Self-Regulation of e-Learning and Students' Divided Experiences: A Mixed Method Study

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Abstract: A mixed methods design was employed to study students' self-regulation of e-learning to understand the phenomenon of the digital divide. Quantitative data consisting of the perceptions of comprehensive school students (N=29,863) on self-regulated learning (SRL) and equal access to digital devices were analyzed to identify subgroups. Qualitative data on e-learning experiences (n=13,310) were then analyzed according to their subgroups. The results indicated equal access to devices but strongly divided e-learning experiences between students. Those assessed as having the highest SRL (31%) provided remarkably detailed descriptions of how they developed new learning strategies, metacognitive, and digital skills during e-learning. In contrast, students belonging to the lowest SRL group (21%) expressed divided experiences; half of them claimed not to have learned anything. These students were often left without parental support. The current study provides empirical evidence of the digital divide and its realization during the pandemic, leading to deviant poor learning experiences for students with low SRL skills. Therefore, in the future, schools should create structures to recognize students who require support and ensure equal opportunities for meaningful e-learning.

Keywords: e-learning, self-regulated learning, digital divide, mixed methods, compulsory education

Autorégulation de l'apprentissage en ligne et expériences contrastées parmi les élèves de l'enseignement secondaire général – une étude à méthode mixte

Résumé : Une méthode mixte a été utilisée pour étudier l'autorégulation de l'apprentissage en ligne parmi les élèves d'établissements d'enseignement secondaire général, afin de comprendre le phénomène de la fracture numérique. Les données quantitatives concernant les perceptions des élèves (N=29,863) sur l'apprentissage autorégulé (AAR) et l'égalité d'accès aux appareils numériques ont été analysées pour identifier trois sous-groupes. Les données qualitatives des expériences d'apprentissage en ligne (n=13,310) ont ensuite été analysées selon des sous-groupes. Les résultats ont indiqué un accès égal aux appareils, mais des expériences d'apprentissage en ligne toujours fortement contrastées. Les élèves ayant le taux d'AAR le plus élevé (31 %) ont fourni des descriptions remarquablement détaillées de la manière dont ils ont acquis de nouvelles stratégies d'apprentissage, des compétences métacognitives et numériques dans le cadre de l'apprentissage en ligne, tandis que ceux ayant le taux d'AAR le plus bas (21 %) ont exprimé des expériences contrastées, et la moitié d'entre eux ont même affirmé n'avoir rien appris. Ces élèves étaient aussi souvent laissés sans soutien parental. La présente étude fournit des preuves empiriques sur la fracture numérique et sa réalisation pendant la pandémie, menant à des expériences d'apprentissage limitées, voire décalées, pour les élèves ayant de faibles compétences en AAR. Par conséquent, à l'avenir, les écoles devraient créer des structures permettant d'identifier les élèves qui ont besoin de soutien et d'assurer l'égalité des chances pour un apprentissage en ligne optimal.

Mots-clés : apprentissage en ligne, apprentissage autorégulé, fracture numérique, méthode mixte, enseignement obligatoire

Introduction

E-learning has become a prevalent method applied in teaching and learning since the COVID-19 pandemic, although distance learning via technology has existed for decades (Arnesen et al., 2018; Barbour, 2018). Simultaneously, differences in students' digital skills and equal access to digital devices have created and enlarged the gap, or *digital divide*, between students (Pierce & Cleary, 2024). Perhaps as a result, students' e-learning experiences vary considerably from positive to negative. In this study, we utilized the approaches of self-regulated learning (SRL) and the digital divide to examine the e-learning experiences of comprehensive school students from the perspectives of individual learners and their home-based learning environments.

Students in compulsory education usually study face-to-face, which enables teachers to direct their attention to the learning process (Sahlberg, 2021). A change from a physical classroom to an e-learning environment implies a change from teacher-led to student-led learning (Järvelä et al., 2016). This change calls for skills in the self-regulation of learning (Johnson et al., 2023); specifically, it calls for individual skills to monitor and regulate learning processes (Pintrich, 2004). When e-learning is conducted at home, variations in support and guidance from parents in the navigation of digital environments may result in students having divided experiences (Engzell et al., 2021). That is, the differing home-based learning environments can lead to inequalities students have in the prerequisites for e-learning (Chauke & Dlamini, 2024). The concept of the digital divide has been used to discuss the

inequality between individuals caused by digitalization (van Deursen & van Dijk, 2015). In their systematic review of the field, Johnson et al. (2023) warned of the possibility of a digital divide among K-12 students if they are not provided with enough support to manage their learning regulation under e-learning conditions.

The unexpected schooling period that took place due to the COVID-19 pandemic provided a setting for collecting significant evidence on the factors needed to understand what should be done when designing e-learning and instruction in the future (Power et al., 2023). A growing body of literature focuses on e-learning in the K-12 context, but the majority of studies are conducted in North America (Arnesen et al., 2018; Barbour 2018; Martin et al., 2023). This study provides evidence from North Europe in order to broaden the perspective by examining how Finnish comprehensive school students in grades 7 to 9 (N=29,863) described their e-learning during the two-month school closure period caused by COVID-19 in May 2020. First, we undertook a quantitative analysis of students' responses to a questionnaire (Pintrich et al., 1993) that evaluated their self-regulation of effort, peer collaboration, study environment, and equal access to digital learning. Then, we examined students' written responses to an open-ended question:

What new skills did you learn during the e-learning?

Literature Review

E-learning and Associations with Self-Regulated Learning

"E-learning is instruction facilitated by technology designed to enable a learner to achieve a specific learning goal without the requirement for the learner and the instructor to be in the same physical location" (O'Neill, 2023, p. 14). E-learning is not new as it has developed from arrangements of distance education since 1919 (Barbour, 2018). Computers with fast online connections and video conferencing opportunities made e-learning more accessible since the 1990s (Barbour, 2018). Although the history of distance K-12 education with computers is long, teacher preparation programs still do not provide the knowledge needed to support e-learning (Barbour, 2022).

Academic e-learning achievements are strongly associated with preparedness for SRL, and students often need help in regulating their e-learning (Dijkstra et al., 2023; Johnson et al., 2023). Self-regulated learners are assumed to monitor their cognitive and metacognitive processes actively and autonomously, and to regulate their behaviour and motivation to achieve learning goals (Efklides, 2011, 2018; Pintrich, 2004). It is assumed that students individually regulate their learning strategies, such as by organizing information and managing their time or learning environment (Pintrich, 2000). The importance of student-centred SRL has been strongly emphasized in recent decades (Johnson et al., 2023; Lüftenegger et al., 2012; Pintrich, 2004). It is evident that a change from teacher-led to student-led tasks also changes the requirements for SRL. As a result, the sudden shift from physical

classrooms to e-learning in 2020 challenged students (Johnson et al., 2023). E-learning requires higher levels of autonomy compared to traditional face-to-face situations, and some students may struggle with these expectations (Johnson et al., 2023). Even university students are reported to miss being able to learn in classrooms when they are studying remotely (Power et al., 2023). Students' characteristics such as weaker readiness to study individually and lack of technological skills can create detrimental barriers to e-learning (Hanny et al., 2023). Teachers in K-12 education have been surprised by how weak the digital skills are that some students have, and they underlined that new routines need time and effort both from teachers and students in order for e-learning to be accessed equally (Hanny et al., 2023). In order for students to be able to concentrate on e-learning, familiarity with digital tools and provision of individual and personal support are needed (Barbour, 2022; Hanny et al., 2023).

Each student develops their SRL skills over the course of years in an individual way (Efklides, 2018; Pintrich, 2004), yet these SRL skills can be fostered by teachers, parents, and peers (Volet et al., 2009). Students with lesser SRL skills do not always notice when they are learning new skills and acquiring new knowledge (Kontturi, 2016). However, with the help of others, becoming aware of the progress being made is likely to increase the meaningfulness of learning. In their systematic review, Johnson et al. (2023) concluded that in e-learning, external regulation from both teachers and parents is needed. Although students' SRL skills are often context-specific, they can predict achievement (Dörrenbäcker-Ulrich et al., 2021; Iiskala et al.,

2021). Therefore, it is important to study the overall context and conditions at home.

It is known that doing school work at home requires the regulation of persistence and negative emotions, such as frustration, when facing difficult tasks (Corno, 2011). The structure offered by parents or a teacher may help students develop their self-regulation skills (Corno, 2011). Especially during COVID-19, the help provided by parents in regulating e-learning was crucial for K-12 students (Johnson et al., 2023). It seems that parental support and help in mediating concentration and completion of homework predict higher academic achievement in students in junior high and high school (Núñes et al., 2015). Even advanced college students have difficulties regulating their working habits and time spent studying. Therefore, regulation of learning by others may be needed, especially when studying at home.

Technological Skills and Resources Causing a Digital Divide

Differences between students will occur not only because of individual characteristics, but also because of the resources available at home in the form of support and guidance for navigating the digitalized world (Parycek et al., 2011; Scheerder et al., 2017). Therefore, schools should offer structures and resources that decrease the gap caused by digital devices (Pierce & Cleary, 2024).

The concept of the digital divide has its origin in describing differences between wealthy and less-wealthy countries or regions and their population's access, take-up, and use of digital technology (van Deursen & van Dijk, 2014).

This concept may also describe differences between students who have access to digital resources and those who do not (Chauke & Dlamini, 2024). In the Nordic countries, focus has shifted towards describing the increasing inequality between people due to their technological skills as the second-level digital divide (van Deursen & van Dijk, 2014; Zillien & Hargittai, 2009). Technological skills among students at an appropriate age for compulsory education are crucial for their future. Schools can play a central role in diminishing the digital divide in terms of technological skills by providing opportunities and guidance (Pierce & Cleary, 2024). In their review, Johnson et al. (2023) focused on the digital divide among K-12 students in the United States. They were worried that students differ not only in terms of their access to devices, but also due to their attitudes, skills, and willingness to learn and develop themselves actively, compared to those who passively consume entertaining materials (Johnson et al., 2023).

It is assumed that students' ability to concentrate and control their schoolwork in digitalized environments will lead to differentiated learning experiences between them (Oinas et al., 2022; Huber & Helm, 2020). In the Nordic countries, despite the unexpected but seemingly smooth transition to e-learning due to the COVID-19 pandemic, some schools, teachers, and students and their parents were better prepared than others to face the situation they encountered (Oinas et al., 2022). During an e-learning period, students' special needs, parents' educational background, the home situation, and lack of resources may threaten educational equity (Hyejin, 2020; Letzel et al., 2020).

Subgroups and Regulation of Learning

Earlier research has studied students by classifying them in subgroups based on their SRL skills. In comparing the metacognitive regulation of low and high achieving subgroups, Iiskala et al. (2021) noted how the level of regulation of metacognition is dependent on the task at hand: deep self-regulation of metacognition occurs with tasks designed for higher levels of cognitive activity, such as problem-solving, critical thinking, or creating explanations for causal functioning. If the task only entails a low-level cognitive challenge, it is unlikely to awaken deep thinking.

Teachers in Finnish comprehensive schools reported that teaching during the COVID-19 outbreak needed a somewhat different instructional emphasis compared to face-to-face teaching (Mankki, 2021). Teachers highlighted the importance of clarity of instructions and reported how their practices were aimed at controlling the completed assignments. Instead of focusing on supporting students' thinking skills, teachers' efforts towards high-quality teaching mainly concentrated on what they could do to be more available, and how they could give clear guidelines to students during e-learning (Mankki, 2021). This indicates that assignments were perhaps less challenging than usual and therefore needed less regulation. In their review, Johnson et al. (2023) underlined the importance of including engaging tasks, such as problem-solving, to maintain students' motivation and create meaningful communication between the students and teacher.

In the e-learning context, Dijkstra et al. (2023) identified that students need support in their SRL based on their individual level of regulation.

Verstege et al. (2019) assigned students to three groups based on the students' self-evaluations: bottom, middle, and top. The names of the three groups reflected how students' behaviour in a virtual learning environment resulted in different outcomes (Verstege et al., 2019). In this study, students are assigned into subgroups by following the original procedure introduced by Pintrich et al. (1991), who classified college students according to their responses in a questionnaire evaluating SRL skills. Pintrich et al. (1991) identified levels of SRL to give supportive feedback to students. In this study, we used the classification to understand e-learning experiences and provide recommendations to narrow the digital divide in future schooling.

The research questions were:

1. What subgroups indicating SRL skills can be identified in the data?
2. Do students assigned to subgroups have equal digital access and e-learning experiences?
3. How do students in subgroups describe their learning after a two-month school closure in their open answers?

Methods

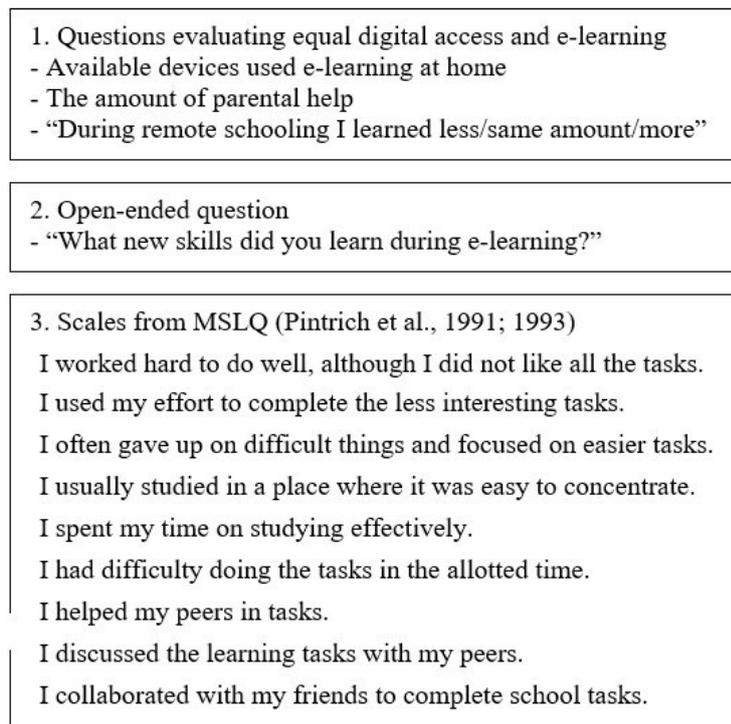### Participants and Ethical Considerations

In total 29,863 students (girls 56%, boys 42%, and non-binary students 2%) studying in grades 7 to 9 of comprehensive school completed the survey about their e-learning experiences during the period between March and May in 2020. In Finland, students in grades 7 to 9 are 13 to 16 years old. The data covered around half of the total students in the age cohorts. Finland is a bilingual country, and the survey was available in Finnish and Swedish.

Participation in the study was voluntary. The students were provided with information about the study and their rights as research participants. The research approvals were secured from the Ministry of Education and Culture. Additionally, school principals were approached to obtain permission to conduct research at the schools. Parents were notified through a digital letter and had the option to remove their child from the study. While most students completed the survey during school hours, they also had the opportunity to complete the survey at home. The responses were collected anonymously, but students were informed that the identification codes of their schools and municipalities were included in the data.
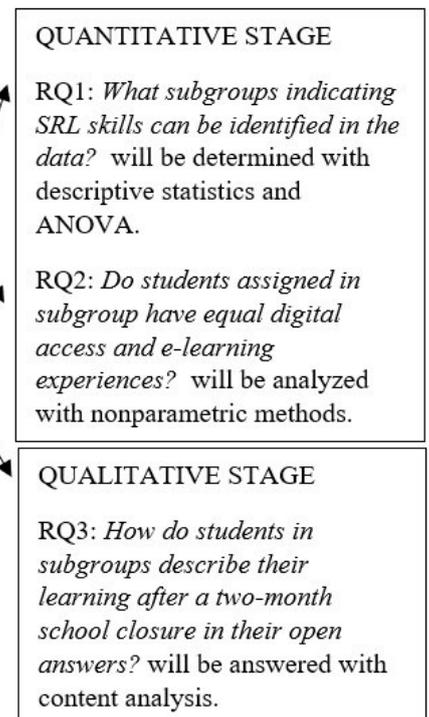
Measures

In a convergent parallel mixed-method design, quantitative and qualitative data are gathered at the same time, but analyzed independently (Creswell, 2014). Our aim with this study was to explore whether the findings from quantitative and qualitative stages could substantiate one another (Creswell, 2014). In the questionnaire, the open-ended question preceded the statements related to SRL, to avoid the pre-direction of students' open answers to the themes of self-regulation (Figure 1). The data were analyzed in reverse order. The SRL questionnaire was studied first to identify the subgroups of SRL, and then the open responses were analyzed.

Order of the questions in electronic survey:

Stages of the mixed method analyses:

1. Questions evaluating equal digital access and e-learning
- Available devices used e-learning at home
- The amount of parental help
- "During remote schooling I learned less/same amount/more"

2. Open-ended question
- "What new skills did you learn during e-learning?"

3. Scales from MSLQ (Pintrich et al., 1991; 1993)
  I worked hard to do well, although I did not like all the tasks.
  I used my effort to complete the less interesting tasks.
  I often gave up on difficult things and focused on easier tasks.
  I usually studied in a place where it was easy to concentrate.
  I spent my time on studying effectively.
  I had difficulty doing the tasks in the allotted time.
  I helped my peers in tasks.
  I discussed the learning tasks with my peers.
  I collaborated with my friends to complete school tasks.

QUANTITATIVE STAGE

RQ1: *What subgroups indicating SRL skills can be identified in the data?* will be determined with descriptive statistics and ANOVA.

RQ2: *Do students assigned in subgroup have equal digital access and e-learning experiences?* will be analyzed with nonparametric methods.

QUALITATIVE STAGE

RQ3: *How do students in subgroups describe their learning after a two-month school closure in their open answers?* will be answered with content analysis.

Figure 1. *Order of the data collection and analyses.*
Image description available

The questionnaire began by evaluating experiences of the digital divide. Students were asked to compare their e-learning experiences with the "usual" classroom teaching using a 5-point scale (1=Clearly less; 5=Clearly more). Based on the digital divide theory, students' equal access to digital devices was evaluated with questions about whether students used their family computers or computers from school, and if they had to take turns when using the computer. In addition, the availability of parental help was evaluated. Then the open-ended question was presented: "What new skills did you learn during the e-learning?"

Perceptions about SRL were measured in part by using the Motivational Strategies for Learning Questionnaire (MSLQ) created by Pintrich et al. (1991,

1993). The scales measuring *Study Environment*, *Effort,* and *Peer Collaboration* were used (see Figure 1), and measured on a 7-point scale, where 1 was defined as "totally disagree" and 7 as "totally agree."

Data Analyses

The handling of the responses was divided into quantitative and qualitative stages (Figure 1) and proceeded corresponding to the research questions (RQs). Subgroups were identified by following the procedure by Pintrich et al. (1991) who divided students into three groups based on the students' scores on each scale separately: the bottom 25%, the middle 50%, and the top 25%. Before identifying the subgroups, the descriptive statistics of the SRL measurement were analyzed. All nine SRL items from the three scales were correlated and thus merged into one (α=.79) sum of variable. Then, the cut-off points for the subgroups were decided on, based on the descriptives of the summed variable. Analysis of variance (ANOVA) with Tukey post-hoc comparisons was used to confirm statistical differences between subgroups. To evaluate equal access or digitally divided experiences (RQ2), items measured with ordinal scales were analyzed using Kruskal-Wallis nonparametric tests.

At the qualitative stage, the results of the quantitative stage were used to extract open-ended responses (n=13,310). The decision to focus the qualitative analysis on only two subgroups (*Developing SRL* and *Advanced SRL*) was based on observed large differences related to SRL and experiences of digital divide between students belonging to these groups. The decision was supported by Iiskala et al. (2021), who considered exploring

only the low achieving and high achieving subgroups most relevant. The qualitative analysis of the open responses was guided by principles of content analysis (Elo & Kyngäs, 2008). A combination of inductive and deductive methods was used in the category building (Elo & Kyngäs, 2008). That is, the work was based on both open coding and coding guided by knowledge related to SRL. To strengthen the integrity of the findings and consider alternative perceptions, investigator triangulation was used as a crucial part of the analysis process (Anney, 2015), and the first two authors worked in close collaboration during the analysis phase.

The qualitative analysis proceeded through four rounds. First, the researchers started by reading the data to make sense of it. That was followed by a second round of reading, during which researchers open-coded all learning-related expressions (e.g., subject content) and identified SRL-related parts with an *SRL* code. Third, the researchers discussed their observations, which were similar, likely due to the short descriptions of the students. Based on the discussion, six thematic categories depicting the overall situation of e-learning experiences were decided on: *digital skills*, *SRL*, *nothing*, *something*, *subject content*, and *valuation*. Next, the analysis moved to a deeper examination of the category of SRL to identify the various elements from the SRL framework and earlier research. Thus, the methodology of this study was based on a deductive approach (Assaroudi et al., 2018; Elo & Kyngäs, 2008).

Results

This section begins by presenting the results from the quantitative analysis. Then, the results of the qualitative analysis of the open responses are described.

SRL Subgroups with Digitally Divided Experiences

Students evaluated their skills in SRL overall as quite high: based on the mean value, the sum of the variable describing SRL was as high as *M*=4.84, *sd*=1.17. Pintrich et al. (1991) wrote that a college student's average mean score of the above three groups, measured with a 7-point scale, indicates that the student can regulate their learning *well enough*. Usually, adolescents report perceptions of themselves slightly positively (Anyan et al., 2021), and mean values closer to 5 indicate that the students in this survey observed their SRL more positively than the college students in the Pintrich et al. 1991 study. It was therefore decided to set the first cut-off point at 3.99.

Students assigned in three subgroups based on their SRL are shown in Figure 2 (RQ1). In this sample, 21% of the students rated their SRL as falling between values 1 and 3.99, and they were designated as *Developing SRL*. This name connotates that these students have a poorer preparedness for regulating their learning, and thus their skills are still developing. In the middle group, 47% of the students rated their SRL as falling between 4 and 5.50 and they were described as having *Moderate SRL*. The remaining 31% of students who rated their SRL as being between 5.51 and 7 were designated as having *Advanced SRL* (N=9,288), indicating that they have high SRL skills. Results of

ANOVA indicating statistically significant differences between subgroups and measured scales are presented in Appendix 1.
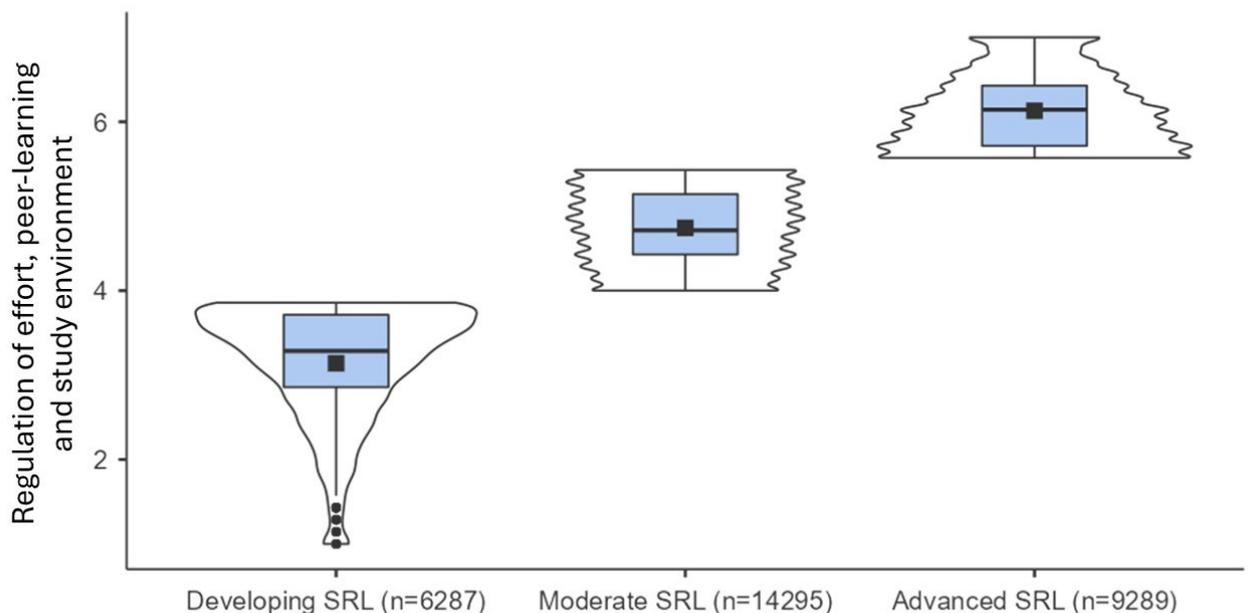
Figure 2. Division of students in SRL subgroups based on their perceptions of effort, peer-learning and regulation of study environment.
Image description available

Observing the equal access that the students had to digital devices and divided learning experiences (RQ2) shows that there are true differences between subgroups. From Figure 3 it can be noted that over 40% of students with *Developing SRL* skills experienced learning "clearly less" or "less", and they were often left without parental help (60%). In contrast, the share of students with *Advanced SRL* was 25% and 15%, respectively. All observations in Figure 3 were statistically significant (see Appendix 1). However, there were no statistically significant differences between subgroups in terms of access to digital devices: around 70% of students in each group reported using a family computer, and around 18% needed to take turns with siblings.
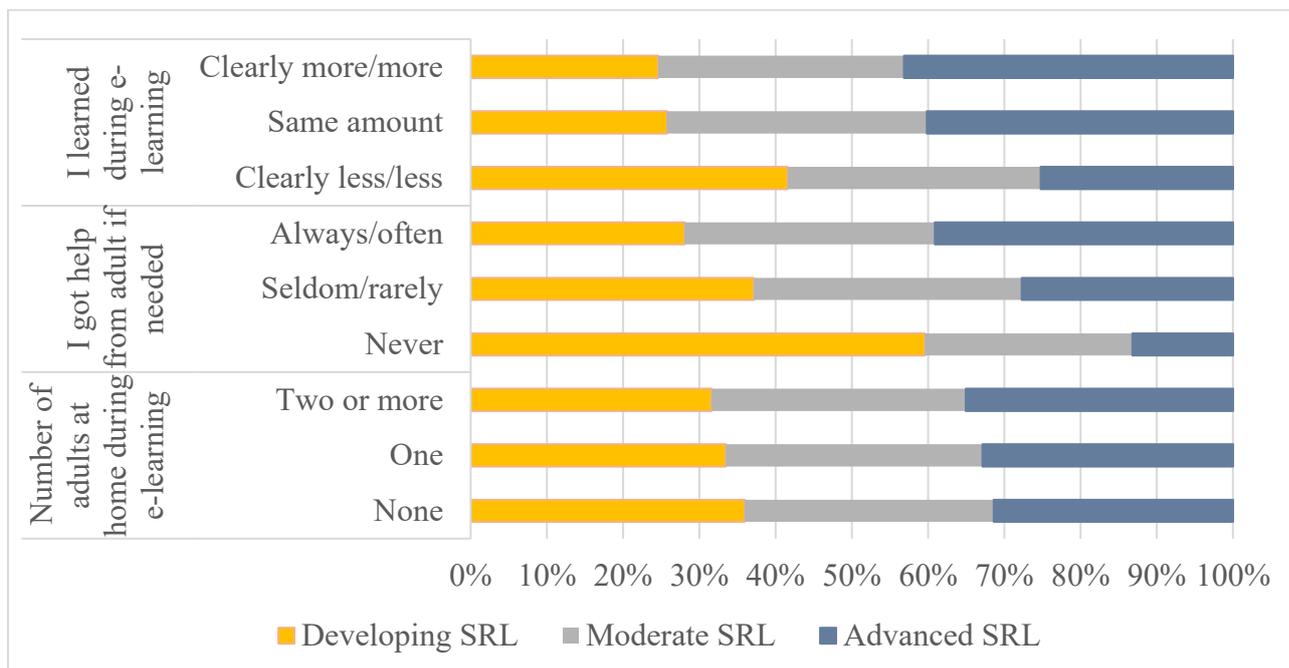
Figure 3. Frequencies of the background information
describing e-learning conditions at home.
Image description available.

Students' Perceptions of Their E-Learning

RQ3 explored how students described their learning during the two-month school closure in their written responses. Six thematic categories depict the students' overall e-learning experiences (Table 1) and form the first half of this section. In the second half, the focus is on the category of self-regulation and its subcategories (Table 2).

The students' responses were sometimes composed of multiple elements, thus covering more than one thematic category. Multiple categories were given a primary classification according to the theme that was the most emphasized (e.g., digital skills), and a secondary classification indicating the

co-existing theme (e.g., subject content). Overall, there were large differences between the themes expressed by students with *Developing SRL* as compared to *Advanced SRL*. Percentages have been presented to evaluate the proportion of the expressions in relation to the number of the students in the groups. There were also differences in the length of the descriptions. In both groups, students who reported learning "nothing" used only one to two words (e.g., nothing=*en mitään* in Finnish). Students who monitored and recognized learning new skills wrote one to two sentences. Overall, students with *Advanced SRL* used more words to describe their learning.

Learning experiences were categorized primarily related to *digital skills*, *self-regulation*, *nothing*, *something*, *subject contents,* and *valuation*. As expected, students in both SRL groups reported learning *digital skills* when they studied at home via computer. However, there were almost twice as many students with *Advanced SRL* compared to students with *Developing SRL* who mentioned learning these new skills, thereby illustrating the second level of the digital divide in learning experiences (van Deursen & van Dijk, 2014). Responses included actual skills, such as the use of a computer, new programs, platforms, or applications. In addition, several students mentioned seeking information from the internet, which implies their ability to use cognitive strategies and self-organize information (Pintrich et al., 1993). Along with technology skills, students with *Advanced SRL* mentioned self-regulation as a secondary theme in 280 responses, while students with *Developing SRL* did so in only eight responses. Thus, the data indicate there is a digital divide between students, and technological skills are the central reason for the gap (van Deursen & van Dijk, 2014; Zillien & Hargittai, 2009).

Table 1. *Distribution of the themes occurring in the written responses*

Theme	Advanced SRL		Developing SRL	
	Number of Excerpts	Example with student ID	Number of Excerpts	Example with student ID
1. Digital skills	3158 (39%)	"I learned to use internet and apps needed in schoolwork" (ID 56621)	1064 (21%)	"I learned to use Google Meet" (ID 12274)
2. Self-regulation	2687 (33%)	"To plan the day in order to get all schoolwork done" (ID 28263)	747 (15%)	"Find out assignments and take initiative" (ID 2859)
3. Nothing	1569 (19%)	"Not much" (ID 62440)	2619 (51%)	"Nothing" (ID 25407)
4. Something	275 (3%)	"School stuff" (ID 57532)	119 (2%)	"Just something" (ID 22168)
5. Subject content	193 (2%)	"Math" (ID 1243)	128 (2%)	"Cooking" (ID 40088)
6. Valuation	62 (1%)	"That it is easier and nicer at school" (ID 40807)	61 (1%)	"Value teaching at school and teachers" (ID 12713)

Students' responses in which they could not name what they had learned were classified under the *nothing* category. Most responses in this category were written with one word—"nothing"—and covered a sizeable proportion of all responses, especially among respondents in the *Developing SRL* group where half of the students felt so. It is known that in terms of SRL, less skilful students do not always recognize their learning (Kontturi, 2016).

Further, students may avoid metacognitive processing, indicating that they would be likely to benefit from other forms of regulation (Iiskala et al., 2021). Regarding the narrowness of the written responses, the categories of *something* and *subject content* were like the category of *nothing*. In these categories, students mentioned single skills such as "cooking", "math", or just a vague "something" or "school stuff" without specification and using only one to three words. Due to the concise nature of these expressions, it is impossible to interpret whether students' responses indicate helplessness, a lack of motivation, frustration, or other negative feelings about e-learning or even the questionnaire.

The category described as *valuation* is the smallest, yet it brought out students' reflections on the longing for face-to-face teaching—a phenomenon that was also reported in the study by Power et al. (2023). The importance of attending lessons in a face-to-face manner in the school building, being together in the same physical space with peers and teachers, were elements that we observed in the students' responses under this category. Students described how they had struggled with e-learning and had therefore started to value learning at school. This can be interpreted as an indication that these students would benefit from the peer-learning and external regulation of the study environment (Pintrich et al., 1993). These descriptions differ from all other categories in the aspect of hope and gratitude mediating thoughts.

Students E-Learning Experiences Related to Self-Regulation

As mentioned earlier, while examining the thematic category *self-regulation* and its subcategories (Table 2), a clear division between the two

SRL subgroups could be noted. More than 30% of the *Advanced SRL* students monitored their cognitive and metacognitive processes in their responses, while only 15% of the *Developing SRL* students intuitively paid attention to these. The students' written responses showed that typically students with *Advanced SRL* seemed to provide more nuanced descriptions of their e-learning. They seemed to be able to monitor their motivation, as well as their metacognitive and cognitive processes in a more elaborate way: "I learned how to make schedules, maintain motivation, be less harsh on myself, teamwork skills, flexibility, making compromises" (*Advanced SRL* ID 1557). Students with *Developing SRL* usually mentioned a single skill such as "concentration" or "independent work".

Students frequently explained how they had learned to regulate their *independence* during the two-month e-learning period. The responses to do with independent ways of working were connected to studying, searching for information, problem-solving, or taking care of schoolwork. These aspects of independence can be conceptualized as representing ways of regulating the effort put into learning and the overall ability to engage in autonomous behaviour (Efklides, 2011, 2018). Within this category, there were students who described e-learning as frustrating and too difficult to handle independently. The following response clearly signals that a student is capable of metacognitive reflection and recognizes that they need help and support for learning (Efklides, 2011): "I learned that independent e-learning is obviously not for me" (*Developing SRL* ID 32452).

Scheduling, as regulation of time, was the second most common subcategory belonging to strategies of resource management that are separate from cognitive and metacognitive strategies (Pintrich et al., 1993). Alongside students reporting on scheduling their schoolwork, some students described how the situation necessitated careful planning of their own life: "I have learned to organize my life. That was a skill I was compelled to learn to somehow manage e-learning" (*Advanced SRL* ID 32844). Hence, in responses like this, the regulation of time was reflected from a wider perspective, combining school-related duties with other aspects of the student's everyday life.

Table 2. *Identified Subcategories Under the Thematic Category of Self-Regulation*

SRL subthemes	Advanced SRL		Developing SRL	
	Number of excerpts	Example with student ID	Number of excerpts	Example with student ID
1. Independence	1258	"I created my own functional way of independent studying" (ID 12437)	309	"Find out assignments and take initiative" (ID 2859)
2. Scheduling	499	"To plan the day in order to get all schoolwork done" (ID 28263)	152	"Keeping up the deadlines" (ID 47137)
3. Responsibility	300	"To take responsibility for own learning" (ID 14387)	57	"I learned that I must take the responsibility of my own learning" (ID 37732)

SRL subthemes	Advanced SRL		Developing SRL	
	Number of excerpts	Example with student ID	Number of excerpts	Example with student ID
4. Self-disciplinary	171	"To keep my self-discipline even better" (ID 14458)	42	"That I must do school tasks first and then I can play" (ID 52571)
5. Patience	123	"I'm now more patient and can take initiative" (ID 23758)	41	"Tolerance for pressure" (ID 25741)
6. Concentration	79	"My concentration has developed." (ID 8972)	16	"To listen what the teacher says and to follow what we do" (ID 19063)

The subcategories of *responsibility*, *self-discipline*, and *patience* are connected to the *independence* subcategory, representing motivation to work to reach the learning goal (Pintrich, 2004). These issues were placed under their own subcategories to bring out the slight differences in expressions. While *responsibility* forms a whole that reflects students' views on how they value learning and are proud of it, the responses under *self-discipline* reflect autonomous control (Efklides, 2011). Students described how they could develop their ways of working even though no one was constantly able to control them: "When no one has been observing me, I have really properly learned to study" (*Advanced SRL* ID 62205). The difference between students in the *Developing SLR* and the *Advanced SRL* subgroups is large, indicating that some *Advanced SLR* students may have even benefitted from

the autonomous leadership in their e-learning, while students with lesser SRL skills may have felt insecurity.

Students' responses related to the *patience* subcategory had an almost univocally one-to-three-word message expressing patience, yet they underlined the regulation of behaviour and motivation (Efklides, 2011, 2018). Patience was learned through frustrating situations, such as technical problems with computers and applications, or complicated school assignments.

In the least numerous subcategory students mentioned learning skills that helped them *concentrate* better, which refers to the control of cognition (Pintrich et al., 1991). Students described how they had learned to listen and study despite family disturbance and background noise.

Discussion

The closure of schools caused by the global COVID-19 pandemic divided students' learning experiences: some students perceived that they had learned more, while others perceived they had learned less compared to usual face-to-face classroom settings (Huber & Helm, 2020; Oinas et al., 2022). The aim of this mixed method study was to understand these divided experiences by observing students' SRL skills and their equal access to digital devices through quantitative analysis and open-ended responses describing e-learning with qualitative analysis. Results from quantitative and qualitative stages substantiate one another and confirm the conclusions. The Finnish students seem to have equal access to devices indicating the non-existence of the first-level of the digital divide (van Deursen & van Dijk, 2014), but the

results of this study provide empirical evidence showing the existence of the second-level digital divide. That is, there is increasing inequality between students in their e-learning skills, and this is crucial for meaningful learning experiences (van Deursen & van Dijk, 2014; Zillien & Hargittai, 2009).

According to the current findings, most students positively evaluated their skills in self-regulating effort, peer collaboration, and the learning environment. Students described the development of well-functioning strategies to cope with unexpected conditions. Unfortunately, it became evident that not all of the students were able to adapt to e-learning. Perceptions of learning seemed to be strongly connected to students' SRL skills. Strikingly, half of the students with a lower level of SRL reported learning nothing. Therefore, this study confirms the suggestions made by earlier researchers (Johnson et al., 2023) that it seems to be crucial to support students' SRL, but also their digital learning skills, to avoid widening the gap between students who succeed and those who suffer when learning is arranged via digital devices.

E-learning Increasing the Digital Divide

According to the data from the large sample in this study, every fifth student in Finnish comprehensive schools would need help in regulating their learning; their SRL skills can be described as less adequate. These students reported less frequently learning digital skills or receiving help that would be important in preventing actualizing the second-level digital divide (van Deursen & van Dijk, 2014). Nevertheless, it is worth noting that students may have acquired a variety of new skills during the school closure, but they were

not able to recognize their progress by themselves. Therefore, earlier research has suggested that students may benefit from other external forms of regulation in situations in which they doubt their learning and refuse to pay attention to metacognitive regulation (Iiskala et al., 2021). Moreover, there is evidence, especially in e-learning, stating that students require parental assistance (Johnson et al., 2023) and support for their learning regulation (Dijkstra et al., 2023).

The qualitative results imply that some students were proud and satisfied that they could regulate their e-learning autonomously. It seems that the ability to study more freely without control can be one factor promoting pleasant e-learning experiences. Parental control, especially support without authoritarian pressure, may enhance the self-control of students lacking skills to regulate learning by themselves (Núñes et al., 2015). It is likely that students with poorer skills would benefit from examples set by adults indicating how to regulate learning related behaviour. Yet, it seems that students with lesser SRL skills are more often left without parental assistance during e-learning. To support students' learning and future motivation to keep reaching new academic goals, it is essential for teachers to support students' self-monitoring skills so that they can follow their own learning process. Dörrenbäcker-Ulrich et al. (2021) suggest that individually tailored interventions are needed to support the development of students' self-regulation skills at school.

The findings concerning parents' availability in e-learning conditions provide indirect evidence of the widening achievement gaps between low and high performing students in contexts in which self-regulation skills are

associated with academic success (Dörrenbäcker-Ulrich et al., 2021). It is possible that better-educated parents are able to provide their children with more support, enhancing the social reproduction of learned skills (Reichelt et al., 2019; van Deursen & van Dijk, 2015). However, this claim should be studied more in depth in the future. According to the evidence of this study, there is a danger that the digital divide will be exacerbated by the fact that e-learning requires individuals to have skills in regulating their effort and learning strategies. Unfortunately, experiences of lacking appropriate e-learning skills may have a long-lasting impact on students' academic and working careers (Pierce & Cleary, 2024). Digital exclusion from society is a rising concern and should be the focus of future research.

The current study provides evidence that there is a clear connection between qualitative data and the items typically measured with SRL questionnaires. Somewhat surprisingly, students' open responses mentioned all of the following:

- Cognitive strategies measured as *elaboration* and *organization*;
- Metacognitive strategies measured as *planning* and *monitoring*;
- Resource management strategies measured as *effort* and *scheduling*; and
- Motivation evaluation measured as *values*, *expectations,* and *self-beliefs* (Efklides, 2011; Pintrich et al., 1993).

Also, the students' open-ended answers indicate that they developed new strategies to cope independently and were often skilful at regulating their e-learning. However, the responses also introduced students who were aware that they lacked the ability to control their work on their own. Their

reflections and frustration indicate that they were capable of metacognitive processing of the skills they do not yet have.

Limitations

The literature suggests that there is a connection between school achievement and SRL (Kontturi, 2016), and parental assistance with difficult homework (Núñes et al., 2015). In this study, information about achievements at school was not collected and, therefore, this should be studied in the future.

Although, the sample in this study was exceptionally large and nationally representative, the reader must keep in mind that the open responses analyzed in this study were often expressions of one to three words, and therefore did not allow nuanced interpretations but a large amount of evidence based on compact verbal expressions.

Conclusions and Implications for Future

During the rapid school closures in 2020, teachers concentrated mainly on giving clear guidelines rather than supporting the deeper thinking skills of their students (Mankki, 2021). This may have influenced students' perceptions that they learned nothing, which was alarmingly common in this study. It should be ensured in e-learning situations that students receive motivating learning material, such as challenging problem-solving tasks, to engage them (Johnson et al., 2023). Therefore, future research is needed to study the connections between the level of cognitive activity achieved in e-learning and students' perceptions of learning.

SRL and the concept of the digital divide enable analysis of e-learning from individual and environmental viewpoints. Self-regulated learners are assumed to be autonomous and actively regulating their cognitive and metacognitive processes, as well as their motivation in relation to learning goals (Efklides, 2011, 2018; Pintrich, 2000). The results of this study show that, when compared to face-to-face classroom settings, around half of the students perceived that they learned less—or even nothing—during the school closures caused by COVID-19, whatever their SRL level. However, there was a clear connection between the experiences of e-learning and the students' SRL level, which supports the actualization of a second-level digital divide.

Aligned with previous research (Hanny et al., 2023), this study shows that students' individual characteristics and digital skills need teachers' attention and support in order to prevent digital divide among students. In the future, it will be important to pay attention to students' digital skills and how they describe and regulate their learning. Moreover, teacher professional development should target attention to e-learning, which so far has not been present in teacher preparation programs (Barbour, 2022). E-learning is expected to play a significant role in the future of education; therefore, it is essential that teachers are equipped with the necessary e-teaching competencies. While teachers cannot change the conditions at home, schools and institutions should offer supporting and inclusive structures for their students to narrow the digitally divided learning experiences.

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Image Descriptions

Figure 1 image description: Diagram outlines research study mixed-methods approach, combining quantitative and qualitative data collection and analysis:

- **Electronic Survey Structure:** The study uses an electronic survey with three parts: questions on digital access and e-learning experiences, an open-ended question about new skills learned, and scales from the Motivated Strategies for Learning Questionnaire (MSLQ).

- **Quantitative Analysis:** The quantitative stage addresses RQ1 and RQ2, focusing on identifying student subgroups based on SRL skills and examining their digital access and e-learning experiences using descriptive statistics, ANOVA, and nonparametric methods.

- **Qualitative Analysis:** The qualitative stage addresses RQ 3, analyzing students' descriptions of their learning experiences during remote schooling through content analysis of their open-ended survey responses.

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Figure 2 image description: Graph illustrates distribution of regulation of effort, peer-learning, and study environment across three group: Developing SRL (n=6,287), Moderate SRL (n=14,295), and Advanced SRL (n=9,289).

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Figure 3 image description: Bar chart illustrates the relationship between Developing SRL, Moderate SRL, and Advanced SRL levels on three aspects of e-learning:

- Perceived learning during e-learning: This section compares how much students felt they learned during e-learning compared to traditional learning, categorized as "Clearly more/more," "Same amount," or "Clearly less/less."

- Help received from adults during e-learning: This section indicates the frequency of receiving help from adults when needed, categorized as "Always/often," "Seldom/rarely," or "Never."

- Number of adults at home during e-learning: This section shows the number of adults present at home during e-learning, categorized as "Two or more," "One," or "None."

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Appendix 1

Table A1a: *Descriptive statistics of SRL conditions between subgroups*

		Developing SRL n=6287		Moderate SRL n=14295		Advanced SRL n=9289		ANOVA		
		M	SD	M	SD	M	SD	F	p	η
SRL α = .790	Effort	3.44	1.33	5.05	1.15	6.24	0.80	12254.85	.001	0.45
	Study environment	3.63	1.19	5.02	1.00	6.15	0.76	12541.81	.001	0.46
	Peer-learning	2.61	1.17	4.35	1.21	6.04	0.80	18932.22	.001	0.56

Table A1b: *Descriptive statistics of e-learning experiences at home between subgroups*

		Developing SRL n=6287		Moderate SRL n=14295		Advanced SRL n=9289		Kruskal-Wallis	
		M	SD	M	SD	M	SD	χ^2	p
Learning experiences	Adults at home	2.12	0.73	2.16	0.72	2.18	0.72	28.339(2)	.001
	Available help from parents	3.27	1.19	3.52	1.11	3.84	1.09	169.923(2)	.001
	Learning compared to "usual"	2.25	1.08	2.58	0.98	2.83	0.97	835.303(2)	.001