Master Thesis

The Impact of Online Reading Activities and ICT Use on 15-Year-Old Students' Digital Reading Performance: Comparing Estonia and Finland

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Thank you!

Lin Lin

Abstract

Technology development has shifted the nature of reading literacy massively from print to digital texts, which has placed a changing demand on our reading skills. Reading on screen requires the same skills as in traditional print reading, with the important addition of being able to navigate, where basic ICT skills are required (OECD, 2015). This study focused on quantitative regression analysis to gain more insights into the impact of online reading activities and ICT use on 15-year-olds' digital reading performance in Estonia and Finland. While both Estonia and Finland were top-performing OECD countries with geographic and cultural similarities, a contrary trend in their PISA reading performance has been witnessed. While Estonia steadily improved its reading performance and advanced to the top since its first participation in the PISA surveys in 2006, Finland has been observed with a continuous declining performance over the same period. Regression analyses based on PISA 2018 data showed that online reading activities positively influenced students' digital reading performance. ICT use at school had a negative impact on students' digital reading performance. ICT use outside school showed different results depending on user groups and types of use. Further comparison to PISA 2009 data revealed that the declining performance in Finland could be accounted for by ICT use. Details of the findings and their implications were elaborated.

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1. Introduction

The rapid information and communications technology (ICT) development has changed our daily lives in many ways, including individuals' reading practices. Over the past two decades, the nature of reading literacy was massively shifting from print to digital texts (OECD, 2019b, 2019c). The transform to read digitally on screen (i.e., computers, smartphones, tablets, etc) has placed a changing demand on our reading skills. Reading on screen requires the same skills as in traditional print reading, with the important addition of being able to navigate (OECD, 2015). Navigation is a key component of digital reading that explains a significant part of digital reading performance (OECD, 2019b). In addition to the cognitive interaction with the text, navigation requires basic ICT skills, such as operating a mouse and keyboard to use hyperlinks, browser buttons, drop-down menus and text-entry fields (OECD, 2015).

In response to the digital development, many countries have invested considerable resources in ICT infrastructures in schools and issued policies regarding the integration of ICT into education. ICT has been widely used in educational settings, but a digital divide in the use of ICT is still evident between and within countries (OECD, 2011, 2019a). Although the correlation between digital and print reading performance is strong (OECD, 2011, p74), there are also some performance differences between the two types of reading. Cheung, Mak, and Sit (2013) indicated that 31% of the remaining digital reading performance variance that was not shared with print reading might be accounted for by ICT-related variables. Quite a number of studies have been conducted to examine the potential influence of various ICT factors on students digital reading performance (e.g., Cheung et al., 2013; Gil-Flores et al., 2012; Gubbels et al., 2020; Hu et al., 2018; Lee & Wu, 2012), but rarely at subscale levels. Given the situation that the spread of ICT among the general public has gone through drastic changes in recent years, it is necessary to constantly monitor the impact of ICT use related factors on students' digital reading performances at both composite and subscale levels.

On the other hand, as access to the internet has allowed uncontrolled profusion of information, the ability to discern between fact and opinion, and navigate through different sources of texts to construct meaning are becoming ever more important (Mo, 2019). Accordingly, the last round of PISA test conducted in 2018, which marked reading as the major domain, has revised and expanded its reading literacy framework to reflect the evolving nature of how students read (OECD, 2019b). The new reading framework put an emphasis on students' ability to find, compare, contrast and integrate information across multiple sources (Mo, 2019). Reporting on the digital reading performance at both composite scale and subscales were available, as it was in 2000 and 2009.

From the 70 participating countries/economies that adopted the new reading framework and delivered the PISA 2018 assessment on computers, Estonia and Finland were among the top performers (Mo, 2019; Schleicher, 2019). Estonia, with a mean score of 523, ranked first among OECD members in reading. Geographically close to Estonia, Finland ranked third in reading among OECD members with a mean score of 520. Both countries have achieved a significantly higher mean reading scores than the OECD average of 487 (OECD, 2019c). However, a continuous declining trend in reading performance of the Finnish students has been observed with no sign of a reversal after 2006 (Markus, 2019). The steepest declines were particularly noticed among the weakest students and performance gaps widened (Avvisati, 2020). Contrary to this, Estonia has steadily improved its reading performance over the past years and advanced to the top since it first participated in the PISA surveys in 2006 (see Table 1). Despite the expenditure per student in Estonia remains about 30% lower than the OECD average (Schleicher, 2019), the number of top performers has increased than in the previous PISA assessment in 2015 (Otsmaa, 2019).

Table 1

Overview of Mean Reading Score of Estonia and Finland in PISA 2000-2018

	2018	2015	2012	2009	2006	2003	2000
Estonia	523	519	516	501	501	-	-
Finland	520	526	524	536	547	543	546

(*Source*: OECD)

The present study aims to gain further insights into the extent to which online reading activities and ICT use related factors correlate with 15-year-old students' digital reading performances at both composite and cognitive process subscale levels in the Estonia and Finland samples, using PISA 2018 data. It also further compares the data of PISA 2018 to PISA 2009 to explore the extent to which the changes in reading performances in the Estonia and Finland samples can be accounted for by online reading activities and ICT use related factors. Empirical evidence revealed in this study can contribute to the larger literature of ICT influence on students' learning performances and to serve as a knowledge base for policy research and analysis.

1.1 Theoretical Framework

1.1.1 PISA reading framework

The PISA assessment was designed to measure the extent to which 15-year-old students near the end of their compulsory education have acquired the knowledge and skills that are essential for full participation in modern societies (Schleicher, 2019). Definition of the reading literacy has changed over time to reflect the evolving changes in society, economy, culture and technology (OECD, 2019b). In the earliest PISA cycle conducted in 2000, reading literacy was defined as "understanding, using and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society" (OECD, 2019a, p.27). This definition was revised in PISA 2009 with engagement in reading as part of reading literacy as an addition. For 2018, the definition was again revised and expanded to as "understanding, using, evaluating, reflecting on and engaging with texts in order to achieve

one's goals, to develop one's knowledge and potential and to participate in society" (OECD, 2019a, p.28).

The PISA reading literacy assessment aims to "measure students' mastery of reading processes by varying the dimensions of text and scenarios with one or more thematically related texts" (OECD, 2019a, p.31). Accordingly, the reading process has been operationalized into three cognitive process subscales as "locating information", "understanding", and "evaluating and reflecting".

***Locating information*.** Previously known as "access and retrieve" in PISA 2000 and 2009. This subscale refers to students' abilities in accessing and retrieving information within a piece of text and searching for and selecting relevant text. It assesses how efficiently a student can assess the relevance of a piece of text to retrieve target information. There is little or no need to comprehend the text beyond the phrase level. (OECD, 2019b)

Understanding. Previously known as "integrate and interpret" in PISA 2000 and 2009. This subscale refers to students' abilities in acquiring a representation of the literal meaning of a text and constructing an integrated text. It assesses how well a student can comprehend sentences or short passages and generate various types of inferences to complete a reading task. (OECD, 2019b)

Evaluating and reflecting. Previously known as "reflect and evaluate" in PISA 2000 and 2009. This subscale refers to students' abilities in assessing quality and credibility of the information in a piece of text and reflecting on content and form. It assesses how well a student can critically assess the quality and validity of the information. Students need to be aware of contradicting information when comprehending, comparing and integrating multiple pieces of texts and find ways to deal with it (OECD, 2019b).

1.1.2 Reporting of students' digital reading performance in PISA

PISA reports student performance through plausible values. Plausible values are the ability estimates resulting from an IRT model, which represent the range of abilities that a student might reasonably have. For the population variance, plausible values give the best estimates close to the true value since it also allows for computing the uncertainty in the estimate of student ability due to the lack of precision in the measurement test (OECD, 2009). In both PISA 2009 and 2018 waves, plausible values for reading at both composite and cognitive subscale levels were included in the international database.

1.1.3 The role of ICT in digital reading

Technology development has created new opportunities for ICT use in teaching and students' learning process. With access to computers and the internet, students can acquire knowledge beyond what was available through teachers. Computer-mediated communication and web navigation are the key components in digital reading (Gil-Flores et al., 2012), and therefore influence students' digital reading performance.

Online reading activities. PISA 2018 results show that students tend to read more in online formats instead of print reading, such as chats, online news or websites containing practical information to fulfil practical needs (Schleicher, 2019). These online reading related activities were reported to have a positive impact on students' digital reading performance (OECD, 2011). Online reading activities can be further categorized into online information searching activities and online social activities. While more frequent online information searching activities (e.g., reading news, searching online information to learn about a particular topic, and searching for practical information online) are related to better performance in digital reading, online social activities (e.g., reading emails, chatting, and taking part in online group discussions) are weakly related to higher digital reading proficiency (OECD, 2011). One plausible reason for the distinction might be students were confronted with distraction and loss of time with online social activities due to uncontrolled internet access (Gil-Flores et al., 2012).

ICT use at school. Researches struggle to find a positive association between ICT use at school and reading performance (Gubbels et al., 2020; Hu et al., 2018; Lee & Wu, 2012; Petko et al., 2017). One interpretation of this negative association was that teachers have not yet become good enough at the kind of pedagogies that make the most of technology (OECD, 2015). Despite increases in computer access and technology training, teachers' low-level uses of technology are not adequate to meet the needs of the 21st century learner (Ertmer & Ottenbreit-Leftwich, 2010). Technology alone cannot improve teaching and learning (Ertmer & Ottenbreit-Leftwich, 2013). Narrowed pedagogical purposed ICT use can only affect a narrow set of learning areas (Ertmer & Ottenbreit-Leftwich, 2013; Skryabin et al., 2015). Without effective pedagogy, technology can even sometimes distracts teacher-student interactions in building deep, conceptual understanding and higher-order thinking (OECD, 2015).

ICT use outside school. Studies reveal inconclusive findings on the association between ICT use at home and digital reading performance (Hu et al., 2018; Petko et al., 2017). There are two categories of ICT use outside school, for leisure or for schoolwork. Petko et al. (2017) found that ICT leisure use at home was negatively associated while ICT academic use at home was positively associated with students' digital reading performance. This finding is in line with the findings from Skryabin et al. (2015). In contrast, Hu et al. (2018) reported a positive impact of ICT leisure use at home and a negative impact of ICT academic use at home, which is in line with the findings of Gumus and Hasan Atalmis (2011). On the other hand, Xiao et al. (2019) found no significant connection between ICT academic use at home and reading performance but a negative association between ICT leisure use at home and reading performance. One possible reason for the mixed results might be explained by the fact that the PISA ICT familiarity questionnaire has been developed with new items over time and different constructs were applied among studies.

1.1.4 Reading on screen vs. reading in print

How people read has changed since 2009 (Mo, 2019). Reading now involves not only the printed pages but also in digital formats. Kucirkova (2019) synthesised that in contrast to the "deep reading" within print culture's emphases on reflection, contemplation, and analytical thinking, reading in the digital world emphasizes the proliferation of information, rapid rates of processing, and the bombardment of continuous stimuli. Different from the relative linearity of printed text, digital information presents both new richness and new challenges to readers (Wolf & Barzillai, 2009).

A key distinction between reading on screen and reading in print is that the reader is generally unable to see the physical extent of the available text at any given moment when reading on screen while having almost immediate access to a nearly infinite array of material via the internet at the same time (OECD, 2011). The digital environment offers seemingly endless opportunities to enhance comprehension through easy access to information, such as vocabulary and background information. However, readers tend to underutilize their access to these information even though they consider it would be useful to do so (Dalton & Proctor, 2008). A possible explanation to this behavior is that readers are often unable to evaluate whether links are useful and confront themselves with irrelevant and unrelated information (Wolf & Barzillai, 2009). It seems that free access to the uncontrolled and readily available information could divert reader's attention with the potential to form a more passive learner (Wolf & Barzillai, 2009).

As a result, there are concerns indicating that digital technologies could hinder reading and learning (Salmerón & Delgado, 2019; Wolf, 2018). Wolf (2018) pointed that readers tend to skim, dart around and browse when reading on screen, which reduces the time for concentrated deep reading. Deep reading is central to a child's ability to read, whereas printed texts are more appropriate, especially with lengthy texts (Delgado & Salmerón, 2021). In comparison, reading on screen was found to lead to inattentive reading that could cause a

shallow information processing and lower comprehension (Delgado & Salmerón, 2021). However, it is also argued that comprehension difficulties in digital reading may potentially disappear once readers have enough experience with digital technologies (Delgado et al., 2018).

Nevertheless, the correlation between digital and print reading performance is strong (OECD, 2011) since the major cognitive processes involved are the same (OECD, 2015). However, it may be more challenging to perform reading tasks that demand these processes in the digital medium than on paper due to the additional requirement of navigation (OECD, 2015). In the assessment of digital reading, the ICT knowledge and skills on navigation are measured together with the mastery of reading processes (OECD, 2015).

A typical reading practice in print reading involves reader's access to a single text at a particular time while digital reading usually involves multiple source texts that are composed by different authors and appearing in different formats (OECD, 2011). Digital readers need to be able to handle various navigational features (e.g., use different search tools, deal with multiple tabs on different websites, etc) to search information across multiple documents and integrate information across texts to generate inferences (OECD, 2015). While reflection and evaluation processes tend to be required only for the most difficult tasks in print reading, digital readers must often assess the quality and credibility of the online content and handle conflict across sources even when solving simple tasks (OECD, 2015). The use of multiple sources to solve a text question has expanded the range of reading processes and strategies (Mo, 2019).

1.1.5 The impact of ICT development on reading

Reported by PISA (OECD, 2019b), about 15% students in OECD countries did not have access to the internet at home in 2009 while this percentages had shrunk to less than 5% by 2018. The growth in access to online services is likely to be even larger than suggested by these self-reported percentages captured in PISA's student context questionnaires. The rapid

digitalisation of communication is having a profound impact on the way people read and exchange information, whether at home, at school or in the workplace. Students seem to read less for leisure and to read fewer fiction books, magazines or newspapers because they want to do so (as opposed to needing to do so). Instead, they read more to fulfil their practical needs, and they read more in online formats, such as chats, online news or websites containing practical information. More students consider reading "a waste of time" and fewer students read for enjoyment.

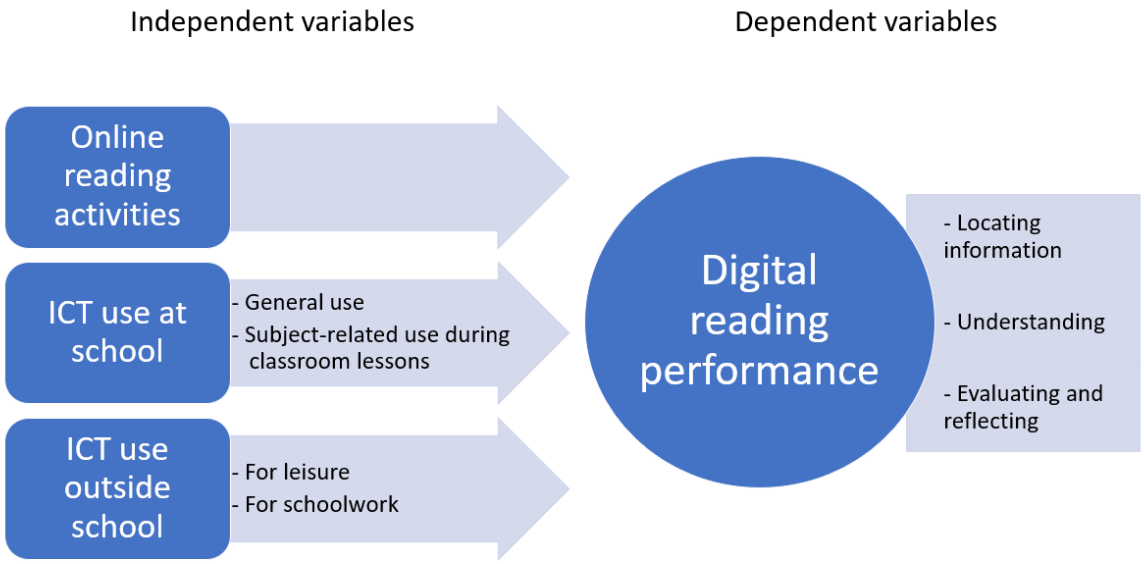
Despite the wider spread of ICT, access to ICT facilities and ICT use can be limited by specific constraints, such as income, age, and educational attainment (Cruz-Jesus et al., 2016). As a results, a digital divide appear between and within countries, which poses a major challenge to reach the best of ICT potentials (OECD, 2011). The term "digital divide" has been defined as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the internet for a wide variety of activities." (OECD, 2001). Epstein et al. (2011) noted that different types of digital divide require different actions. While the gaps in ICT access may be bridged when economic conditions improve, education and training appear to be critical to manage the gaps in ICT use, such as lack of skills and awareness towards ICT (Cruz-Jesus et al., 2016; Epstein et al., 2011).

1.2 Research Questions and Hypotheses

The present study explores 1) the extent to which online reading activities and ICT use related factors correlate with 15-year-olds' digital reading performances in the Estonia and Finland samples; 2) the extent to which changes in Estonian and Finnish students' digital reading performances between 2009 and 2018 can be accounted for by online reading activities and ICT use related factors.

Figure 1

Overview of Variables in the Current Study



The following research questions and corresponding hypotheses are central in this research:

Research question 1

To what extent is digitally assessed reading performance of 15-year-old students in Estonia and Finland related to their online reading activities and ICT use?

Sub-question 1.1. *To what extent does online reading activities predict the digitally assessed reading performance of 15-year-old students in Estonia and Finland at both composite and subscale levels?*

Hypothesis 1 (H1): Students who are more involved in online reading activities score higher in reading performance at both composite and subscale levels than students who are less involved in online reading activities in Estonia and Finland.

Sub-question 1.2. *To what extent does ICT use at school predict the digitally assessed reading performance of 15-year-old students in Estonia and Finland at both composite and subscale levels?*

Hypothesis 2 (H2): Students who use more ICT at school score lower in reading performance at both composite and subscale levels than students who use less ICT at school in Estonia and Finland.

Sub-question 1.3. *To what extent does ICT use outside school predict the digitally assessed reading performance of 15-year-old students in Estonia and Finland at both composite and subscale levels?*

Hypothesis 3 (H3): Students who use more ICT outside school score higher in reading performance at both composite and subscale levels than students who use less ICT outside school in Estonia and Finland.

Research question 2

To what extent is the changing digitally assessed reading performance of 15-year-old students in Estonia and Finland between 2009 and 2018 related to their online reading activities and ICT use?

Sub-question 2.1. *How do percentages of the student practice in online reading activities, ICT use at school, and ICT use outside school change in Estonia and Finland between 2009 and 2018?*

Sub-question 2.2. *To what extent can the changing digitally assessed reading performance of 15-year-old students in Estonia and Finland between 2009 and 2018 accounted for by online reading activities, ICT use at school, and ICT use outside school?*

Hypothesis 4 (H4): The changes in digital reading performance in Estonia and Finland between 2009 and 2018 can be accounted for by ICT use. When controlling for ICT use, the difference in reading performance between 2009 and 2018 is smaller than without controlling.

1.3 Scientific & Practical Relevance

Given the situation that the spread of ICT among the general public has gone through drastic changes in recent years, it is both scientifically and practically relevant to constantly monitor the impact of ICT use related factors on students' learning outcomes. By conducting this study, more will be known about the influence of online reading activities and ICT use on digital reading performance. Empirical evidence revealed in this study can contribute to the larger literature of ICT influence on students' learning performances and to serve as a knowledge base for policy research and analysis.

2. Methods

2.1 Research Design

The present study focuses on quantitative regression analyses to gain more insights into the impact of online reading activities and ICT use on 15-year-olds' digital reading performance in Estonia and Finland. Online reading activities, ICT use at school, and ICT use outside school were independent variables. ICT use at school had two types: general use and subject-related use during classroom lessons. ICT use outside school also had two types: for leisure activities and for schoolwork activities. Digital reading performance was the dependent variable and had three process subscales: locating information, understanding, evaluating and reflecting. The data used in this study were extracted from the PISA 2018 and 2009 database. First, PISA 2018 was analyzed to answer research question 1. Then, PISA 2018 data was compared to PISA 2009 data in order to answer research question 2.

2.2 Respondents

The PISA assessment adopted a two-stage stratified sampling procedure in both Estonia and Finland to sample 15-year-old students attending educational institutions in grades 7 and higher. In the first stage, schools were selected with probabilities that were proportional to a measure of size. In the second stage, a number of eligible students from the sampled schools were randomly selected according to the predetermined target cluster size. If a sampled school had a list of eligible students fewer than the target number, all students on the list were selected.

The PISA 2018 database included a total of 5,316 Estonian students (49.9% female) and 5,649 Finnish students (49.1% female). The Estonian students ranged in grade from 7 to 11 (M = 8.8, SD = .44). The Finnish students ranged in grade from 7 to 10 (M = 8.86, SD = .35).

The PISA 2009 database included a total of 4,727 Estonian students (48.6% female) and 5,810 Finnish students (50.8% female). The Estonian students ranged in grade from 7 to 11 (M = 8.76, SD = .49). The Finnish students ranged in grade from 7 to 11 (M = 8.88, SD = .36)

2.3 Instrumentation

The measures adopted in the present study were taken from the PISA student context questionnaire. Many questionnaire items in the PISA student context questionnaire were designed to be combined in some way in order to measure latent constructs that cannot be observed directly. To make a valid comparison between 2009 and 2018 data, questionnaire items used in the two test cycles were compared and only items with the same measures were selected to construct the variables in the present study. An overview of the scaling of constructs in this study can be found in appendix A.

Six items were used to measure online reading activities (ONLNREAD). All items had five response categories varying from “I don’t know what it is”, “never or almost never”, “several times a month”, “several times a week” to “several times a day”.

Nine items were used to measure ICT use at school for general activities (USESCH). Seven items were used to measure ICT use outside school for leisure activities (ENTUSE). Five items were used to measure ICT use outside school for schoolwork activities (HOMESCH). In parallel with items in 2009, items in 2018 were recoded to four response categories ranging from “Never or hardly ever”, “Once or twice a month”, “Once or twice a week”, “Almost every day”. The fifth category “Every day” in PISA 2018 data had been recoded into “Almost every day”.

Three items were used to measure ICT use at school for subject-related activities during classroom lessons (ICTCLASS). In parallel with items in 2009, items in 2018 were recoded to four response categories including “No time”, “1-30 minutes a week”, “31-60 minutes a week”, “More than 60 minutes a week”. The fifth category “I do not study this subject” in PISA 2018 data had been recoded into “No time”.

Gender, social-economics (ESCS), immigrant status (IMMIG) and language spoken at home (LANGN) were taken as control variables in performing multiple regression analysis.

ESCS was a derived variable based on IRT scaling in PISA. In the current study, IMMIG was recoded into a binary variable to indicate the difference between natives and those with immigration backgrounds. LANGN was also recoded into a binary variable to indicate the difference between official language speakers and other languages speakers.

2.4 Procedure

In PISA 2018, computer-based tests were used in both Estonia and Finland. The assessment lasted a total of two hours for each student with test material comprised in four 30-minute clusters. A multi-stage adaptive approach was applied in reading whereby students were assigned a block of test items based on their performance in preceding blocks. Students spent one hour on the reading assessment and one hour on one or two other subjects in mathematics or science. Students were instructed to take a break before the contextual questionnaires were administered. The obligatory student background questionnaire took about 35 minutes to complete. After administering the student background questionnaire, additional questionnaires were distributed in both Estonia and Finland to elicit more information about student learning, which included the ICT familiarity questionnaire.

In the current study, student questionnaire data was firstly downloaded from the OECD website. The dataset was split into country files. Estonia and Finland files were selected and merged into a new datafile. Variable constructs as specified in this study were then computed. After the data was prepared, regression analyses with control variables were performed via IDB Analyzer to answer the first research question. To assess whether the changes in digital reading performance can be accounted for by ICT use related factors as outlined in the second research question, a new dataset that contained both student data from 2009 and 2018 was constructed. In this new dataset, a binary variable was included to indicate students in different PISA waves of 2009 or 2018. This binary variable was used as an additional independent variable in further regression analyses.

2.5 Data Analysis

PISA declares itself to be the most comprehensive and rigorous international programme to assess student performance and to collect data on the student, family and institutional factors that can help explain differences in performance (OECD, 2019b). As a result of its stringent-assurance mechanisms applied in translation, sampling and data collection, results have a high degree of validity and reliability. To ascertain the reliability of the scales adopted in the present study, Cronbach's Alpha was computed via SPSS for Estonia and Finland respectively (see table 2).

Table 2

Overview of Cronbach's Alpha for Scaling of Independent Variables

Variable	Estonia		Finland	
	2018	2009	2018	2009
ONLNREAD	.72	.72	.73	.72
USESCH	.91	.84	.87	.78
ICTCLASS	.79	**.63**	.70	**.52**
ENTUSE	**.68**	**.64**	**.64**	**.67**
HOMESCH	.76	**.65**	.82	.73

Note. Cronbach's Alpha coefficient under .70 appear in bold.

A Cronbach's Alpha coefficient at cut-off value of 0.9 signifies excellent, 0.8 for good, and 0.7 for acceptable internal consistency of the items. A coefficient under 0.7 is relatively low and might have happened because it was decided that the scales in the present study should include the exact same items in both years, so that a valid comparison between 2009 and 2018 can be made. For the purpose of this study, the listed alpha coefficient between 0.6 and 0.7 were accepted for regression analyses. Cronbach's Alpha of 0.52 of ICTCLASS for Finland in 2009 is very low. However, since the reliabilities of this scale was acceptable in 2018 for Finland and for both years in Estonia, it was included in the regression analyses in this study.

3. Results

The aim of this study was to gain more insights into the impact of online reading activities and ICT use on 15-year-olds' digital reading performance at both composite and cognitive process subscale levels in the PISA 2018 samples. Estonia and Finland were identified from the PISA participating countries for data comparison. Both country data were further compared to explore the extent to which their changes in digital reading performance between 2009 and 2018 could be accounted for by ICT-related factors. To answer the research questions, the data was analyzed via IDB Analyzer and SPSS. Effects of the mentioned variables on 15-year-olds' reading performance were tested.

3.1 Description of study variables

In PISA 2018, digital reading performance (Estonia: *M* = 523.02, *SD* = 93.21; Finland: *M* = 520.08, *SD* = 99.55) had three process subscales: locating information (Estonia: *M* = 528.53, *SD* = 91.76; Finland: *M* = 525.89, *SD* = 101.80), understanding (Estonia: *M* = 525.64, *SD* = 94.09; Finland: *M* = 517.91, *SD* = 102.55), evaluating and reflecting (Estonia: *M* = 521.00, *SD* = 96.26; Finland: *M* = 516.88, *SD* = 101.73). There were three independent variables, online reading activities (Estonia: *M* = 3.67, *SD* = .63; Finland: *M* = 3.52, *SD* = .62), ICT use at school, and ICT use outside school. ICT use at school had two types: general use (Estonia: *M* = 1.84, *SD* = .79; Finland: *M* = 2.16, *SD* = .72) and subject-related use during classroom lessons (Estonia: *M* = 1.73, *SD* = .73; Finland: *M* = 1.84, *SD* = .71). ICT use outside school also had two types: for leisure activities (Estonia: *M* = 3.09, *SD* = .60; Finland: *M* = 2.97, *SD* = .61) and for schoolwork activities (Estonia: *M* = 2.55, *SD* = .78; Finland: *M* = 2.03, *SD* = .77).

Pearson's r was computed via IDB Analyzer to assess the relationship between the pre-described independent and dependent variables in Estonia (see Table 3) and Finland (see Table 4) respectively. Based on the data, a positive relationship to students' digital reading performance was observed in online reading activities and ICT use outside school for entertainment in Estonia. Meanwhile, a negative relationship to Estonian students' digital reading performance was observed in ICT use at school and ICT use outside school for schoolwork.

Table 3

Pearson Correlation and Descriptive Statistics of Study Variables – Estonia

	1.	2.	3.	4	5	Etc.	X.	X1.	X2.	X3.
1. ONLNREAD										
2. USESCH	.13									
3. ICTCLASS	.03	.26								
4. ENTUSE	.22	.16	.07							
5. HOMESCH	.21	.49	.16	.27						
Etc.	…	…	…	…	…	…	…	…	…	…
X. Digital reading performance	.22	-.24	-.17	.10	-.09	…				
X1. Locate information	.20	-.22	-.16	.12	-.09	…	.86			
X2. Understanding	.21	-.24	-.16	.10	-.09	…	.90	.93		
X3. Evaluating and reflecting	.23	-.21	-.17	.10	-.07	…	.88	.89	.94	
Mean	3.67	1.84	1.73	3.09	2.55	…	523.02	528.53	525.64	521.00
SD	.63	.79	.73	.60	.78	…	93.21	91.76	94.09	96.26

Note. "Etc" refer to all other variables that can predict digital reading performance but were not included in the current study.

In Finland (see Table 4), a positive relationship to students' digital reading performance was observed only in online reading activities. Negative relationships were observed in ICT use both at school and outside school. Among which, the negative relationship observed in subject-related ICT use during classroom was very low at an alpha of .01.

Table 4

Pearson Correlation and Descriptive Statistics of Study Variables – Finland

	1.	2.	3.	4	5	Etc.	X.	X1.	X2.	X3.
1. ONLNREAD										
2. USESCH	.28									
3. ICTCLASS	.08	.24								
4. ENTUSE	.30	.35	.13							
5. HOMESCH	.26	.61	.16	.28						
Etc.	….	…	…	…	…	…	…	…	…	…
X. Digital reading performance	.19	-.21	-.03	-.06	-.14	…				
X1. Locate information	.19	-.20	-.04	-.04	-.15	…	.89			
X2. Understanding	.18	-.21	-.03	-.06	-.14	…	.91	.94		
X3. Evaluating and reflecting	.20	-.20	-.02	-.05	-.12	…	.90	.91	.95	
Mean	3.52	2.16	1.84	2.97	2.03	…	520.08	525.89	517.91	516.88
SD	.62	.72	.71	.61	.77	…	99.55	101.80	102.55	101.73

Note. "Etc" refer to all other variables that can predict digital reading performance but were not included in the current study.

3.2 Regression on ICT use predicting reading performance

To answer research question 1, regression analyses based on PISA 2018 data was first performed to test the relationship between students' ICT use and their digital reading performance via IDB Analyzer. Results reported in Table 5 showed that 14% of the reading performance variance among 15-year-old Estonian students in PISA 2018 could be explained by ICT use. ONLNREAD and ENTUSE showed positive relationships while USESCH and ICTCLASS showed negative relationships. A t-value of -1.75 (p = .080) for HOMESCH showed that the effect of ICT use outside school for schoolwork almost disappeared when taking other ICT use factors into account.

In comparison, 12% of the reading performance variance among 15-year-old Finnish students were related to ICT use. ONLNREAD showed a positive relationship while USESCH, ENTUSE and HOMESCH showed negative relationships. When other ICT use factors were taken into account, a positive relationship of ICTCLASS was found. However, the t-value of 1.12 (p = .263) indicated that this relationship was not significant.

Table 5

Regression on Students' Self-reported ICT Use Predicting Digital Reading Performance

Country	Variable	b	SE b	β	t
Estonia	(Constant)	431.72	10.65		
R^2 = .14	ONLNREAD	35.00	2.50	.24	13.52
	USESCH	-28.10	2.14	-.24	-13.58
	ICTCLASS	-14.62	2.26	-.11	-6.46
	ENTUSE	16.07	2.50	.10	6.42
	HOMESCH	-3.72	2.13	-.03	-1.75
Finland	(Constant)	461.60	11.39		
R^2 = .12	ONLNREAD	46.02	3.08	.28	15.61
	USESCH	-34.59	2.95	-.25	-11.89
	ICTCLASS	2.75	2.45	.02	1.12
	ENTUSE	-6.67	2.86	-.04	-2.35
	HOMESCH	-6.84	2.80	-.05	-2.45

Four control variables were added into the multiple regression analysis, including gender, social-economics (ESCS), immigrant status (IMMIG) and language spoken at home (LANGN). The multiple regression analysis (see Table 6) showed that there was significant effect of student background on the reading performance. However, the effects of ICT use on 15-year-olds' reading performance changed only to limited extent when these background control variables were introduced.

Table 6

Regression on Students' Self-reported ICT Use Predicting Digital Reading Performance with Control Variables

Country	Variable	b	SE b	β	t
Estonia	(Constant)	381.32	10.91		
R^2 = .24	ONLNREAD	26.20	2.50	.18	10.15
	USESCH	-17.94	2.16	-.15	-8.39
	ICTCLASS	-12.45	2.09	-.10	-5.94
	ENTUSE	22.98	2.45	.15	9.36
	HOMESCH	-8.43	1.94	-.07	-4.30
	Gender_D1	33.12	2.80	.18	11.96
	ESCS	24.53	1.90	.21	13.57
	IMMIG_D1	14.11	3.98	.05	3.56
	LANGN_D1	28.98	3.45	.14	8.48
Finland	(Constant)	357.46	13.34		
R^2 = .28	ONLNREAD	30.92	2.88	.19	11.09
	USESCH	-32.62	2.71	-.24	-12.05
	ICTCLASS	1.80	2.20	.01	.82
	ENTUSE	9.43	3.12	.06	2.99
	HOMESCH	-7.02	2.30	-.05	-3.06
	Gender_D1	45.87	2.95	.23	16.19
	ESCS	32.17	2.08	.26	16.04
	IMMIG_D1	40.30	7.80	.11	4.91
	LANGN_D1	41.01	7.95	.11	5.11

After confirming the general impact of ICT use on students' digital reading performance, the effect of different types of ICT use as defined in the current study was tested. Regression analyses were performed on each individual type of ICT use predicting students' digital reading performance at both composite and subscale levels. Results are shown below.

3.2.1 Online reading activities

A linear regression analysis was generated by the IDB Analyzer to test if online reading activities significantly predict digital reading performance. The results of this regression (see Table 7) indicated that 5% of the digital reading performance variation in Estonia and 4% of the digital reading performance variation in Finland could be explained by online reading activities. The variable ONLNREAD was found to be a significant positive predictor of 15-year-olds' digital reading performance in both Estonia (b = 32.18, t (5314) = 11.75, p < .001) and Finland (b = 30.59, t (5647) = 11.02, p < .001). On average, students who had more online reading activities scored relatively higher in reading. This relationship applied to digital reading performance at both composite and subscale levels. Hypothesis 1 was therefore confirmed.

Table 7

Regression on ONLNREAD Predicting Digital Reading Performance

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	405.04	9.96		
	R^2 = .05	ONLNREAD	32.18	2.65	.22	11.75
	Locate Information	(Constant)	419.66	10.92		
	R^2 = .04	ONLNREAD	29.70	2.81	.20	10.27
	Understanding	(Constant)	407.50	10.60		
	R^2 = .05	ONLNREAD	32.23	2.82	.21	11.27
	Evaluating and reflecting	(Constant)	391.50	11.25		
	R^2 = .05	ONLNREAD	35.33	3.05	.23	11.22
Finland	Digital reading performance	(Constant)	412.56	10.13		
	R^2 = .04	ONLNREAD	30.59	2.81	.19	11.02
	Locate Information	(Constant)	415.75	11.24		
	R^2 = .04	ONLNREAD	31.93	3.14	.19	9.92
	Understanding	(Constant)	412.55	10.95		
	R^2 = .03	ONLNREAD	29.97	3.05	.18	10.03
	Evaluating and reflecting	(Constant)	400.07			
	R^2 = .04	ONLNREAD	33.23	3.52	.20	9.73

3.2.2 ICT use at school

General ICT use at school

The regression analysis on USESCH (see Table 8) indicated that 6% of the digital reading performance variation in Estonia and 5% of the digital reading performance variation in Finland could be explained by general ICT use at school. The variable USESCH was found to be a significant negative predictor of 15-year-olds' digital reading performance in both Estonia (b = -27.79, t (5314) = -14.91, p < .001) and Finland (b = -29.95, t (5647) = -12.14, p < .001). On average, students who used more ICT at school scored relatively lower in reading. This relationship applied to digital reading performance at both composite and subscale levels. Hypothesis 2 was therefore confirmed.

Table 8

Regression on USESCH Predicting Digital Reading Performance

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	574.28	4.09		
	R^2 = .06	USESCH	-27.79	1.91	-.24	-14.91
	Locate Information	(Constant)	575.49	4.12		
	R^2 = .05	USESCH	-25.46	1.9	-.22	-13.24
	Understanding	(Constant)	577.62	4.33		
	R^2 = .06	USESCH	-28.18	1.96	-.24	-15.22
	Evaluating and reflecting	(Constant)	568.87	4.85		
	R^2 = .05	USESCH	-25.95	2.40	-.21	-10.93
Finland	Digital reading performance	(Constant)	583.18	5.22		
	R^2 = .05	USESCH	-29.25	2.42	-.21	-12.14
	Locate Information	(Constant)	587.59	6.70		
	R^2 = .04	USESCH	-28.60	3.28	-.20	-8.87
	Understanding	(Constant)	583.38	5.44		
	R^2 = .05	USESCH	-30.34	2.47	-.21	-12.35
	Evaluating and reflecting	(Constant)	578.62	5.13		
	R^2 = .04	USESCH	-28.62	2.64	-.20	-10.54

Subject-related ICT use during classroom lessons

The regression analysis on ICTCLASS (see Table 9) indicated that 3% of the digital reading performance variation in Estonia could be explained by subject-related ICT use during classroom lessons. The variable ICTCLASS was found to be a significant negative predictor of 15-year-olds' digital reading performance in Estonia (b = -21.28, t (5314) = -9.32, p < .001). This relationship applied to digital reading performance at both composite and subscale levels in Estonia. On average, Estonian students who used more ICT during classroom lessons scored relatively lower in reading performance. On the other hand, there was hardly any correlation found between ICTCLASS and reading performance in Finland (b = -4.78, t (5647) = -1.89, p = .059) at both composite and subscale levels. Hypothesis 2 was therefore only partially confirmed.

Table 9

Regression on ICTCLASS Predicting Digital Reading Performance

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	559.83	4.25		
	R^2 = .03	ICTCLASS	-21.28	2.29	-.17	-9.32
	Locate Information	(Constant)	562.50	4.63		
	R^2 = .02	ICTCLASS	-19.63	2.66	-.16	-7.48
	Understanding	(Constant)	561.82	4.45		
	R^2 = .03	ICTCLASS	-20.91	2.38	-.16	-8.82
	Evaluating and reflecting	(Constant)	559.97	5.24		
	R^2 = .03	ICTCLASS	-22.52	2.84	-.17	-7.81
Finland	Digital reading performance	(Constant)	528.85	4.82		
	R^2 = .00	ICTCLASS	-4.78	2.53	-.03	-1.89
	Locate Information	(Constant)	535.41	5.39		
	R^2 = .00	ICTCLASS	-5.19	2.74	-.04	-1.89
	Understanding	(Constant)	525.52	5.11		
	R^2 = .00	ICTCLASS	-4.14	2.62	-.03	-1.58
	Evaluating and reflecting	(Constant)	523.40	5.36		
	R^2 = .00	ICTCLASS	-3.55	3.01	-.02	-1.18

3.2.3 ICT use outside school

For entertainment

The regression analysis on ENTUSE (see Table 10) indicated that 1% of the variation in digital reading performance in Estonia could be explained by ICT leisure use outside school. The variable ENTUSE was found to be a significant positive predictor of 15-year-olds' digital reading performance in Estonia (b = 15.84, t (5314) = 6.16, p < .001). This relationship applied to digital reading performance at both composite and subscale levels. On average, Estonian students who used more ICT outside school for entertainment scored relatively higher in reading performance. It also seemed that ENTUSE could explain slightly more performance variation in locating information than in the other two process subscales in Estonia.

On the other hand, a negative relationship was observed between ENTUSE and 15-year-olds' digital reading performance in Finland (b = -9.12, t (5647) = -3.53, p = .002). However, the reading performance variations among Finnish students could be hardly explained by ENTUSE. Hypothesis 3 was therefore only partially confirmed.

Table 10

Regression on ENTUSE Predicting Digital Reading Performance

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	474.09	8.16		
	R^2 = .01	ENTUSE	15.84	2.56	.10	6.16
	Locate Information	(Constant)	470.18	7.89		
	R^2 = .02	ENTUSE	18.89	2.42	.12	7.77
	Understanding	(Constant)	478.81	8.24		
	R^2 = .01	ENTUSE	15.16	2.59	.10	5.91
	Evaluating and reflecting	(Constant)	471.44	10.08		
	R^2 = .01	ENTUSE	16.04	3.17	.10	5.10
Finland	Digital reading performance	(Constant)	547.22	7.95		
	R^2 = .00	ENTUSE	-9.12	2.62	-.06	-3.53
	Locate Information	(Constant)	544.30	9.57		
	R^2 = .00	ENTUSE	-6.19	3.23	-.04	-1.92
	Understanding	(Constant)	547.06	8.42		
	R^2 = .00	ENTUSE	-9.80	2.79	-.06	-3.54
	Evaluating and reflecting	(Constant)	543.90	8.98		
	R^2 = .00	ENTUSE	-9.08	3.02	-.05	-3.01

For schoolwork

The regression analysis on HOMESCH (see Table 11) indicated that 1% of the variation in digital reading performance in Estonia and 2% of the variation of digital reading performance in Finland could be explained by academic ICT use outside school. The variable HOMESCH was found to be a significant negative predictor of 15-year-olds' digital reading performance in both Estonia (b = -10.56, t (5314) = -5.18, p < .001) and Finland (b = -18.19, t (5647) = -8.01, p < .001). On average, students who used more ICT outside school for schoolwork scored relatively lower in reading. This relationship applied to digital reading performance at both composite and subscale levels. Hypothesis 3 was therefore not confirmed. In addition, it seemed that HOMESCH could explain slightly less variation in students' performance in evaluating and reflecting than in other two process subscales.

Table 11

Regression on HOMESCH Predicting Digital Reading Performance

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	549.98	5.96		
	R^2 = .01	HOMESCH	-10.56	2.02	-.09	-5.18
	Locate Information	(Constant)	554.71	6.42		
	R^2 = .01	HOMESCH	-10.26	2.16	-.09	-4.71
	Understanding	(Constant)	553.75	6.53		
	R^2 = .01	HOMESCH	-11.02	2.24	-.09	-4.91
	Evaluating and reflecting	(Constant)	542.18	7.21		
	R^2 = .00	HOMESCH	-8.30	2.59	-.07	-3.17
Finland	Digital reading performance	(Constant)	556.95	4.45		
	R^2 = .02	HOMESCH	-18.19	2.28	-.14	-8.01
	Locate Information	(Constant)	566.91	5.42		
	R^2 = .02	HOMESCH	-20.23	2.95	-.15	-7.12
	Understanding	(Constant)	555.80	4.43		
	R^2 = .02	HOMESCH	-18.69	2.26	-.14	-8.24
	Evaluating and reflecting	(Constant)	548.59	4.56		
	R^2 = .01	HOMESCH	-15.65	2.37	-.12	-6.55

3.3 Changes of student practice in self-reported ICT use 2009-2018

To answer research question 2, data extracted from PISA 2018 and 2009 were compared. First, boxplots generated in SPSS were used to compare Estonian and Finnish students' practice change in ICT use between 2009 and 2018. Statistics of the individual variable were reported in Appendix B.

3.3.1 Online reading activities

Regarding ONLNREAD (see Figure 2), there was a slight decrease in both the median and the interquartile range for Estonia in 2018 while the median increased slightly in Finland. This indicated that Estonian students have slightly decreased their online reading activities while Finnish students have slightly increased their online reading activities between 2009 and 2018. In comparison, Estonian students remained to be slightly more involved in ONLNREAD than Finnish students in 2018.

Figure 2

Changes in ONLNREAD 2009-2018

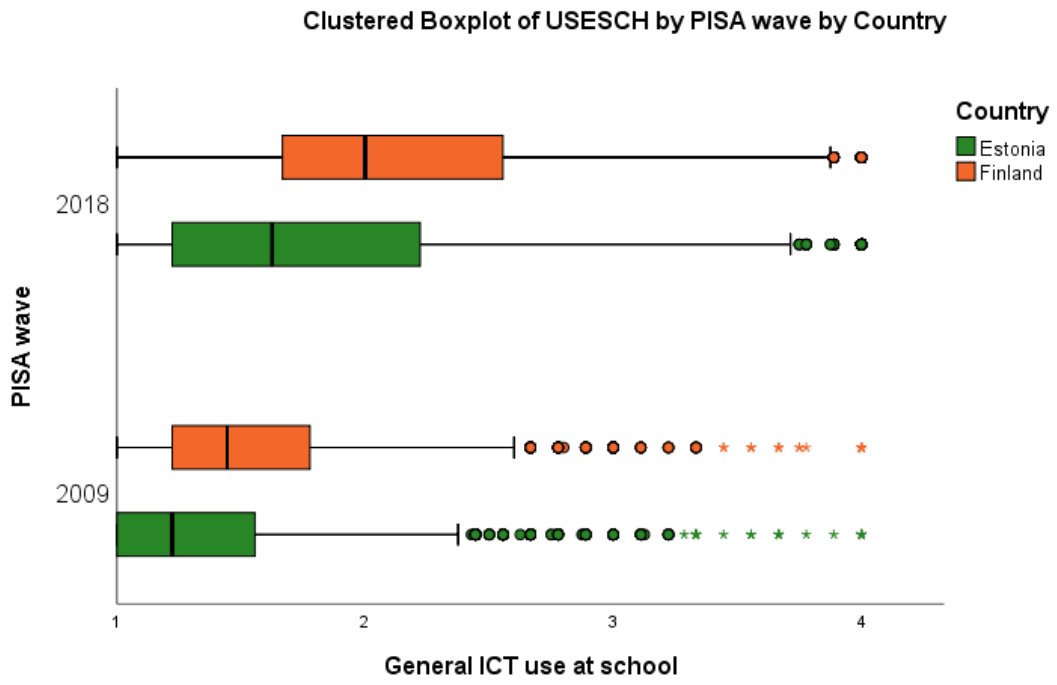
3.3.2 ICT use at school

General ICT use at school

In USESCH (see Figure 3), the median has increased in both Estonia and Finland. There was a clear increasing trend of USESCH in both countries between 2009 and 2018. In comparison, Estonian students were less involved in USESCH than Finnish students in both years.

Figure 3

Changes in USESCH 2009-2018

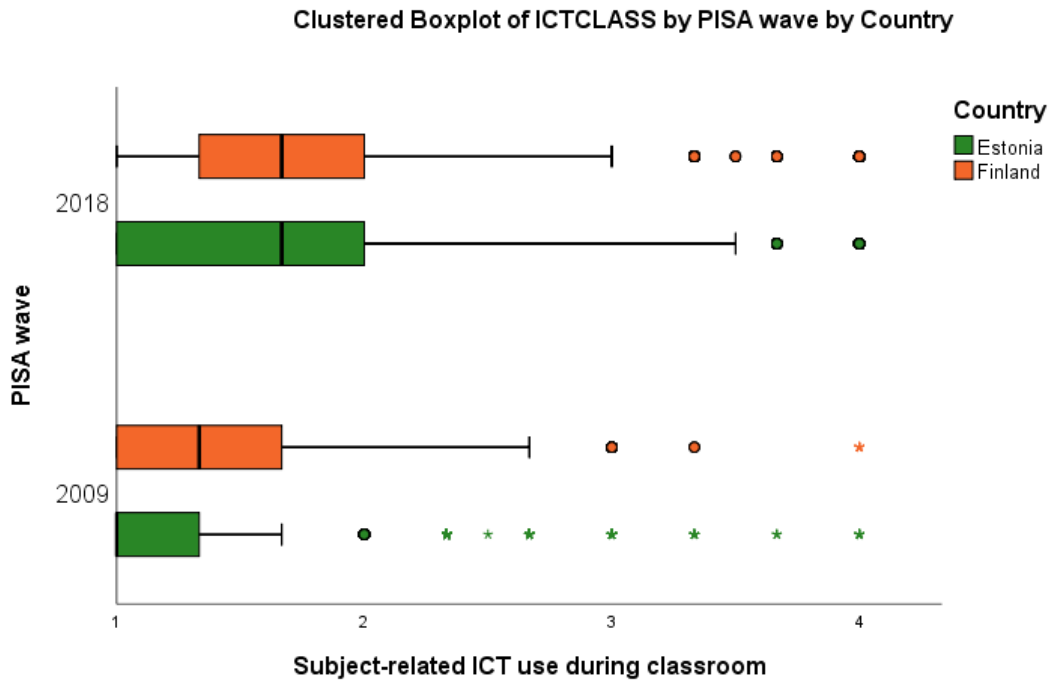


Subject-related ICT use during classroom lessons

Compared to the rare use of ICTCLASS in 2009, both Estonian and Finnish students had significantly increased the use of digital device during classroom lessons (See Figure 4). While the use of ICTCLASS in Estonia was clearly less than in Finland in 2009, it had a notable increase to have the same median as Finland in 2018 with a larger interquartile range.

Figure 4

Change in ICTCLASS 2009-2018



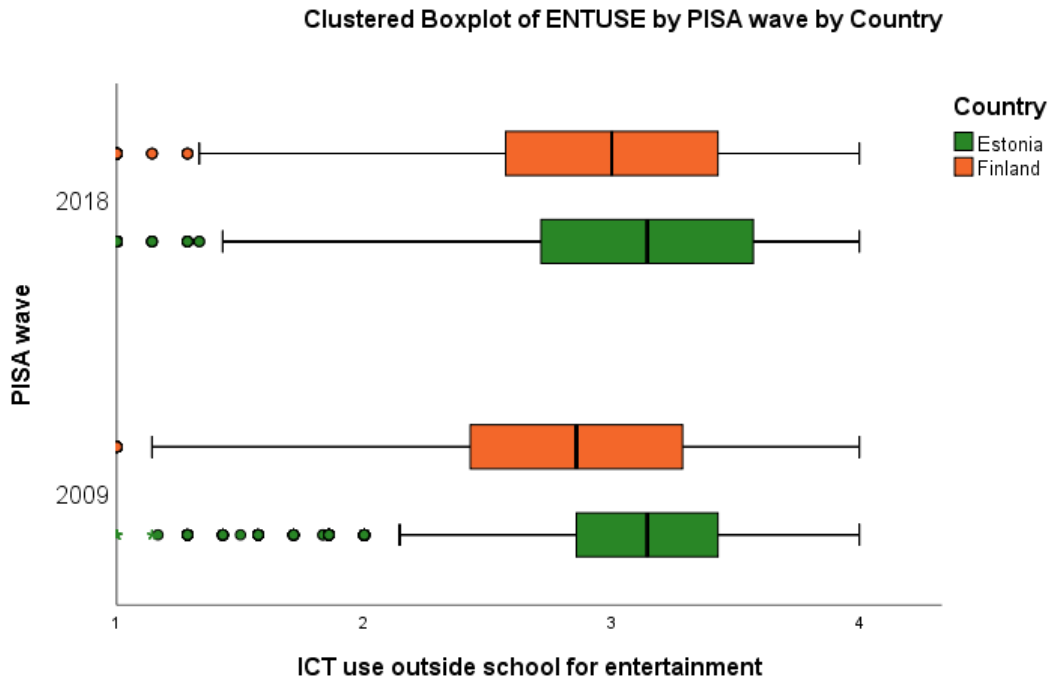
3.3.3 ICT use outside school

For entertainment

In ENTUSE (see Figure 5), the median remained the same for Estonia between 2009 and 2018 while it increased slightly for Finland. The lower half of the Estonian population seemed to use less ENTUSE while almost no change was observed for Finland. Both countries showed similar pattens in 2018. In comparison, the Estonian students were slightly more involved in ENTUSE than the Finnish students.

Figure 5

Changes in ENTUSE 2009-2018

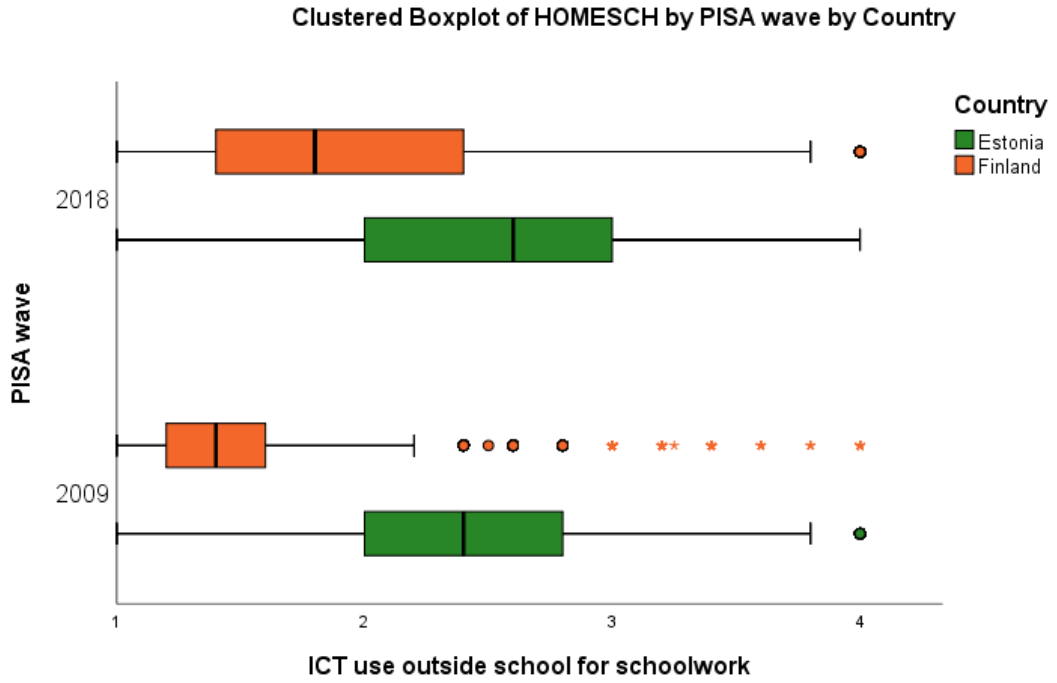


For schoolwork

An increasing trend in HOMESCH was observed in both Estonia and Finland (see Figure 6). Although the increase was significant in Finland, the Estonian students were still clearly more involved in HOMESCH than the Finnish students.

Figure 6

Changes in HOMESCH 2009-2018



3.4 Regression on ICT use predicting the changing reading performance

After comparing students' practice change in ICT use between 2009 and 2018, a regression analysis was performed via IDB Analyzer to analyze the reading score difference in Estonia and Finland between 2009 and 2018 (see Table 12). Results showed that Estonia students scored on average 22 points more in 2018 than in 2009, wherein on average 25 points more in locating information, on average 26 points more in understanding, and on average 19 points more in evaluating and reflecting. In contrast, Finnish students scored on average 16 points less in 2018 than in 2009, wherein on average 6 points less in locating information, on average 20 points less in understanding, and on average 19 points less in evaluating and reflecting.

Table 12

Regression on the Changing Digital Reading Performance

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	500.96	2.64		
	R^2 = .02	PISA wave_D2	22.26	3.06	.13	7.32
	Locate Information	(Constant)	502.82	2.97		
	R^2 = .02	PISA wave_D2	25.13	3.32	.14	7.78
	Understanding	(Constant)	500.02	2.80		
	R^2 = .02	PISA wave_D2	25.72	3.32	.14	7.86
	Evaluating and reflecting	(Constant)	502.51	2.62		
	R^2 = .01	PISA wave_D2	18.54	3.68	.10	5.13
Finland	Digital reading performance	(Constant)	535.88	2.25		
	R^2 = .01	PISA wave_D2	-15.71	3.23	-.08	-4.90
	Locate Information	(Constant)	532.29	2.75		
	R^2 = .00	PISA wave_D2	-6.42	3.80	-.03	-1.69
	Understanding	(Constant)	538.33	2.35		
	R^2 = .01	PISA wave_D2	-20.27	3.47	-.11	-5.89
	Evaluating and reflecting	(Constant)	535.53	2.25		
	R^2 = .01	PISA wave_D2	-18.70	3.30	-.10	-5.69

When controlled for ICT use (see Table 13), the difference in reading performance got bigger for Estonia while it got significantly smaller for Finland. Hardly any difference remained between 2009 and 2018 for Finland. This indicated that the rising reading performance in Estonia were not related to ICT use, but the declining performance in Finland could be accounted for by ICT use. Hypothesis 4 was therefore partially confirmed. It was worth to note that the Estonian student would have achieved even higher performance in reading without change in ICT use. When controlling for ICT use the wave effect in Estonia increased substantially (from 22.26 to 46.76).

Table 13

Regression on the Changing Digital Reading Performance (ICT controlled)

Country	Variable	b	SE b	β	t
Estonia	(Constant)	470.31	8.29		
R^2 = .12	ONLNREAD	32.81	1.92	.23	17.08
	USESCH	-30.70	2.12	-.23	-15.18
	ICTCLASS	-15.31	1.88	-.11	-7.97
	ENTUSE	-8.68	1.83	-.06	-4.72
	HOMESCH	-1.79	1.76	-.01	-1.02
	PISA wave_D2	46.76	3.05	.26	15.50
Finland	(Constant)	509.39	7.20		
R^2 = .10	ONLNREAD	42.71	2.07	.28	21.43
	USESCH	-31.45	2.39	-.22	-13.10
	ICTCLASS	2.95	2.06	.02	1.43
	ENTUSE	-22.17	2.11	-.15	-10.83
	HOMESCH	-5.10	2.61	-.04	-1.96
	PISA wave_D2	-1.32	3.45	-.01	-.38

When the four students' background control variables were added to the multiple regression analysis (see Table 14), it was observed that the effect of ICT use related factors on the changing performance had changed only to a limited extent in both Estonia and Finland. Interestingly, students' economic, social and cultural status appeared to have almost no influence on the changing performance in both countries.

Table 14

Regression on the Changing Digital Reading Performance (with additional control variables)

Country	Variable	B	SE b	β	t
Estonia	(Constant)	381.71	9.02		
R^2 = .19	ONLNREAD	32.18	1.87	.22	17.31
	USESCH	-20.39	2.05	-.15	-10.18
	ICTCLASS	-14.44	1.80	-.10	-7.88
	ENTUSE	1.71	1.84	.01	.93
	HOMESCH	-7.48	1.60	-.06	-4.61
	PISA wave_D2	45.58	2.90	.26	15.96
	Gender_D1	35.75	1.77	.20	20.16
	ESCS	.00	.00	-.02	-2.05
	IMMIG_D1	15.97	3.05	.06	5.26
	LANGN_D1	32.31	2.83	.16	11.62
Finland	(Constant)	383.64	8.96		
R^2 = .20	ONLNREAD	34.94	1.98	.23	18.33
	USESCH	-29.31	2.26	-.20	-12.90
	ICTCLASS	3.50	1.99	.02	1.75
	ENTUSE	-7.73	2.22	-.05	-3.51
	HOMESCH	-3.85	2.33	-.03	-1.66
	PISA wave_D2	-1.34	3.16	-.01	-.43
	Gender_D1	45.74	1.92	.25	24.39
	ESCS	.00	.00	-.02	-2.06
	IMMIG_D1	53.00	5.76	.13	8.59
	LANGN_D1	33.28	3.78	.10	8.64

Further regression analyses were performed on each individual type of ICT use to examine the effect of different types of ICT use on the changing digital reading performance at both composite and subscale levels. Results were shown as below.

3.4.1 Online reading activities

When taking ONLNREAD into account (see Table 15), the difference in reading performance between 2009 and 2018 was bigger for both Estonian (b = 24.58, t (10040) = 15.50, p < .001) and Finland (b = -20.11, t (11456) = 15.50, p < .001) than without ONLNREAD. For students who scored the same or similar in ONLNREAD in both waves, it was very likely to find that the 2018 students had on average 25 points more in Estonia while on average 20 points less in Finland than the 2009 students. This indicated that the changing digital reading performance in both Estonia and Finland could hardly be accounted for by online reading activities.

Table 15

Regression on ONLNREAD Predicting the Changing Digital Reading Performance 2009-2018

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	408.39	7.95		
	R^2 = .05	ONLNREAD	24.62	1.90	.17	12.96
		PISA wave_D2	24.58	3.02	.14	8.22
	Locate Information	(Constant)	420.41	8.40		
	R^2 = .04	ONLNREAD	21.92	2.01	.15	10.80
		PISA wave_D2	27.20	3.29	.15	8.51
	Understanding	(Constant)	408.35	8.37		
	R^2 = .05	ONLNREAD	24.38	1.98	.17	12.42
		PISA wave_D2	28.02	3.25	.16	8.76
	Evaluating and reflecting	(Constant)	402.25	8.62		
	R^2 = .05	ONLNREAD	26.66	2.05	.18	12.84
		PISA wave_D2	21.05	3.67	.11	5.85
Finland	Digital reading performance	(Constant)	458.09	6.58		
	R^2 = .03	ONLNREAD	23.39	1.81	.15	12.94
		PISA wave_D2	-20.11	3.14	-.11	-6.48
	Locate Information	(Constant)	451.20	7.58		
	R^2 = .02	ONLNREAD	24.38	2.08	.15	11.43
		PISA wave_D2	-11.01	3.75	-.05	-2.95
	Understanding	(Constant)	463.26	6.90		
	R^2 = .03	ONLNREAD	22.57	1.92	.15	11.73
		PISA wave_D2	-24.51	3.40	-.13	.7.30
	Evaluating and reflecting	(Constant)	450.67	7.20		
	R^2 = .04	ONLNREAD	25.51	2.05	.17	12.67
		PISA wave_D2	-23.50	3.19	-.12	-7.41

3.4.2 ICT use at school

General ICT use at school

When taking USESCH into account (see Table 16), the difference in reading performance between 2009 and 2018 got bigger for Estonia (b = 35.99, t (10040) = 11.84, p < .001) while it got smaller for Finland (b = 1.72, t (11456) = .52, p = .302) than without USESCH. This indicated that the declining performance in Finland could be accounted for by general ICT use at school. It was worth to note that USESCH had a significant impact on Finnish students' performance in locating information (b = 11.69, t (11456) = 3.09, p = .002). For Finnish students who scored the same or similar in USESCH in both waves, it was very likely to find that the 2018 students had on average 12 points more in locating information than the 2009 students. This strongly differed from Finnish students' performance in other subscales and overall reading performance.

Table 16

Regression on USESCH Predicting the Changing Digital Reading Performance 2009-2018

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	545.95	3.74		
	R^2 = .07	USESCH	-31.97	1.75	-.24	-18.55
		PISA wave_D2	35.99	3.06	.20	11.84
	Locate Information	(Constant)	545.94	3.94		
	R^2 = .06	USESCH	-30.65	1.83	-.22	-16.65
		PISA wave_D2	38.29	3.23	.21	12.31
	Understanding	(Constant)	544.92	4.15		
	R^2 = .07	USESCH	-31.91	2.03	-.24	-16.09
		PISA wave_D2	39.42	3.37	.22	11.94
	Evaluating and reflecting	(Constant)	545.94	4.17		
	R^2 = .06	USESCH	-30.87	2.22	-.23	-13.68
		PISA wave_D2	31.79	3.59	.17	9.06
Finland	Digital reading performance	(Constant)	580.46	3.99		
	R^2 = .04	USESCH	-29.01	2.05	-.20	-14.35
		PISA wave_D2	1.72	3.32	.01	.52
	Locate Information	(Constant)	578.61	4.88		
	R^2 = .03	USESCH	-30.13	2.76	-.19	-11.55
		PISA wave_D2	11.69	3.79	.06	3.09
	Understanding	(Constant)	579.35	3.74		
	R^2 = .04	USESCH	-26.72	1.84	-.20	-14.82
		PISA wave_D2	-2.18	3.58	-.01	-.61
	Evaluating and reflecting	(Constant)	578.33	3.82		
	R^2 = .04	USESCH	-27.85	2.17	-.19	-12.51
		PISA wave_D2	-1.96	3.46	-.01	-.57

Subject-related ICT use during classroom lessons

When taking ICTCLASS into account (see Table 17), the difference in reading performance between 2009 and 2018 got bigger for Estonia (b = 34.77, t (10040) = 11.63, p < .001) while it got smaller in Finland (b = -12.72, t (11456) = -3.60, p < .001). This indicated that the declining performance in Finland could be accounted for by subject-related ICT use during classroom lessons. For Finnish students who scored the same or similar in ICTCLASS in both waves, it was very likely to find that the 2018 students had on average 12 points less than the 2009 students in overall reading performance, on average 2 points less in locating information, on average 18 in understanding, and on average 16 in evaluating and reflecting. Comparing these results to what was revealed in Table 12, the declining reading performance in Finland could be accounted for by subject-related ICT use during classroom lessons.

Table 17

Regression on ICTCLASS Predicting the Changing Digital Reading Performance 2009-2018

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	530.30	3.56		
	R^2 = .04	ICTCLASS	-24.28	1.85	-.17	-12.78
		PISA wave_D2	34.77	3.03	.20	11.63
	Locate Information	(Constant)	533.46	3.92		
	R^2 = .04	ICTCLASS	-25.36	2.20	-.17	-11.16
		PISA wave_D2	38.19	3.24	.21	12.26
	Understanding	(Constant)	528.79	3.84		
	R^2 = .04	ICTCLASS	-23.82	1.98	-.17	-11.69
		PISA wave_D2	37.98	3.32	.21	11.70
	Evaluating and reflecting	(Constant)	532.20	3.71		
	R^2 = .03	ICTCLASS	-24.58	2.12	-.17	-11.43
		PISA wave_D2	31.19	3.89	.17	8.26
Finland	Digital reading performance	(Constant)	543.81	3.11		
	R^2 = .01	ICTCLASS	-5.99	2.12	-.04	-2.84
		PISA wave_D2	-12.72	3.55	-.07	-3.60
	Locate Information	(Constant)	543.18	3.39		
	R^2 = .00	ICTCLASS	-8.22	2.30	-.05	-3.61
		PISA wave_D2	-2.32	4.18	-.01	-.55
	Understanding	(Constant)	544.89	3.28		
	R^2 = .01	ICTCLASS	-4.95	2.15	-.03	-2.31
		PISA wave_D2	-17.79	3.75	-.09	-4.78
	Evaluating and reflecting	(Constant)	542.57	3.41		
	R^2 = .01	ICTCLASS	-5.31	2.42	-.04	-2.20
		PISA wave_D2	-16.04	3.51	-.08	-4.59

3.4.3 ICT use outside school

For entertainment

When taking ENTUSE into account (see Table 18), the effect of PISA wave for Estonia (b = 22.26, t (10040) = 7.32, p < .001) remained almost the same as without ENTUSE (see Table 12). On the other hand, the effect of PISA wave for Finland got slightly smaller (b = -14.40, t (11456) = -4.55, p < .001). The declining reading performance in Finland could be accounted for by ENTUSE, but the effect was very small. In addition, the effect of ENTUSE on Finnish students' declining performance in locating information was also not significant (b = -5.32, t (11456) = -1.41, p = .159).

Table 18

Regression on ENTUSE Predicting the Changing Digital Reading Performance 2009-2018

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	503.09	5.77		
	R^2 = .02	ENTUSE	-.69	1.75	.00	-.40
		PISA wave_D2	22.26	3.06	.13	7.32
	Locate Information	(Constant)	500.48	6.04		
	R^2 = .02	ENTUSE	.76	1.82	.00	.42
		PISA wave_D2	25.13	3.32	.14	7.78
	Understanding	(Constant)	504.53	6.17		
	R^2 = .02	ENTUSE	-1.46	1.78	-.01	-.82
		PISA wave_D2	25.72	3.32	.14	7.86
	Evaluating and reflecting	(Constant)	505.35	7.03		
	R^2 = .01	ENTUSE	-.92	2.12	-.01	-.44
		PISA wave_D2	18.54	3.68	.10	5.13
Finland	Digital reading performance	(Constant)	574.01	6.13		
	R^2 = .01	ENTUSE	-13.27	1.84	-.09	-7.33
		PISA wave_D2	-14.40	3.19	-.08	-4.55
	Locate Information	(Constant)	564.25	6.68		
	R^2 = .01	ENTUSE	-11.12	2.01	-.07	-5.58
		PISA wave_D2	-5.32	3.77	-.03	-1.41
	Understanding	(Constant)	578.91	6.29		
	R^2 = .02	ENTUSE	-14.12	1.88	-.09	-7.60
		PISA wave_D2	-18.87	3.43	-.10	-5.54
	Evaluating and reflecting	(Constant)	573.74	6.79		
	R^2 = .02	ENTUSE	-13.30	2.11	-.09	-6.30
		PISA wave_D2	-17.38	3.26	-.09	-5.36

For schoolwork

When taking HOMESCH into account (see Table 19), the effect of PISA wave for Estonia got slightly bigger (b = 23.73, t (10040) = 7.74, p < .001) while it got smaller in Finland (b = -7.60, t (11456) = -2.13, p = .033). For Finnish students who scored the same or similar in HOMESCH in both waves, it was very likely to find 2018 students scored on average 8 points less than 2009 students. At subscale levels, 2018 students scored on average 12 points less in understanding and on average 13 points less in evaluating and reflecting than 2009 students, whereas the difference in locating information was very small and no longer significant. Comparing these results with what was revealed in Table 12, the declining reading performance in Finland could be accounted for by ICT use outside school for schoolwork.

Table 19

Regression on HOMESCH Predicting the Changing Digital Reading Performance 2009-2018

Country	Dependent variable	Independent variable	b	SE b	β	t
Estonia	Digital reading performance	(Constant)	519.44	4.71		
	R^2 = .02	HOMESCH	-7.82	1.61	-.06	-4.80
		PISA wave_D2	23.73	3.08	.13	7.74
	Locate Information	(Constant)	523.95	5.05		
	R^2 = .02	HOMESCH	-8.95	1.71	-.07	-5.25
		PISA wave_D2	26.81	3.32	.14	8.29
	Understanding	(Constant)	520.57	5.10		
	R^2 = .03	HOMESCH	-8.71	1.70	-.07	-5.10
		PISA wave_D2	27.35	3.34	.15	8.30
	Evaluating and reflecting	(Constant)	513.59	5.31		
	R^2 = .01	HOMESCH	-4.69	1.77	-.04	-2.62
		PISA wave_D2	19.42	3.64	.11	5.42
Finland	Digital reading performance	(Constant)	557.38	3.69		
	R^2 = .02	HOMESCH	-14.73	2.18	-.11	-6.83
		PISA wave_D2	-7.60	3.57	-.04	-2.13
	Locate Information	(Constant)	556.63	4.39		
	R^2 = .01	HOMESCH	-16.68	2.57	-.11	-6.64
		PISA wave_D2	2.76	3.88	.01	.71
	Understanding	(Constant)	561.29	3.54		
	R^2 = .02	HOMESCH	-15.74	1.99	-.11	-7.93
		PISA wave_D2	-11.60	3.71	-.06	-3.14
	Evaluating and reflecting	(Constant)	551.96	3.22		
	R^2 = .02	HOMESCH	-11.26	1.95	-.08	-5.81
		PISA wave_D2	-12.50	3.55	-.07	-3.53

4. Discussion

The current study examined how online reading activities and ICT use affect digital reading performance of 15-year-olds in Estonia and Finland. The study also examined the extent to which the changing reading performance between 2009 and 2018 in Estonia and Finland can be accounted for by ICT use. Results revealed that online reading activities positively influenced students' digital reading performance in both countries. ICT use at school generally had a negative impact on students' digital reading performance. Depending on the type of use, ICT use outside school showed different results in Estonia and Finland. For entertainment use, ICT use outside school showed a positive effect on Estonian students' performance but a negative effect on Finnish students' performance. For academic use, ICT use outside school showed a negative effect on students' performance in both Estonia and Finland. Furthermore, the analysis on the changing ICT use and changing digital reading performance showed that the rising reading performance in Estonia was not related to ICT use, but the declining performance in Finland could be accounted for by ICT use. Details of the findings and their implications are elaborated below.

Online reading activities

In the current study, online reading activities was confirmed to have a positive effect on 15-year-olds' digital reading performance. However, a further regression analysis showed that online reading activities were not accountable for the changing digital reading performance in both Estonia and Finland. Nevertheless, when taking online reading activities into account, there was still a significant effect of PISA wave. For students who scored the same or similar in terms of online reading activity frequencies, it was found that 2018 Estonian students scored on average 25 points more while Finnish students scored on average 20 points less than their 2009 peers. It seemed that the Estonian students made more effective use of online reading activities than their Finnish peers. This could possibly happen due to different reasons, for example, quality of online reading materials, guidance for reading online, digital competence, etc. It is

necessary to have a closer look into the types of online reading activities and the conditions while the reading activities were carried out to identify the possible causes of this contradiction.

ICT use at school

In line with previous studies (Gubbels et al., 2020; Hu et al., 2018; Lee & Wu, 2012; Petko et al., 2017), no positive relationship was found between ICT use at school and 15-year-olds' digital reading performance in the current study. The more students used ICT at school, the lower their reading scores were. A possible explanation was that students were making ineffective use of ICT at school. Reasons for this can be various. For example, students who could not read well opt for searching help online and therefore used more ICT. Students might as well end up in more but ineffective ICT use without clear instruction and proper scaffolding. Both students' and teachers' digital competencies could also play a role in how students approach ICT use at school.

Further regression analysis revealed that the rising reading performance in Estonia was not related to ICT use at school whereas the Estonian students could have achieved even higher performance in reading without ICT use at school. A possible explanation was that teachers have not yet become good enough at the kind of pedagogies that make the most of technology (OECD, 2015). Despite the clear increase of ICT use at school in both Estonia and Finland between 2009 and 2018, the level of teachers' digital skills is very uneven and the readiness of schools to use technology varies (Aru-Chabilan, 2020). As Ertmer & Ottenbreit-Leftwich (2013) pointed out, technology alone cannot improve teaching and learning.

The declining performance in Finland was however identified to be accountable for by ICT use at school. In addition, a distinctive exception was found between general ICT use at school and Finnish students' changing performance in performing locating information tasks with a positive relationship. This indicated that the general ICT use at Finnish school has been helpful to improve its students' efficiencies in assessing and retrieving target information

without comprehending the text. However, the contribution of this individual factor alone was not significant enough to impact the declining reading performance at a wider scope. It could be possible that the pedagogical purposed ICT use in Finland was narrowed that only affected a narrow set of learning areas (Ertmer & Ottenbreit-Leftwich, 2013; Skryabin et al., 2015). It is also possible that students were distracted while using ICT and could not concentrate on interactions with teachers to build deep, conceptual understanding and higher-order thinking.

ICT use outside school

ICT use outside school appeared to have different effects on 15-year-olds' reading performance depending on user groups and types of use. ICT leisure use outside school had a positive influence on students' digital reading performance in Estonia while a negative influence in Finland was found. Possible reasons for the distinction could come from how students were guided to deal with digital distractions and the types of activities the students considered as entertaining. For example, purposefully watching inspiring videos online or getting spoiled by uncontrolled internet access. The positive relationship found in the Estonian context might also have something to do with the ICT popularity and general ICT competency levels in the Estonian society that resulted from political attention and support (Aru-Chabilan, 2020). The level of ICT integration is very high in the Estonian society since the government launched its Tiger Leap initiative in 1996 to prepare its education system and the whole society for the information age (Aru-Chabilan, 2020). Consequently, there is a different degree of national interest in contributing to the creation and dissemination of digital learning materials (Aru-Chabilan, 2020). It should however be noted that the size of the positive effect of ICT leisure use outside school on Estonian students' digital reading performance was rather low, which could only explain 1% of the performance variation among Estonian students.

On the other hand, ICT academic use outside school was found with negative impact on 15-year-olds' digital reading performance in both Estonia and Finland, although the effect size

for Estonia was relatively low. This finding is in line with the findings from Hu et al. (2018) and Gumus and Hasan Atalmis (2011).

Further regression analysis with comparison to PISA 2009 data revealed that the rising reading performance in Estonia could not be accounted for by ICT use outside school. However, ICT use outside school was found to be accountable for the declining reading performance in Finland. Among which, the effect of ICT leisure use was very small while the effect of ICT academic use was significant. There was a clear increasing trend of ICT academic use outside school in both Estonia and Finland between 2009 and 2018. The increase was particularly significant in Finland. This result hints that students will not automatically become digitally literate through increasing their academic ICT use at home. It is therefore important that teachers provide clear instructions and scaffolds for schoolwork and parents support with guidance of ICT use at home for students to make more efficient use of ICT resources outside school.

Implications

The current study centred on ICT use predicting 15-year-olds' digital reading performance. Empirical evidence was presented to underpin the positive effect of online reading activities and the negative effect of ICT use at school on 15-year-olds' digital reading performance, which can be considered as a theoretical contribution. The negative relationship between ICT use at school and students digital reading performance was previously reported by Gubbels et al. (2020), Hu et al. (2018), Lee and Wu (2012), Petko et al. (2017). The current study enabled to test this relationship among a different specific group of students than previous studies. Therefore, the findings are potentially relevant to generate conclusions to a wider range of students. Empirical evidence revealed in this study contributes to the larger literature of ICT influence on students' learning performances.

In spite of the considerable promotion of ICT-based education innovations, it was unexpected to see the extent to which both ICT use at school and outside school negatively influenced students' digital reading performance. The findings have yielded insights that have practical implication for ICT integration in education to prepare students of tomorrow. First, it is essential to enhance digital competencies of teachers to make more out of technology by creating clear competence standards, establishing assessment and training systems, and providing free trainings to develop digital competences in different subjects. It is also important to support this development along with expanding the availability of authentic digital learning resources and accessibility to specialists with ICT expertise. Special attention can be paid to the development of digital competencies of teachers in older age groups who are reluctant to ICT integration. Second, teachers need to provide clear instructions and scaffold on when, what and how students should use ICT at school and outside school for schoolwork. It is important for teachers to not rush into teaching with narrowed pedagogical purposed ICT use. ICT use might distract the teacher-students interactions during classroom lessons. Therefore, teachers need to carefully review their lesson plans and the pedagogies adapted in carrying out the lesson plan. If the objective of a lesson was to build deep, conceptual understanding and higher-order thinking, teachers need to be aware of the effect of involving ICT use during such lessons and adapt their plans accordingly. Third, parents need to support students with guidance of ICT use at home for students to make more efficient use of ICT resources outside school.

Limitation and future research

The present study has several limitations. First, the current study is based on self-reported PISA data. Self-reported data may contain bias or incorrect interpretation of questions. Relationships between different aspects of ICT use and digital reading performance might also be reciprocal. Second, PISA student context questionnaire has been developed over the years and the same construct may contain different question items in different PISA waves. To make

a valid comparison between 2009 and 2018 data, constructs used in the two test cycles were compared and only items with the same measures were selected to construct the variables in the current study. However, different constructs may be constructed when comparing data in different PISA cycles or using a different methodology, which might influence the results differently. Third, as indicated earlier in the data analysis, the Cronbach's alpha coefficient for some variables were relatively low, particularly ICTCLASS in Finland in 2009. This raises some doubts about the reliability of the measures. However, the results should still be acceptable as the samples are large and the reliability of all other scales were also either good or acceptable. Lastly, the current study focused on the influence of ICT use on digital reading performance, but there are other interesting ICT-related variables that could also affect students' digital reading performance, such as ICT interest, ICT competency, and ICT autonomy. In PISA, these three self-perceived ICT-related variables were introduced in the PISA 2015 cycle, where science was the major domain. Due to lack of earlier data for comparison in the context of reading performance, they were not included in the present study.

To serve the knowledge base for policy research, it is necessary for future research to continue monitoring the impact of ICT use both at school and outside school on students' digital reading performance in different contexts. Based on the indication that students could have achieved a better reading performance without changes in ICT use, it is also important for further research to look more into types of pedagogical purposed ICT use and assess how they influence students' learning outcomes.

5. Conclusion

In conclusion, the current research has contributed to the understanding of the extent to which ICT use influence 15-year-olds' digital reading performance. The results revealed that investing in ICT resources and increasing ICT use alone do not enhance students' performance in digital reading. Born in the digital age does not equal to be automatically digitally literate. The development of digitally competent citizens of tomorrow requires the input of effective guidance from both teachers and parents. Therefore, it is important for researchers and policymakers to focus on the types of pedagogies and activities that can utilize the effective use of ICT resources both at school and outside school to enhance students' digital reading competencies.

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Appendix A. Scaling of independent variables in the present study

Table A1

Overview of Variable Constructs in ONLNREAD

No.	Name 2018	Name 2009	Item
1	ST176Q01IA	ST26Q01	How often involved in: Reading emails
2	ST176Q02IA	ST26Q02	How often involved in <Chat on line> (e.g. <Whatsapp>, <Messenger>)
3	ST176Q03IA	ST26Q03	How often involved in: Reading online news
4	ST176Q05IA	ST26Q05	How often involved in: Searching information online to learn about a particular topic
5	ST176Q06IA	ST26Q06	How often involved in: Taking part in online group discussions or forums
6	ST176Q07IA	ST26Q07	How often involved in: Searching for practical information online (e.g. schedules, events, tips, recipes)

Table A2

Overview of Variable Constructs in USESCH

No.	Name 2018	Name 2009	Item
1	IC011Q01TA	IC06Q01	Use digital devices at school: <Chatting on line> at school.
2	IC011Q02TA	IC06Q02	Use digital devices at school: Using email at school.
3	IC011Q03TA	IC06Q03	Use digital devices at school: Browsing the Internet for schoolwork.
4	IC011Q04TA	IC06Q04	Use digital devices at school: Downloading, uploading or browsing material from the school's website (e.g. <intranet>).
5	IC011Q05TA	IC06Q05	Use digital devices at school: Posting my work on the school's website.
6	IC011Q06TA	IC06Q06	Use digital devices at school: Playing simulations at school.
7	IC011Q07TA	IC06Q07	Use digital devices at school: Practicing and drilling, foreign language learning or math.
8	IC011Q08TA	IC06Q08	Use digital devices at school: Doing homework on a school computer.
9	IC011Q09TA	IC06Q09	Use digital devices at school: Using school computers for group work and communication with other students.

Table A3

Overview of Variable Constructs in ICTCLASS

No.	Name 2018	Name 2009	Item
1	IC150Q01HA	IC07Q01	Time spent using digital devices during classroom lessons in a typical school week: <Test language lessons>
2	IC150Q02HA	IC07Q02	Time spent using digital devices during classroom lessons in a typical school week: <Mathematics>
3	IC150Q03HA	IC07Q03	Time spent using digital devices during classroom lessons in a typical school week: <Science>

Table A4

Overview of Variable Constructs in ENTUSE

No.	Name 2018	Name 2009	Item
1	IC008Q01TA	IC04Q01	Use digital devices outside of school: Playing one-player games.
2	IC008Q02TA	IC04Q02	Use digital devices outside of school: Playing collaborative online games.
3	IC008Q03TA	IC04Q04	Use digital devices outside of school: Using email.
4	IC008Q04TA	IC04Q05	Use digital devices outside of school: <Chatting online> (e.g. <MSN>).
5	IC008Q05TA	IC04Q09	Use digital devices outside of school: Participating in Social Networks (e.g. <Facebook>, <MySpace>).
6	IC008Q08TA	IC04Q06	Use digital devices outside of school: Browsing the Internet for fun (such as watching videos, e.g. <YouTube>).
7	IC008Q11TA	IC04Q07	Use digital devices outside of school: Downloading music, films, games or software from the Internet.

Table A5

Overview of Variable Constructs in HOMESCH

No.	Name 2018	Name 2009	Item
1	IC010Q01TA	IC05Q01	Use digital devices outside of school: Browsing the Internet for schoolwork (e.g. for preparing an essay or presentation).
2	IC010Q03TA	IC05Q02	Use digital devices outside of school: Using email for communication with other students about schoolwork.
3	IC010Q04TA	IC05Q03	Use digital devices outside of school: Using email for communication with teachers and submission of homework or other schoolwork.
4	IC010Q07TA	IC05Q04	Use digital devices outside of school: Downloading, uploading or browsing material from my school's website (e.g. timetable or course materials).
5	IC010Q08TA	IC05Q05	Use digital devices outside of school: Checking the school's website for announcements, e.g. absence of teachers.

Appendix B. Statistics of student practice in self-reported ICT use 2009-2018

Table B1

Statistics of Student Practice in ONLNREAD 2009-2018

Statistics		Estonia		Finland	
		2018	2009	2018	2009
Mean		3.68	3.77	3.54	3.32
95% Confidence Interval	Lower Bound	3.66	3.76	3.52	3.30
for Mean	Upper Bound	3.69	3.79	3.56	3.33
5% Trimmed Mean		3.70	3.78	3.55	3.31
Median		3.67	3.83	3.50	3.33
Variance		.38	.36	.35	.36
Std. Deviation		.62	.60	.59	.60
Minimum		1.00	1.00	1.00	1.00
Maximum		5.00	5.00	5.00	5.00
Range		4.00	4.00	4.00	4.00
Interquartile Range		.67	.83	.67	.67
Skewness		-.67	-.20	-.35	.18
Kurtosis		1.56	-.08	1.29	.14

Table B2

Statistics of Student Practice in USESCH 2009-2018

Statistics		Estonia		Finland	
		2018	2009	2018	2009
Mean		1.84	1.40	2.15	1.55
95% Confidence Interval	Lower Bound	1.82	1.38	2.13	1.54
for Mean	Upper Bound	1.87	1.41	2.17	1.56
5% Trimmed Mean		1.77	1.34	2.11	1.51
Median		1.56	1.22	2.00	1.44
Variance		.63	.22	.52	.17
Std. Deviation		.79	.47	.72	.41
Minimum		1.00	1.00	1.00	1.00
Maximum		4.00	4.00	4.00	4.00
Range		3.00	3.00	3.00	3.00
Interquartile Range		1.00	.56	.83	.56
Skewness		1.12	1.82	.95	1.64
Kurtosis		.50	4.23	.46	4.41

Table B3

Statistics of Student Practice in ICTCLASS 2009-2018

Statistics		Estonia		Finland	
		2018	2009	2018	2009
Mean		1.72	1.20	1.84	1.35
95% Confidence Interval	Lower Bound	1.70	1.19	1.82	1.34
for Mean	Upper Bound	1.75	1.21	1.86	1.36
5% Trimmed Mean		1.65	1.14	1.78	1.30
Median		1.67	1.00	1.67	1.33
Variance		.53	.17	.50	.19
Std. Deviation		.73	.41	.71	.43
Minimum		1.00	1.00	1.00	1.00
Maximum		4.00	4.00	4.00	4.00
Range		3.00	3.00	3.00	3.00
Interquartile Range		1.00	.33	.67	.67
Skewness		1.20	2.74	.91	1.48
Kurtosis		1.16	9.27	.60	2.90

Table B4

Statistics of Student Practice in ENTUSE 2009-2018

Statistics		Estonia		Finland	
		2018	2009	2018	2009
Mean		3.09	3.10	2.98	2.87
95% Confidence Interval	Lower Bound	3.07	3.08	2.96	2.85
for Mean	Upper Bound	3.11	3.11	3.00	2.89
5% Trimmed Mean		3.12	3.12	3.00	2.89
Median		3.14	3.14	3.00	2.86
Variance		.35	.30	.37	.38
Std. Deviation		.60	.55	.61	.61
Minimum		1.00	1.00	1.00	1.00
Maximum		4.00	4.00	4.00	4.00
Range		3.00	3.00	3.00	3.00
Interquartile Range		.86	.57	.86	.86
Skewness		-.61	-.78	-.41	-.44
Kurtosis		.62	1.10	-.07	-.02

Table B5

Statistics of Student Practice in HOMESCH 2009-2018

Statistics		Estonia		Finland	
		2018	2009	2018	2009
Mean		2.56	2.39	2.03	1.48
95% Confidence Interval	Lower Bound	2.54	2.37	2.01	1.47
for Mean	Upper Bound	2.58	2.41	2.05	1.50
5% Trimmed Mean		2.56	2.39	1.98	1.43
Median		2.60	2.40	1.80	1.40
Variance		.59	.43	.59	.22
Std. Deviation		.77	.66	.77	.47
Minimum		1.00	1.00	1.00	1.00
Maximum		4.00	4.00	4.00	4.00
Range		3.00	3.00	3.00	3.00
Interquartile Range		1.00	.80	1.00	.40
Skewness		.17	.00	.90	1.80
Kurtosis		-.45	-.42	.25	4.28