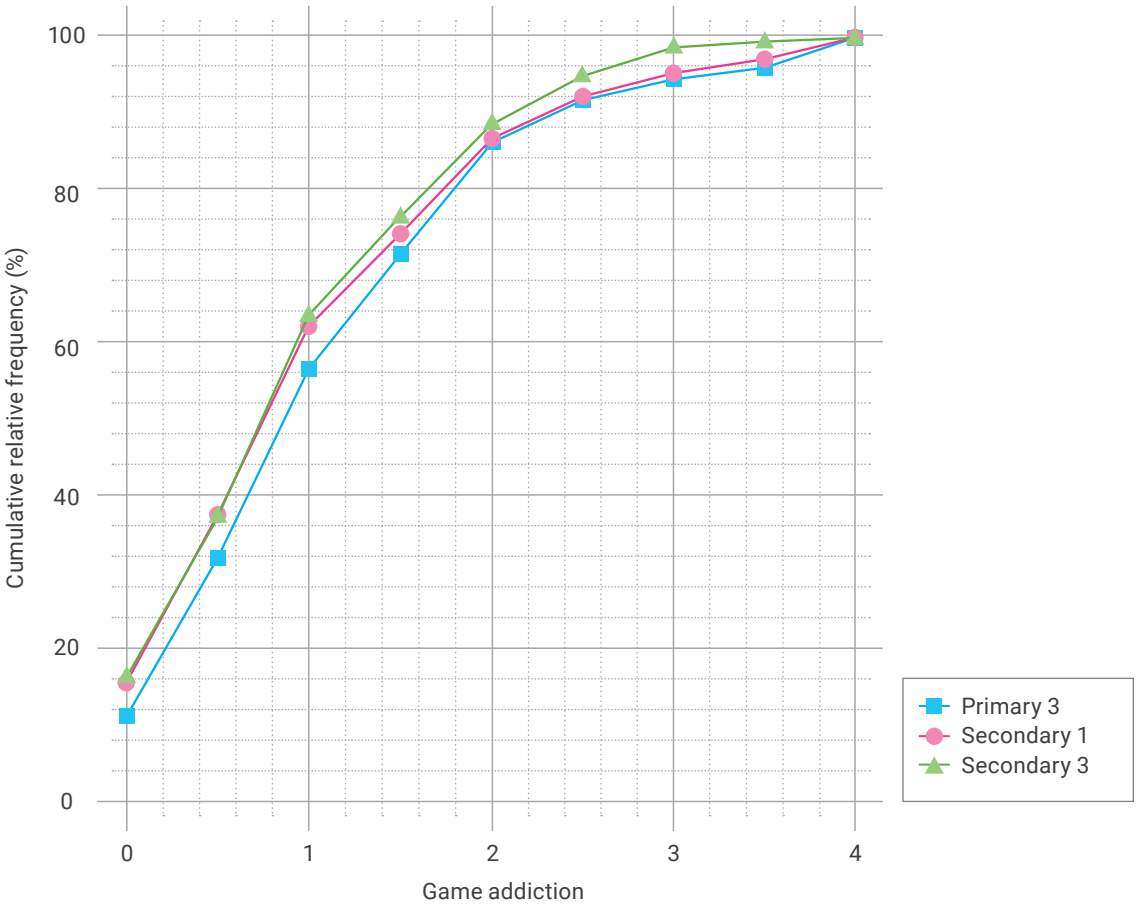


*Figure 16.* Cumulative Frequencies of Students' Digital Gaming Addiction.

Gaming frequency and addiction were also examined with respect to students' digital competences. CPS skills (not administered to primary students) were particularly advanced

among secondary students who reported playing 3-4 times per week, and rather poor among students who either never play games on digital devices or do it almost daily. Lower levels of pathological gaming were also associated with better performance in the assessments among the two younger student cohorts (P3 and S1).

### 4.2.3. 35% of students reported experiences with cyberbullying

Students further indicated whether they had ever cyberbullied someone (e.g., posted something mean about another person) or been a victim of cyberbullying themselves (e.g., rumors about the student were spread electronically). Twelve questions measuring cyberbullying and cybervictimization were adapted from an instrument validated in other cultural contexts (Shapka, Onditi, Collie, & Lapidot-Lefler, 2018). Two thirds (65%) of all surveyed students reported no cyberbullying experiences. About a quarter of each cohort reported having been a victim and a slightly lower percentage reported having been a perpetrator (Figure 17). Among them, almost half (48%) were both victims and perpetrators, indicating a strong correlation ($r$=.53) between being a victim and being a perpetrator. Although male students reported more cyberbullying incidents, the gender differences became narrower for the older cohorts of students.

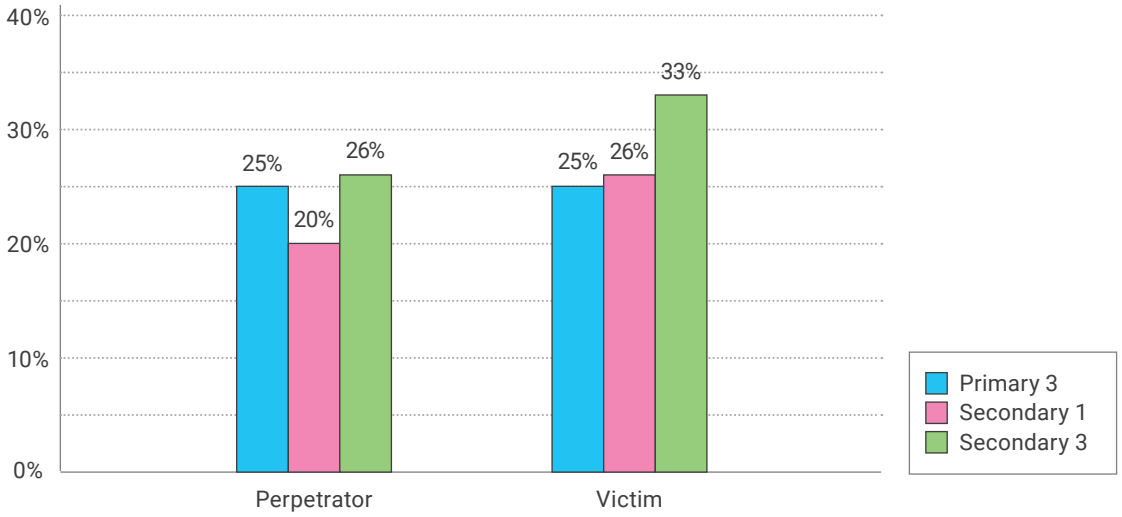


*Figure 17.* Percentages of Students Reporting at Least One Incident of Cyberbullying as Perpetrator or Victim.

Cyberbullying experiences (as victim or as perpetrator) were also associated with lower scores in the digital literacy assessment, especially with P3 and S1 respondents. Schools need to be aware that cyberbullying is a problem and our results show that the problem is correlated with students' digital literacy. While the reported occurrence of cyberbullying is similar across the three age cohorts, teachers' reporting of having to handle such situations were very different across the three age cohorts. A much higher percentage of secondary teachers (42%) than primary teachers (22%) reported having to handle cyberbullying cases at their school, even though the percentages reported by students are similar across cohorts. A few of the teachers who were involved in the handling of cyberbullying (6%) said they handled cyberbullying cases about monthly or more often, while all other teachers said they had to do that less frequently.

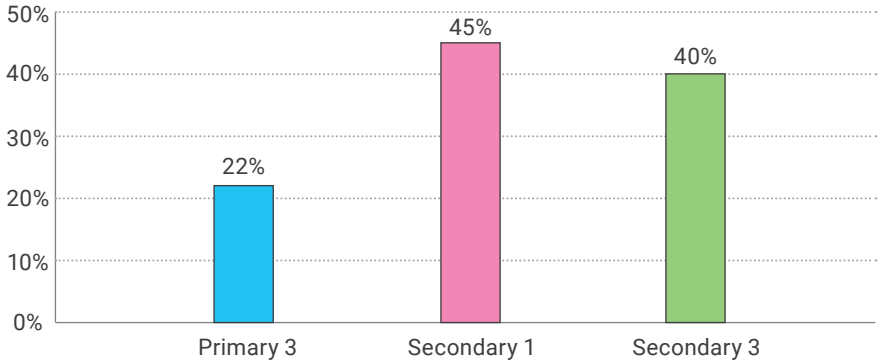


*Figure 18.* Percentages of Teachers Who Reported Handling Cases of Cyberbullying at Their Schools.

A particularly intriguing finding is shown in Figure 19, where a high percentage of teachers (68% of primary and 54% of secondary teachers) reported not knowing whether there was a cyberbullying policy at their school. In half of the schools surveyed, some teachers in the school reported that a cyberbullying policy existed. However, in almost all schools where a teacher believed a policy on cyberbullying existed, another teacher in the same school reported no such policy existed. One possible explanation for such discrepancies may be the fact that only those teachers assigned to handle cyberbullying know the relevant school policy. However, to prevent or adequately handle cyberbullying at school requires a concerted whole school awareness and effort rather than only relegating it to a few teachers.

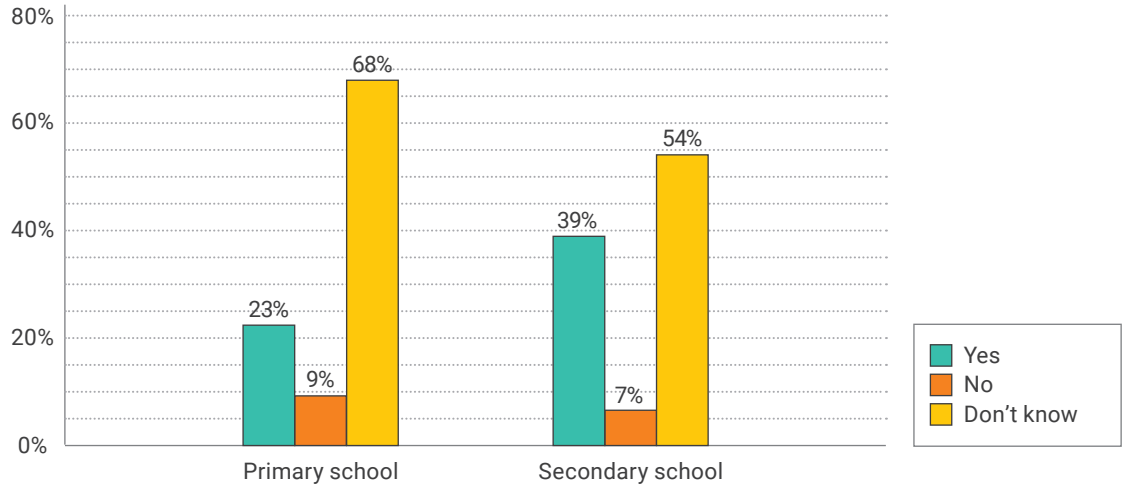


*Figure 19.* Percentages of Teachers Reporting Existence of a School Policy on Cyberbullying.

### 4.2.4. Teachers need to talk more about cyberwellness

A set of questions was developed based on a policy review on building digital citizenship in the Asia-Pacific that had been conducted by UNESCO (2016). The teachers were surveyed on whether they talked with their students about any of twelve topics related to cyberwellness. Some teachers (17%) did not talk about any of the topics shown in Figure 20 at all, and a third of them (34%) said that they would talk about all of these topics. The remaining half of the surveyed teachers reported talking about some but not all of the listed cyberwellness topics.

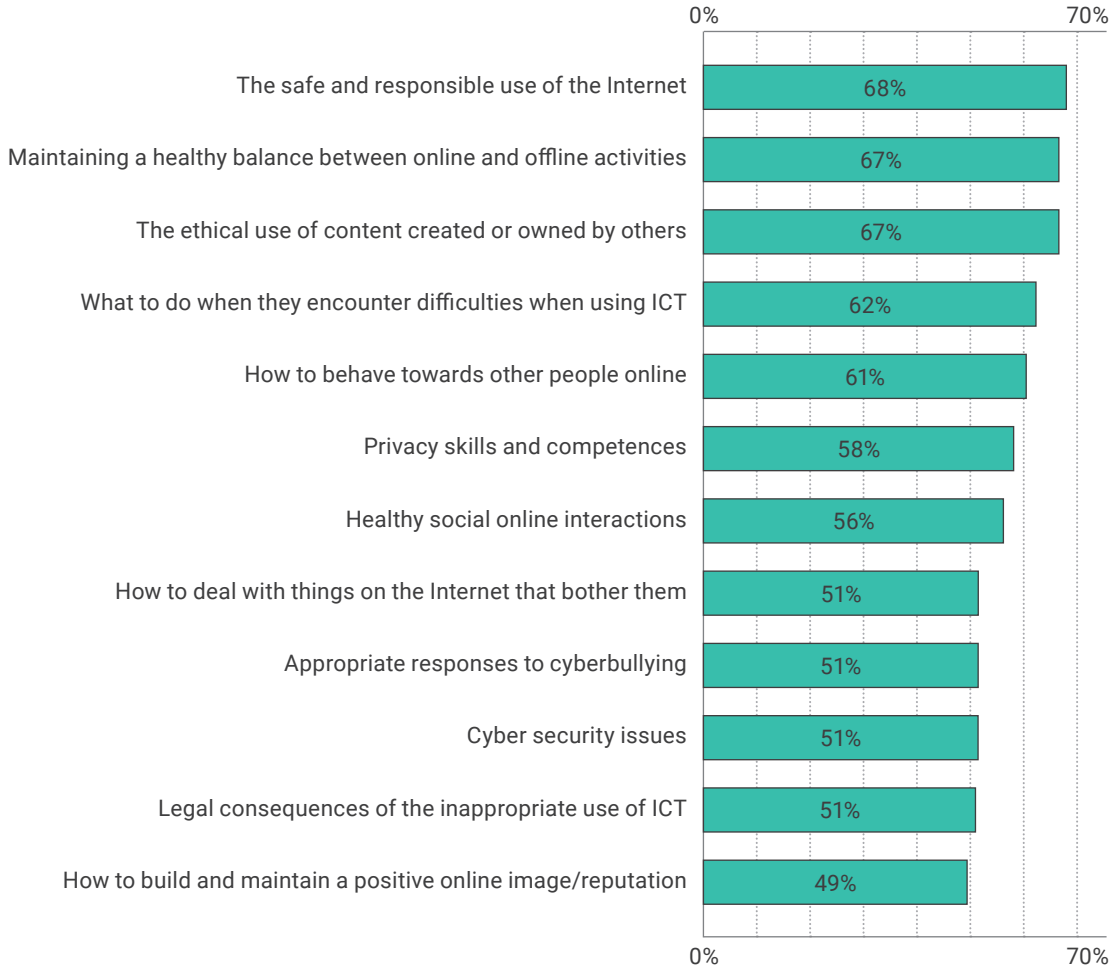


*Figure 20.* Percentages of Teachers Who Reported "Sometimes" or "Often" Talking About Various Cyberwellness Topics with Their Students (most to least frequent).

Across the three cohorts, the most common topics the teachers discussed with students were the safe use of the Internet, maintaining a healthy balance of online and offline activities, and the ethical use of online material owned by others. Less than half of the teachers said they would talk about handling things that bother students on the Internet, appropriate responses to cyberbullying, cyber security issues, legal consequences of the inappropriate use of ICT, and how to maintain a positive online reputation.

## 4.3. Online safety

### 4.3.1. One in ten students fell victim to online scam

A set of five questions adapted from EU Kids Online asked students whether they had encountered security problems on the Internet (Livingstone, Haddon, Görzig, & Ólafsson, 2011). 64% of students reported no security problems. Of those who did, the most common problems were with the unauthorized usage of personal information by others and computer viruses. Surprisingly, about 10% of students reported having lost money in an online scam, and a higher percentage being reported by primary students.

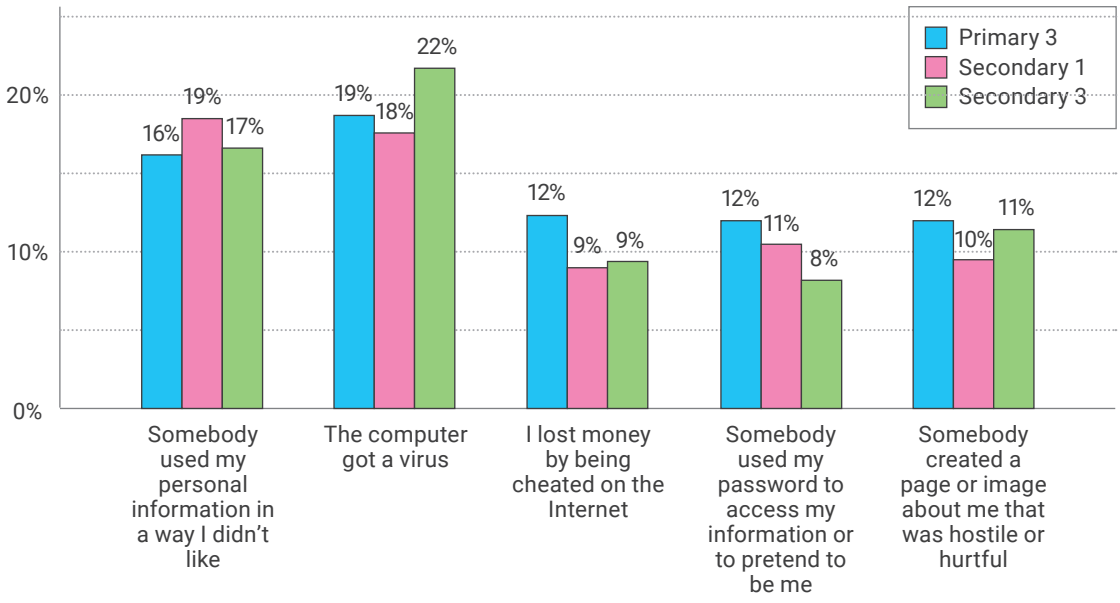


*Figure 21.* Percentages of Students Who Experienced Security Problems on the Internet.

### 4.3.2. Students engaging in risky online communication

Five questions were adapted from the EU Kids Online study to capture at-risk practices in engaging with online contacts (Livingstone et al., 2011). The rates increased significantly from P3 to S3. Particularly common was to look for new friends on the Internet and pretend to be older to get access to websites. Among primary school students, boys engaged in more risky online communications. However, girls caught up and reported a comparable rate in S3.

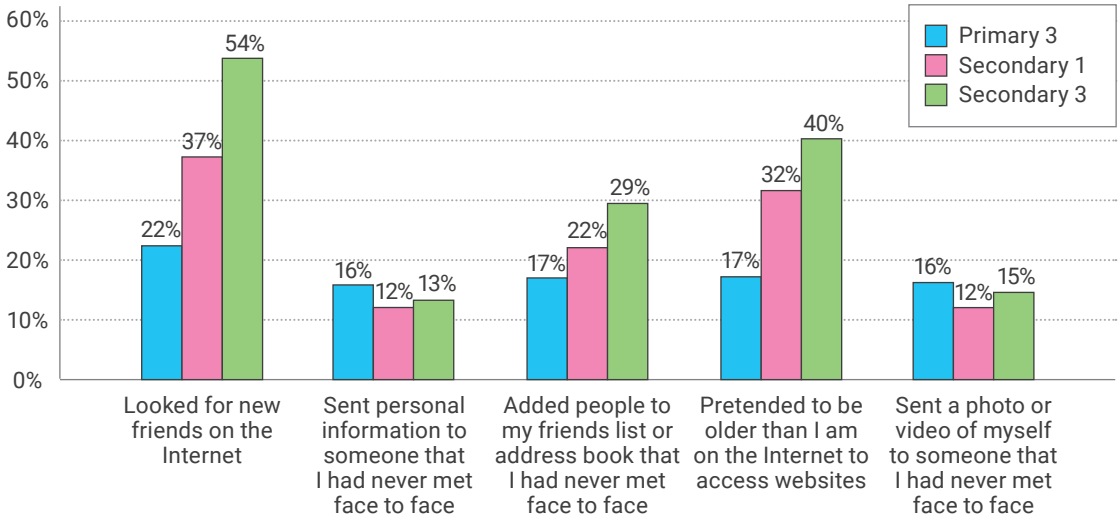


*Figure 22.* Percentages of Students Who Have Engaged in Risky Online Communication.

### 4.3.3. Data privacy

Students were also asked about their perceived skills in ensuring an adequate level of data privacy online. They indicated their agreement with five statements (five response options ranging from 0 = "strongly disagree" to 4 = "strongly agree"). Secondary students consistently perceived themselves as more competent in handling data privacy on the Internet than primary students. There were no statistically significant differences between S1 and S3 students. Moreover, girls in secondary school reported significantly higher levels of data privacy competence than their male counterparts.

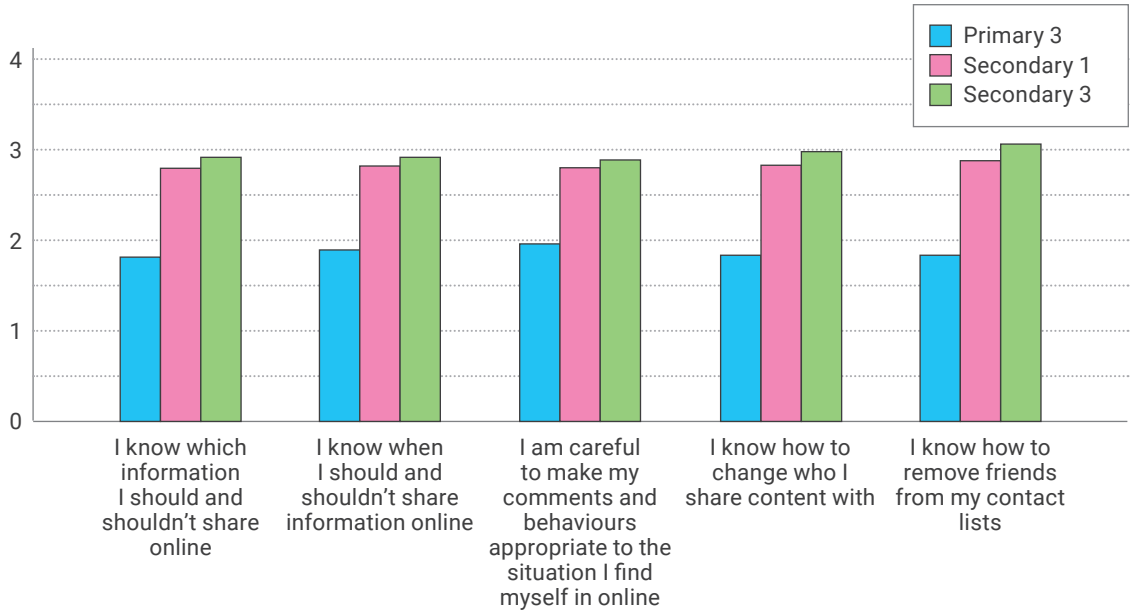


*Figure 23.* Students' Perceived Data Privacy Skills (0 = "strongly disagree" ... 4 = "strongly agree").

### 4.3.4. Higher digital literacy correlates with better online safety

Correlations between average scores of the three safety measures reported in this section and students' performance in digital literacy and collaborative problem solving reveal interesting insights. Students with higher digital literacy and CPS process skills in all three cohorts reported more data privacy knowledge, especially among secondary students. This association was stronger for digital literacy. Students lacking digital literacy were more likely to report security problems on the Internet or/and risky online communications, except students in S3. These results could mean that low levels of digital literacy represent a risk factor of encountering online risks, but the changes in the strengths of the identified associations across different age cohorts could also indicate that students learn from encountered risks as they get older.

## 4.4 Support for digital learning

### 4.4.1 Parental support and mediation

In the survey, students were asked to report the support they receive from various sources, such as parents, siblings, friends, and teachers. Figure 24 shows students' reports on whether their parents had supported them in various aspects of Internet use. These questions were adopted from the EU Kids Online study to capture parent's active mediation of students' Internet use (Livingstone et al., 2011). As seen in Figure 24, S3 students reported the least interactions with parents in most respects while S1 students reported the most parental guidance for all items. This may reflect S1 students encountering a wider spectrum of Internet uses as they transition from primary to secondary school. Older students were also more likely to say that their parents did not provide these supports, which may be due to a lower perceived need to receive help from parents. It is noteworthy that many students did not remember whether or not their parents had provided these supports.

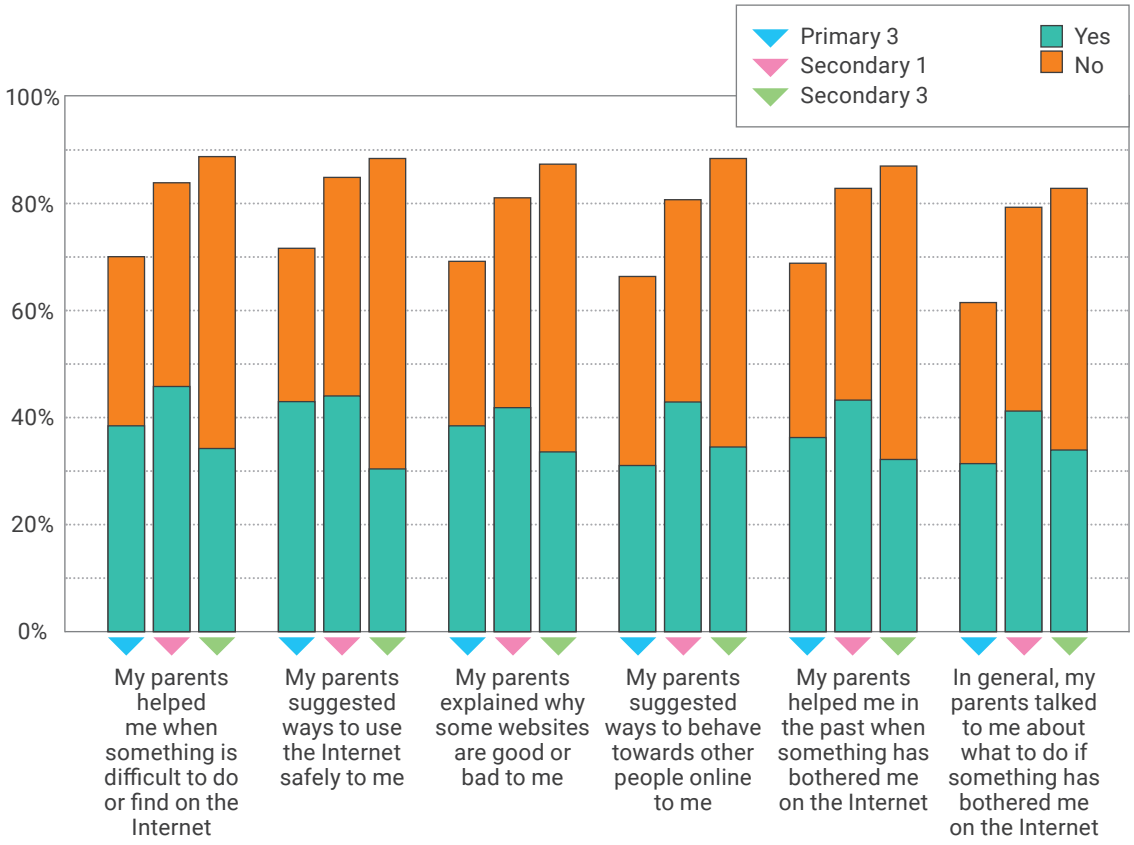


*Figure 24.* Percentages of Students Who Answered "Yes" or "No" Regarding Parental Support and Mediation (remainders to 100% answered "don't know").

### 4.4.2 Students at higher-grade levels most likely to turn to friends for help

Among the surveyed students, 14% of the P3, 15% of the S1, and 24% of the S3 students respectively, reported having experienced something on the Internet that had bothered them in some way. These students were further asked with whom they had talked about what had happened, using questions adapted from the EU Kids Online study (Livingstone et al., 2011). According to the results in Figure 25, secondary students appear to be less likely to seek help from others when they encounter something unpleasant on the Internet. Specifically, older cohorts of students are less likely to seek help from adults or family members but instead turn to their friends (most likely peers). Professionals such as teachers and social workers are among the least sought-after providers of help by students under such circumstances. It appears that older students are more independent, and the source of their social support gradually moves from family members and other adults to their friends.

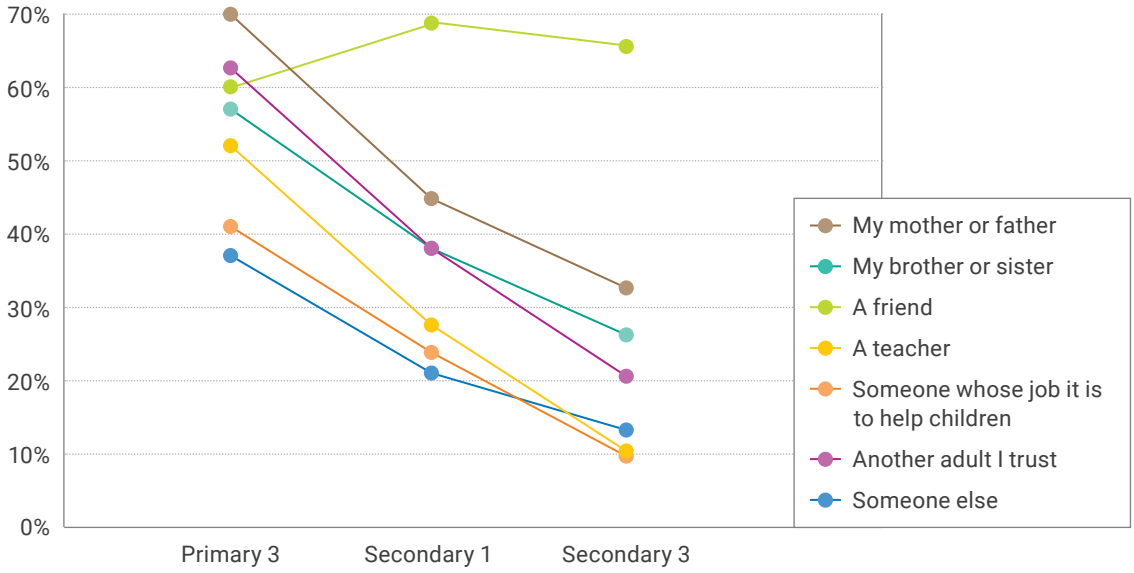


*Figure 25.* Percentages of Students Who Sought Help from Different People After Experiencing Something Bothering Online.

### 4.4.3 Perceived sources of digital skills

Questions from the ICILS 2013 study (Fraillon et al., 2014) were modified for the eCitizenship project to understand which persons helped students acquire different digital skills. Figure 26 shows the averages of eight items (e.g., accessing information with a computer, organizing information obtained from Internet sources, working out whether to trust information from the Internet) for all three cohorts. Older students were more likely to claim mastery of these essential digital skills and having learned the skills themselves. These results indicate that students might have developed these digital skills during senior primary school.

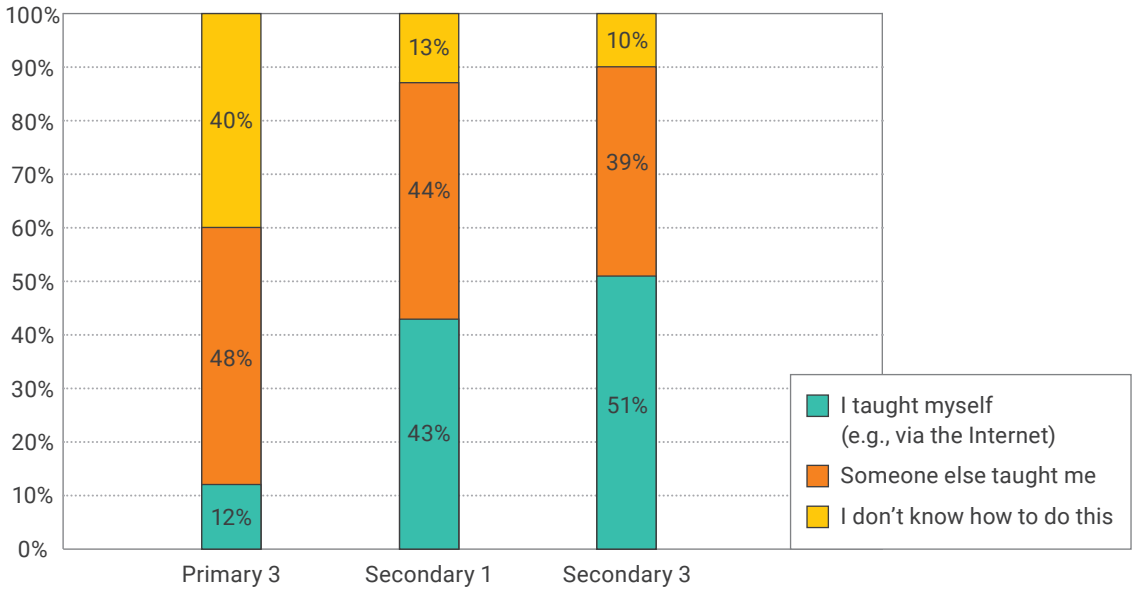


*Figure 26.* Sources of Students' Digital Skills (in percent).
*Note.* "Someone else taught me" captures five categories of external help, including parents, teachers, siblings, classmates and friends.

Students who said that they do not know how to do these things consistently showed the lowest performance in the digital literacy and CPS assessments. Those who reported having learned those digital skills by themselves had the highest levels of digital literacy and cognitive CPS process skills. This also applied to social CPS process skills, with two exceptions: Students who had learned from someone else how to present information for a given audience or purpose with a computer, and/or how to work out whether to trust information from the Internet, showed significantly better social CPS process skills than other students.

### 4.4.4. Teachers place little emphasis on evaluating online information

Teachers were surveyed on how much emphasis they placed on the development of several ICT-based capabilities in students, using questions adopted from the ICILS 2013 study (Fraillon et al., 2014). On average, the strongest emphasis was on the use of software to construct digital work products, such as presentations, documents or diagrams. The least emphasis was on the evaluation of the relevance and credibility of digital information. There were no statistical differences across the teachers of the three student cohorts, except for a greater emphasis placed by primary teachers on understanding the consequences of making information publicly available on the Internet and using computer software to construct digital work products.

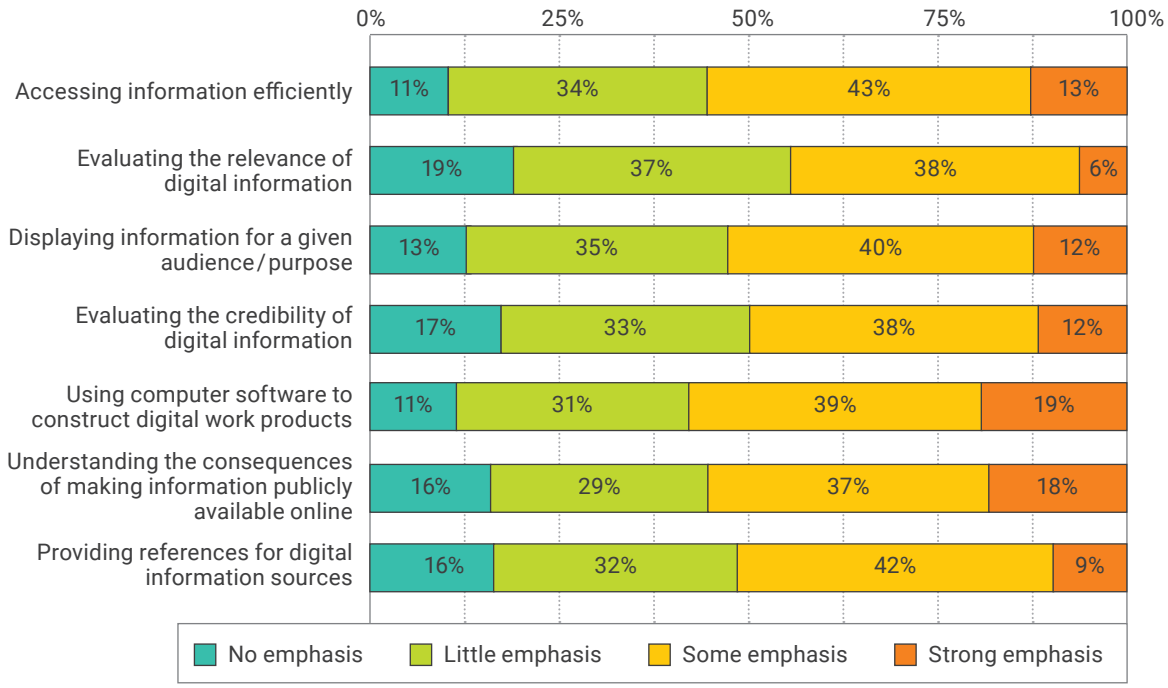


*Figure 27.* Teachers' Emphasis on Developing Students' ICT-based Capabilities.

The low emphasis on evaluating the relevance and credibility of digital information highlights a potential problem. Serious social and political ramifications caused by rampant propagation of "fake news", targeted propaganda and inaccurate information through social media have been widely reported globally. It is a concern that teachers do not recognize the need to take on the responsibility for helping their students evaluate the relevance and credibility of information. It is noteworthy that younger teachers reported more emphasis on the efficient access of information, the evaluation of the relevance and credibility of digital information, and the understanding of the consequences of publicly sharing information online than older teachers. This indicates a possible need for digital literacy related professional development among teachers, particularly for those who did not grow up with digital and social media.

## 4.5. Digital Participation—30% of students had no interest in social and political issues

Students were surveyed on how often they use online and offline media to find information about social or political issues. Starting from June 2019, Hong Kong has seen a protest movement that has staged events throughout the city, fueled and monitored by the extensive use of social media. Students constituted a sizeable proportion of the participants in these social movements, some as young as 11 years old. Note that the data collection for the current study was completed by April 2019, shortly before the social unrest. Hence, one needs to keep in mind that findings from students' reports of civic participation through conventional or digital means for civic- related activities reported here may have changed since the data was collected. Across the three cohorts, around 30% of the students indicated that they neither use online nor offline media to find information about social or political issues. On the

other hand, interest in finding such information increased with age. Offline, conventional media were more frequently used channels as shown in Figure 28. Male primary school students were somewhat more inquisitive, but there were no significant gender differences among secondary students

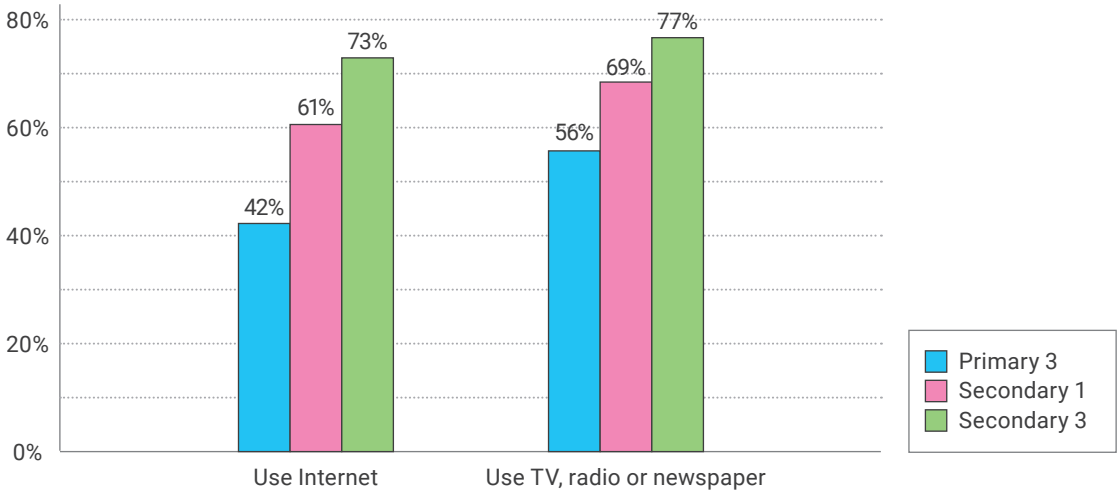


*Figure 28.* Percentages of Students Using Online and Offline Media to Find Information About Social or Political Issues.

While the students' interest in such information may be generally low, we find that secondary school students (but not primary school students) who reported using online and/or offline sources to gather information about social or political issues performed better in the digital competence assessments. Collaborative problem-solving performance showed stronger correlations with news gathering than digital literacy performance with news gathering. However, the identified associations were more noticeable for students in S3.

It has been widely reported that students comprise a significant proportion of those who participated actively in the anti-extradition bill social movement that started in June 2019. The strong participation of students in the social movement stands in stark contrast to the apparent lack of interest in social and political issues just a few months before the social movement started. This clearly shows that students' interests in social and political issues can be influenced strongly by social media and other influences in a very short time. This is an area that needs further investigation and research.

# 5. Conclusion and policy recommendations

As technology becomes essential to every aspect of life in the 21st century, more attention is given to the notion of "digital citizenship"–competence, wellbeing and participation empowered by and under the influence of information technology. Digital competence is compared to reading and writing literacy as a basic skill in everyday life, for learning, general well-being and career purposes. At the time of writing, school suspension is in place in many countries around the world, including Hong Kong, due to the spread of COVID19, and schools are obliged to move all teaching and learning activities online. While online learning can be stipulated at the policy level, how this is implemented, and its effectiveness depends greatly on the preparedness of teachers, schools, students and families. Students' access to appropriate digital learning technology at home, their digital competence, as well as their opportunities to learn and develop digital competence (which depends on the teacher's digital and pedagogical competence to design and implement effective online learning) are key factors regarding online learning preparedness.

As revealed in our findings, there are very large digital divides in all these aspects of digital learning preparedness, which are a particular concern during times of social stress. The research results show huge intraschool and inter-school diversity in students' digital competence. The intraschool differences increase with the age of the student cohort, indicating that the within-school digital divide is increasing with education level in the school system. While the digital competences of all three cohorts are not high, we also note that the competence of the S3 cohort is only marginally better than S1 students, indicating that most S3 students did not show gains in digital competence even though they have two more years of schooling compared to their S1 counterparts. Furthermore, although secondary students generally perform better than the P3 students, there are some primary schools in which more than 25% of students perform better than 25% of the students in some secondary schools. In the most extreme case, more than 25% of the P3 students in one school had higher scores than half of the students in a S3 class.

The divide in preparedness for online learning is also observed at the basic level of technology access. This is despite the finding reported by the Hong Kong Centre for Health Protection (CHP, 2019) and by other studies according to which access to digital devices for children starts early and is very common. Our findings show that a small percentage of students (8% of P3 and 1% to 2% of S1 and S3 students, respectively) did not have any access to digital devices at home. Of those who have access, some only have access to smartphones (5%, 8%, 7% for P3, S1 and S3), which is very inefficient for serious learning activities. Of those who have access to a device with a large display (desktop, laptop or tablet), many had to share access with other family members (between 40% to 51% for the three cohorts). This digital divide disadvantage at the access level can prove to be very damaging at times when online means of learning become the only channel for access to education.

Results from the collaborative problem-solving assessment show that Hong Kong secondary students had relatively high social process skills but only moderate cognitive process skills. Students need help to develop better meta-cognitive knowledge and strategic planning and application skills in problem solving. Our findings also indicate that digital literacy and collaborative problem solving are distinct competences that may require different forms of educational support and pedagogical intervention.

Significant proportions of the surveyed students in all cohorts reported using digital devices for more than two hours every day for various purposes, exceeding the CHP's (2019) recommended daily recreational screen time of no more than two hours for primary school students. Excessive usage appears to be problematic and may hamper students' digital literacy development. Our survey findings further show that one in ten students were at risk of Internet addiction.

The availability of digital technologies and social media also brings other risks for well-being and safety. Up to 35% of students reported having been a victim and/or a perpetrator of cyberbullying. While teachers seem to be aware that cyberbullying is a problem among their students, most believe that it is only a minor issue, and many are unaware of whether their school has a cyberbullying policy in place. Since cyberbullying experiences are not only a health risk but also negatively associated with digital competences, schools should provide clear and explicit guidelines and implementation strategies to address these issues.

Digital literacy is core not only to digital preparedness for learning, but also for cyberwellness. It helps to protect against online risks. Students with limited digital literacy are more likely to encounter online risks. The unauthorized use of personal information by others and computer viruses are common problems reported by the surveyed students. Surprisingly, about 10% of all surveyed students reported having lost money to an online scam. Many students seem to be aware of these risks and believe that they can handle them, but the results also suggest that students need to learn how to protect their data and privacy. At least, school students may benefit from education pertaining to financial services and online scams.

At the time when these data were collected, about 70% of Secondary 3 students and just over one third of Primary 3 students reported having searched for information about social or political issues online. The apparent strong interest and participation by adolescent students both online and offline during the anti-extradition bill social movement is totally unpredicted by the relatively low interest in such matters found in the present study. Further in-depth studies should be conducted to explore how far engagement in social and political issues is dependent on the prevailing social environment, and whether the proneness to environmental influence is correlated to a person's digital competence.

Digital competence as well as appropriate values and dispositions to contribute as digital citizens are important learning outcome goals for school education in Hong Kong and in other parts of the world. It is paradoxical that the unprecedented global connectedness that we are experiencing also creates unprecedented crisis situations, such as the COVID19 pandemic that forces individuals, communities and countries to self-isolate and practice social distancing. Digital means of communication and social connectivity offers alternative ways for individuals and societies to continue with their everyday activities such as teleworking, online learning, digital commerce and transactions in diverse social, economic and political arenas. Our findings reported here show that our students, our schools, and our educational system are not well-prepared for these challenges. In order to address the digital divide and to enhance the digital preparedness of our education system, we recommend the following policy priorities:

1. Ensure that each student has access to personal digital devices with large display and broadband access for learning at home.

2. Put digital competence as a core curriculum element to be integrated throughout K-12 education and develop adequate curriculum and pedagogical guidelines for their teaching.

3. Provide professional development support to teachers and school leaders on digital citizenship.

4. Support research and development on digital citizenship education, including parental education for digital citizens.

# Appendix: Measurement of digital literacy

As noted in the main report, all test items were assigned to one of the five dimensions in the DigComp 2.1 framework (Carretero et al., 2017): Information and data literacy, communication and collaboration, digital content creation, digital safety, and problem solving in ICT environments. Table A1 below summarizes the competence means for each cohort.

Table A1
*Average Scores by Competence Area and for Each Cohort*

| DL competence dimension | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|
| Information and data literacy | -0.75 | 0.35 | 0.51 |
| Communication and collaboration | -0.76 | 0.35 | 0.52 |
| Digital content creation | -0.71 | 0.33 | 0.48 |
| Digital safety | -0.75 | 0.36 | 0.5 |
| Problem solving | -0.75 | 0.35 | 0.51 |
| Overall digital literacy score | -0.76 | 0.36 | 0.52 |

*Note.* The scores were scaled to have a mean of zero across the three cohorts. Higher scores indicate better performance.

Although students' scores on the five competence dimensions were highly correlated, it is important to understand what is assessed under each dimension. In this section we look at the five competences one by one. The table shows that the older cohorts consistently performed better than the younger cohorts of students in all five competence areas. However, it is noteworthy that the performance differences were slightly smaller for digital content creation when compared with the other four competences.

In the subsections of this appendix, we illustrate the performance levels with descriptions of the tasks students were asked to complete using easy, moderately easy, and difficult assessment items. In the tables below, "correct (%)" indicates how many students of each cohort correctly answered the sample question. "Average score" is the mean performance score (across the test items of the respective dimension) of the students who were able to give a correct answer to the sample question. The score is always higher than the average score of all students, as it has already excluded students who were not able to answer these questions. The average score so calculated is also higher for more difficult questions as students who were able to give a correct answer to a more difficult question would have a higher ability in the particular dimension.

## Dimension 1: Information and data literacy

Information and data literacy captures students' capacity to browse, search and filter data, information and digital content; to evaluate data, information and digital content; and to manage data, information and digital content (Carretero et al., 2017). Detailed competence descriptions as well as sample items are shown in Table A2. Note that the difference between S1 and S3 students who correctly answered the sample question for advanced literacy was

very small and occurred only by chance (i.e. it was not statistically significant, and one should not interpret too much meaning into this particular result).

Table A2

*Level Descriptors for Information and Data Literacy and Sample Questions for the Different Difficulty Levels*

| | | | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|---|---|
| **Basic literacy** | Competence description | | Students can conduct simple and well-defined search routines in digital environments; they can also access digital content and organize it in a straightforward fashion. | | |
| | **Sample item** | Question | *Students selected one out of four keywords that is most suitable to find a repair store in Hong Kong.* | *Given a spreadsheet with two columns of 5 fictitious names and corresponding test scores, students indicated which setting would order the list from the highest to the lowest score.* | |
| | | Correct (%) | 54% | 80% | 85% |
| | Average score | | -0.47 | 0.52 | 0.67 |
| **Intermediate literacy** | Competence description | | Students can organize information searches, as well as analyze and evaluate the credibility of well-defined sources of information; they are also able to interpret and evaluate digital content and to organize data and information to be easily stored and accessed. | | |
| | **Sample item** | Question | *In this scenario, the task was to transfer a file from a computer to a USB flash drive. Students saw an interactive display of the context menu (i.e. the menu that opens upon right-click on the file to be transferred) and in this menu they clicked on the option that would perform the file transfer.* | | *Given screenshots of four websites about internships, students judged which most likely had questionable credibility.* |
| | | Correct (%) | 17% | 63% | 43% |
| | Average score | | -0.21 | 0.69 | 0.80 |
| **Advanced literacy** | Competence description | | Students can adapt search strategies to find the most appropriate data and personalize these search strategies, they have the capacity to critically evaluate the credibility of different data sources and to process and manipulate digital content for appropriate storage and easy retrieval. | | |
| | **Sample item** | Question | *From a list with five keywords, students identified all appropriate search terms for an online search aimed at finding a Thai restaurant in proximity. This was more difficult for students than the simple search routine described above, because students (a) selected from five instead of four choices; (b) had to identify multiple keywords; and (c) the location was not explicitly given in the question (i.e. instead of a set location such as "Hong Kong" the search should use location information provided by the mobile device).* | | |
| | | Correct (%) | 10% | 17% | 15% |
| | Average score | | -0.24 | 0.76 | 0.90 |

## Dimension 2: Communication and collaboration[3]

Communication competence measures students' ability to interact with others and to share content through digital technologies, to adopt appropriate online behavior when interacting with others, and to manage their digital identity (Carretero et al., 2017). The competence levels are described in Table A3.

Table A3

*Level Descriptors for Communication and Collaboration and Sample Questions for the Different Difficulty Levels*

| | | | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|---|---|
| Basic literacy | Competence description | | Students can identify appropriate simple means to communicate and share digital content in a given context, conduct simple and routine interactions, and they can identify and distinguish well-defined digital identities. | | |
| | Sample item | Question | *Students were given details about the birthday party of a close relative and out of four different choices, they selected an appropriate template for a digital invitation card.* | | |
| | | Correct (%) | 82% | 92% | 93% |
| | Average score | | -0.65 | 0.42 | 0.61 |
| Intermediate literacy | Competence description | | Students can select a variety of digital technologies appropriate to communicate and share digital content in a given context; they can also display a variety of digital identities and discuss behavioral norms. | | |
| | Sample item | Question | *Students chose the most appropriate of four possible responses to hostile communications among classmates on social media.* | *Students selected the most appropriate of four possible ways on how to work (i.e. store, share, modify digital documents) efficiently with two classmates on a collaborative group project involving digital data and files.* | |
| | | Correct (%) | 36% | 51% | 70% |
| | Average score | | -0.33 | 0.59 | 0.71 |
| Advanced literacy | Competence description | | Students can use the most suitable communication means, and appropriately adapt their communication strategies to various contexts and audiences; they can share digital content in a variety of ways and have the ability to protect their digital identities in various ways. | | |
| | Sample item | Question | *Students selected all appropriate actions given a situation in which they received an email chain letter from a friend demanding under the threat of bad luck to forward it to others.* | | |
| | | Correct (%) | 6% | 28% | 22% |
| | Average score | | -0.20 | 0.81 | 1.08 |

3 Collaboration competence was measured in a separate assessment (see Section 3).

## Dimension 3: Digital content creation

Students competence in the area of digital content creation comprises their capacity to develop digital content and to understand issues related to copyright and licenses in digital environments (Carretero et al., 2017). This competence was captured by a relatively small set of questions and therefore only one sample question is summarized in Table A4 as most questions captured an intermediate level of digital content creation competence. It measures whether students are able to indicate how to edit, create and change digital products, whether they know and understand rules of copyright and licenses that apply to digital content, and to choose the most appropriate rules in applying that understanding to digital data and information.

Table A4
*Sample Question for Digital Content Creation*

| | | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|---|
| **Sample item** | Question | *Students reviewed four scenarios (such as someone drawing a painting of beautiful scenery and sharing it on WeChat) and selected the one scenario that could be considered a violation of intellectual property rights.* | | |
| | Correct (%) | 25% | 42% | 47% |
| Average score | | -0.63 | 0.49 | 0.66 |

## Dimension 4: Safety

Digital safety captures students' competence in protecting digital devices, personal data, and privacy, as well as health and well-being while using digital devices (Carretero et al., 2017). The competence levels and sample questions are described in Table A5. Note again that the differences between students in S1 and in S3 on the sample question for advanced literacy were not statistically significant and should therefore not be overinterpreted.

Table A5

*Level Descriptors for Digital Safety and Sample Questions for the Different Difficulty Levels*

| | | | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|---|---|
| **Basic literacy** | Competence description | | Students can select simple ways of protecting their devices, privacy and digital content, they can identify simple privacy policies, as well as differentiate and select simple ways to avoid health risks and threats to physical and psychological well-being. | | |
| | **Sample item** | Question | *Students selected the most appropriate action in response to witnessing a friend uploading a photo of someone else with insulting comments on social media.* | | *Students indicated which one of four emails posed no threat to their online security.* |
| | | Correct (%) | 73% | 96% | 84% |
| | Average score | | -0.53 | 0.42 | 0.59 |
| **Intermediate literacy** | Competence description | | Students can select safety and security measures, organize ways to protect their devices, and explain how to behave online with respect to privacy; they can also discuss ways to protect their personal data and select ways to protect themselves and others in digital environments. | | |
| | **Sample item** | Question | *Students saw a pop-up window in a browser asking whether or not to save a password in the browser. Students selected the best action by choosing from four options.* | *Students saw a screenshot of a browser message according to which the selected weblink posed a data security risk; they then selected from a list of four options the most appropriate action in response to that message.* | |
| | | Correct (%) | 29% | 62% / 60% | 62% |
| | Average score | | -0.47 | 0.53 / 0.53 | 0.68 |
| **Advanced literacy** | Competence description | | Students can choose the most appropriate protection for devices, digital content and privacy, evaluate the most appropriate ways for sharing digital content such as personal information, and adapt appropriate ways to protect themselves and others from health risks in digital environments. | | |
| | **Sample item** | Question | *Students selected all safe ways to use a USB flash drive with a computer from a list of four possible choices. This was more difficult than other tasks because students had to identify all possible ways to safely use a flash drive, and some of these choices may be more common and intuitive than others.* | | |
| | | Correct (%) | 5% | 23% | 18% |
| | Average score | | 0.03 | 1.05 | 1.10 |

## Dimension 5: Problem solving

This competence measures students' ability to solve technical problems and to identify digital competence gaps (Carretero et al., 2017). Sample questions are shown in Table A6 along with descriptions of the performance levels.

Table A6

*Level Descriptors for Problem Solving Using ICT and Sample Questions for the Different Difficulty Levels*

| | | | Primary 3 | Secondary 1 | Secondary 3 |
|---|---|---|---|---|---|
| **Basic literacy** | Competence description | | Students can identify and solve simple digital problems when using digital devices; they can also recognize where their digital competence needs to be improved and identify how to keep up-to-date with digital developments. | | |
| | **Sample item** | Question | *Shown images of three smartphone screens each indicating a common technical problem, students suggested the appropriate solution for each problem using drag-and-drop.* | | *Not captured by any item in the assessment.* |
| | | Correct (%) | 74% | 95% | |
| | Average score | | -0.53 | 0.45 | |
| **Intermediate literacy** | Competence description | | Students are able to differentiate technical problems when using digital devices and select solutions to solve these problems; they can also discuss where their digital competence needs to be improved or updated and indicate how to support others in their digital competence development. | | |
| | **Sample item** | Question | *Students saw a screenshot of a browser with multiple open tabs and selected the most efficient action that would enable the return to these webpages in the future without having to find all webpages anew from scratch.* | | |
| | | Correct (%) | 21% | 54% | 67% |
| | Average score | | -0.35 | 0.69 | 0.76 |
| **Advanced literacy** | Competence description | | Students can assess and appraise technical problems in digital environments and apply the most appropriate solutions; they have the capacity to identify and choose the most appropriate ways and opportunities to improve their digital competence, and they can assess the digital competence needs of others. | | |
| | **Sample item** | Question | *From four possible options, students selected all that could solve the problem of not hearing any audio from the computer while watching a video on it.* | | *Students chose from a list of six skills all those needed to create a short video.* |
| | | Correct (%) | 17% | 42% | 43% |
| | Average score | | -0.14 | 0.73 | 0.95 |

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