# Unlocking Insights: Harnessing Primary School Children's Experiences and Reflections on Emergency Remote Learning to Shape K-12 e-Learning in the Post-Pandemic Era

**Maria Meletiou-Mavrotheris, Zoe Oikonomidou, Nektaria Klada and Argyro Fyseki**[1]
European University Cyprus, Nicosia, Cyprus

m.mavrotheris@euc.ac.cy

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**Abstract:** The study aimed to investigate the impact of the COVID-19 pandemic on primary education in Cyprus and to discern the implications for the post-pandemic era, specifically focusing on the Emergency Remote Learning (ERL) experiences and reflections of upper primary students (ages 9-12). Grounded in socio-constructivist learning theory, which emphasizes the importance of active student engagement and social interaction in the learning process, the research explored the challenges students faced during the rapid shift to remote education. A mixed-methods design was employed, using an in-depth online survey that incorporated both quantitative and qualitative questions. Data were collected from a sample of 204 students selected through non-probability, convenience sampling. The analysis revealed that students experienced several challenges, including technology constraints, lack of interaction, and difficulty maintaining concentration, which are consistent with global findings on K-12 ERL. Among demographic factors, the type of school attended (public vs. private) had a significant influence on most aspects of students' ERL experience. Private school students reported more favourable conditions than their public school counterparts, which facilitated a smoother shift to both asynchronous and synchronous ERL, resulting in a more positive overall ERL experience. Regardless of the type of school attended, students overwhelmingly expressed a strong preference for face-to-face learning. Comparisons with other studies conducted in Cyprus during the same period involving older student age cohorts suggest significant age-related differences. The young students in our study encountered greater challenges during the transition to ERL, which can be attributed to their heightened need for scaffolding and external regulation to learn in the virtual space, as well as the higher importance they attached to the social aspects of school life taken away by ERL. Despite their largely negative experiences with ERL, a high proportion of the children advocated integrating the e-learning tools and technologies they got acquainted with during ERL into the normal context of schooling. These findings underscore the importance of further research into effective instructional strategies tailored to young learners in both online and blended learning settings. They also highlight the potential benefits of incorporating e-learning tools into conventional classrooms to enhance the teaching and learning process.

**Keywords**: COVID-19, Primary education, Students' perceptions, Emergency remote learning, Online learning, e-Learning

## 1. Introduction

The conditions imposed by the outburst of the COVID-19 pandemic, which led to a general lockdown and social distancing had a major impact on all areas of human activity, with education being one of the sectors most severely affected. The suspension of face-to-face education presented unprecedented challenges, causing the most significant and widespread disruption in educational history (UNESCO, 2020), affecting nearly all students worldwide, and causing major implications for both the delivery and experience of education (Meinck, Fraillon and Strietholt, 2022). Nonetheless, educators and educational systems globally made massive efforts to sustain the educational process, swiftly transitioning to online forms of instruction to mitigate the repercussions of school closures on student learning. Students were hurried to online learning platforms and to what has come to be known as Emergency Remote Learning (ERL), a term coined to depict the sudden shift to an alternate instructional mode during crisis situations (Barbour et al., 2020), and to distinguish it from intentionally planned and executed online learning in non-crisis circumstances (Johnson et al., 2023).

During the pandemic's first peak in 2020, researchers globally engaged in empirical research aimed at examining the impact on education of the seismic shifts in both school as a physical structure and schooling as a broader concept (Stone-Johnson, 2020). While a considerable amount of research has examined the pandemic's impact on education, much of it has focused on higher education and specific disciplines (Tang, 2023). Studies on primary education are limited, and even fewer have investigated how young students, particularly in primary schools, adapted to the abrupt shift to ERL. Understanding how younger students navigated this transition is crucial, as they may have faced distinct challenges compared to older students, especially in terms of digital literacy, learning environments, and educational support at home. This study addresses the gap by focusing



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specifically on upper primary school students (ages 9-12) in Cyprus, exploring their experiences during the initial lockdown in March 2020 and reflecting on the implications for K-12 education post-pandemic.

The core educational problem this study aims to investigate is how the abrupt shift to ERL impacted primary students' learning experiences and outcomes. In particular, this research seeks to examine the challenges students faced, the effectiveness of the ERL implementation, and the broader implications for future education in the post-COVID-19 era. By focusing on students' own perspectives, this study aims to provide valuable insights into the needs and adaptations required for young learners in ERL situations.

The following research questions guided the study:

- What were students' technological background and level of technology use at home and school prior to COVID-19, and how did these vary based on demographic characteristics (gender, grade level, type of school)?
- How was ERL implemented during the first lockdown and how did this vary based on students' demographic characteristics?
- What issues and challenges did students face during the transition from face-to-face to ERL and how did these vary based on demographic characteristics?
- What were students' reflections on their ERL experience and suggestions for the post-COVID-19 era?

## 2. Literature Review

The COVID-19 crisis acted as an accelerator for educational change, providing a unique opportunity for digitalizing education and transforming educational infrastructures and services into a new, unprecedented reality. The sudden transition to ERL, compelled educators of all levels worldwide to rapidly integrate modern internet technologies into teaching and learning processes, as these became the sole medium available (Xu and Xue, 2023). This was instrumental for the promotion of e-learning platforms and tools (Tang, 2023). Despite the abruptness of this transition, educators demonstrated remarkable resilience, adapting traditional face-to-face instruction to virtual environments while exploring innovative pedagogical approaches (Kosmas et al., 2022). This shift, which starkly contrasted with the slow pace of technological adoption in mainstream classrooms pre-pandemic (Sofianidis et al., 2021), allowed educators to cultivate valuable skills in online learning environment design and management (Kosmas et al., 2022). However, the process was fraught with challenges, as most educational systems were ill-equipped for the swift changes required in course design, delivery, and infrastructure, which occurred too rapidly to enable a systematic and organized move to the virtual space (Schueler and West, 2023). Educators grappled with restructuring curriculum, pedagogy, and assessment methods for virtual instruction, facing heightened levels of anxiety and burnout amidst limited support and resources (Santagata et al., 2023).

Students also had to cope a wide range of educational, psychological, social, and technological challenges during the transition to ERL (Giannoulas et al., 2021; Meletiou-Mavrotheris et al., 2022). These challenges can be partly explained by Self-Determination Theory (Deci and Ryan, 2000), which posits that students' motivation and well-being are driven by their need for autonomy, competence, and relatedness. During the transition to ERL, students' experiences of autonomy in learning were hindered by the lack of direct engagement with teachers and peers, while technological hurdles and academic losses weakened their sense of competence (Giannoulas et al., 2021). Additionally, social isolation eroded students' sense of relatedness, increasing stress and diminishing their sense of community within the learning environment. The transition to online education also undermined the adoption of pedagogical models driven by the socio-constructivist theory (Vygotsky, 1978), which highlights the importance of social interaction and collaboration in the process of knowledge construction. In a traditional classroom setting, students depend on direct interactions with peers and teachers to create meaningful learning experiences. However, during the ERL period, they were largely deprived of this social environment, which may have impeded the process of knowledge construction. Studies indicate that many students found it difficult to engage with ERL, as it offered fewer opportunities for the kind of collaborative learning essential to socio-constructivism (Kosmas et al., 2022).

In an effort to comprehensively present the impact and implications of COVID-19 on K-12 and tertiary education, Tang (2023) conducted a systematic review of the relevant literature using the PRISMA model. The review showed that the shift to ERL affected learners and educators across all levels in multiple ways, especially in relation to learning loss, limitations in methods of instruction and assessment, technology constraints, and adverse effects on psychosocial well-being. These impacts were exacerbated by disparities in resource distribution and socio-economic, gender, ethnic, and disability-related inequities. Tang's (2023) review of 41

 

studies found a focus on higher education, with only 10 papers addressing the impact of COVID-19 on pre-primary/primary education. Survey studies on primary education mainly involved teachers and parents due to limitations in children's participation. Non-survey studies focused on quantifying learning gain or learning loss, with findings indicating learning loss or slower gains, especially among students from disadvantaged backgrounds. Regarding students' engagement in ERL, studies highlighted challenges such as increased screen time, technological hurdles, and connectivity issues. The review also identified numerous challenges faced by teachers, including technological and pedagogical issues, resource scarcity, and limited student engagement. . It also revealed parents' concerns about the quality and time-consuming nature of ERL, mirroring teachers' challenges in student engagement and effective tool selection. Regarding children's psychological well-being, home confinement was reported to negatively impact their social, physical, and mental well-being, with insights primarily drawn from parental and/or teacher observations.

Yun (2023) conducted a systematic review of articles focused on the challenges faced by the education sector during the crisis period, again using the PRISMA approach. Four themes emerged. The first theme highlighted challenges of transition to online teaching and learning, which fell into three main sub-clusters: technological tools, digital competences, and acceptance of e-learning. The second theme highlighted professional digital competence and pedagogy challenges faced by teachers due to limited prior exposure to e-learning tools and online pedagogy. The third theme underscored educational inequality and psychological challenges, including unequal access to reliable internet and devices widening learning gaps, and student well-being concerns (e.g. excessive workload, mental stress). The final theme centred on challenges to the sustainable development of digitalized learning and highlighted the importance of digital literacy in strengthening and advancing sustainable education while promoting inclusive opportunities for all students post-COVID. Yun's (2023) review findings are consistent with Self-Determination Theory (Deci and Ryan, 2000), as inequitable access to resources weakens students' sense of autonomy and competence, leading to decreased motivation and engagement.

Xu and Xue (2023) conducted a meta-analysis spanning two decades, involving 93,686 participants across 26 countries, to assess online education satisfaction. They found student, teacher, and parent satisfaction rates of 59.5%, 75.3%, and 70.7% respectively, with students exhibiting significantly lower satisfaction. The authors attributed this to differing evaluation criteria, stressing the influence of social interactions with teachers and peers on student satisfaction, while noting that such interactions have lesser impact on teacher and parent satisfaction. Comparing satisfaction levels in ERL to non-emergency settings, they found significant drops for both students (47.1% vs. 62.3%) and teachers (40.6% vs. 79.5%). The abrupt shift to ERL, compounded by teachers' insufficient lesson design and lack of online pedagogy training, contributed to decreased satisfaction and negatively impacted mental health and academic performance. Regarding educational level, Xu and Xue (2023) found that a significantly higher proportion of adult education learners expressed satisfaction with online study compared to K-12 and university students.

Most of the studies reviewed by Yun (2023) and Xu and Xue (2023), similarly to Tang's (2023) review, centred on higher education, reflecting the dominant research focus on tertiary-level education amid the pandemic. Only few studies explored the impact of COVID-19 on primary and secondary education. Moreover, given that, in contrast to K-12 settings, online teaching and learning has been established in higher and adult education for years (Martin, Xie and Bolliger, 2022), most of the pre-pandemic online learning literature also originated from higher or adult education (Barbour, 2018). The extent to which the findings of this literature generalize to K-12 settings remains unclear (Schueler and West, 2023).

In summary, the abrupt closure of schools during the COVID-19 lockdown and the rapid shift to ERL was an unprecedented and dramatic experience for the global educational community. The limited research on K-12 students' experiences, particularly those of primary students, during this transition prompted the current study, which aimed to explore how upper primary students in Cyprus navigated the educational changes brought on by the pandemic and how these insights can inform post-pandemic education. Grounded in Self-Determination Theory (Deci and Ryan, 2000), the study sought to provide a deeper understanding of the challenges that students faced during ERL. This theoretical foundation also offered a framework for interpreting students' reflections and suggestions for the development of more resilient and adaptive educational practices in the post-pandemic era.

# 3. Methodology

## 3.1 Research Design

The study employed a mixed-methods design, combining both quantitative and qualitative data to provide a comprehensive understanding of upper primary school students' experiences with ERL. The rationale behind choosing a mixed-methods approach was to triangulate the findings with both quantitative data and qualitative insights, thereby strengthening the study's overall validity (Creswell and Plano Clark, 2018). Quantitative data helped to identify general trends in students' ERL experiences, while qualitative data allowed for deeper exploration of students' personal reflections and challenges during this transition. The convergence of these methods ensured that both the breadth and depth of students' ERL experiences were captured, with qualitative insights enriching the interpretation of the quantitative results.

The research adopted a convergent parallel mixed-methods approach, where qualitative and quantitative data were collected concurrently and analysed independently. The results were then merged during the interpretation stage to provide a comprehensive account of students' ERL experiences. This approach allowed the qualitative data to deepen the understanding of patterns identified in the quantitative results, yielding a richer and more perspective on the research problem and questions.

## 3.2 Instrument Development and Constructs

A survey instrument targeting upper primary school students (Grades 4–6, ages 9–12) was carefully designed to address the study's primary aim and research questions. To enhance content validity, its development was informed by both the relevant international research literature and earlier surveys conducted by the first author during the early stages of the pandemic (EDUCAUSE, 2022; Meletiou-Mavrotheris et al., 2023; Sofianidis et al., 2021), ensuring that the measured constructs were reliable and relevant to the pandemic's impact on primary education. The survey primarily consisted of closed-ended Likert-scale and multiple-choice questions, with a few open-ended items included to allow for elaboration on students' ERL experiences.

The instrument was initially pilot-tested with five students (who were later excluded from the final sample) to evaluate its clarity, validity, and relevance. Feedback from the pilot phase led to refinements in wording and structure, ensuring the instrument was both age-appropriate and aligned with the study's aim.

The final version of the survey comprised 34 questions: 28 closed-ended and 6 open-ended, organized into five sections. Section 1 collected demographic information: gender, school grade, type of school (public or private). The remaining sections examined three key constructs, carefully selected in alignment with the Self-Determination Theory framework (Deci and Ryan, 2000), which asserts that students' motivation and learning experiences are influenced by their feelings of autonomy, competence, and relatedness. These constructs were deemed appropriate for understanding the challenges students encountered during ERL, especially in terms of how the pandemic influenced their motivation and engagement with learning. The constructs are as follows:

- **Technological Background and Usage:** This construct explored in Section 2 of the survey (Technology Access and Usage prior to the pandemic), was informed by research on digital literacy and students' readiness for online learning (Barbour, 2018). It investigated children's access to devices and personal study space, and their technological background and use of ICT at home and in school before the lockdown, factors which are critical to shaping learning in online contexts (Schueler and West, 2023).
- **ERL Implementation:** Sections 3 and 4 of the survey were developed based on literature on ERL (Johnson et al., 2023; Barbour et al., 2020). These sections aimed to capture the different modalities (synchronous vs. asynchronous) and platforms utilized during ERL, as well as the challenges students encountered during this sudden shift. The questions were designed to reflect the distinct nature of ERL as an emergency-driven approach, separate from traditional online learning models. Section 3 examined technology use post-lockdown, including the initiation of asynchronous material sharing, the tools and applications employed during ERL, and the availability of synchronous sessions. Section 4, completed by students who participated in synchronous ERL, inquired about the timing and platforms used during synchronous sessions, along with any difficulties experienced during the shift to ERL.
- **Challenges and Reflections:** Section 5 featured reflective open-ended questions designed to students' perspectives on the implementation of ERL. Drawing from research on student engagement and psychological well-being during ERL (Kosmas et al., 2022), these questions explored the key challenges students faced, including social isolation and technological obstacles. They also inquired about

 

measures taken by teachers to foster interaction and socialization, students' coping strategies to manage stress and anxiety, and which ERL practices students hoped would continue after the return to regular classroom settings. The open-ended format allowed students to provide thoughtful feedback on their ERL experiences and offer suggestions for improving post-pandemic education.

### 3.3 Data Collection and Analysis Procedures

The survey was conducted between mid-July and early September 2020, coinciding with the summer holiday period. A non-probability, convenience sampling method was used, as direct distribution to schools was not feasible due to pandemic restrictions and the timing of administration. After obtaining approval from the Cyprus Centre of Educational Research and Evaluation and the Ministry of Education, invitation letters explaining the study's purpose and providing a survey link were sent via email to the teachers' trade union board and to primary school parent associations. The teachers' trade union board, representing most primary school teachers in Cyprus, informed its members about the study and encouraged them to contact the parents/guardians of students in their class/school that had been enrolled in Grades 4-6 during the 2019-2020 school year. Likewise, parent associations' representatives distributed an invitation letter with a survey link to their members. Parents/guardians who consented, then forwarded the survey to their child for completion. Participation in the survey was voluntary and anonymous, with no personal information collected.

The quantitative data from the survey, consisting of 28 closed-ended questions, were analyzed using IBM SPSS Statistics software, employing descriptive and inferential statistics to address the research questions. Descriptive statistics (e.g. frequencies, percentages, means) summarized student responses, while inferential statistics (Mann-Whitney U tests, Kruskal-Wallis tests, t-tests, ANOVA) were used to identify variations in responses based on demographic characteristics (gender, grade level, type of school).

For the six open-ended questions, a qualitative thematic analysis approach was employed (Braun and Clarke, 2006). This involved coding the responses, identifying recurring themes, and grouping them into broader categories. Both inductive and deductive approaches were used to ensure that the analysis accurately captured the nuances of students' experiences while aligning with the research questions. This thematic analysis provided deeper insights into students' emotional and reflective responses, complementing the statistical findings from the quantitative data and offering a more comprehensive understanding of their transition from traditional to ERL environments.

### 3.4 Participants' Demographic Characteristics

The survey distribution method allowed for a wide reach across Cyprus, though it relied on teachers and parents to forward the survey to eligible students. A total of 204 primary school students completed the survey, with an even distribution of boys (n = 106, 52.0%) and girls (n = 98, 48.0%). Grade distribution was relatively balanced: 38% in Grade 4 (n = 77), 31% in Grade 5 (n = 64), and 31% in Grade 6 (n = 63). The majority of students (85%, n = 173) attended public schools, while 15% (n = 31) were enrolled in private schools, reflecting fairly well the typical distribution of primary school students in Cyprus. Thus, while the sample was non-random, the demographic composition of the participants closely mirrored that of the broader population of upper primary students in Cyprus in terms of gender, grade distribution, and the proportion of public vs. private school attendees. As such, the sample was considered sufficiently representative of the study's target population (ages 9-12 in Grades 4-6) for the purposes of this research.

## 4. Results

The survey findings have been organized into the following four sections, reflecting the research questions.

1. Technological background and technology use pre-pandemic
2. The transition to ERL
3. Issues and challenges during the transition to ERL
4. Students' reflections on their ERL experience.

The impact of students' demographic characteristics (gender, grade, type of school) on their technological background and ERL experience was explored during the analysis. Relevant results are presented in the sections that follow.

### 4.1 Technological Background and Technology use Pre-Pandemic

#### *4.1.1 Technological background*

The survey utilized a five-level Likert scale (1 = None at all…5 = Excellent) to gauge participants' proficiency in using PCs/laptops and tablets/smartphones. Around four-fifths (82.9%), rated their PC/laptop skills at intermediate level or higher, with one-fifth (21.6%) considering themselves to have excellent skills. Conversely, nearly everyone (88.7%) rated their proficiency with mobile devices as very high or excellent, with no participant indicating complete lack of familiarity.

Table 1 displays the results of Mann-Whitney U tests, revealing no gender-related differences in students' self-reported proficiency for either PCs/laptops (p = -0.203 > 0.05) or tablets/smartphones (p = 0.939 > 0.05). However, significant differences were observed between public and private school students for both PCs/laptops *(p < 0.01)* and tablets/smartphones *(p < 0.01)*. Additionally, Kruskal-Wallis tests revealed significant grade-related differences for both PCs/laptops *(p < 0.01)* and tablets/smartphones *(p < 0.01)*.

**Table 1: Mann Whitney U tests for impact of gender and type of school, and Kruskal Wallis H for impact of grade level on self-reported level of proficiency in the use of PCs/Laptops and tablets/smartphones**

| Statement1 | Gender differences | | | Type of school | | | Grade level | |
|---|---|---|---|---|---|---|---|---|
| | U(106, 98) | z | p | U(173, 31) | z | p | H(2, n=204) | p |
| **PCs/laptops** | 4677.0 | -1.27 | -0.203 | 680.0 | 6.855 | **<0.01** | 42.35 | **<.01*** |
| **Tablets/smartphones** | 5166.0 | -0.08 | 0.939 | 1788.0 | 3.392 | **<0.01** | 9.814 | **<.01*** |

*Statistically significant at a=0.05

As shown in Figure 1, students' self-reported level of proficiency tended to increase with grade/age.

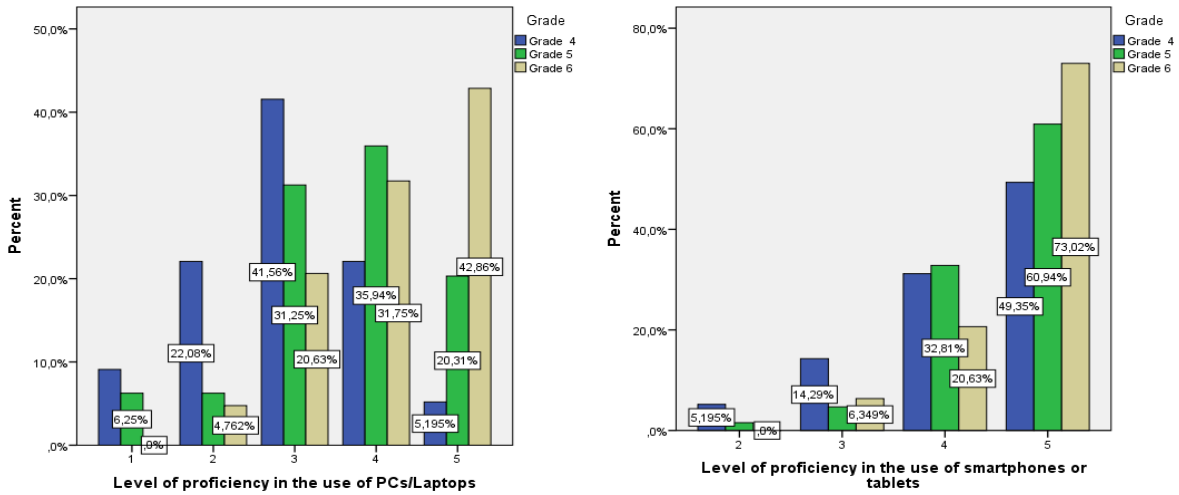


**Figure 1: Self-reported levels of proficiency with PCs/laptops and tablets/smartphones, separated by grade level**

Public school students tended to rate their proficiency lower, especially with PCs/laptops (see Figure 2).

 

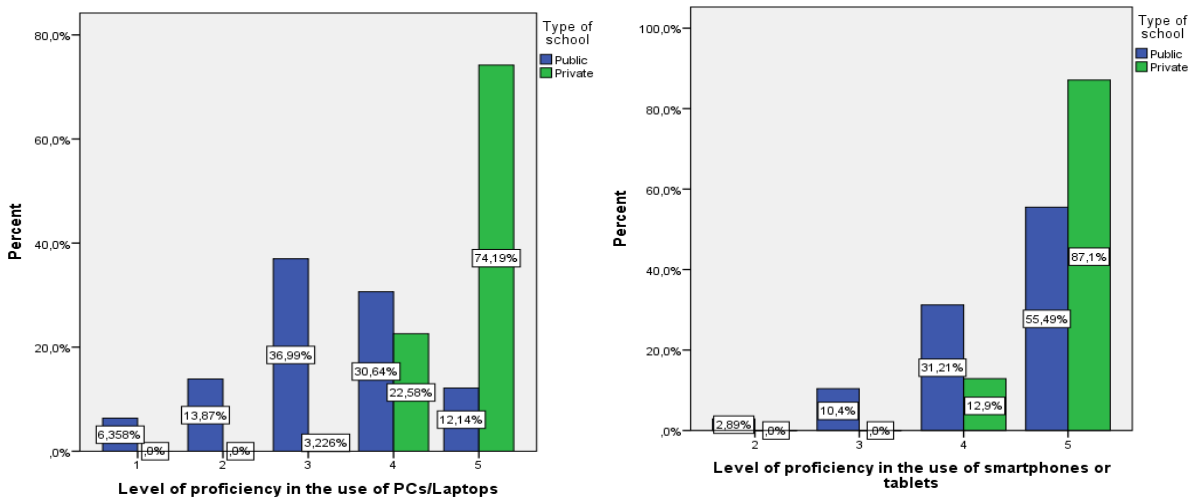


**Figure 2: Self-reported level of proficiency with PCs/Laptops and Tablets/Smartphones, separated by school type**

While almost all private school students (96.8%) rated their proficiency with PCs/laptops as high (4 or 5), only around 40% of public school students did. A notable proportion of public school students (20.2%) rated their skills as low (1 or 2), indicating limited or no familiarity with PCs/laptops.

### *4.1.2 Access to and use of technology at home and school prior to COVID-19*

During ERL, home setting emerged as a critical factor affecting students' experience. Access to the internet and to a reliable device, in particular, were essential for participation in ERL. Nearly all students (98.5%) reported having access to at least one device at home, with two-thirds (66.7%) owning a smartphone, and slightly over half (55.9%) owning a tablet. Personal access to PCs/laptops was more limited, with only one-third (32.4%) owning one. The majority shared one with family members.

Almost all students (98.0%) used a mobile device at least 1-2 times a week at home, and more than half (58.7%), used a PC/laptop with the same frequency. By contrast, the majority of students reported having rarely or never used a mobile device (75.0%) and/or a computer (58.3%) at school.

As seen Table 2, grade level significantly impacted the frequency of use at school of both PCs/laptops *($p < 0.01$)* and tablets/smartphones *($p < 0.01$)*, with Grade 6 and Grade 5 students using them more often than Grade 4 students. Additionally, there were significant differences based on type of school for both PCs/laptops *($p < 0.01$)* and tablets/smartphones *($p < 0.01$)*.

**Table 2: Results of Mann Whitney U tests for impact of type of school, and Kruskal Wallis H tests for impact of grade level on frequency of use at school prior to the pandemic of PCs/laptops and tablets/smartphones**

| Statement | Type of school | | | Grade level | |
|---|---|---|---|---|---|
| | U (173, 31) | z | p | H (2, n=204) | p |
| PCs/laptops | 456.0 | -8.254 | <0.01* | 37.0 | <0.01* |
| Tablets/smartphones | 1162.5 | -6.613 | <0.01* | 18.06 | <0.01* |

*Statistically significant at a=0.05

Private school students reported much more frequent use of both devices prior to the pandemic (see Figure 3).

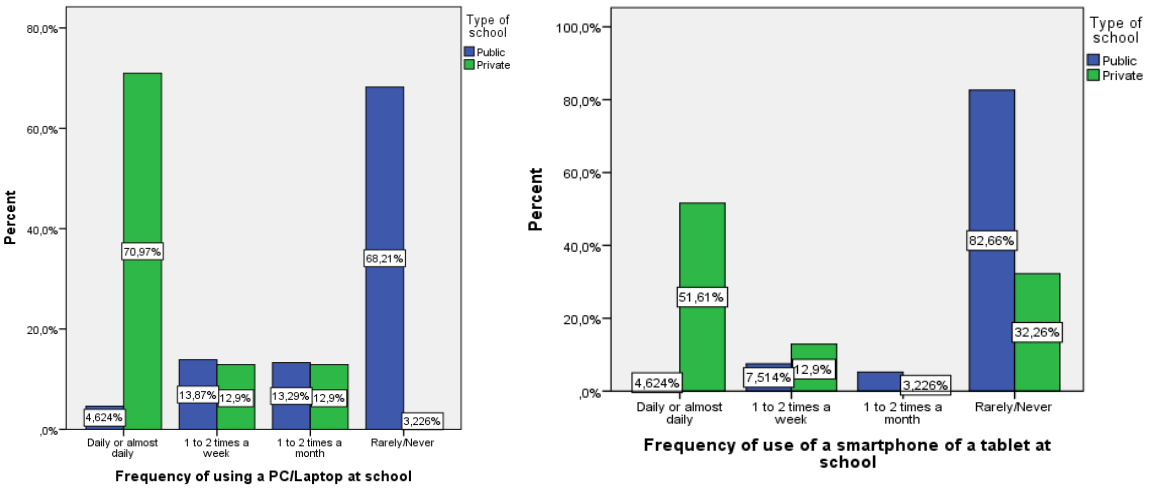


**Figure 3: Students' self-reported frequency of use of PCs/laptops and tablets/smartphones at school pre-pandemic, separated by type of school**

While 71% of private school students reported daily or almost daily use of PCs/laptops at school prior to COVID-19, only 5% of public school students did. In fact, two-thirds of public school students (68.2%) indicated having rarely or never used PCs/laptops at school. Similarly, while 65% of private school students indicated having used smartphones/tablets at school at least 1-2 times a week, only 12% of public school students did. Moreover, 82.7% of public school students reported having rarely or never used a smartphone/tablet at school.

Nearly all students (94.1%) reported having a dedicated study space and internet access at home. However, 12 students (5.9%) lacked internet access at home. During lockdown, to engage in education, these children had to find places with internet access outside their homes to download learning material sent by their teachers and/or attend virtual sessions.

### 4.2 The Transition to ERL

#### *4.2.1 Organization of communication, educational material, and teaching methods*

Following the closure of schools in Cyprus in mid-March 2020, teachers began exploring ways to engage with students remotely. Initially, they adopted asynchronous instruction, sending study materials and assignments. All participants reported being offered asynchronous ERL during the lockdown. More than half (53.4%) started receiving study materials within the first week, and around 90% within 2-3 weeks. Synchronous ERL took longer to initiate, with two-thirds (72.1%) starting synchronous sessions after at least 2-3 weeks, and about one-third (31.4%) after at least a month. Thirty students (14.7%) were not offered synchronous instruction at all.

As seen as Table 3, grade level had a statistically significant influence on the onset of both asynchronous ERL *($p < 0.01$)* and synchronous ERL *($p < 0.01$)*, with Grade 6 students having started both types of lessons earlier than students in Grades 4 and 5. There were also significant differences based on the type of school attended for both asynchronous ($p < 0.01$) and synchronous *($p < 0.01$)* ERL.

**Table 3: Mann Whitney U test results for impact of type of school, and Kruskal Wallis H for impact of grade level on time it took to start asynchronous and synchronous ERL**

| Statement | Type of school | | | Grade level | |
|---|---|---|---|---|---|
| | U (173, 31) | z | p | H (2, n=204) | p |
| **Asynchronous ERL** | 560.5 | -7.446 | **<0.01*** | 16.757 | **<0.01*** |
| **Synchronous ERL** | 269.0 | -8.045 | **<0.01*** | 23.112 | **<0.01*** |

*Statistically significant at a=0.05

Private schools initiated both asynchronous and synchronous ERL much earlier than public schools, as they were more prepared to cope with the challenges posed by the pandemic (see Figure 4 and Figure 5).

 

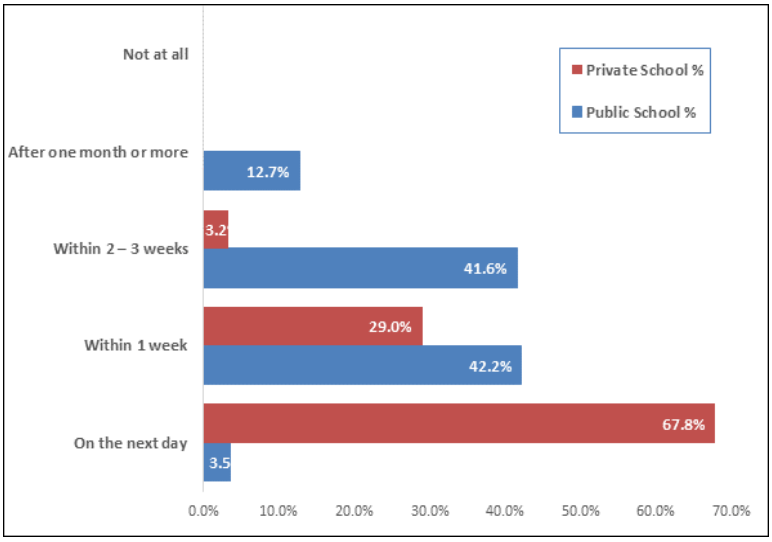


**Figure 4: Time it took for asynchronous ERL to start, by type of school**

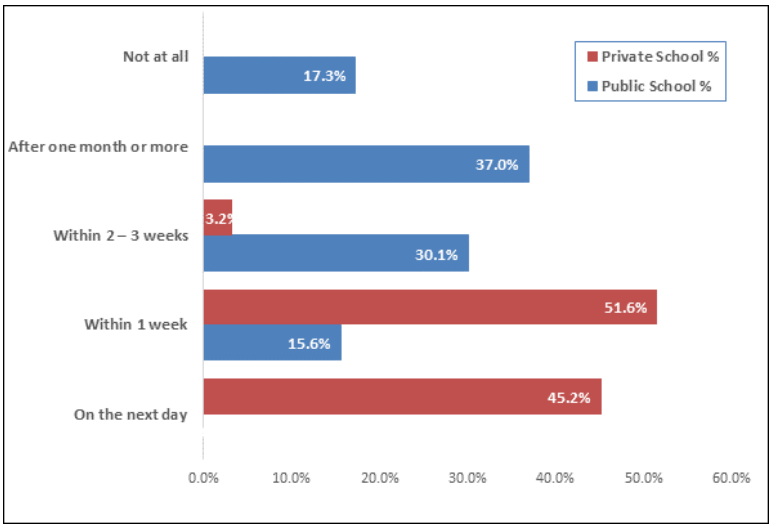


**Figure 5: Time it took for synchronous ERL to start, by type of school**

As discussed in Sofianidis et al. (2021), teachers in several private schools had received prior training on the use of online platforms like Microsoft Teams, enabling them to efficiently transition to ERL within a couple of days of the lockdown.

### *4.2.2 Technological tools employed during ERL*

Various digital tools were used for teaching and learning during ERL. Figure 6 shows, in ascending order, the percentage of students who reported that their teacher incorporated each technology/technological tool into their teaching during ERL.

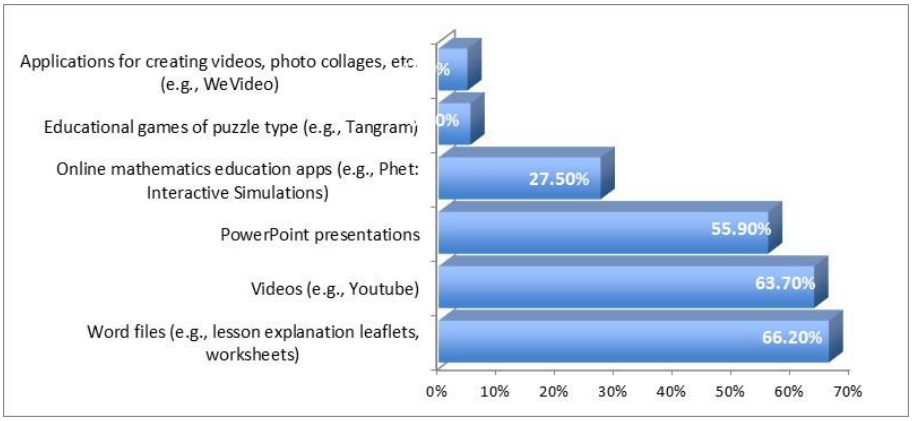


**Figure 6: Digital tools employed during ERL**

Approximately two-thirds reported the use of Word documents, while a similar percentage the use of YouTube videos and around half the use of PowerPoint presentations. However, fewer than one-third indicated the integration of online applications for mathematics and physics, and only a small minority the use of interactive tools like video makers or educational puzzle games like Tangram.

### 4.3 Challenges During the Transition to ERL

Students faced several challenges in the transition to ERL, related to infrastructure and technology access, to teachers' and students' preparedness for ERL, and to the pedagogical, social and practical aspects of ERL

#### *4.3.1 Challenges related to infrastructure and technology access*

As previously noted, not all students engaged in synchronous ERL. The 174 students (85.3%) who did, responded to questions about the challenges they encountered during the transition to ERL. A key challenge reported by students was access to appropriate technological infrastructure, including suitable devices, good internet connection, and reliable communication software. Additionally, the readiness of both teachers and students to support and manage the sweeping changes was crucial.

As already noted, almost all of the study participants had access to at least one electronic device (PC/laptop/tablet/smartphone) for individual use. This is probably the reason why, in a related question, a high majority responded that they encountered no problems at all (57.8%) or only minor problems (17.2%) in securing access to a reliable digital device. No significant differences based on gender *(U(90, 84) = 3674,50, z = -0.385, p = 0.70 > 0.05)*, grade *(H(2, n=174) = 3.661, p = 0.16 > 0.05)*, or type of school *(U(143, 31) = 1818.0, z = -1.90, p = 0.057 > 0.05)* were observed.

A reliable internet connection is vital for the needs of ERL. Looking at Figure 7, which shows students' responses to a question inquiring them about possible problems they faced related to internet connection, it becomes obvious that slow internet connection was a major issue for students in Cyprus during the lockdown.

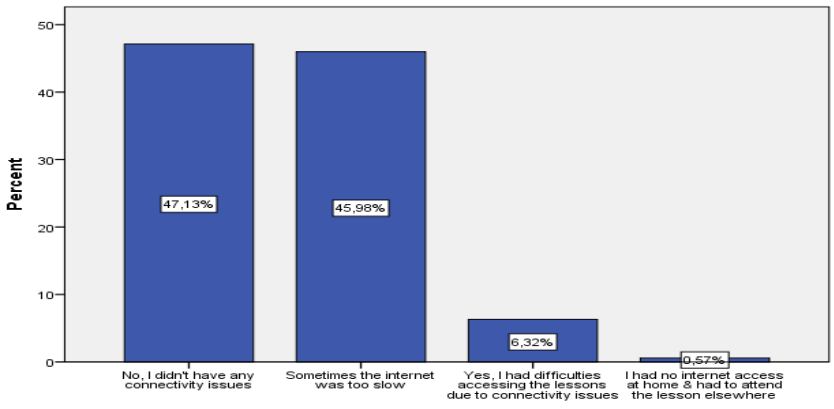


**Figure 7: Students' issues in accessing a trusted internet connection**

 

The main platform used by nearly all the surveyed students during synchronous sessions was MS Teams (92.1%) as it was endorsed in official guidelines and supported by the Ministry of Education. However, one-third also indicated use of Zoom (36.8%), and a sizeable proportion (17.2%) of some other platform (e.g. WebEx, Jitsu, Skype). The shift to ERL in the public sector took several weeks to officially start, and teachers experimented in the meantime with other platforms to maintain the educational process. When asked about the ease of accessing these platforms, the vast majority of students (94.2%) stated that they found them easy to use, encountering no problems or only minor ones (see Figure 8). However, a small proportion (5.9%) reported having encountered several problems that took a long time to resolve. No significant differences based on demographic characteristics were observed: $U_{gender}(90, 84) = 3486.500$, $z = -0.576$, $p = 0.565 > 0.05$; $H_{grade}(2, n=174) = 0.995$, $p = 0.61 > 0.05$; $U_{school}(143, 31) = 1757.500$, $z = -1.90$, $p = 0.058 > 0.05$.

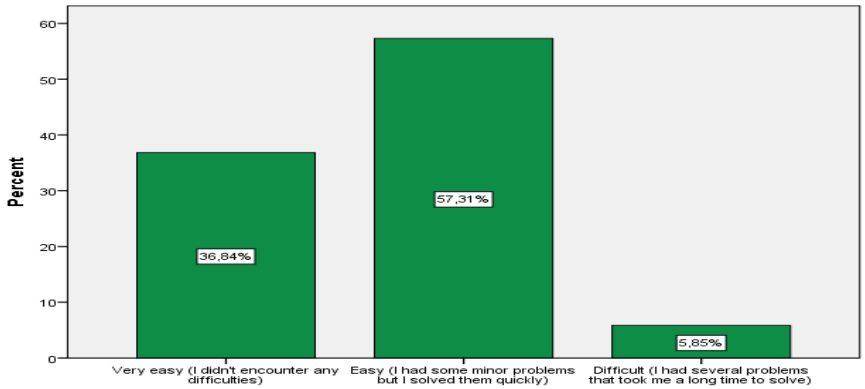


**Figure 8: Students' ease of access to the e-learning platform(s) used during ERL**

### *4.3.2 Challenges related to teachers' and students' level of preparedness for ERL*

Students' challenges in transitioning to synchronous ERL were influenced by both their teachers' preparedness for ERL and their own readiness. Regarding students' perceptions about their teachers' level of familiarity with the technologies and/or tools needed for synchronous ERL, the majority (79.9%) stated that their teachers faced only minimal difficulties. Still, for 35 students (20.1%), their teachers' lack of familiarity with e-learning tools was a challenge that negatively affected, to a large or moderate extent, their transition to ERL (see Figure 9).

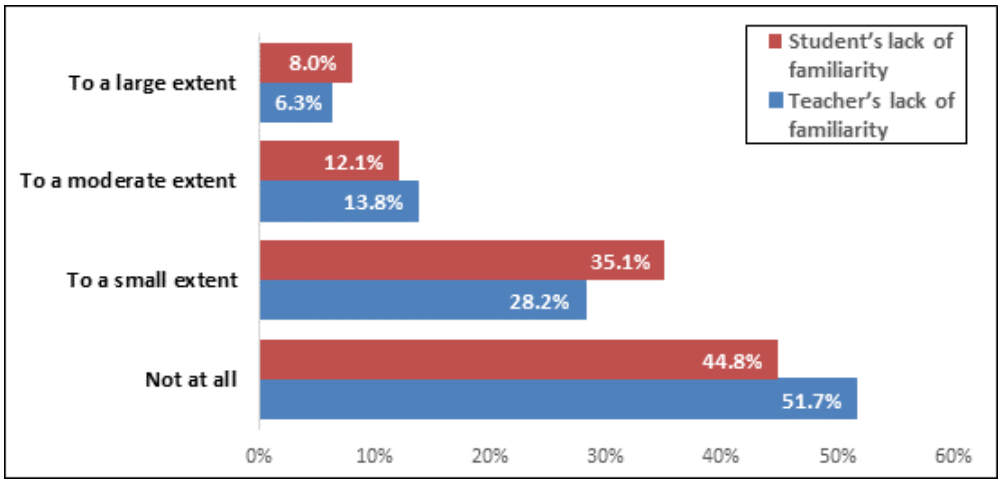


**Figure 9: Extent to which their teachers' and/or their own lack of familiarity with e-learning tools and technologies made students' transition to synchronous ERL difficult**

Students' perceptions regarding their own level of familiarity with e-learning tools and technologies were similar. Although most respondents (79.9%) reported that they experienced minimal problems during the transition to ERL, 35 students (20.1%) indicated that their own discomfort or lack of familiarity with the required technologies or tools was a challenge negatively impacting their transition to ERL.

The factors gender *($U_{teachers}(90, 84) = 3724.500$, $z = -0.183$, $p = 0.855 > 0.05$; $U_{students}(90, 84) = 3569.500$, $z= 0.682$, $p = 0.495 > 0.05$)* and grade *($H_{teachers}(2, n = 174) = 0.868$, $p = 0.648 > 0.05$; $H_{students}(2, n = 174) = 4.656$, $p = 0.097$*

*> 0.05)* did not have a significant effect on students' perceptions regarding their own level of readiness or that of their teachers. In contrast, the type of school attended did have an impact on perceptions of both teacher readiness *(U(143, 31) = 1634.0, z = -2.505, p = 0.012 < 0.05)* and students' *readiness (U(134,31) = 1142.50, z = -3.274, p = 0,001 < 0.05),* with private school students considering both their teachers and themselves to be more familiar with the technologies employed in online class sessions than public school students did.

### *4.3.3 Challenges Related to the Pedagogical, Social and Practical Aspects of ERL*

Students that participated in synchronous ERL (n = 174) were asked to indicate, using a four-level Likert scale (1 = To a large extent, 2 = To a moderate extent, 3 = To a small extent, and 4 = Not at all), the extent to which a number of educational, social, and practical issues made it difficult to switch to ERL. Figure 10 shows, in ascending order, the percentage indicating that each issue was a challenge to a moderate or large extent.

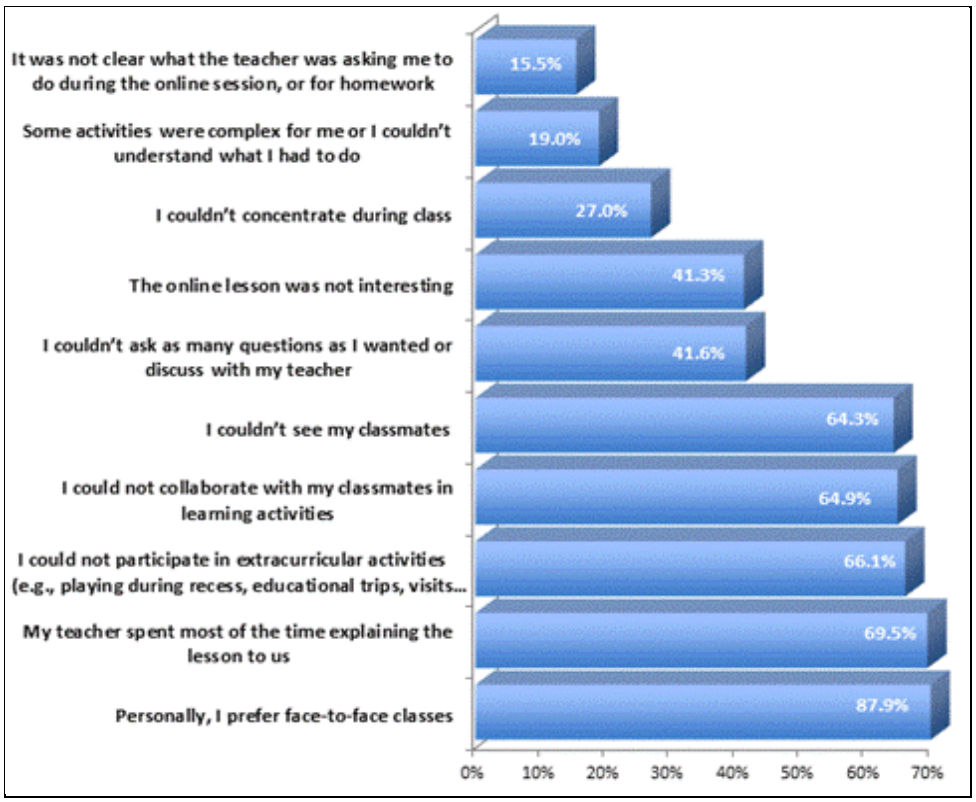


**Figure 10: Percentage of students for whom each issue was a challenge "to a moderate extent" or "to a large extent". during the transition to ERL**

Nearly 90% of participants (87.9%) expressed preference for face-to-face instruction which made it difficult for them to switch to ERL. This seems to be linked to teachers lecturing during most part of the lesson (69.5%), making online classes less interesting (41.3%) and harder to concentrate in (27.0%), with limited opportunities for discussion or posing of questions (41.6%). Additionally, the inability to see their classmates (64.9%) and engage in collaborative learning (64.9%) or extracurricular activities (66.1%), also seems to have influenced students' preference for face-to-face instruction. Smaller but still sizeable proportions indicated finding online activities challenging (19.0%) or having difficulties understanding teacher instructions (15.5%).

Students' responses to the open-ended questions echo quantitative data, indicating their preference for face-to-face instruction. They stressed limited opportunities for communication/interaction with their classmates and the teacher during ERL, and the teacher's tendency to mainly lecture. Several children expressed feelings of loneliness and disconnection from peers, exacerbated by the inability to activate video cameras during synchronous sessions (in Cypriot public schools, cameras were centrally disabled for safety/privacy reasons):

*S42 It would be nice to see each other, but this is not the teacher's choice.*

*S98 I could not see my classmates/friends on camera.*

 

Most students expressed a desire for collaborative work, lamenting its absence during ERL. Nonetheless, some reported positive experiences fostering a sense of closeness through activities like breakout groups. Regarding the lack of extracurricular activities, many longed for pre-pandemic events like school excursions.

Mann Whitney U tests were conducted to examine the impact of gender and school type and Kruskal Wallis H tests the impact of grade level on students' ratings of the extent to which each issue posed a challenge for them during their transition to ERL. The results are illustrated in Table 4.

**Table 4: Mann Whitney U test results for gender and type of school, and Kruskal Wallis H for grade level**

| Statement | Gender differences | | | Type of school | | | Grade level | |
|---|---|---|---|---|---|---|---|---|
| | U(90, 84) | z | p | U(143, 31) | z | p | H (2,n=174) | p |
| **Personally, I prefer face-to-face classes** | 3464 | -1.213 | 0.225 | 2138 | -0.393 | 0.694 | 0.002 | 0.999 |
| **My teacher spent most of the time explaining the lesson to us** | 3740 | -0.126 | 0.899 | 940.5 | -5.265 | **<.001*** | 14.707 | <.001* |
| **I could not participate in extracurricular activities** | 3772 | -0.027 | 0.979 | 992 | -5.357 | **<.001*** | 13.289 | 0.001* |
| **I could not collaborate with my classmates in learning activities** | 3686.5 | -0.3 | 0.764 | 805.5 | -5.92 | **<.001*** | 12.819 | 0.002* |
| **I couldn't see my classmates** | 3594.5 | -0.607 | 0.544 | 1428.5 | -3.365 | **<.001*** | 2.322 | 0.313 |
| **I couldn't ask as many questions as I wanted or discuss with my teacher** | 3489.5 | -0.913 | 0.361 | 1051 | -4.785 | **<.001*** | 2.843 | 0.241 |
| **The online lesson was not interesting** | 3348 | -1.349 | 0.177 | 1668.5 | -2.235 | **0.025*** | 0.564 | 0.754 |
| **I couldn't concentrate during class** | 3304.5 | -1.514 | 0.13 | 1581.5 | -2.641 | **0.008*** | 1.605 | 0.448 |
| **Some activities were complex for me or I couldn't understand what I had to do** | 3113 | -2.162 | **0.031*** | 1425.5 | -3.348 | **<.001*** | 6.662 | **0.036*** |
| **It was not clear what the teacher was asking me to do during the online session, or for homework** | 3453.5 | -1.093 | 0.274 | 1625 | -2.586 | **0.01*** | 0.887 | 0.642 |

*Statistically significant at a=0.05

Grade level significantly influenced students' ratings of four issues in Table 4, while gender affected only one. In contrast, the type of school attended significantly influenced students' ratings of all issues except for preference for face-to-face classes. Private school students had higher Mean Ranks for all issues compared to public school students, indicating milder experiences with ERL. This is evident when comparing the percentage of private school students considering each issue a moderate or large challenge during the transition to ERL, compared to the corresponding percentage of public school students (see Figure 11).

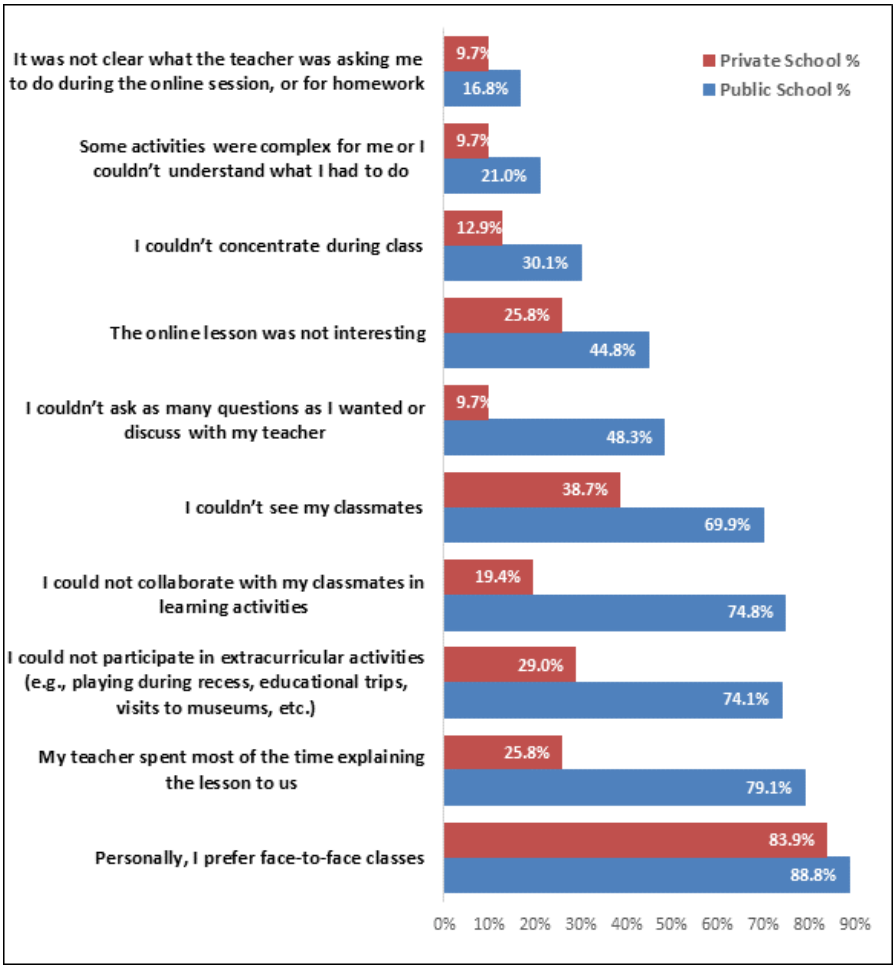


**Figure 11: Percentage of students for whom each issue was a challenge "to a moderate extent" or "to a large extent". during the transition to ERL, separated by type of school**

As depicted in Figure 11, public and private school students expressed a similarly strong preference for face-to-face instruction. However, the percentage of private school students indicating that each of the remaining issues posed a serious challenge during their transition to ERL was notably lower. This suggests that private school students may have experienced a more student-centred and interactive virtual learning environment, possibly due to their teachers having received prior training in online education and its pedagogy (e.g., managing breakout rooms for collaborative group work).

The qualitative analysis delved deeper into students' experiences during ERL. While a minority (13.2%) reported minimal stress during the lockdown, others reported coping with stress by communicating with friends and relatives and engaging in leisure activities like reading, exercise, music, and games. Regarding their biggest concern about COVID-19's impact on education, nearly 45% had no response or expressed no concerns. However, the majority had serious concerns about the negative impact of online education on their learning.

> *S52 My biggest concern is that if this continues, I will not be able to learn the course material adequately well to be able to start secondary school without facing difficulties.*
>
> *S180 I am worried that schools will be closed again and we will not proceed with our learning. We will move to the next grade with gaps in our knowledge.*

### 4.4 Students' Reflections on their ERL Experience

#### *4.4.1 Use of tools and practices employed during ERL in the post-COVID classroom*

In the last survey question, students were asked if they wanted teachers to continue any practices from the lockdown once normal school operations resumed. Almost half (47.1%) responded negatively with comments such as.

 

*S41 No, because things at my school were much better before the pandemic.*

*S169 Nothing. I want things to be exactly like they used to be before COVID-19.*

Among the other half who responded positively, the majority expressed a desire for teachers to integrate the tools and technologies used during ERL period into their courses:

*S36 I liked the videos and apps the teacher sent us.*

*S80 To have the course material in electronic format.*

*S170 To communicate electronically with teachers if I have questions or when I miss classes due to illness.*

*S204 To continue using Teams in order to collaborate in groups and exchange ideas.*

*S12 To use tablets in the classroom.*

*S85 The quizzes the teacher sent us on the computer and other applications we used.*

*S186 Each day, we were learning more about technology and how to use it. I would like this to continue.*

### *4.4.2 Overall ERL experience*

When asked if they found it easier or more difficult to participate in synchronous sessions compared to the face-to-face classroom, two-thirds (62.1%) responded that they found it more difficult. Only 15 students (8.6%) found online classes easier. Examining the influence of demographic characteristics, a Mann Whitney U test indicated no gender-related impact on students' ease of adaption to e-learning *(U(90, 84) = 3478.500, z = 1.059, p = 0.29 > 0.05)*, in contrast to grade level where significant differences were observed *(H(2, n = 174) = 8.497, p = 0.014 < 0.05)*, with older students tending to adapt more easily. Also, the type of school attended had a statistically significant effect on ease of adaption to online learning *(U(143, 31) = 1100.500, z = -5.119, p < 0.01)*, with private school students adapting more easily.

Finally, a measure (*ERL_Experience*) was constructed from the 10 statements included in Figure 10 to measure students' overall ERL experience. The value of this new variable was obtained by calculating the average of students' responses to the 10 statements (Cronbach's alpha = .85). As mentioned earlier, students' responses to these statements were based on a four-point Likert scale (1 = To a large extent, 2 = To a moderate extent, 3 = To a small extent, and 4 = Not at all). Therefore, the higher the value of the variable *ERL_Experience*, the lower the extent to which the issues in Figure 10 posed a challenge to participants. Looking at the centre (mean=2.49, median=2.4) and overall distribution of *ERL_Experience* shown in Figure 12, one can conclude that *ERL_Experience* values tend to concentrate around 2.0-2.5, i.e. between moderate and moderate-low.

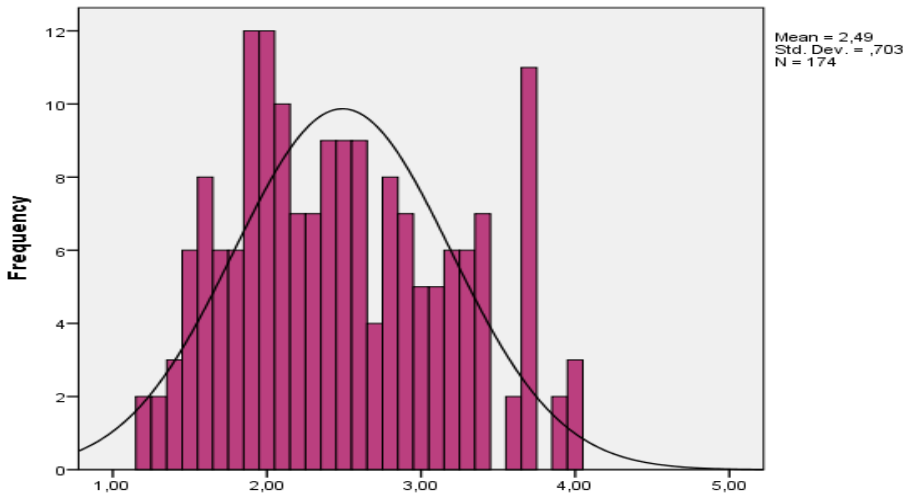


**Figure 12: Frequency histogram of students' experience with emergency remote learning**

An independent samples t-test revealed no gender-related differences in students' overall ERL experience *(t(172) = 1.140, p = 0.950 > 0.05)*, but a statistically significant impact of type of school attended (*t(172) = -6,449, p < 0,01),* with private school students reporting a more positive overall ERL experience (3.15 > 2.35). A one-way ANOVA showed a statistically significant effect of grade level *(F(2, 171) = 4.155, p = 0.017)* on *ERL_Experience*.

Post-hoc paired comparisons using Tukey's HSD indicated that Grade 6 students had a more positive overall ERL experience than Grade 4 students (2.69 > 2.33).

## 5. Discussion

This study explored the impact of the initial COVID-19-related school closure on primary education in Cyprus, with a focus on upper primary students' (ages 9-12) perspectives and experiences during the transition to ERL. While the analysis provided valuable findings, certain limitations must be acknowledged, particularly concerning the study's methodology and its implications for the validity and reliability of the findings.

The self-selected nature of survey participants and reliance on students' subjective views and perceptions limit the generalizability of the results. However, the analysis of the collected data was conducted rigorously, utilizing both quantitative and qualitative methods, which enhanced the credibility of the findings. The mixed-methods approach allowed for the triangulation of quantitative survey responses with qualitative thematic insights, offering a comprehensive understanding of students' ERL experiences. Nonetheless, the non-probability sampling method and online survey distribution may have resulted in underrepresentation of students without access to digital resources, potentially affecting the results. Additionally, given the young age of participants, parental assistance in completing the survey could have influenced their responses. The timing of the survey (summer 2020), may have also influenced participants' responses, potentially yielding different results compared to conducting it during or after subsequent lockdowns, when teachers and students became more accustomed to distance education.

Despite these limitations , the study offers some unique insights that concur with and add to the sparse literature on K-12 students', and particularly primary students', experiences during the transition to ERL. The findings indicate that the children in our study faced several challenges in their transition to ERL, similar in nature to those reported globally for K-12 and higher education students (Tang, 2023, Yun, 2023): technology constraints, internet connectivity issues, disparities in access and/or accessibility to ICT tools and resources, gaps in teachers' and students' digital literacy skills, feelings of loneliness, teacher-centred environments with limited interactions, concentration issues, concerns about learning loss, psychological well-being issues.

A key finding of the study was the huge impact of the type of school attended on students' ERL experience. In contrast to gender, which showed no significant effect on any aspect of ERL, and grade level which affected only some aspects (e.g., an earlier shift for Grade 6 students to both asynchronous and synchronous ERL), the type of school attended had a significant impact on almost all aspects of students' ERL experience. Private school students, typically from middle or upper socioeconomic backgrounds, had more favourable conditions compared to their public school counterparts. They reported greater familiarity with technology and readiness for ERL along with higher technology use at school prior to the pandemic. Additionally, they benefited from teachers with prior e-learning training and experienced a much swifter transition to both asynchronous and synchronous ERL. Consequently, they transitioned more smoothly to ERL, adapting more easily to the virtual environment and reporting a more positive overall ERL experience than public school students. Thus, our findings are consistent with international research showing that the pandemic's impact on students was worsened by socioeconomic disparities (Davidovitch, 2022; Tang, 2023). These results emphasize how COVID-19 amplified existing educational inequalities, underscoring the need for educational policies that address these disparities.

Our findings also suggest that younger students, particularly those in primary education, faced greater challenges adapting to remote learning compared to older students. The overwhelming majority of the children expressed preference for face-to-face instruction and the desire to return to conventional education. Almost 90% agreed that this preference made difficult the transition to ERL. To provide context, we compare these findings with prior research conducted in Cyprus by the first author on secondary and tertiary students' transition to ERL (Meletiou-Mavrotheris et al., 2022; Meletiou-Mavrotheris et al., 2023; Sofianidis et al., 2021). These studies employed survey instruments with several identical or similar questions to those in the present study. When posed the same question, secondary and tertiary students in the studies by Meletiou-Mavrotheris et al. (2022) and Sofianidis et al. (2021) similarly expressed a clear preference for face-to-face instruction. However, the percentages agreeing that this preference hindered their transition to emergency remote learning (ERL) were lower than in this study: 76% of secondary students, 70% of undergraduates, and 40% of graduate students. These statistics suggest that younger students are more inclined towards face-to-face instruction, implying that age and developmental stage played a significant role in students' transition to ERL. This trend reinforces the idea that a student's developmental stage plays a crucial role in how students engage with online learning environments.

 

Another factor contributing to the strong preference for face-to-face learning among the young students in our study was the loss of socialization associated with school life. In line with the international literature (Giannoulas et al., 2021; Tang, 2023; Xu and Xue, 2023; Yun, 2023), social distancing from classmates, teachers, and friends made it particularly challenging for the primary school children to adapt to the ERL environment. Missing interactions with classmates and the cancellation of extracurricular activities were significant obstacles for 64% and 66% of participants, respectively.

Students' expressed preference for face-to-face instruction may also be linked to the teacher-centred approach adopted during ERL, which resulted in less engaging virtual lessons. Similarly to educators globally (Yun, 2023), most teachers in Cyprus lacked familiarity with online pedagogy and the real affordances of e-learning technologies for promoting student-centred, collaborative learning. This limited opportunities for active participation, interaction, and collaboration in virtual classrooms, which are central to socio-constructivist views of learning.

A further indication of primary students' strong preference for face-to-face learning in our study is that nearly half of the participants reported not wanting any aspects of the ERL period to continue in normal school operations. The heightened challenges faced by these younger students, along with their stronger preference for in-person instruction compared to older counterparts, can be partially explained through Self-Determination Theory (Deci and Ryan, 2000), which highlights the importance of autonomy, competence, and relatedness in fostering motivation and engagement. Given their developmental stage, primary students are less independent and require more scaffolding (Martin et al., 2022), making it difficult for them to meet these psychological needs in a remote learning environment, where teacher support was often lacking due to the sudden and unplanned transition to ERL. The loss of direct interaction with teachers and peers, essential for satisfying the need for relatedness, and the absence of structured guidance typical of face-to-face learning, crucial for building competence and autonomy, proved particularly challenging for younger learners.

Although nearly half of the children, upon reflecting on their ERL experience, stated they did not wish for any elements of that period to be carried forward into regular school operations, the other half expressed a desire for their teachers to integrate e-learning tools and technologies into conventional instruction. Although this proportion is considerably lower than the percentage of secondary and higher education students in Cyprus that expressed a similar wish (Meletiou-Mavrotheris et al., 2022; Sofianidis et al., 2021), it still signifies that many children found the online tools beneficial in the normal context of schooling. The majority of Cypriot public primary school teachers in the Meletiou-Mavrotheris et al. (2023) survey study also advocated the integration of e-learning tools and practices into face-to-face instruction, with over 70% expressing their intent to continue using such tools post-pandemic. Indeed, a study by Kosmas et al. (2022) which investigated the reality in K-12 schools after return to face-to-face instruction, found that a significant percentage of teachers continued to integrate distance learning tools and practices to enhance learning and communication in their conventional classrooms.

Our findings have important implications not only for research and practice in ERL situations but, more broadly, for K–12 online teaching and learning. They suggest that the established research base on the essential components of online instruction for adult learners may not be directly applicable to K-12 education due to the diverse developmental needs, situational characteristics, and support systems required for school-age children (Johnson et al., 2023; Barbour, 2018). Knowles' principles of andragogy, which underpin online pedagogy, emphasize adults' autonomy in learning (Groenestijn, 2007). The greater openness to online learning generated by the pandemic (Schueler and West, 2023), underscores the urgency for further research focused on K-12 learners to comprehend and cater to their developmental needs. As Johnson et al. (2023) stress, and as confirmed by our study, while developmental characteristics vary among same-age learners, there is a correlation between human development and chronological age influencing students' learning approaches and thus necessitating tailored pedagogical approaches for online learning. Younger students tend to require more scaffolding and external regulation to learn in the virtual space (Martin et al., 2022), as evidenced by studies conducted during the pandemic which indicated inadequate skills for independent online learning even among upper secondary students (Bhaumik and Priyadarshini, 2020). Future research targeting young learners can contribute to enhancing our understanding of effective instructional practices in both remote and blended learning contexts.

## 6. Conclusions

Several methodological limitations of the current study, such as the self-selected sample, subjective responses, and non-representative sampling, limit the generalizability of its results. To strengthen the validity of future research, more rigorous sampling methods and the inclusion of diverse student populations are essential.

Despite the limitations, the study findings offer important insights into primary school students' experiences with ERL during the early stages of the COVID-19 pandemic. The research has highlighted significant challenges encountered by students, including technology-related barriers and psychological difficulties. Future studies should aim to refine this focus further. Instead of broadly addressing students' overall ERL experience, it would be beneficial to investigate more specific aspects, such as digital literacy, accessibility issues, and mental health outcomes. This approach will facilitate a deeper understanding of how various student groups were impacted by remote education.

The results also underscore the importance of addressing socioeconomic disparities in access to education, which were exacerbated by the pandemic. The educational inequalities laid bare during the shift to ERL, should serve as an impetus for systemic reform in the post-COVID era. Educational systems must seize this opportunity to evaluate and tackle practical barriers to learning, including limited access and accessibility to technological devices, and to promote-e-education equity. Embracing pedagogical approaches and frameworks that foster motivating and inclusive learning environments will ensure that all learners, irrespective of socio-economic background, have access to high-quality learning experiences.

Although this research highlights the downsides to virtual learning that make in-person instruction preferable for K-12 students (Schueler and West, 2023), it also points to the potential for integrating e-learning tools into conventional classroom settings. The e-learning skills and experiences that teachers gained during ERL should be leveraged to instigate sustainable, positive changes to the schooling system (Santagata et al., 2023). However, any integration of e-learning tools in online and blended learning environments must be done thoughtfully, with careful consideration of young learners' unique developmental needs. Ongoing professional development in e-learning pedagogy, informed by research focused on K-12 online teaching and learning, is essential for educators to acquire the knowledge and skills necessary to utilize e-learning technologies in pedagogically sound ways that promote student engagement, inquiry-based learning, and the development of 21st century competencies like self-directed learning, communication, collaboration, and ICT proficiency (Choy and Cheung, 2022).

In conclusion, while this study has shed light on primary school students' experiences during the COVID-19 school closures, it has also highlighted several avenues for further investigation. More specific, targeted studies that explore the differential impact of ERL on various student subgroups are needed to inform educational strategies moving forward. By doing so, we can ensure that all students have the opportunity to thrive in a post-pandemic educational landscape.

**Ethics statement:** The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the Cyprus Center of Educational Research and Assessment and by the Department of Secondary Education of the Ministry of Education of the Republic of Cyprus (protocol code 7.4.01.2, 26 May 2020).

**AI statement:** No AI was employed during the research conduct or initial drafting of this paper. During the manuscript refinement phase, ChatGPT was used selectively for language editing when deemed beneficial. This assistance was aimed at enhancing the clarity, coherence, and style of the text, while ensuring the integrity of the original content was preserved.

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