



Remote learning experiences of girls, boys and non-binary students[☆]

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ABSTRACT

Self-regulated learning (SRL) may determine adapting to online environments. This study is an evaluation of students' (N = 33 912) SRL and integration in remote learning in Finnish lower secondary schools when educational institutions all over the world were urgently closed and teaching was arranged in remote settings due to COVID-19. Neither the teachers nor the students had time to prepare themselves for the transition, resulting in variations in coping. To learn from experiences during the pandemic, we evaluated students' remote learning experiences by using a nationally representative survey. Results of SEM reveal that students' better preparedness for SRL and positive experiences related to clear guidelines and encouraging feedback from teachers predict more time invested in studying. Surprisingly, regulation of peer learning during remote learning period had the strongest correlation with positive experiences, indicating the need for social interaction when schools were closed. Moreover, results show that girls and non-binary students were slightly more concerned about the amount and quality of support for learning during remote learning compared to boys. Overall, when teaching is implemented via technology, students should not be left to cope with the skills they have, but instead, strategies to regulate their learning should be taught consistently. Opportunities for peer learning need to be kept in mind as they can easily be forgotten when students study online. Technology that is easy to deploy by teachers and enabling gender sensitive peer learning should be developed. An instrument measuring SRL should be updated to study learning in technology-enhanced environments.

1. Introduction

Children and adolescents undertaking basic education usually study in traditional classroom settings, face-to-face with a teacher. When online learning was suddenly implemented, *remotely*, due to the global COVID-19 pandemic, it is understandable that students had a range of life circumstances and opportunities to meet the requirements of regulating their learning at home (Carter, Rice, Yang, &

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Jackson, 2020; MacMahon, Leggett, & Carroll, 2020). In an uncertain situations such as a global pandemic, well-developed self-regulation skills may enhance the overall feeling of control (Carter et al., 2020), and thus increase positive experiences related to remote learning. However, discordant findings according to students' capacity to self-regulate online learning at home are presented (Börnert-Ringleb, Casale, & Hillenbrand, 2021; Huber & Helm, 2020). Therefore, to provide implications for educators as well as technology developers, the aim with this study was to find empirical evidence of remote learning experiences within the self-regulated learning (SRL) framework.

Self-regulated learners in general are assumed to have the potential to monitor and reflect on their progress, activities and learning environment (Heirweg, De Smul, Merchie, Devos, & Van Keer, 2020; Pintrich, 2004) and it is known that well-developed SRL is often associated with higher achievements (Heirweg, De Smul, Devos, & Van Keer, 2019; van Alten, Phielix, Janssen, & Kester, 2020). Regulation of behaviour means the ability to control effort, study the environment and the time used for studying (Pintrich, 2004). However, children and adolescents have various developmental paths of self-regulation (Heirweg et al., 2019; 2020), and not even all adults are able to regulate their learning-related behaviour as defined above (Peeters, De Backer, Kindekens, Triquet, & Lombaerts, 2016). When learning is implemented remotely at home, concentration on tasks and choosing a peaceful place to study is more dependent on students' self-regulation skills than when learning happens under a teacher's control.

As the focus of this study is on students' learning experiences during an unexpected school closure, the concept of *remote learning* is chosen and used to describe the phenomenon (Bond, 2020). Carter et al. (2020) concluded that research is needed to compare whether factors determining SRL are consistent in remote learning among children and adolescents compared to earlier findings. They suggested that supporting the development of SRL may increase students' perceptions of coping as well when they are transferred to remote learning (Carter et al., 2020). There has been speculation that existing and increasing learning outcome differences related to gender and other social differences are based on students' increasing SRL differences (Heirweg et al., 2019). For example, Finland has the largest gender gap between girls and boys, according to PISA results (OECD, 2016). Interestingly, Tang et al. (2021) found no differences between males and females in terms of their preparedness for remote learning in higher education settings. It has been argued that gender understood as a binary cannot provide in-depth understanding of the phenomenon, which is also related to other social differences such as ethnicity/race, economic situation such as poverty, health, and other social differences. Moreover, there is a gap in knowledge related to minority students' experiences (Bond, 2020). Therefore, it is important to study girls, boys, and non-binary students' remote learning experiences within the SRL framework, to develop online learning practices universally. In this study, students' remote learning experiences were studied by measuring strategies for regulating study environment, effort, and peer learning (Pintrich, Smith, Garcia, & McKeachie, 1993). Moreover, time used for remote learning and experiences related to unexpected school closure were observed.

1.1. Self-regulation of remote learning

Self-regulated learning (SRL) is defined as "learning that results from self-generated thoughts and behaviours that are systematically oriented toward their learning goals" (Schunk & Zimmerman, 2003, p. 59). The framework of SRL consists of at least ten separate models developed to understand how information processing, motivation, and emotions direct learning processes (Boekaerts, 2011; Panadero, 2017; Pintrich et al., 1993; Schunk & Zimmerman, 2003; Winne, 2017). In this study, the focus is regulation of *learning environment*, *effort* and *peer learning*, as outlined by Pintrich, Smith, Garcia, and McKeachie (1991; 1993) Pintrich, Smith, Garcia, and McKeachie (1991). Students' preparedness to regulate their learning in digital environments can be very different from classroom education (Persico & Steffens, 2017) and perhaps in terms of fairness and life circumstances. Younger students at least may find it difficult to operate available options in technology-enhanced environments by themselves (Persico & Steffens, 2017). But university students are also reported to have found difficulties in scheduling their studies and maintaining their persistence during the remote learning (Parpala, Katajavuori, Haarala-Muhonen, & Asikainen, 2021).

It is assumed that regulating time spent on studying and choosing a suitable place to do schoolwork require more abilities in remote learning compared to learning in the classroom. Huber and Helm (2020) have already reported that during COVID-19 some students spent less than 2 h on studying while others spent more than 5 h per day in Germany, Austria and Switzerland. Students who reported spending a lot of time on studying felt that they were skilled at self-regulating their learning routines, and that they learnt even more at home compared to learning at school (Huber & Helm, 2020). Earlier, (Oinas, Vainikainen, & Hotulainen, 2018) found that students with most of the absences also had problems with school assignments and behaviour, indicating that they may suffer from a lack of self-regulation skills. Meyers, Pignault, and Houssemand (2013) conclude that connections between SRL and dropping out of school should be studied more closely while SRL can still be developed. Therefore, studying the connections between SRL and time spent on studying during remote learning can reveal students at risk.

Facing difficult and boring tasks or problems with digital devices may challenge persistence in remote learning. Thus, abilities to regulate the learning environment and effort play a role in managing resources other than cognitive resources (Heirweg et al., 2020; Pintrich et al., 1993). Effort mediates the use of cognitive and metacognitive learning strategies and commitment to goals, thus predicting overall academic success (Pintrich et al., 1991). Niemi and Kousa (2020) reported that during remote learning, some students struggled with the workload and had problems maintaining their motivation. Obviously, teachers need more evidence-based knowledge to be better prepared for supporting the online learning of students who struggle (Bragg, Walsh, & Heyeres, 2021; Scherer, Howard, Tondeur, & Siddiq, 2021).

Learning is constructed through social collaboration (Zimmerman, 1989). Social isolation caused by school closures may have had an impact on some students' senses of belonging, which may lower their motivation (MacMahon et al., 2020). Therefore, teachers are encouraged to implement even social media platforms to avoid students' isolation (Greenhow & Chapman, 2020). Pintrich et al.

(1993) use the term *peer learning* when they measure learning in collaboration with study groups or friends. Recent findings indicate that learning in study groups has been less satisfactory in remote mode compared to peer learning before COVID-19 isolation (Lee, Fanguy, Lu, & Blight, 2021). When learning is transferred into a digital environment in the middle of the school year, students may already have had functioning study groups (Lee et al., 2021). If no social ties have been established in face-to-face situations, it is harder to collaborate with peers online (Lee et al., 2021; Sabato, Abraham, & Kogut, 2021). Moreover, MacMahon et al. (2020) are worried that regulation of learning can be challenging without face-to-face collaboration. Sharing completed task results or opinions in digital environments may require a high degree of self-regulation and not even most university students are comfortable with it (Yot-Dominguez & Marcelo, 2017). However, increased interaction with introvert students was a pleasant surprise for teachers in the Netherlands during remote learning (van der Spoel, Noroozi, Schuurink, & van Ginkel, 2020). Niemi and Kousa (2020) report that some students felt it easier to share their thoughts online compared to face-to-face, while other students missed meeting their friends in real. However, Sabato et al. (2021) reported that during the COVID-19 isolation, some were too lonely to help a peer.

Educational research often describes SRL related to socially-produced differences between demographics such as socio-economic background, school achievements, school region or gender (Jansen, van Leeuwen, Janssen, Jak, & Kester, 2019; Panadero, Jonsson, & Botella, 2017). Based on the meta-analysis, gender is reported as binary (Panadero et al., 2017), which obviously may shape gendered practices creating bias and hierarchical and heteronormative stereotypes related to gender. Binary division has repeatedly resulted in assumptions about the fundamental dissimilarity of girls and boys. The assumption of differing characteristics has led to different treatment, which then has produced differences that strengthen the assumption of gender-bound characteristics (e.g., Brunila, 2011; Brunila & Edström, 2013). Previous research and national reports have also shown how non-binary and transgender youths have experienced discrimination and other kinds of othering in schools in Finland (e.g., Jokela et al., 2020). Moreover, teachers promote students' SRL differently based on their individual characteristics (Peeters et al., 2016), and overall, teachers would require more support for online teaching practices (Börnert-Ringleb et al., 2021; Scherer et al., 2021). Therefore, in order to develop remote learning, it is important to look at gender as a social construction because it enables an aspiration to change treatment and conditions, and this can also provide space for those students who cannot be categorised into either gender.

1.2. Positive experiences and worries related to learning

Positive experiences occur when instruction or learning tasks are experienced as exciting or appealing (Buff, Reusser, Rakoczy, & Pauli, 2011). Achievements, learning environment and perceived quality of teaching affect learning experiences (Pekrun, 2009). However, the rapid shift from classrooms to remote learning may have jeopardised the quality of teaching (Usher, Hershkovitz, & Forkosh-Baruch, 2021). It is suggested that positive experiences are mediated by self-beliefs about being able to manage the requirements of learning (Buff et al., 2011). For instance, it is likely that a student with doubt and worries about coping in remote settings may face negative experiences. Positive experiences are known to increase cognitive engagement and will indirectly affect achievements (Buff et al., 2011). Niemi and Kousa (2020) reported that Finnish high school students had both positive and negative experiences during remote learning. University students described negative online learning as 'feeling lost in cyberspace' (Mansour, Mupinga, & Davidson, 2007). Students' positive experiences were related to the teacher's availability and convenient interactions, while isolation and lack of personal contacts caused negative experiences (Mansour et al., 2007).

Perceived social support and feedback from the teacher (Tennant et al., 2015) are known to influence learning experiences (Buff et al., 2011; Oinas, Thuneberg, Vainikainen, & Hotulainen, 2020). Usually, pleasant or constructive information as a form of feedback is perceived as positive (Tennant et al., 2015). Being treated unpleasantly and unfairly (Schenke, Ruzek, Lam, Karabenik, & Eccles, 2018), or being left out of any information is perceived as negative (Oinas, Ahtiainen, Vainikainen, & Hotulainen, 2021; Oinas, Thuneberg, Vainikainen, & Hotulainen, 2020). Feedback and digital communication with a teacher may be especially important in unexpected situations such as remote learning, as there is evidence that compared to no-feedback conditions, even critical comments may support learning (Fong, Patall, Vasquez, & Stautberg, 2019; Oinas, Ahtiainen, Vainikainen, & Hotulainen, 2021). Also, peer feedback is known to be beneficial for learning (Latifi, Noroozi, Hatami, & Biemans, 2021; Noroozi et al., 2020). In relation to remote learning, van der Spoel et al. (2020) reported that teachers implemented technology to give feedback. Usher et al. (2021) suggest that more data-driven methods for remote teaching are needed if teachers are to be able to support their students' learning and well-being.

Screens and multiple online platforms used during school hours have changed learning environments and as a result, social interaction is no longer restricted to inside the classroom (Sahlström, Tanner, & Olin-Scheller, 2019). As in face-to-face interactions, it is likely that online presence is also perceived differently by students, impacting how pleasant or unpleasant digital interaction is experienced. At least teachers in higher education reported difficulties in supporting students' collaboration with each other in remote learning because of the lack of verbal and non-verbal cues (Usher et al., 2021). However, students who perceive discriminative or biased school practices, such as gendered treatment, as unpleasant may even benefit from remote learning. Recent findings show that non-binary and transgender students were lonelier and often felt unsafe at both school and home compared to students identifying as girls and boys (Jokela et al., 2020). To ensure safe learning opportunities for all in the future, it is important to study remote learning experiences as gendered.

1.3. Research questions

Based on the literature, it seems that positive learning experiences and preparedness to regulate daily routines required to learn at home may go hand in hand (Lee et al., 2021). Preliminary findings indicating that students who perceived themselves as being good at regulating their learning thought that they had learned even more in the remote school setting compared to learning in traditional

classrooms (Huber & Helm, 2020). Börnert-Ringleb et al. (2021) reported that students' weak SRL skills resulted in obstacles in remote learning. Therefore, more evidence about students' remote learning experiences and SRL is needed. The research questions are: RQ1) Are the factors measuring SRL (learning environment, effort and peer learning) identified in regular contact teaching also present in remote learning among adolescents and are experiences of remote learning related to them? RQ2) Are the experiences of remote learning connected to time spent on studying? RQ3) How are girls', boys' and non-binary students' perceptions associated with SRL, time and remote learning experiences?

It is expected that the structure of the SRL model created originally to measure regulation of learning in traditional face-to-face classrooms (Pintrich et al., 1991) would also hold in the remote learning. However, Pintrich et al. (1993) decided that the factor measuring the learning environment actually measures two separate constructs, time and place, and therefore the structure of the SRL model might not be entirely acceptable. In addition, we expect students' experiences of remote learning to be related to their SRL skills (Huber & Helm, 2020). It is hypothesised that there are students who faced difficulties but also students who performed successfully, thus students are likely to have both positive and negative experiences (Buff et al., 2011; Pekrun, 2009; Pekrun, Goetz, Titz, & Perry, 2002). Based on prior research (Huber & Helm, 2020), we expect students' SRL skills and experiences to be related to the time they spend on studying. Lastly, we expect gender, among other things, to mediate students' experiences and academic working habits (Jokela et al., 2020; OECD, 2016; Heirweg et al. (2019)), as Heirweg et al. (2019) recently reported associations between SRL and gender.

2. Methods

Right after the two-month period of remote learning caused by the pandemic, a nationally representative sample (N = 35 357) was collected in May 2020 from 7th to 9th graders (13–16 years old) in Finnish basic education. An e-mail was sent to every school and principals were requested to forward the survey link to their students online. Students could complete the questionnaire with their own smartphone or computer during the school day or at home. Participation was voluntary and students could end the questionnaire at any point. The data were collected without names or ID codes, to ensure participants' rights to remain anonymous.

2.1. Context of the study

Altogether 106 countries closed schools due to the global COVID-19 pandemic (UNESCO, 2020). In Finland, basic education schools were closed by the government for two months from March to May in 2020. Schools were reopened for the last two weeks of the school year before the summer break. In Finland, children begin their 9-year-long basic education, including lower secondary education, when they turn seven. Basic education is free of charge and there are no large differences between schools in terms of learning results or students' societal background. In lower secondary education, subject teachers are responsible for teaching, but only a loose norm from the national core curriculum regulates the pedagogical practices used. Therefore, during the remote learning, teachers chose the practices used in instruction.

Finland is officially a bilingual country but around 87% of the population speak Finnish. Around 5% speak Swedish and the remaining 7% speak other languages such as Russian, Estonian, or Arabic (Statistics Finland, 2019). In recent years national surveys have collected data on perceived social gender. In the Finnish National School Health Promotion survey, 3% out of 85 707 participants reported identifying as neither a girl nor a boy (Jokela et al., 2020).

2.2. Participants

The data consisted originally of 35 613 questionnaire responses. Students who reported that they continued studying at school during the school closure (N = 1591) were excluded from the analyses. Moreover, we decided to exclude students participating in the voluntary 10th grade since there were only 130 of them. Finally, the data of 33 912 (55.8% girls, 42.2% boys, 2% non-binary) students from 363 schools were included in the analyses (Table 1). Participants cover around half of the Finnish students in lower secondary education, since there are 750 schools providing teaching for students in grades 7 to 9 (Statistics Finland, 2020). As background information, we only collected grade level and therefore it was impossible to calculate the mean age accurately. However, Finnish students begin their 7th grade the year they turn 13. They end 9th grade in May of the year they turn 16. Data represent mainly native students, as 97.4% of the participants reported speaking either Finnish or Swedish at home. The remaining 2.6% of the participants reported other home languages, such as Russian, Estonian, English, Arabic, Kurdish, Chinese and so forth.

Table 1
Participants of the study.

Grade level	Girl	Boy	Non-binary	Total
7	6577	4968	214	11 759
8	6506	4762	213	11 481
9	6094	4364	214	10 672
Total	19 177	14 094	641	33 912

2.3. Measures

The Motivational Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1991) was partly used to measure students' self-regulation of study environment, effort, and peer learning as resource management strategies during the remote learning period. The items used were translated into Finnish and the wording was slightly modified to measure experiences during the remote learning (presented in Table 2). In addition, based on findings from the literature described above, specific questions were created to detect experiences related to the school closure. Students were requested to evaluate whether they felt that the guidelines were easy to follow when learning was suddenly implemented remotely and whether they perceived learning at home as more comfortable. We also asked them about worries and support needs, as Tennant et al. (2015) have evidence that perceived support from teachers is an important indicator determining learning. Moreover, students were requested to evaluate whether they received encouraging feedback from their teacher during the remote learning period. All the above mentioned items (see Table 2) were measured on a 7-point scale, where 1 was defined as "totally disagree" and 7 as "totally agree". In addition, we asked how much time students spent on studying during the days they studied at home according to a 6-point scale (1 = less than 0.5 h, 2 = around 0.5 h, 3 = around 2–3 h, 4 = 4–5 h, 5 = 6–7 h, 6 = 8 h or more).

2.4. Data analyses

Analysis was undertaken using the statistical programs SPSS (version 24.0) and Mplus (version 8, Muthén & Muthén, 2018). First, to understand the nature of the data, preliminary calculations, such as descriptive statistics and reliability of the measured scales were done using SPSS24 (Table 2). Next, the analyses were continued in Mplus. The structure of SRL and remote learning experiences (RQ1) was examined first with confirmatory factor analysis (CFA). Maximum Likelihood Robust (MLR) estimation was used as some of the variables were slightly non-normally distributed (Lai, 2018). CFI and TLI >0.95 and RMSEA <0.06 were used to define the acceptable model (Kline, 2005). After the factorial structure of the measures had been confirmed with CFA, a two-level model with school as a cluster variable at the between level, was carried out to examine whether analyses should be continued in multilevel setting (Silva, Bosancianu, & Littvay, 2019). However, school-level differences explained only 1–3% of the variance of different factors, indicating that differences are located mainly at the individual student level. Therefore, analyses were continued with single-level SEM models.

To answer RQ2, a dependent variable of time used in studying was added to the CFA model (see Fig. 1). Finally, gender differences (RQ3) were studied with multiple-group analysis. For comparing coefficients, confidence intervals for the estimates were produced by bootstrapping with 1000 replicates (Wright, London, & Field, 2011). Before group comparisons, measurement invariance was examined by imposing restrictions stepwise on the model parameters and then comparing fit indices of different models in order to determine whether the model deteriorated or not (see Table 3 in the chapter 3.4). Analysis proceeded from an unrestricted baseline model by first constraining the factor loadings (i.e., metric invariance) and then the intercepts of the items (i.e., scalar invariance) (e.g., Millsapp & Cham, 2013). We studied the changes in CFI, RMSEA and SRMR, using the cutoff criteria for unequal subsample sizes as

Table 2
Descriptive statistics of the scales used.

	All (N = 30 211)	Girls (N = 17 285)	Boys (N = 12 376)	Non-binary (N = 553)
	M (SD)	M (SD)	M (SD)	M (SD)
SRL Learning environment ($\alpha = .556$ *)	5.08 (1.32)	5.10 (1.28)	5.10 (1.35)	4.25 (1.61)
I usually studied in a place where it was easy to concentrate.	5.54 (1.53)	5.57 (1.44)	5.54 (1.62)	4.65 (1.93)
I spent my time for studying effectively.	4.59 (1.68)	4.60 (1.65)	4.61 (1.70)	3.78 (1.91)
I had difficulty doing the tasks in the allotted time. ¹⁾				
SRL Effort ($\alpha = .757$ *)	5.08 (1.47)	5.21 (1.45)	4.94 (1.48)	4.28 (1.76)
I worked hard to do well, although I did not like all the tasks.	5.29 (1.56)	5.47 (1.52)	5.08 (1.61)	4.41 (1.98)
I used my effort to complete the less interesting tasks.	4.85 (1.73)	4.94 (1.68)	4.77 (1.76)	4.08 (1.91)
I often gave up on difficult things and focused on easier tasks. ¹⁾				
SRL Peer-learning ($\alpha = .810$)	4.51 (1.64)	4.75 (1.56)	4.21 (1.68)	3.89 (1.77)
I helped my peers on tasks.	4.87 (1.88)	5.20 (1.74)	4.45 (1.95)	4.26 (2.10)
I discussed learning tasks with peers.	4.38 (1.93)	4.59 (1.89)	4.11 (1.94)	3.69 (2.02)
I collaborated with my friends to complete school tasks.	4.28 (1.97)	4.44 (1.94)	4.08 (2.00)	3.72 (2.03)
Positive experiences ($\alpha = .678$ *)	4.26 (1.18)	4.25 (1.14)	4.31 (1.22)	3.71 (1.42)
During the remote learning, my skills for self-regulation have improved.	4.92 (1.69)	5.04 (1.65)	4.79 (1.72)	4.19 (1.97)
I think studying at home was more efficient compared to studying at school as usual.	3.96 (2.09)	3.94 (2.07)	4.02 (2.10)	3.64 (2.23)
I got encouraging feedback from the teacher.	4.76 (1.71)	4.82 (1.69)	4.72 (1.73)	4.02 (1.91)
It was easy to follow guidelines from the teacher.	4.76 (1.56)	4.76 (1.51)	4.80 (1.61)	4.01 (1.80)
It was nice to use video or audio recordings for tasks. ²⁾				
Worries & support needs ($\alpha = .724$)	2.95 (1.67)	3.06 (1.68)	2.76 (1.62)	3.60 (1.88)
I would have needed more support for learning.	2.99 (1.83)	3.07 (1.83)	2.85 (1.81)	3.54 (2.05)
I am afraid that I have fallen behind in my studies.	2.93 (1.95)	3.06 (2.00)	2.72 (1.85)	3.64 (2.15)

Note 1: reversed items were excluded from the model due to inconsistent responses.

Note 2: the item was excluded from the model due to residuals.

*) When the factor structure was estimated in Mplus, the items measuring Learning environment, Effort and Positive experiences loaded on one factor (see Fig. 2).

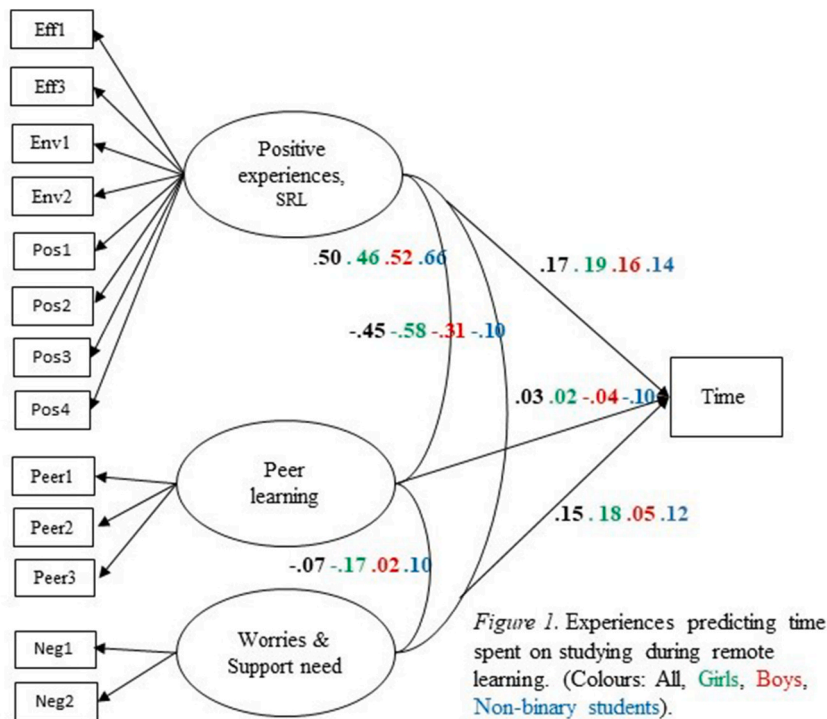


Fig. 1. Experiences predicting time spent on studying during remote learning.

Table 3

Goodness-of-fit statistics for alternative models in measurement invariance testing.

Model	Hypothesis	χ^2	df	CFI	RMSEA	SRMR
M1	Baseline model	3664.554	172	.967	.045	.027
M2	Metric invariance (factor loadings invariant between groups)	3841.745	192	.965	.043	.029
M3	Scalar invariance (item intercepts invariant between groups)	5021.207	212	.954	.047	.033
M3b	One item intercept (Peer1) free in group boys	4693.594	211	.957	.046	.031
M3c	Item intercepts Peer1 and Eff1 free in group boys	4284.710	210	.961	.044	.030

The cutoff value of the SRMR ≤ 0.08 indicates an acceptable fit (Cho, Hwang, Sarstedt, & Ringle, 2020).

suggested by Chen (2007). For metric invariance, a change less than 0.005 in CFI combined with a change of less than 0.010 in RMSEA or 0.025 in SRMR are acceptable. For scalar invariance, the change of CFI must be less than 0.005 combined with a change less than 0.010 in RMSEA 0.005 in SRMR. The table shows that to meet these criteria, we had to release the constrain on two intercepts for the boys group. Otherwise, the scales were measurement invariant across groups.

3. Results

Observing descriptive statistics of SRL indicate that overall, students rated their skills to regulate learning environment, effort, and peer-learning somewhat positively (Table 2). Next, each research question has been addressed separately.

3.1. Self-regulation of remote learning

RQ1 studied whether the instrument for measuring SRL developed originally for face-to-face conditions is reliable in remote settings. Before the actual analyses, we calculated descriptive statistics for the items and reliability scores for the expected sum scores (see Table 2.). After that, we examined whether this structure could be verified in our data. Unlike our expectations, results from confirmatory factor analysis (CFA) performed in Mplus did not confirm the originally expected structure because of the multicollinearity. Best model fit ($\chi^2 = 3081.518$ df = 58; RMSEA = 0.042; CFI = 0.971; TLI = 0.960; SRMR = 0.023) was achieved in the model in which items from the originally planned scales *learning environment*, *effort* and *positive experiences* were allowed to load on the same factor. Moreover, in the final factor model, four residual correlations and two cross-loadings between items were allowed. This result means that positive experiences during remote learning are strongly associated with the ability to regulate effort and resources of learning and thus in our model, they comprised together the *positive experiences SRL* factor (see Fig. 1). However, without questions

measuring experiences, the SRL factors terminated reliably, indicating that the factors alone are present and relevant also in remote learning. As the designed questions measuring positive experiences loaded strongly on SRL, it can be interpreted that students' preparedness for SRL at home, receiving understandable guidelines and encouraging feedback from teachers are the basis of positive experiences.

The items measuring *peer learning* loaded, as expected, on one factor (see Fig. 1). Additionally, as expected, two items measuring students' perceived need for support and concerns related to learning during remote learning loaded on one factor, which was named *Worries & Support needs*.

The relationships between different factors were logical and confirmed our expectations. As expected, *Positive experiences SRL* and *Worries & Support needs* correlated negatively with each other, indicating that students' positive and negative experiences are negatively dependent on each other. The strongest correlation in the model was between positive experiences, SRL and peer learning (Fig. 1.), indicating that students who are well prepared to work independently and have positive learning experiences also work with their peers. This result can also be interpreted as those who have worked with peers during remote learning have more positive learning experiences (confident intervals for latent means are presented in Appendix A). In turn, the relationship between peer learning and "Worries & Support needs" was negative, indicating that students who had faced difficulties during remote learning worked alone more.

3.2. Does study time reflect experiences?

The time used for studying during the remote learning period varied from zero to 8 h or more per school day. Descriptive information of the time used for studying by gender is illustrated in Fig. 2. The two lowest options (less than 0.5 h and around 0.5 h) from the scale were merged. Around 32% of all students reported using 2–3 h and 30% of students reported using 4–5 h for studying (mode for girls: 4–5 h, boys: 2–3 h, non-binary: 2–3 h).

The answer to RQ2, whether the time spent on studying during the remote learning period is connected to learning experiences, is yes. All three factors significantly predicted the time used for studying, but the *Positive Experiences SRL* as well as *Worries & Support needs* predicted studying time more strongly than the peer learning factor, which had only a minor, yet significant, effect on time (see Fig. 1). Overall, the model ($\chi^2 = 4436.282$ df = 66; RMSEA = 0.043; CFI = 0.960; TLI = 0.945; SRMR = 0.027) explained only 3.4% of the variance of the dependent *time* variable.

3.3. SRL and experiences of girls, boys and non-binary students

The final research question (RQ3) concerned how gender is associated with SRL, time and learning experiences during the remote learning period. This was done with multiple-group analysis to examine the differences between genders. Before that, measurement invariance of the factor model was examined between groups. As can be seen from Table 3, a partial yet sufficient level of invariance was achieved.

Results from multiple-group analysis revealed that, as expected, there were differences between genders but overall, the differences were quite small. Model fit for the estimated model was sufficient ($\chi^2 = 6196.230$ df = 240; RMSEA = 0.046; CFI = 0.957; TLI = 0.951; SRMR = 0.032) and the final model explained 3.4% of the variance of the dependent *time* variable for girls and approximately 2% of the variance for boys and for non-binary students.

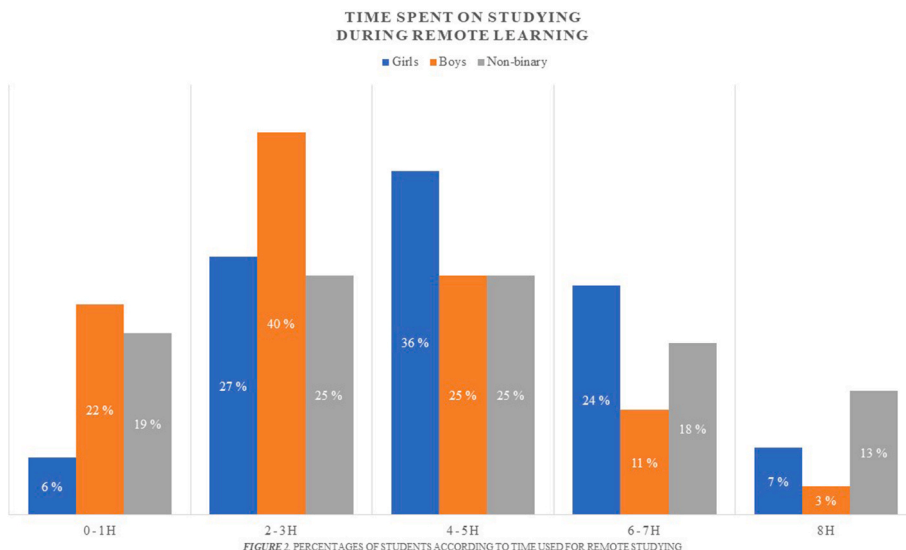


Fig. 2. Time used for remote studying.

Gender differences were most explicit in the latent means of the SRL factors (see Fig. 3). In the model, girls' values are set as zero and boys and non-binary students are then compared to girls' scores. The strong negative correlation for girls indicates that those who have worries in remote settings have fewer positive experiences and may lack SRL skills, or vice versa. The result indicates that inside of the large dataset there may be different patterns for girls: those who succeed and those who would need more support. In terms of these factors, the correlation is weaker for boys and not significant for non-binary students. Overall, boys seemed to be less afraid that they had fallen behind during remote learning. The latent means in Fig. 3. show that overall boys have fewer worries and non-binary students have more worries than girls do.

The connections between experiences and time used were not straightforward. Overall, it seems that regardless of experiences, girls spent more time on studying (M = 3.96, CI low = 3.94, CI high = 3.97). The results can be interpreted as students who are engaged in learning may use more time but those who struggle spend a lot of time as well. Of boys (M = 3.25, CI low = 3.23, CI high = 3.27), those who had positive experiences invested more time in studying than boys with worries and support needs. Discordantly, non-binary students seemed to spend more time on studying if they had worries or had experienced a lack of support (M = 3.66, CI low = 3.54, CI high = 3.76); however, the connection was not statistically significant (Appendix A).

Finally, it can be concluded that gender and time used for studying explained students' remote learning experiences quite weakly. The strong correlation between SRL and positive experiences indicates that preparedness to regulate learning environment, effort and peer learning seem to serve as a pre-condition for coping in unexpected situations.

4. Discussion

The aim of this study was to understand students' remote learning experiences during the school closure due to COVID-19 in Finland in 2020. Moreover, whether SRL is associated with remote learning experiences was studied, as it has been suggested that in digital environments students need to be more prepared to regulate their learning by themselves than in traditional classrooms (Persico & Steffens, 2017). National survey responses of girls (N = 19 177), boys (N = 14 094) and non-binary students (N = 641) in lower secondary education were analysed. The results are important, as schools globally should adapt for the future challenges in the situation where both teachers and students would need support in online learning (Börnert-Ringleb et al., 2021; Lee et al., 2021; Scherer et al., 2021). This study also provides important knowledge related to non-binary students' perceptions.

As the starting point, we tested whether the SRL instrument developed by Pintrich et al. (1991) for traditional classroom settings has parallel properties when measuring learning in digital/remote settings (Carter et al., 2020). Evidence from this study shows that at least regulation of effort, learning environment and peer learning (Pintrich et al., 1993) were related to learning experiences and thus are relevant when studying remote learning. Given this encouraging result, it would be crucial to update the SRL questionnaire to study, the technology that would best support peer learning within SRL, since there is evidence that at least peer feedback improves learning via online platforms (Latifi et al., 2021; Noroozi et al., 2020). Also, Usher et al. (2021) suggest that technology should be designed to provide information for teachers about how they can support peer collaboration in remote learning. In the future the scale measuring *Learning environment* should be modified as it seems to measure two separate constructs, *time* and *place*, noticed already by Pintrich et al. (1993) themselves. Due to low reliability of this single scale with the current sample, the CFA utilizing the common variance of the original items was performed.

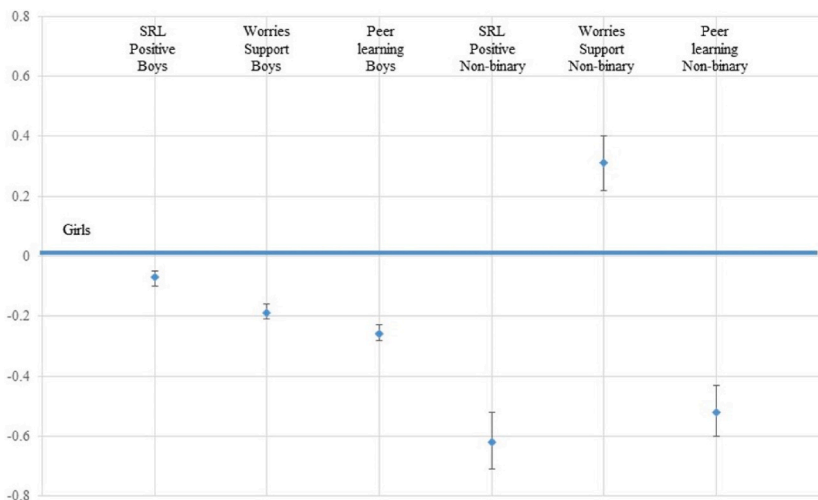


Figure 3. Standardised latent means and their 95% confidence intervals between observed factors.

Fig. 3. Latent means and intervals between observed factors.

4.1. Regulation of effort and peer learning as a pre-condition for positive experiences

The findings from this study indicate that students who were well prepared to regulate especially their effort and peer learning had a mainly positive remote learning experience. They expressed that their skills to regulate learning by themselves had even improved during the school closure. This finding is in line with [Huber and Helm \(2020\)](#) who also reported an association between SRL and remote learning experiences. In the higher education context, there have been reports that some students prefer remote learning ([Lee et al., 2021](#)). In this sample, some students reported learning more efficiently at home than usually at school, which may indicate that formal classroom education does not offer meaningful skills or interesting challenges for these students. Schools and teachers should show their students that teachers can differentiate teaching even for more able students. Learning analytics could provide tools to follow students' individual progress ([Usher et al., 2021](#)). [van der Spoel and colleagues \(2020\)](#) reported that teachers implement technology in their teaching to differentiate and personalise learning materials.

Perceived quality of teaching, defined by criteria such as clear instructions and interesting tasks have an impact on learning experiences ([Pekrun, 2009](#)). The results from this study show indirectly that Finnish teachers have adjusted well to the unexpected change requiring remote teaching skills, as students rated the quality of remote teaching mainly as good. This conclusion is in line with [Niemi and Kousa \(2020\)](#). Perceived good quality was associated with students' study time too. Moreover, this study shows that students who experienced remote learning as positive received encouraging feedback from the teacher. It is known that feedback increases perceived support from teacher ([Tennant et al., 2015](#)), and hence, students' remote learning experiences and sense of coping could perhaps be developed simply by providing encouraging attention along with fair and equal support for learning.

The results of peer learning in this study indicate that there was perhaps less collaboration than usual with peers during the remote learning period. The result strengthens earlier findings ([Lee et al., 2021](#); [Usher et al., 2021](#)). [MacMahon et al. \(2020\)](#) pointed out the need for social interaction to strengthen sense of belonging and coping. The results of this study indicate that unfortunately, there are adolescents who are growing up suffering from isolation, which may reflect further on their learning. Non-binary students reported that they collaborated or discussed with their peers less often compared to girls and boys. The standard deviation of the peer learning indicated that there are students in the gender minority who did not have any social collaboration at all at least in remote learning. In changing situations, such as dramatic school closures, teachers should pay attention especially to those students who are at risk of being left out of the group to prevent social isolation. Creating new bonds for social collaboration is harder online ([Lee et al., 2021](#); [Sabato et al., 2021](#)), so teachers would need training about how to support peer learning with gender sensitive methods. Moreover, something else to be studied is whether implementing technology designed to support peer learning and peer feedback ([Latifi et al., 2021](#); [Noroozi et al., 2020](#)) could foster social interaction in remote conditions.

4.2. Worries and lack of support in remote learning

Learning experiences are mediated by self-beliefs about the capacity to meet the requirements of learning ([Buff et al., 2011](#)). This study shows that during the remote learning there were students who were without the support they would have needed, indicating that these students may have had doubts about their skills to regulate learning by themselves. The experiences of being left alone and struggling with overly difficult tasks may be devastating for future learning. [Persico and Steffens \(2017\)](#) remind us that in technology-enhanced learning, students' age and developmental stage particularly have an impact on how they cope with the requirements of SRL. The sample used in this study was students in lower secondary education and thus it seems that the requirements of and guidelines of remote learning were not suitable for all the 13- to 16-year-old students.

Evaluating the time spent on studying during remote learning revealed that there were students who seemed not to participate in education at all, while at the same time there were students who studied intensively. Interestingly, there was a relatively large number of non-binary students who spent even 8 h or more for studying during remote learning. According to the results, there were boys particularly who were worried but spent less time for studying, indicating that perhaps they were too frustrated to even try studying without support. According to [Sabato et al. \(2021\)](#) perceived loneliness during the isolation may slump prosocial behaviour.

Online learning has sometimes been described as a feeling of being lost ([Mansour et al., 2007](#)). While learning transitioned from classrooms to homes overnight, it is understandable that some students worried about school closure and the pandemic, as they would all be in new and unexpected situations. It is also known that concentration in online learning is easily interrupted by notifications from entertaining applications ([Hollis & Was, 2016](#)) or by technical problems ([Lee et al., 2021](#)). Thus, negative experiences related to remote learning may also be explained because learning and communicating via computer was a very new situation for the students.

4.3. Limitations

We are aware that the current data is biased in that they were collected only in one country by using self-reported questionnaire representing students in basic education. Often young participants report their perceptions as slightly positively ([Anyan et al., 2021](#)), affecting results also in this study. In the future, log data about SRL could provide meaningful insight to remote learning ([Huang & Lajoie, 2021](#); [Winne, 2017](#)). The level of digitalization and the amount of technology available at home may vary between countries resulting a different starting point for remote learning ([Bond, 2020](#)). As there were students with worries, these should be studied with more than the two items used in this survey to reach more reliable conclusions in the future.

Unfortunately, the most important question related to school closures remains unresolved with these data. We cannot say how school closure affected learning. Given the evidence of different learning experiences, longitudinal data should be collected to understand the effect of the remote learning period on achievement at school. Moreover, we should study whether the period of isolation

had an impact on well-being and on the future of the growing children.

5. Conclusion and future implications

Educational research often uses a range of background variables to present the results of a study. Often these categorisations do not provide alternatives for solving the inequalities found (e.g., gender, socioeconomic background, cultural background) but instead they strengthen the stereotypes found. In this study, we noticed that girls’ and boys’ remote learning experiences were quite similar. Although differences between males and females are often reported (Noroozi et al., 2020; Panadero et al., 2017), the current result is in line with the findings of Tang et al. (2021), who reported that males and females have been equally prepared for remote learning. According to earlier evidence, students who seem to be introverted in traditional face-to-face classrooms were more present in remote learning (van der Spoel et al., 2020) and felt that it was easier to join discussion online (Niemi & Kousa, 2020). Further research is needed to study whether virtual environments compared to traditional classrooms can create a more secure and free place for learning in terms of gender and different students. It is important to keep previous research results and reports in mind showing that students who belong to gender and sexuality minorities experience discrimination and other forms of othering in schools (e.g., (Brunila & Kallioniemi, 2018)). As the results of this study show a strong connection between SRL, positive remote learning experiences and time spent on studying, an intervention should be applied to do research on whether developing self-regulation skills can support students, especially those who reported not attending online lessons and those who had worries about coping.

Based on the literature and empirical evidence of this study, the following recommendations for teachers and technology developers can be given: 1) as SRL is a skill that can be developed, students should not be left alone to cope with the skills they have, but instead, strategies to manage their learning should be taught consistently; 2) requirements of SRL should be reasonable according to students’ ages and developmental stages; 3) learning new skills and knowledge should be pointed out clearly, especially in remote settings, as there are students who may not recognise their progress by themselves, resulting in worries about coping; 4) guidelines about the learning tasks should be clear for all the students; 5) opportunities for peer learning should be made possible during remote learning; 6) rights of the gender minorities belonging to the school community should be supported; 7) special attention should be given to students with special needs and those who do not attend online lessons; 8) encouraging feedback should be provided to all students; 9) online learning environments should be developed to be easily accessible to both teachers and students; 10) technology should be created to support students SRL and peer learning automatically.

Credit author statement

Data for this study is collected in collaboration with Sanna Oinas, Risto Hotulainen and Mari-Pauliina Vainikainen. Data analyses are conducted by Sanna Oinas, Mari-Pauliina Vainikainen and Satu Koivuhovi. As corresponding author, Sanna Oinas has written the body of manuscript together with Risto Hotulainen, Kristiina Brunila and Satu Koivuhovi. In this manuscript, responsibility of SRL theory belongs to Oinas & Hotulainen, knowledge related to non-binary students to Kristiina Brunila and methodological issues to Vainikainen & Koivuhovi.

Appendix A. Standardised estimates and their 95% confidence intervals (CI).

	All			Girls			Boys			Non-binary		
	β	CI low	CI high	β	CI low	CI high	β	CI low	CI high	β	CI low	CI high
Time on Positive experiences, SRL	.17**	.15	.20	.19**	.16	.22	.16**	.13	.19	.14	.01	.28
Time on Worries & Support needs	.15**	.13	.17	.18**	.16	.21	.05**	.03	.08	.12	.01	.22
Time on Peer learning	.03	.01	.05	.02	.00	.04	-.04	-.07	-.02	-.10	-.23	.01
	ns											
* $p < .001$ level, ns = non significant	r	CI low	CI high	r	CI low	CI high	r	CI low	CI high	r	CI low	CI high
Positive experiences, SRL with Worries & Support needs	‘-.45	‘-.46	‘-.43	‘-.58	‘-.59	‘-.56	‘-.31	‘-.33	‘-.28	‘-.10	‘-.21	‘.03
Positive experiences, SRL with Peer learning	.50	.49	.51	.46	.45	.48	.52	.50	.54	.66	.58	.72
Worries & Support needs with Peer learning	‘-.07	‘-.09	‘-.05	‘-.17	‘-.20	‘-.15	.02	.00	.05	.10	‘-.02	.21

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