



The global rise of online chatting and its adverse effect on reading literacy

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ABSTRACT

In the past decade, reading has moved massively from printed paper to digital displays. Thus far, large-scale surveys have not shown clear-cut effects of ICT use on reading literacy. This study addresses the impact of per country increases in online chatting, using data from the worldwide PISA surveys in 2009 and 2018 covering 63 countries. During that period, online chatting increased substantially in nearly every country, but the rate of increase varied considerably across countries. The empirical evidence shows a strong correlation of per country increase in online chatting among 15-year-olds with per country declines in both reading literacy and awareness of useful reading strategies.

1. Introduction

In recent decades, the ongoing diffusion of information and communication technology (ICT) has strongly affected people's lives all over the world. One important consequence is that reading has massively moved from paper to digital displays (OECD, 2019b; UNESCO, 2014). The PISA (Programme of International Student Assessment) surveys have shown that over the 2009–2018 period, reading from screens steadily increased among 15-year-olds across the world. Traditional sources such as books, newspapers and magazines have lost ground to more modern options such as e-mail, online chatting and internet forums (Schleicher, 2019). In particular, the rise in online chatting has been remarkably strong. Therefore, this study focuses on the impact of that particular type of ICT use. Across countries, online chatting has increased more strongly than any other type of ICT use addressed in the PISA surveys. The rate of increase in chatting also shows the strongest cross-national variation (see the supplementary materials, Appendix A). The nature of reading has changed enormously, but it remains unclear to what extent this has affected reading skills. This paper addresses the relation of per country increase in online chatting over the 2009–2018 period with changes in both reading literacy and awareness of reading strategies among 15-year-olds across the world.

2. Theoretical background and prior research

2.1. ICT use and reading literacy

The widespread availability of information over the internet

provides great opportunities for discovery and learning. Thanks to ICT, information can be accessed rapidly through various modes of presentation. This may provide multiple viewpoints, but it may also create confusion and distraction (Wolf & Barzillai, 2009). Prominent scholars such as Carr (2010) and Wolf (2018) have argued that digital media stimulate superficial reading strategies including scanning, skimming and browsing, at the expense of more time-consuming strategies that allow for deeper comprehension. Several studies have supported the notion that the ability to reflect on one's reading strategies and subsequently control these strategies is correlated with reading literacy (Artelt et al., 2001; Brown et al. 1984; OECD, 2010).

Recurrent exposure to digital media may cause the human brain to rearrange itself (Carr, 2010; Wolf, 2018), as it is possible for neural networks in the brain to adapt in response to external stimuli, also known as neuroplasticity (Fuchs & Flügge, 2014). Recent meta-analyses have confirmed that digital media have negative effects on reading comprehension (Delgado et al., 2018; Kong et al., 2018): when the same texts are presented on paper or on digital devices, comprehension is higher when reading from paper. This notion has been taken into account when scoring student responses in the PISA surveys. Computer-based assessments were introduced in 2015. The computer versions of most test items turned out to be more difficult to answer correctly than the traditional versions on paper (Jerrim et al., 2018; OECD, 2017; Robitzsch et al., 2020). This required the organizers to adjust for "mode effects" (i.e., change from print to computer). Without these adjustments, the comparability of findings across years would be invalidated.

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2.2. Reading literacy and use of ICT in PISA surveys

The PISA surveys present an excellent opportunity to study the impact of ICT use on reading literacy of young people worldwide. The triennial surveys assess the skills of 15-year-olds in using reading, mathematics and science in real-world situations. In addition to cognitive tests, student questionnaires are administered in order to collect information on their attitudes, perceptions and activities in and outside of school, including use of ICT.

However, studies on the relation between the use of ICT at home and reading literacy in PISA have shown ambiguous results (Gubbels et al., 2020). Even though the way people read has changed dramatically, analyses of PISA data thus far have not shown a clear-cut relation between ICT use and reading literacy. If the risks associated with exposure to digital media really are severe, then why is it so hard to detect indications of its impact in survey data? An important message of the present study is that this requires a focus on change over time. This corroborates prior research, which assessed reading and math trajectories of North Carolina students from grades 5–8 between 2000 and 2005 (Vigdor et al., 2014). The present study covers a considerably broader geographical range (63 countries) and a wider time span.

Survey research on the relation between ICT use and reading literacy has typically focused on cross-sectional variation between individuals. Students who differ in their use of ICT at a given point in time are compared with regard to their test scores. Wolf (2018) advocated longitudinal research to assess the impact more accurately. This study presents an alternative perspective, making use of per country variation with regard to growth in online chatting over the 2009–2018 period. The 2018 population of 15-year-old students is compared to the 2009 population, per country. The focus is on the correlation of per country change in online chatting with change in both reading literacy and awareness of reading strategies. Thus, the analysis explicitly assesses the impact of increased online chatting. Still, the present study could only address change at the country level. Only cross-sectional data are reported at the individual level. Individual change was beyond the scope of this study.

2.3. Correlations between per country changes vs. correlations at the individual level

Correlations between variables may be very different at distinct levels of aggregation (Robinson, 1950). Consider the example of wealth and obesity. When a country's wealth increases, so does the prevalence of obesity (Sturm & An, 2014). Within countries, however, the least wealthy individuals are the ones with the highest risks (Lamerz et al., 2005). A similar pattern may apply to the relation between online chatting and reading literacy, for example, if the increase in online chatting bears the greatest risks for youth with already poorly developed reading skills. Furthermore, more literate individuals may engage more frequently in activities such as chatting. This would yield positive correlations between online chatting and reading literacy at the individual level. Still, even positive correlations at the individual level do not preclude the possibility that national reading levels are adversely affected by increases in online chatting.

2.4. Hypothesized relations between online chatting, reading strategies and literacy

The concerns raised by authors such as Carr (2010) and Wolf (2018) imply that increasing ICT use coincides with decreases in both deep reading strategies and comprehension. Decrease in deep reading strategies may act as a mediating variable in the impact of online chatting on reading literacy. Fig. 1 presents a graphical display of the conceptual model for which empirical support was sought in the PISA data. The model posits a direct negative effect of change in online chatting on both awareness of reading strategies and reading literacy. In addition, the

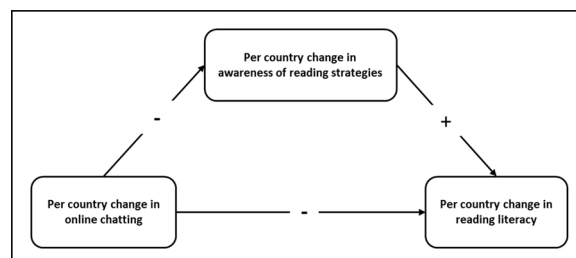


Fig. 1. Conceptual model.

Relations between per country changes in online chatting, awareness of reading strategies and reading literacy.

model depicts an indirect effect of change in online chatting on reading literacy via change in awareness of reading strategies. In PISA questionnaires, the use of specific reading strategies is not explicitly assessed. Students are asked to rate the usefulness of a number of reading strategies for understanding and remembering a text. In this way, awareness of reading strategies is measured.

3. Research objectives

The main objective is to quantify the strength of the relations between per country variation in the increase in online chatting and change in reading literacy and awareness of reading strategies over the 2009–2018 period. More specifically, the following findings are reported:

1 Correlations between:

- per country change in online chatting and change in reading literacy
- per country change in online chatting and change in awareness of reading strategies
- per country change in awareness of reading strategies and change in reading literacy

2 The extent to which the relation between per country change in online chatting and reading literacy is mediated by per country change in awareness of reading strategies.

4. Method

4.1. Data

Data were collected in the PISA surveys of 2009 and 2018. PISA is conducted by the Organisation for Economic Cooperation and Development (OECD). Its primary aim is to measure student knowledge and skills needed for participation in today's societies, with regard to reading, mathematics and science. Data collection through tests and questionnaires is standardized, allowing for cross-country comparison. The focal subject rotates every 3 years. In 2009 and 2018 the main portion of the test items measured reading literacy (OECD, 2019b). The background questionnaires provide information on various aspects of students' lives.

Countries were the main unit of analysis. In total, 63 countries participated in both PISA 2009 and 2018. The samples provide a reliable representation of the 15-year-old student populations, per country and year. The total number of students included in the national surveys was 452,862 in 2009 and 476,760 in 2018. Table 1 presents an overview of the number of countries per continent in 2009 and 2018. Europe contributed the most countries. When taking into account the size of the student population each sample represented (summed over 2009 and 2018), the distribution across continents was more even. Four continents (Europe, Australasia, North and South America) were almost completely covered. Asia was partly covered, but African countries were absent. Appendix C presents an inventory of all countries covered.

Table 1
Countries studied (and their populations) by continent.

Continent	Number of Countries	Populations of 15-year-olds, summed over 2009 and 2018 (millions)	Percentage of 15-year-olds
Europe	35	12.1	26.5
Asia	15	14.8	32.4
North America	5	10.6	23.2
South America	6	7.6	16.6
Australasia	2	0.6	1.3
Africa	–	–	–
Total	63	45.7	100.0

Note: 64 countries participated in both years. Spain was excluded, because data on reading literacy were not available for 2018.

PISA makes use of age-based samples. The target populations consist of 15-year-olds. Students are selected by age, regardless of their school year. In the analyses, the country-level data were weighted by population size. The national samples in the PISA surveys represent populations that vary greatly in size. In the smallest countries (e.g., Iceland, Malta), the target populations include just about 4000 individuals. In the largest countries (e.g., Brazil, Indonesia, U.S.) these amount to two or three million.

The standard approach in cross-national studies using PISA data is to assign equal weights to all countries. This may be appropriate when the analysis relates to effects of deliberate national policies. The current study, however, focuses on the impact of an autonomous development and takes into account that samples from large countries represent (many) more individuals than data from smaller ones. A consequence of equal weights for each and every country would be that the data from a country such as Iceland (representing some four thousand 15-year-olds in 2018) would carry the same weight as the U.S. sample, which represents a population of over three and a half million students in 2018 (i. e., 870 times as large). More details on population sizes and country weights are reported in Appendix D.

4.2. Measurements

Two cohorts (2009 and 2018) were compared per country. For each country, the change in online chatting was assessed, and also the change in reading literacy and awareness of reading strategies. The outcome variable was the per country difference in reading literacy between 2009 and 2018. The explanatory variable was the per country change in online chatting. Change in awareness of reading strategies was the mediating variable. Additional analyses were conducted to assess to what extent correlations between the main variables changed when the impact of possibly confounding variables was taken into account.

4.2.1. Reading literacy

The PISA tests assess to what extent 15-year-old students have mastered the knowledge and skills needed for participation in modern societies. The tests include both multiple-choice items and open-ended questions. While in 2009, students still took a classic paper-and-pencil test, the default mode in 2018 was a computer assessment (OECD, 2019a). In 2018, the assessment focused more strongly on reading in digital environments, placing more emphasis on using multiple sources. Still, the study design allows for the assessment of trends in reading literacy over time (Schleicher, 2019). The average test score across OECD countries equals about 500. The standard deviation in student scores is approximately 100.

4.2.2. Online chatting

Change in online chatting frequency constituted the explanatory variable. It was measured as the per country change in the percentage of students reporting being involved in online chatting several times a day.

4.2.3. Awareness of reading strategies

Changes in awareness of reading strategies were assessed by means of responses to a question on the usefulness of strategies for understanding and memorizing a text. Students were asked to evaluate six distinct strategies (see Appendix B for details). The student scores express to what extent his/her ordering of the strategies is in agreement with the preferred ordering according to reading experts (OECD, 2012). This variable was standardized to have a mean of 0 and a standard deviation equal to 1 in OECD countries.

4.3. Data analysis

First, descriptive findings are reported on the variation between countries with regard to change in online chatting, reading literacy and awareness of reading strategies. Second, correlations between these variables are reported. Third, the results of four regression analyses that quantify the relations between the variables are presented. Fourth, the empirical validity of the conceptual model was assessed by means of structural equation modelling. This allowed for estimation of the direct and indirect effect of change in online chatting on change in reading literacy. Data were weighted by population size.

Although this study focused on correlations between changes at the country level, additional findings on cross-sectional correlations per year are reported as well. These related both to country-level aggregates and individual scores. For individuals, information on prior achievement was absent. PISA data do not allow for analysis of the relation between change in online chatting and reading literacy at the individual level. In contrast to correlations between change scores, these correlations provide a snapshot view. They show to what extent countries and individuals scoring high on online chatting in a given year also show relatively high/low scores on reading literacy and awareness of reading strategies.

In additional analyses, a wide range of variables was considered to check whether controlling for possibly confounding variables changed the estimated effects of online chatting. In total, 36 variables were considered, grouped in five categories (variables related to sample characteristics and data collection; variables related to socioeconomic change; variables related to change in online reading activities; variables related to reading behaviour and attitudes; variables related to educational changes). Finally, correlations between change in online chatting and change in mathematics and science performance are reported. These correlations were expected to be weaker than that between change in online chatting and reading literacy.

5. Findings

5.1. Descriptive statistics

The supplementary materials include a dataset with details on per country change in reading literacy, awareness of reading strategies and chatting. Table 2 reports descriptive statistics across countries (weighted by population size).

The average change in reading literacy was -3.94 points. The international averages were 457.71 in 2009 and 453.76 in 2018. This indicates a small decline on average. The median was slightly positive.

Table 2
Descriptive statistics; per country change over 2009–2018 ($N = 63$).

	Reading performance	Percentage of 15-year-olds chatting several times a day	Awareness of reading strategies
Mean	-3.94	39.26	.042
Median	1.12	37.80	.062
Std. Dev.	15.52	17.36	.123
Minimum	-30.74	-24.11	-.367
Maximum	38.48	76.47	.462

Note: Countries are weighted by population size.

Macao-China showed the largest improvement (38.48) and Indonesia the strongest decline (-30.74).

With regard to online chatting, nearly all countries showed an increase. Lithuania and Bulgaria were the only exceptions. For Lithuania, the decrease was sizable (68.6 % of 15-year-olds chatting several times a day in 2009 vs. 44.5 % in 2018). The decrease in Bulgaria was very small (73.1 % vs. 71.0 %). All other countries showed an increase. Japan showed the largest growth (9.0 % vs. 85.5 %). The average increase was about 39 percentage points (31.5 % vs. 70.8 %).

The average change with regard to awareness of reading strategies was .042 (-.158 vs. -.115). The number of improving countries slightly outweighed the number of declining countries. Georgia showed the strongest improvement (.462) and Albania the strongest decline (-.367).

5.2. Correlations

The correlations between per country change in online chatting, reading literacy and awareness of reading strategies are compelling. This is illustrated in Fig. 2. The six largest countries are explicitly indicated. The top graph shows an unmistakable negative correlation between change in online chatting and reading literacy ($r = -.718$). In countries where online chatting increased most strongly, such as Indonesia and Japan (62.7 and 76.5 percentage points respectively), reading literacy clearly decreased (Japan: 16.0; Indonesia: 30.7). Countries with below-average increases in chatting, such as the USA and the Russian Federation (25.0 and 16.0 percentage points) showed growth in reading literacy (U.S.A.: 5.5; Russian Federation: 19.1).

The correlation between change in online chatting and awareness of reading strategies was also negative and strong ($r = -.494$). Countries with a sharp increase in online chatting showed little improvement or even a decline in awareness of reading strategies. Finally, a strong, positive correlation (.701) was found between change in awareness of reading strategies and reading literacy. Countries with a marked improvement in awareness of reading strategies made relatively strong progress in reading literacy (and vice versa).

5.3. Regression analyses

Four regression analyses were conducted to quantify the relations between the main variables. In the first three analyses, change in reading literacy was the outcome variable. Analyses 1 and 2 were bivariate in nature, with change in online chatting and reading strategies as the respective explanatory variables. The third analysis included both explanatory variables. In the final regression analysis, change in reading strategies was the outcome variable and change in online chatting was the explanatory variable. Table 3 reports both standardized (beta) and unstandardized results. The standard errors and p -values indicate high statistical significance. If the actual relations were zero, it would be very unlikely to find these results.

The first regression analysis indicated that a 1 % increase in 15-year-olds chatting several times a day corresponded to a .642 decrease in the national reading average. Recall that the average increase across countries was nearly 40 % (see Table 2). The regression intercept implies that zero growth in chatting would result in an improvement of 21.2 points in reading. Estonia closely fit this pattern (2.0 % chatting increase; 22.1 reading improvement). A 33 % increase in chatting implied zero change. Germany fits this pattern (35.1 % chatting increase; 1.0 reading improvement). For completeness sake, the second regression analysis confirmed the strong correlation (.701) between change in awareness of reading strategies and reading literacy. The third regression analysis detailed the joint impact of change in chatting and awareness of reading strategies. The net effects of these variables were smaller than the gross effects in the bivariate analyses, but both effects remained substantial. The fourth analysis described the relation between change in online chatting and change in awareness of reading

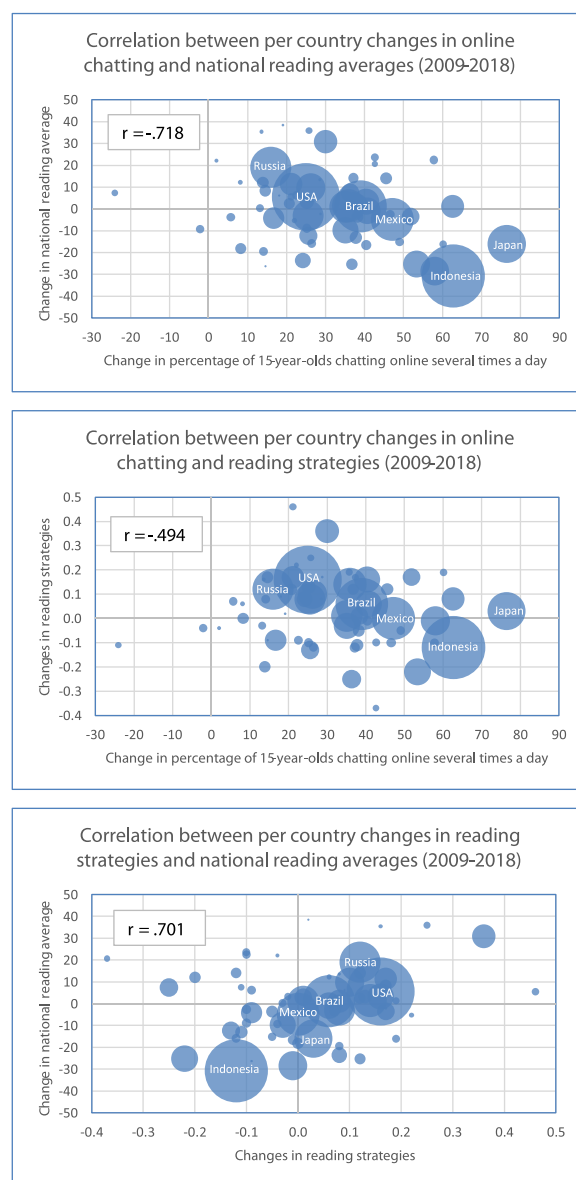


Fig. 2. Correlations between per country change in online chatting, reading literacy and strategies.

Note: A country's population size determines the size of each bubble. The six largest countries are indicated explicitly.

strategies.

5.4. Structural equation modelling

The results were in line with the conceptual model based on the concerns expressed by Carr (2010) and Wolf (2018). The model posited an effect of change in online chatting on both awareness of reading strategies and reading literacy and also that the effect of online chatting on reading literacy was partly mediated by reading strategies. Fig. 3 presents a graphic display. The results reported in the figure were obtained through structural equation modelling. They can also be inferred from the regression findings in Table 3 (analyses 3 and 4). The total effect of change in chatting on reading literacy (-.718; analysis 1) equals the sum of the direct effect (-.491) and the indirect effect (-.494 \times .458 = -.226).

Table 3
Regression analyses; effects of per country changes in online chatting and awareness of reading strategies.

	Coefficient	Standard error	p-value	beta	R ²
Outcome variable: Per country change (2009–2018) in reading literacy					
1 Intercept	21.242	3.418	.000		
Change in online chatting	-.642	.080	.000	-.718	.515
2 Intercept	-7.684	1.488	.000		
Change in awareness of reading strategies	88.511	11.529	.000	.701	.491
3 Intercept	10.848	3.419	.002		
Change in online chatting	-.439	.076	.000	-.491	
Change in awareness of reading strategies	57.873	10.709	.000	.458	.674
Outcome variable: Per country change (2009–2018) in awareness of reading strategies					
4 Intercept	.180	.034	.000		
Change in online chatting	-.003	.001	.000	-.494	.244

Note: Countries are weighted by population size (N = 63).

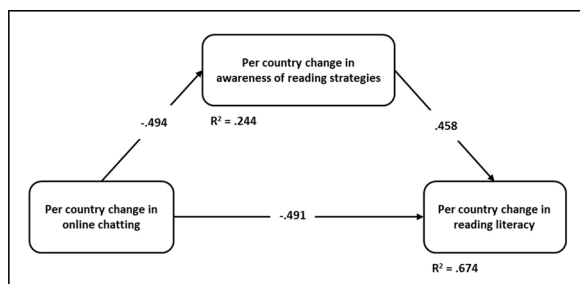


Fig. 3. Quantified effects of per country changes in online chatting and awareness of reading strategies on reading literacy. (Standardized regression coefficients and percentages of explained variance).

5.5. Cross-sectional correlations

At the country level, all cross-sectional correlations were positive. This implies that in both 2009 and 2018 countries with high levels of online chatting showed high levels of reading literacy and awareness of reading strategies. In contrast to the correlations between changes, these correlations provide a snapshot view. They failed to detect the relations that came to the fore when the correlations addressed change between 2009 and 2018. At the individual level, the cross-sectional correlations were modest but mostly positive. With regard to the correlation between awareness of reading strategies and reading literacy, the cross-sectional findings were more similar to the findings on per country change. See Appendix F for a more detailed account.

5.6. Search for alternative explanations

By means of an exploratory approach, which started out with 36 possibly confounding variables, a few additional variables could be identified that correlated with change in reading literacy or awareness of reading strategies beside change in online chatting. An intriguing finding was that the negative relation between change in online chatting and awareness of reading strategies might be mediated by change in

teachers’ stimulation of reading engagement. See the final section of Appendix D for details on the measurement of this variable. In addition, change in awareness of reading strategies appeared to be correlated with change in population coverage and mode of test administration in 2018 (computer vs. print). Finally, change in reading literacy showed a correlation with per country change in family wealth. Nevertheless, the effects of online chatting and reading strategies decreased only to a limited extent when these variables were included in a more elaborate model. No indications were found of an effect of other types of online reading activities in addition to online chatting (e.g., online searching for information and taking part in forums). The evidence clearly pointed to online chatting as the main factor to account for changes in reading literacy and awareness of reading strategies. See Appendix E for details.

5.7. Correlations of online chatting and reading strategies with math and science performance

In addition to student reading literacy, the PISA surveys cover performance in mathematics and science as well. Table 4 shows the correlations of change in online chatting and awareness of reading strategies with change in reading, mathematics and science performance. The correlations of change in chatting frequency and awareness of reading strategies with change in mathematics and science performance were modest. None of the correlations was statistically significant (for $p < .05$; two-tailed). This is in line with expectations and provides additional support for the credibility of the findings produced by the present study.

6. Conclusion and discussion

This section addresses five issues that call for further discussion, namely, limitations of the study, interpretation of correlations between aggregated data, interpretation of the chatting effect, consequences of the findings for future research and consequences for educational policy.

6.1. Limitations

The present study was entirely based on correlations. This implies that effects of confounding variables cannot be excluded. There is always a chance that some variables that were not included in the data analysis could account for the observed correlations. Still, the empirical evidence is compelling. The correlations were related to change over a 9-year period. As a result, initial differences that might account for variation between countries at a later stage can be ruled out as an alternative explanation. Next to that, a search for effects of possibly confounding factors did yield some indications of relevant effects in addition to the ones hypothesized. But, most importantly, this resulted in relatively minor alterations of the effects reported in Fig. 3 (see Appendix E for details). Finally, from a theoretical perspective, one would expect changes in online chatting to correlate only with reading literacy and

Table 4
Correlations of per country change in chatting frequency and awareness of reading strategies with change in reading, mathematics and science performance (N = 63).

	Per country change in percentage of 15-year-olds chatting several times a day		Per country change in awareness of reading strategies	
	correlation	p-value	correlation	p-value
Change in reading literacy	-.718	.000	.701	.000
Change in mathematics performance	.048	.709	.229	.071
Change in science performance	.228	.072	.190	.136

Note: Countries are weighted by population size.

awareness of reading strategies. There is no reason to expect adverse effects of online chatting on mathematics or science scores. This was borne out in the PISA data.

6.2. Interpreting correlations between aggregated data

The main findings were related to aggregate data. It would be a major mistake to draw conclusions about the individual level from country-level correlations. Given the findings based on country aggregates, it is still possible that within countries, the relation between online chatting and reading literacy is positive at the individual level. The example of the relation between wealth and obesity at the national vs. individual level presents an illuminating illustration of this. But, even if the relation between chatting and reading literacy were positive at the individual level, it does not render the reported findings any less relevant. In any case, the fact remains that increases at the country level decrease national reading averages to a considerable extent. Whatever the effect of online chatting may be on individuals, the findings clearly show that increases in online chatting at the country level coincide with declining reading literacy and awareness of reading strategies.

6.3. Interpreting the size of the chatting effect

The reported correlation of increased online chatting with declining reading literacy and awareness of reading strategies provides empirical support for concerns raised by scholars such as Carr (2010) and Wolf (2018). Research thus far on the impact of ICT use has not revealed clear-cut effects in large-scale surveys. This study addressed the topic from a novel perspective. The focus was on variation in change over time across dozens of countries. The regression analysis indicated that a one percent increase in students chatting several times a day coincides with a loss of .64 points in reading literacy score (see Table 3). Across countries, the average increase in chatting was about 39 percent points (see Table 2). Taken together, this implies that the rise in online chatting accounted for a loss of approximately 25 points on the PISA reading scale ($39 \times .64 = 25$).

On the other hand, the raw differences in reading literacy between 2009 and 2018 were very small, on average. Across the 63 countries included, the decline was only 3.9 points. However, zero change in chatting corresponded to an improvement of 21.2 points in reading literacy (see Table 3). At zero increase in online chatting, a substantial improvement could have transpired instead of a small decline. This perspective likewise shows that the rise in online chatting added up to a loss of 25 points ($21.2 + 3.9$).

The standard deviation in individual reading scores is approximately 100 points in OECD countries. Therefore, the loss in reading literacy due to increased chatting amounted to one quarter of the standard deviation in reading literacy scores. In the context of educational research, an effect of this size must be considered (very) large. Effects this large are rarely found in sound educational research (Kraft, 2019). A decline of .25 standard deviation implies that average students (scoring at the 50th percentile) would drop to the 40th percentile.

6.4. Topics for further research

This study focused on the impact of online chatting, whereas the concerns raised by Carr (2010) and Wolf (2018) related to digital media in general. Chatting was singled out because of its strong increase over the 2009–2018 period and its large variation across countries. This rise appears to be a major development with regard to ICT use in the second decade of the 21st century. Future research might conclude that the reported effects of online chatting are part of a more general trend (i.e., the ongoing impact of digital media). Perhaps the effects of online chatting mainly represent just another manifestation of the continuing effects of expanding ICT use. However, it is also conceivable that specific characteristics of online chatting account for its impact on reading

literacy. An important topic for follow-up studies would be to identify such characteristics. The type of information that is exchanged via online chatting might be an important factor in this respect. Messages exchanged through chatting are typically informal and very brief. An important aspect of text comprehension boils down to connecting diverse informational elements in order to make new inferences (Kintsch, 1998). Especially because chats are so brief, they scarcely stimulate readers to make connections between bits of information at different locations in a larger text. In addition, messages are often exchanged at a rapid pace. This may also stimulate superficial reading and hamper thorough reading.

The results reported indicate that a focus on long-term change is needed to capture the impact of online chatting on reading skills. However, the present study related exclusively to aggregated data. To be able to draw conclusions about the long-term effects of ICT use at the individual level, longitudinal data are needed that track the reading development of individual students. There is a pressing need for longitudinal research into the effects of digital media on the reading skills of today's youth (Wolf, 2018). This type of research appears to be remarkably scarce. The study by Vigdor et al. (2014) seems to be a rare exception. That study was based on data collected in 2000–2005, and addressed the impact of access to home computers.

6.5. How to respond to the challenges posed by the rise of online chatting?

Although it is important to acknowledge the adverse impact of increased online chatting, attempts to reduce online chatting seem neither feasible nor helpful. Especially during the recent covid-19 pandemic, digital tools have been most helpful in maintaining communication when individuals cannot meet in person. Considering a ban on online chatting in order to improve reading skills seems just as radical as promoting a return to poverty in order to free the world from obesity and other wealth-related health issues.

This study indicated that changes in national reading averages over 2009–2018 were due to exogenous developments rather than deliberate education policies. This is in line with prior research showing that compelling evidence for effects of education policies is hard to come by (Aloisi & Tymms, 2017). Decreases in reading literacy are a cause for concern, but this should not be taken as conclusive evidence that education systems are failing. Instead of being blamed for outcomes beyond their control, schools and teachers need support for dealing with the challenges they face in ever-changing circumstances. Still, when reading levels fall, education experts are called upon to develop innovative instruction methods that are hoped to restore student reading skills.

The main contribution of this study is that it demonstrates a long-term global trend. It does not provide specific implications for education on the ground. Still, the outcomes do suggest a promising lever for improvement: namely, a determined focus on the mastery of useful reading strategies. This should be an essential component of any approach to promoting reading literacy. Increased chatting in 2009–2018 clearly coincided with a declining awareness of such strategies. It appears that students need more support and stimulation than before to maintain their awareness and mastery of helpful reading strategies.

It is important to emphasize that this study was based on global data. The working conditions for schools and teachers vary enormously between countries and also between regions and communities within countries. Attempts to battle declining reading skills can only be successful if specific local circumstances are taken into account. In the end, whether the desired changes can be realized will largely depend on teacher efforts in everyday classrooms.

It seems perfectly reasonable to request support for such efforts from the companies that introduced and promoted online chatting with so much success. Both the design and implementation of approaches for the preservation of traditional reading skills will require serious investment (e.g., developing novel instruction approaches and training teachers to

implement them in their classrooms). Online chatting has become part of people's lives. It is highly useful, if not indispensable in their daily pursuits. But, the risk of declining reading skills poses an important downside. Educational policymakers and practitioners are challenged to deal with the consequences of ongoing digitalization. Help from organizations that keep introducing new digital technologies would be welcome and appropriate. It is more than worthwhile to prevent future generations from losing the deep reading skills that seemed more common in the recent past. The ideal situation would be that tomorrow's readers can easily switch from digital to print reading (Wolf, 2018). Preferably, they will optimize distinct reading modes in different circumstances.

One-sentence summary

Deterioration in reading skills between 2009 and 2018 is sharpest in countries with strong increases in online chatting.

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Data and materials availability

Data reported on in the main text are available in the supplementary materials.

Declaration of Competing Interest

The author declares no competing interests.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.stueduc.2021.101101>.

References

Aloisi, C., & Tymms, P. (2017). PISA trends, social changes, and education reforms. *Educational Research and Evaluation*, 23, 180–220. <https://doi.org/10.1080/13803611.2017.1455290>

- Artelt, C., Schiefele, U., & Schneider, W. (2001). Predictors of reading literacy. *European Journal of Psychology of Education*, 16, 363–383. <https://doi.org/10.1007/BF03173188>
- Brown, A., Palincsar, A., & Ambruster, B. (1984). Instructing comprehension-fostering activities in interactive learning situations. In H. Mandl, N. Stein, & T. Trabasso (Eds.), *Learning and comprehension of text* (pp. 657–689). Lawrence Erlbaum Associates.
- Carr, N. G. (2010). *The shallows: What the internet is doing to our brains*. W. W. Norton.
- Delgado, P., Vargas, C., Ackerman, R., & Salmerón, L. (2018). Don't throw away your printed books: A meta-analysis on the effects of reading media on reading comprehension. *Educational Research Review*, 25, 23–38. <https://doi.org/10.1016/j.edurev.2018.09.003>
- Fuchs, E., & Flügge, G. (2014). Adult neuroplasticity: More than 40 years of research. *Neural Plasticity*, 2014, Article 541870. <https://doi.org/10.1155/2014/541870>
- Gubbels, J., Swart, N. M., & Groen, M. A. (2020). Everything in moderation: ICT and reading performance of Dutch 15-year-olds. *Large-scale Assessments in Education*, 8. <https://doi.org/10.1186/s40536-020-0079-02020>
- Jerrim, J., Micklewright, J., Heine, J.-H., Sälzer, C., & McKeown, C. (2018). PISA 2015: How big is the 'mode effect' and what has been done about it? *Oxford Review of Education*, 44, 476–493. <https://doi.org/10.1080/03054985.2018.1430025>
- Kintsch, W. (1998). *Comprehension: A paradigm of cognition*. Cambridge University Press.
- Kong, Y., Seo, Y. S., & Zhai, L. (2018). Comparison of reading performance on screen and on paper: A meta-analysis. *Computers & Education*, 123, 138–149. <https://doi.org/10.1016/j.compedu.2018.05.005>
- Kraft, M. A. (2019). *Interpreting effect sizes of education interventions (EdWorkingPaper #19-10)*. Annenberg Institute at Brown University. <https://files.eric.ed.gov/fulltext/ED602384.pdf>.
- Lamerz, A., Kuepper-Nybelen, J., Wehle, C., Bruning, N., Trost-Brinkhues, G., Brenner, H., Hebebrand, J., & Herpertz-Dahlmann, B. (2005). Social class, parental education, and obesity prevalence in a study of six-year-old children in Germany. *International Journal of Obesity*, 29, 373–380. <https://doi.org/10.1038/sj.ijo.0802914>
- OECD. (2010). *PISA 2009 results: What students know and can do – Student performance in reading, mathematics and science (Volume I)*. OECD Publishing. <https://doi.org/10.1787/9789264091450-en>
- OECD. (2012). *PISA 2009 technical report*. OECD Publishing. <https://doi.org/10.1787/9789264167872-en>
- OECD. (2017). *PISA 2015 technical report*. OECD Publishing. https://www.oecd.org/pisa/data/2015-technical-report/PISA2015_TechRep_Final.pdf.
- OECD. (2019a). *How does PISA assess reading? In PISA 2018 results (Volume I): What students know and can do*. OECD Publishing. <https://doi.org/10.1787/8eebc6cc-en>
- OECD. (2019b). *PISA 2018 assessment and analytical framework*. OECD Publishing. <https://doi.org/10.1787/b25efab8-en>
- Robinson, W. S. (1950). Ecological correlations and the behavior of individuals. *American Sociological Review*, 15, 351–357. <https://www.jstor.org/stable/2087176>.
- Robitzsch, A., Lüdtke, O., Goldhammer, F., Kroehne, U., & Köller, O. (2020). Reanalysis of the German PISA data: A comparison of different approaches for trend estimation with a particular emphasis on mode effects. *Frontiers in Psychology*, 11, 884. <https://doi.org/10.3389/fpsyg.2020.00884>
- Schleicher, A. (2019). *PISA 2018, insight and interpretations*. OECD Publishing. <https://apo.org.au/node/270241>.
- Sturm, R., & An, R. (2014). Obesity and economic environments. *CA: A Cancer Journal for Clinicians*, 64, 337–350. <https://doi.org/10.3322/caac.21237>
- UNESCO. (2014). *Reading in the mobile era: A study of mobile reading in developing countries*. UNESCO. <http://www.unesco.org/open-access/terms-use-cbysa-en>.
- Vigdor, J. L., Ladd, H. F., & Martinez, E. (2014). Scaling the digital divide: Home computer technology and student achievement. *Economic Inquiry*, 52, 1103–1119. <https://doi.org/10.1111/ecin.12089>
- Wolf, M. (2018). *Reader, come home: The reading brain in a digital world*. Harper Collins.
- Wolf, M., & Barzillai, M. (2009). The importance of deep reading: What will it take for the next generation to read thoughtfully both in print and online? *Educational Leadership*, 66, 32–37.