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The interplay between teacher beliefs, instructional practices, and students' reading achievement: national evidence from PIRLS 2021 using path analysis

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Abstract

Background: Reading and reading comprehension are crucial skills, yet many students in grade 4 struggle with them. To address this, several instructional practices have gained popularity. For one, explicit reading strategy instruction (ERSI) is deemed useful, given the finding that successful readers tend to employ reading strategies. As a second example, differentiated reading instruction (DRI) is believed to improve all students' reading comprehension. Indeed, a one-size-fits-all approach may not work for all students, considering their different reader profiles. Despite the importance of ERSI and DRI, much uncertainty remains about what happens in the classroom and why. One way to understand teacher instructional practices such as ERSI and DRI, is by applying psychological behavioural theories to the teaching context. They provide a framework to predict human behaviour based on human characteristics and beliefs. Educational research points to teachers' self-efficacy (TSE) and attitudes (TA) as particularly important concepts, especially in the field of science. However, associations between TA, TSE, instructional practices and students' reading achievement remain insufficiently studied. This study addresses this knowledge gap by exploring the interplay between TSE and TA regarding ERSI and DRI, the implementation of these practices, and students' reading achievement.

Methods: DigitalPIRLS 2021 data from Belgium (Flanders) were used. To gather information about ERSI, DRI, TA and TSE, national adaptations were made to the teacher questionnaires. Three nested path models with a two-level design (students nested into classes) were estimated.

Results: This study indicates that teachers with higher TSE and more positive TA in ERSI and DRI implement these practices more frequently. Positive TA regarding ERSI and DRI also correspond to positive TSE regarding these instructional practices. Furthermore, ERSI and DRI implementation are positively related. Finally, no significant associations between teacher beliefs, instructional practices, and students' reading comprehension were found.

Conclusion: Whereas TSE and TA are considered highly context-dependent, uncertainty remains about TSE and TA regarding ERSI and DRI. The results highlight

the importance of subject-specific TSE and TA for teachers' instructional practices. Ultimately, the findings emphasize the necessity of supporting teachers in developing their TSE and TA towards reading comprehension instruction.

Keywords: Teacher beliefs, Explicit reading strategy instruction, Differentiated reading instruction, Reading comprehension, PIRLS 2021

Introduction

In a world “dominated by the written word, both online and in print” (European Commission, 2012, p.11), reading and understanding what we read are of undeniable importance. Teaching our children to read from an early age on is crucial, since students' level of reading proficiency is an important predictor for both academic and out of school success (e.g., De Naeghel et al., 2014; Merchie et al., 2019; Taboada et al., 2009). Being able to infer meaning from written texts is considered a basic prerequisite for almost all higher-order cognitive skills (McNamara & Magliano, 2009). Furthermore, a low reading comprehension level in primary education is among the best predictors for delayed graduation and school dropout (Hernandez, 2011). Unfortunately, research shows that many students in primary education still struggle with comprehending texts (Mullis et al., 2017). For example, results from the international PIRLS 2016 study indicated that 18% of all participating students performed below the intermediate benchmark (i.e., locate and reproduce explicitly stated information) at the end of grade 4. The recent PIRLS 2021 results paint an even more alarming picture, with 25% of students failing to reach this level (Mullis et al., 2023). Furthermore, PISA 2018 results revealed that these struggles persist throughout compulsory education, with 23% of the 15-year-olds performing below the minimum reading proficiency level (OECD, 2019).

Considering these concerning observations, it is important to acknowledge the multifaceted factors influencing students' reading comprehension. From an economic perspective for instance, the intricate relationship between poverty and poor literacy forms a vicious circle (European Commission, 2012). Given this context, acknowledging the impact of socio-economic aspects is crucial when aiming to enhance reading comprehension. Additionally, from an educational standpoint, effectiveness research points to the important role of teacher practices in contributing to students' academic achievement (Scheerens, 2016). In this respect, as the use of reading comprehension strategies was found to be related to reading comprehension (Cromley & Azevedo, 2007), explicit reading strategy instruction (ERSI) has been gaining momentum as an effective instructional teacher practice over the last decades (NICHD, 2000). When offering ERSI, teachers guide their students to become strategic readers by highlighting the relevance of specific reading comprehension strategies, explaining and modeling the strategies and encouraging the students to use them in various contexts (Duke et al., 2011). Despite the acknowledged positive effects of ERSI in terms of students' reading strategy use and reading comprehension (e.g., Droop et al., 2016; Okkinga et al., 2018), counter-indications for a one-size-fits-all approach have been suggested within reading comprehension instruction, considering a range of different student reader profiles (e.g., Rasinski, 2017). Consequently, offering differentiated reading instruction (DRI), i.e., adapting instruction to accommodate students' differential needs (Parsons et al., 2017), is also gaining

support as an effective instructional practice that could benefit the reading comprehension achievement of all students.

Although the effectiveness of ERSI and DRI has been demonstrated repeatedly, much uncertainty remains about whether and why teachers are actually implementing these instructional practices. One way to better understand and gain insight into teacher instructional practices, is by applying psychological behavioural theories, such as for example the Theory of Planned Behaviour (Ajzen, 1991) and the Social Cognitive Theory (Bandura, 1986), to the teaching context. These theories provide a framework to predict human behaviour based on human characteristics and beliefs. Educational research—mainly in the field of science—points to the particular importance of two of these beliefs, more specifically teachers' self-efficacy and teachers' attitudes (Zint, 2002). *Teacher Attitudes* (TA) refer to teachers' evaluative judgements regarding particular attitude objects, such as the importance of certain instructional behaviours. *Teachers' Self-efficacy* (TSE) encompasses one's own assessment of the ease or unease associated with successfully performing a particular behaviour. To our knowledge, the relationship between TA, TSE, and teachers' instructional practices remains rather unstudied within the research field of reading education.

Despite the widely acknowledged importance of ERSI and DRI, classroom observations of reading lessons suggest that both instructional practices are too often not implemented by primary school teachers (e.g., Peters et al., 2022). To understand and ultimately impact classroom practice, research should gain insight into teacher beliefs in relation to their behaviour (Zint, 2002). Furthermore, considering the alarming trends in students' reading comprehension, it is essential to develop a comprehensive understanding of the teachers' attributes that are related to students' reading achievement. However, within the context of reading comprehension, research into these beliefs is rather scarce (Ness, 2011). As such, the main research question of the present study is: How does the interplay between primary school teachers' TSE and TA towards ERSI and DRI, along with their self-reported instructional practices, relate to students' reading comprehension achievement?

Theoretical framework

Reading comprehension

Reading comprehension is a dynamic and active process involving a complex range of cognitive and metacognitive subprocesses. Many researchers have proposed models and definitions, trying to capture this complexity. The central element in the most cited definitions is the process of actively extracting and constructing meaning from written texts (e.g., McNamara & Magliano, 2009; Snow, 2002). The readers' activities, such as reading strategy use, and the readers' characteristics, such as mother tongue, socio-economic status (SES), and reading difficulties, play a key role in the reading comprehension process. Each of the listed characteristics can be a source of diversity leading to different reader profiles (Merchie et al., 2019).

Direct associations between instructional practices and students' reading comprehension

An important activity for readers to undertake is to apply reading comprehension strategies. These are "deliberate, goal-directed attempts to control and modify the reader's

efforts to decode text, understand words, and construct meanings of text” (Afflerbach et al., 2008, p. 368). Although reading comprehension strategy use benefits students’ reading comprehension achievement, strategy use generally does not develop spontaneously in young readers (Merchie et al., 2019). However, strategies can be taught through teachers’ implementation of ERSI (Dole et al., 1991; Pressley, 2000). ERSI makes students aware of the active nature of reading comprehension and of the importance of reading comprehension strategies (Van Keer, 2004). To this end, students are taught explicitly why, how, and when to use certain reading strategies and how to apply them in various reading tasks. ERSI involves different didactic methods, such as modeling, or demonstrating how to use a certain strategy through a think-aloud approach. Other examples of ERSI practices are related to gradually releasing responsibility to the students, through scaffolding and guided practice (Ness, 2011). The pace of these practices is furthermore dependent on the students’ characteristics, since some students will require longer and more intensive support than others (Ankrum & Bean, 2008). The effect of ERSI both on reading strategy use (e.g., Duffy, 2002) and reading comprehension achievement (e.g., Duke et al., 2011; Friesen & Haigh, 2018; Van Keer, 2004) has been demonstrated repeatedly.

Next to ERSI, the literature points to the benefits of DRI for better reading comprehension (Puzio et al., 2020; Schumm et al., 2000). Differentiated instruction refers to “an instructional approach that accommodates the diversity of students by coping with student diversity, adopting specific teaching strategies, invoking a variety in learning activities, monitoring individual student needs, and pursuing optimal learning outcomes” (Suprayogi et al., 2017, p. 292). Based on a substantial amount of research, it is clear that students’ reading comprehension skills are related to their background characteristics, such as their home resources and language (Mullis et al., 2017), developmental problems and reading disabilities (Rasinski, 2017). To deal with these diverse student characteristics and needs, DRI can be an effective instructional practice to promote students’ reading comprehension (e.g., Förster et al., 2018; Shaunessy-Dedrick et al., 2015).

As pointed out above, positive direct associations between the instructional practices ERSI (*Hypothesis 1*) and DRI (*Hypothesis 2*) and students’ reading comprehension can be expected. Furthermore, since differentiation presupposes scaffolding and guided practice, two instructional practices underlying ERSI, a relation is expected between the implementation of ERSI and DRI (*Hypothesis 3*). Hypotheses 1–3 are presented in Fig. 1.

Direct and indirect associations between teacher beliefs and students’ reading comprehension

In line with the Theory of Planned Behaviour and the Social Cognitive Theory, a great deal of research indicates that teacher beliefs affect their instructional choices, intentions, and practices (Basturkmen, 2012). A first type of beliefs that has been widely explored encompasses *teachers’ self-efficacy* (TSE), i.e., the teachers’ “beliefs in one’s own capabilities to organize and execute the courses of action required to produce given attainments” (Bandura et al., 1997, p. 3). Research findings on the relationship between TSE and students’ reading achievement are inconsistent (Zee et al., 2018). Both positive (e.g., Cantrell et al., 2013), negative (e.g., Zee et al., 2018), and non-significant effects have been found. To elucidate this relationship, Zee et al. (2018) suggested subject-specific

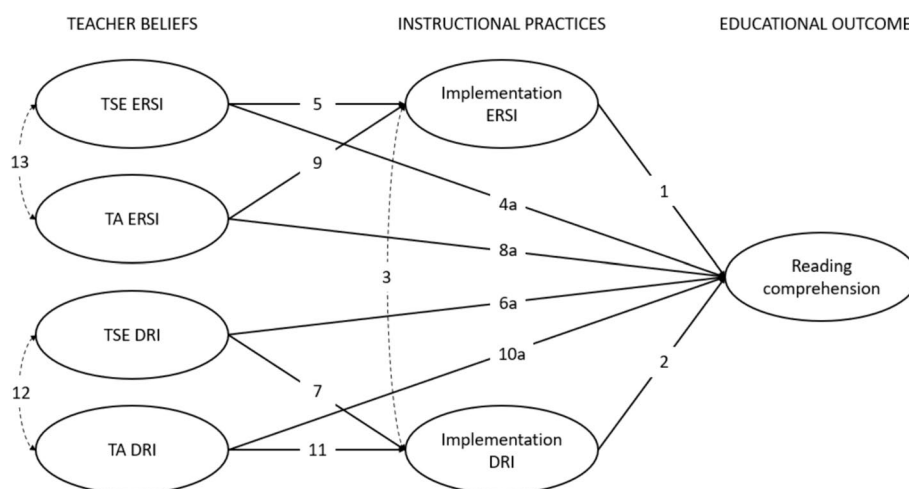


Fig. 1 Visual Representation of Hypotheses 1–13

measures of TSE, specific to the field of reading, rather than a general measure of TSE as used in most studies. Due to a lack of subject-specific measures of both TSE and differentiated instruction in the current literature, the relationship between TSE regarding ERSI and DRI and students' (reading) achievement is still unestablished. Furthermore, the relationship between TSE and students' reading achievement is likely to be a complex one, mediated by a variety of teachers' instructional practices, which in turn can impact on students' reading comprehension (Guo et al., 2012).

As outlined above, ERSI and DRI are both found to be effective instructional practices to foster students' reading comprehension. Despite the importance of ERSI, to our knowledge, no prior research addressing teachers' self-efficacy in implementing this instructional approach has been published. However, it has been established that TSE regarding teaching self-regulating strategies in primary education is a strong predictor of the extent to which they teach self-regulating strategies (Dignath-van Ewijk, 2016). Since reading comprehension strategies can be considered a subject-specific type of self-regulating strategies (Sashikala & Chye, 2023), similar results can be expected for ERSI. Therefore, a positive relationship between subject-specific TSE regarding ERSI and students' reading comprehension achievement is expected to be direct (*Hypothesis 4a*) and could be mediated by teachers' implementation of ERSI (*Hypothesis 4b*). Furthermore, subject-specific TSE regarding ERSI is expected to be positively correlated to teachers' implementation of ERSI (*Hypothesis 5*).

Regarding the relationship between TSE and DRI, a great deal of research has provided evidence on the positive relationship between TSE and teachers' implementation of differentiated instruction (De Neve et al., 2015; Dixon et al., 2014; Suprayogi et al., 2017). However, in most cases, these studies treated differentiated instruction as a general instructional practice, rather than as a subject-specific practice. Since teachers' self-efficacy beliefs are context-dependent (Bandura et al., 1997), it seems essential to investigate teachers' self-efficacy beliefs concerning differentiated instruction within the specific field of reading comprehension, i.e., DRI. Based on the existing literature, a positive relationship between the subject-specific TSE regarding DRI and students' reading

comprehension achievement is expected to be direct (*Hypothesis 6a*) and could be mediated by teachers' implementation of DRI (*Hypothesis 6b*). Furthermore, subject-specific TSE regarding DRI is expected to be positively correlated to teachers' implementation of DRI (*Hypothesis 7*). Hypothesis 4a–7 are presented in Fig. 1, with the exclusion of Hypothesis 4b and 6b, which describe indirect relationships.

A second category of human characteristics of the Theory of Planned Behaviour encompasses *teacher attitudes* (TA), defined as “a disposition to respond favourable or unfavourable to an object, person, institution or event” (Ajzen, 1988, p.4). Regarding teachers' instructional practices, TA refers to the teachers' evaluative judgements (e.g., good/bad, relevant/irrelevant) towards a specific practice (Thibaut et al., 2018). The literature is rather inconclusive on the delineation of the attitude dimensions. However, most, if not all, authors agree on a cognitive dimension, referring to teachers' perceptions of the importance of a specific behaviour or practice (van Aalderen-Smeets et al., 2012). TA in literacy education is believed to be of great importance for students' reading achievement (Krepps, 2010), although empirical evidence to support this idea is scarce, especially for primary education. Behrmann and Souvignier (2012) found evidence for the relationship between pre-service secondary teachers' TA regarding ERSI (e.g., “For text comprehension, it is important to explain to students why it is useful to underline important information in a text”) and students' reading competencies. As TA are believed to play a fundamental role in their actual teaching practices (e.g., Thibaut et al., 2018), the relationship between TA and student reading achievement might also be mediated by teachers' instructional practices. Finally, to our knowledge, the relationship between TA regarding differentiated instruction and students' outcomes has never been investigated.

TA and their positive relationship with actual teacher behaviour have been well established in the field of science education, although the lack of a clearly delineated definition of the construct ‘attitude’ calls for caution (van Aalderen-Smeets et al., 2012). In the field of reading comprehension in primary education, this relationship has remained under-investigated. For example, Bunt (2008) found a positive relationship between primary school teachers' TA regarding direct reading strategy instruction (i.e., comparable to ERSI, with a greater focus on strategy use in context, and less focus on the explicit teaching) and their self-reported implementation of this instructional practice. However, only one questionnaire item for TA was used to measure this relationship. Furthermore, Yu-Chen (2008) found a positive relationship between university language teachers' TA regarding the instruction of cognitive and metacognitive reading strategies and their self-reported implementation of these strategies. Based on these findings, a positive relationship between subject-specific TA regarding ERSI and students' reading comprehension achievement is expected to be direct (*Hypothesis 8a*) and could be mediated by teachers' implementation of ERSI (*Hypothesis 8b*). Furthermore, subject-specific TA regarding ERSI is expected to be positively correlated to teachers' implementation of ERSI (*Hypothesis 9*). Regarding the relationship between TA toward differentiated instruction and the implementation, the literature provides mixed evidence. Letzel et al. (2020) attribute this ambiguity partly to broad conceptualizations of differentiated instruction by other researchers, i.e., “inclusive education” (e.g., Loreman et al., 2007) or “heterogeneity” (e.g., Gebauer et al., 2013). Letzel et al. (2020) claim to be the first ones to measure

TA regarding differentiated instruction as an inclusive practice by developing a new questionnaire. In that study, a positive relationship between TA regarding differentiated instruction and teachers' implementation of differentiated instruction was found. Based on these findings, a positive relationship between subject-specific TA regarding DRI and students' reading comprehension achievement is expected to be direct (*Hypothesis 10a*) and could be mediated by teachers' implementation of DRI (*Hypothesis 10b*). Furthermore, subject-specific TA regarding DRI is expected to be positively correlated to teachers' implementation of DRI (*Hypothesis 11*). Hypothesis 8a–11 are presented in Fig. 1, with the exclusion of Hypothesis 8b and 10b, which describe indirect relationships.

Bringing both TSE and TA together, research in the field of inclusive education suggests that both types of teacher beliefs reinforce one another (Emmers et al., 2020). Therefore, a relationship is expected between TSE and TA regarding DRI (*Hypothesis 12*). Similarly, a relation between TSE and TA regarding ERSI is expected and investigated exploratively (*Hypothesis 13*). All hypotheses are presented in Fig. 1, with the exclusion of the hypotheses describing indirect relationships.

Method

Participants and procedure

Student and teacher data from PIRLS 2021 were used to investigate the hypotheses. A national sample was drawn, stratified implicitly (according to school size and region) as well as explicitly (according to source of funding: private/official; and school composition: low, medium, or high average score on a SES indicator of students' at-risk status) (Von Davier et al., 2023). All grade 4 teachers and students within sampled schools were invited to participate. The original sample consisted of 5114 students, and 291 grade 4 teachers from 141 schools in Flanders, Belgium. Due to the exclusion of five schools for special education and non-response in the teacher questionnaire, 246 teachers from 129 schools and their 4497 grade 4 students remained in the final sample. 82.86% of the teachers were female, 17.14% were male. The teachers' years of teaching experience ranged between 1 and 40 years, with a mean of 16.63 years ($SD=11.16$). The students' age ranged between 8.33 and 13.17 years old, with a mean age of 9.99 ($SD=0.47$). 49.77% of the students were girls, 50.23% were boys. 80.15% of the students were speakers of the language of instruction (Dutch), 19.85% were non-native speakers. Students' reading achievement data were gathered through the PIRLS 2021 assessment. Students had to complete two digital reading comprehension tests, each taking up to 40 min, interspersed with a break. After completion of the second test, students were asked to fill in the PIRLS 2021 student questionnaire. The PIRLS 2021 procedure in Flanders was approved by the Ethical Committee of KU Leuven (file number: G-2020-1688-R2(MIN)).

Measures

Student Reading Comprehension Students' reading comprehension achievement was measured through the PIRLS 2021 reading comprehension assessments. PIRLS 2021 marks the transition from a paper-and-pencil administration mode to a web-based digital mode, called digitalPIRLS. The test assesses students' proficiency in two domains of reading comprehension, i.e., reading to acquire and use information while reading informational texts and/or webtexts, and reading for literary experience while reading literary

texts. Participants were asked to read two digitally presented texts (each text corresponding to one of both domains) and to answer the accompanying questions. To reduce measurement error, students' ability scores were presented by five plausible values. The center point of the ability scale is 500 points, representing the international average score across countries in 2001 (Mullis & Martin, 2019).

Teacher beliefs and implementation regarding ERSI To gather information about ERSI, TA, and TSE, national adaptations were made to the PIRLS 2021 teacher questionnaires. Due to school closures resulting from the COVID-19 pandemic, a pilot study for PIRLS 2021 to assess these national adaptations could not be conducted in Flanders. Instead, all national adaptations were presented to a few grade 4 teachers, asking for feedback on any unclear questions. The Teacher Self-Efficacy Scale to Implement Self-regulated Learning in Reading Comprehension (TSES-SRL-RC) measures teacher beliefs about ERSI. This scale was developed departing from the validated TSES-SRL scale (De Smul et al., 2018), tapping into primary school teachers' beliefs and instruction practices of self-regulated learning strategies. Items from the TSES-SRL were adapted to the context of reading comprehension. The TSES-SRL-RC consists of three main questions: a question about TSE ("How well are you able to do this?"), a question about TA ("How important do you think this is?"), and a question about the frequency of implementation ("How often do you do this?"). For each question, participants had to rate seven items about ERSI (e.g., "Inform students about the importance and usefulness of reading strategies") on a 5-point Likert scale. To internally validate the three unidimensional constructs of ERSI in the primary school context, confirmatory factor analyses (CFA) were conducted using the R-packages Lavaan and Psych. The results of the CFA indicate that all models fit the data for the three constructs based on the robust fit indices: ERSI TSE (CFI=1.000, TLI=1.008, RMSEA=0.045, SRMR=0.049), ERSI TA (CFI=0.998, TLI=0.997, RMSEA=0.058, SRMR=0.058) and ERSI implementation (CFI=0.992, TLI=0.989, RMSEA=0.044, SRMR=0.047). Finally, for each construct, the items were averaged to a scale with a theoretical minimum of 1 and a theoretical maximum of 5. Based on the ordinal alphas (Baglin, 2014), the reliability of the three scales could be considered as excellent: ERSI TSE ($\alpha=0.93$), ERSI TA ($\alpha=0.92$) and ERSI implementation ($\alpha=0.91$).

Teacher beliefs and implementation regarding DRI To gather information about DRI, TA and TSE, national adaptations were made to the PIRLS 2021 teacher questionnaires, which could not be piloted due to the pandemic. TSE, TA, and teachers' implementation of DRI were measured through the same three main questions as the TSES-SRL-RC. For each question, participants had to rate two items on DRI ("Differentiate according to students' social background" and "Differentiate according to students' general knowledge of the world") on a 5-point Likert scale. For each construct, the items were averaged to a scale with a theoretical minimum and maximum of respectively 1 and 5. To assess the reliability of the scales, Spearman-Brown coefficients were calculated (Eisinga et al., 2013). Based on these coefficients, the reliability of the three restricted scales could be considered as acceptable: DRI TSE ($\rho_{y1y2}=0.76$), DRI TA ($\rho_{y1y2}=0.68$), and DRI implementation ($\rho_{y1y2}=0.73$).

Control variables at the student level Students' socio-economic status (SES), native language, gender, and number of books at home were included as control variables at

the student level, as it has been shown repeatedly that these characteristics correlate significantly with students' reading comprehension achievement (Mullis et al., 2017). Students' SES was computed as a categorical variable (0 = low SES; 1 = medium SES; 2 = high SES), by taking the sum of two binary indicators used by the Flemish Government to indicate whether students have a disadvantaged position in education, namely: whether the household receives an education allowance from the state and whether the mother has completed secondary education. Home language (0 = language of instruction; 1 = other) and gender (1 = girl; 2 = boy) were included as dichotomous variables. Data on these background characteristics were obtained from the Department of Education in Flanders. The number of books at home was measured through the PIRLS 2021 student questionnaire and recoded in a categorical variable (score 1–3), in accordance with the PIRLS assessment framework (Mullis & Martin, 2019).

Control variables at the class level To control for class composition effects, students' SES and home language were aggregated to the class level and treated as proportions, i.e., continuous variables. A higher proportion stands for more students with a low SES or a different home language, respectively. Furthermore, the proportion of students with a learning disability within a class (question retrieved from the PIRLS teacher questionnaire) was added as a control variable. The dichotomous variable teacher gender (1 = female; 2 = male) and the continuous variable teacher experience (in years) were added as control variables, since these variables have been shown to be related to teacher beliefs (Basturkmen et al., 2012; Emmers et al., 2020), but are not the main interest of this study. Data on both variables were obtained through the PIRLS teacher questionnaire.

Data analysis

Associations between the constructed factors and scales of TSE and TA regarding the factors and scales of ERSI and DRI, the implementation of both practices and students' reading comprehension, were examined through a two-level path analysis, with students nested in teachers/classes. Three models were fitted for each of the five plausible values: (1) a null model, (2) a model including the student and teacher background variables, and (3) the final model including the teacher beliefs and instructional practices variables. All path analyses were conducted using Mplus version 8 (Muthén & Muthén, 2017). As suggested by the PIRLS 2021 User Guide for the International Database (Fishbein et al., 2023), teacher weights were used (using the 'bweight' command in Mplus). For each of the three models, the resulting values for each of the five plausible values were combined using techniques for multiple imputations, i.e., calculating the mean of the estimates across the five models and computing the variance of these estimates, incorporating both within- and between-imputation variance (OECD, 2019). This process resulted in three combination models.

Results

Descriptive statistics

Table 1 gives an overview of differences in students' mean reading comprehension achievement based on their background characteristics.

Table 1 Students' mean reading comprehension achievement

Student characteristic	Mean reading achievement	SD	Number of students
Girl	517.741	63.868	2229
Boy	510.577	67.601	2267
High SES	529.877	62.100	2634
Medium SES	500.481	64.815	1226
Low SES	475.768	60.675	613
Home language: language of instruction	522.500	63.110	3580
Home language: other language	481.900	66.213	893
Many books at home	535.800	62.286	1102
Some books at home	528.268	62.678	1497
Few books at home	489.446	62.500	1782

This table presents the non-standardized mean reading achievement, standard deviation (*SD*), and the number of students for each category of the student background variables

Correlations and descriptives of the independent variables at the class/teacher level are presented in Table 2.

Regarding the implementation of instructional practices, the descriptive statistics indicate a rather frequently reported ERSI implementation. Furthermore, teachers report to implement DRI less frequent than ERSI. With regard to teacher beliefs, the reported TSE levels regarding ERSI and DRI implementation are highly similar and quite high. This indicates that teachers feel rather competent to implement ERSI and DRI. Finally, the mean score of TA regarding ERSI indicates that teachers generally consider ERSI to be a rather important instructional practice. TA regarding DRI, on the other hand, is lower on average. It appears that overall, teachers do value DRI, but they are taking a more neutral stance compared to their attitudes towards ERSI.

Correlations of all variables at the teacher/class level range between 0.003 and 0.665, indicating that the assumption of no-perfect multicollinearity is not violated. As such, all independent variables at the teacher/class level can be confidently retained for further analyses.

Multilevel path analyses

In this section, the estimates of the three combination models (combining the five plausible values) are presented (see Appendix). First, a two-level null model with students' reading comprehension achievement as dependent variable was fitted. The intercept of 21.000 ($SE = 1.519$) represents students' overall standardized average reading comprehension score. The intraclass correlation of 13.38% suggests considerable variation between classes. Second, student and teacher background characteristics were added to the model. Significant differences were found in students' reading comprehension for student's gender ($\beta = -0.132, p < 0.001$), students' SES ($\beta = 0.162, p < 0.001$), students' home language ($\beta = -0.149, p < 0.001$), students' number of books at home ($\beta = 0.213, p < 0.001$), and the class SES composition ($\beta = -0.311, p < 0.01$). The inclusion of these variables accounts for 14.14% ($SE = 0.012$) of the unexplained variance in students' reading comprehension achievement at the student level and for 11.44% ($SE = 0.057$) of the unexplained variance in students' reading

Table 2 Correlation matrix of all independent class level variables including means and standard deviations

	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
1. Teacher experience	–											16.63	11.16
2. Teacher gender	–0.054**	–										–	–
3. SES class composition	–0.100**	0.008	–									0.28	0.18
4. Home language class composition	–0.089**	0.015	0.472**	–								0.20	0.22
5. Learning disability class composition	0.072**	–0.011	0.039*	–0.015	–							0.17	0.12
6. TSE ERSI	0.057**	–0.170**	0.028	–0.023	–0.049**	–						3.64	0.53
7. TA ERSI	–0.121**	–0.194**	0.013	0.032*	–0.016	0.262**	–					4.19	0.42
8. Implementation ERSI	0.084**	–0.078**	0.160**	0.092**	0.035*	0.375**	0.632**	–				3.44	0.63
9. TSE DRI	–0.086**	0.028	0.020	–0.005	–0.133**	–0.056**	0.216**	0.046**	–			3.48	0.81
10. TA DRI	–0.118**	–0.037*	0.072**	–0.018	0.031*	0.221**	0.191**	0.189**	0.415**	–		3.30	0.83
11. Implementation DRI	–0.093**	–0.006	0.1107**	0.030	0.003	0.045**	0.256**	0.245**	0.665**	0.655**	–	2.75	1.08

This table presents the means, standard deviations (SD), and the Pearson correlation coefficients with * $p < 0.05$, ** $p < 0.01$ of all independent class level variables

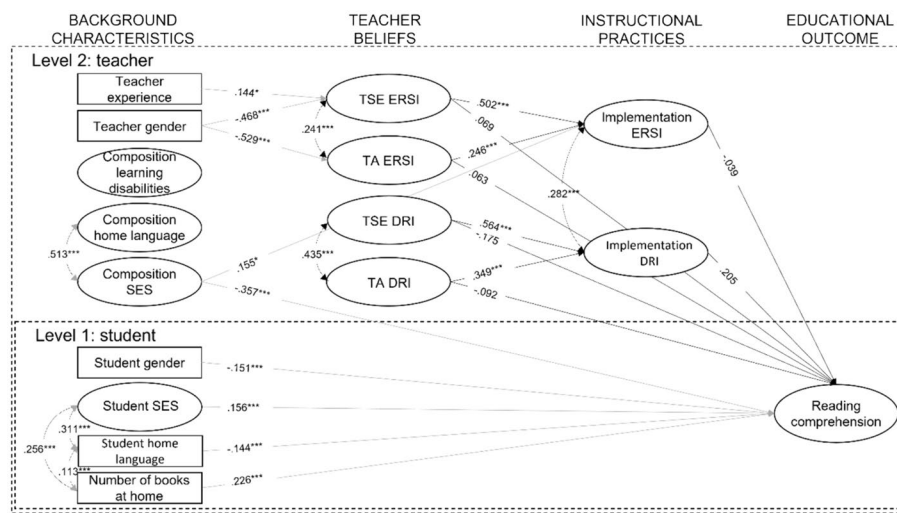


Fig. 2 Standardized parameter estimates of the direct associations in the final multilevel path model. This figure presents the standardized beta coefficients of the direct associations in the final multilevel path model, with * $p < 0.05$, *** $p < 0.001$. Non-significant associations of the control variables are not presented

comprehension achievement at the teacher level. Finally, the variables on teacher beliefs and instructional practices were added. This final model does not add to the explained variance in students’ reading comprehension achievement at the student level as no student level variables were added compared to the previous model. At the teacher level, this model explains an additional 5.98%, accounting for 17.42% ($SE = 0.072$) of the unexplained variance in students’ reading comprehension. The multilevel path model indicated a good fit with the data ($CFI = 0.984$, $TLI = 0.931$, $RMSEA = 0.017$, $SRMR$ for within = 0.010, $SRMR$ for between = 0.050).

Standardized parameter estimates of the direct relationships in the multilevel path model are presented visually in Fig. 2. Non-significant parameters for the relationships between control variables and all other variables are not included in the visual presentation. Figure 2 shows significant positive associations between TSE and TA regarding ERSI and DRI and both teachers’ implementation practices, respectively. This means that teachers holding more positive beliefs regarding the importance of ERSI and DRI, and regarding their self-efficacy to implement ERSI and DRI, report higher implementation frequencies of both instructional practices. Furthermore, significant positive relationships were found between TSE and TA, both regarding ERSI and DRI. So, teachers holding more positive beliefs regarding the importance of ERSI and DRI, also hold more positive feelings about their self-efficacy concerning ERSI and DRI, respectively. At the level of the implementation practices of ERSI and DRI, a positive significant relationship is found, implying that teachers reporting higher implementation frequencies of ERSI, also report higher implementation frequencies of DRI. Regarding the investigated associations between students’ reading comprehension, no significant associations were found with TSE or TA, whether or not mediated by teachers’ implementation practices. Finally, teachers’ self-reported implementation practices were not significantly associated with students’ reading comprehension. All hypothesized associations are discussed below.

Table 3 Standardized coefficients of the indirect and total associations in the final multilevel path model

	β	SE
Indirect associations		
TA ERSI → Implementation ERSI → Reading comprehension	− 0.010	0.032
TSE ERSI → Implementation ERSI → Reading comprehension	− 0.020	0.065
TA DRI → Implementation DRI → Reading comprehension	0.072	0.057
TSE DRI → Implementation DRI → Reading comprehension	0.116	0.092
Total associations		
TA ERSI → Reading comprehension	0.054	0.098
TSE ERSI → Reading comprehension	0.050	0.123
TA DRI → Reading comprehension	− 0.020	0.089
TSE DRI → Reading comprehension	− 0.059	0.114

This table presents the standardized beta coefficients of the indirect and total associations in the final multilevel path model. All associations are insignificant

Table 3 presents the specific indirect, and the total associations between teacher beliefs, instructional practices and students' reading comprehension, estimated in the final model. None of these associations were significant.

Discussion

Teachers play a crucial role in teaching their students how to read (e.g., Duke & Pearson, 2009). As beliefs give direction to teachers' behaviour in the classroom, insight into these beliefs can help to understand educational practice (Zint, 2002). However, research on primary school teachers' beliefs regarding reading comprehension instruction is sparse. To help fill this knowledge gap, the purpose of the present study was to investigate the interplay of primary school teachers' self-reported self-efficacy beliefs and attitudes towards ERSI and DRI, their self-reported ERSI and DRI implementation, and students' reading comprehension achievement using PIRLS 2021 data.

Direct associations between instructional practices and students' reading comprehension

This study sought to investigate whether the positive associations between ERSI and DRI and students' reading achievement, as established mainly in intervention research (e.g., Friesen & Haigh, 2018; Puzio et al., 2020), could be confirmed using large-scale assessment data. The results of the present study could not provide corroborating evidence in this respect (*Hypotheses 1 and 2*). Previous secondary analyses using PIRLS data—relying on two international PIRLS questions (i.e., summarizing and locating information)—also found insignificant results when studying students' reading achievement relative to teachers' self-reported frequency of reading strategy instruction (Marôco, 2021). This lack of significant associations as found in the present study may be explained by the fact that the complex relationship between teachers' instructional practices and students' reading achievement may not be fully captured through the instruments applied in large-scale assessments. This might be due to the use of standardized tests to measure students' achievement in large-scale assessments, including PIRLS. Therefore, the findings of the present study can be understood within the scope of the meta-analysis by Okkinga et al. (2018), who found a small effect of interventions aimed at improving

reading comprehension, when comprehension was measured through standardized reading comprehension tests. Okkinga et al. (2018) found that intervention effects were larger when reading comprehension was measured through research-developed tests, often measuring more specific reading objectives aligned with the targeted teacher practice in the intervention (Okkinga et al., 2018). Second, also the use of self-report questionnaires to collect information in large-scale assessments might have impacted the relationship between teachers' evidence-based instructional practices and students' reading achievement. Teachers may have over- or underestimated their ERSI and DRI implementation, or may have answered in line with what they perceive to be socially expected. Furthermore, large-scale assessment questionnaires are typically structured to gather information across various topics, and therefore do not comprehensively capture the subtle intricacies of the research phenomenon, due to space and time constraints in the questionnaire administration (Leino et al., 2022).

Regarding the instructional practices, teachers overall reported a rather frequent ERSI and DRI implementation. Furthermore, the present study indicates that teachers who implement more ERSI also implement more DRI and/or vice versa (*Hypothesis 3*). This finding was expected since differentiation presupposes scaffolding and guided practice, two instructional components of ERSI (Ness, 2011). Furthermore, this finding is a tentative positive indication of the co-occurrence of teachers' evidence-based instructional practices in reading comprehension instruction, rather than a fragmented implementation of individual practices.

Direct and indirect associations between teacher beliefs and students' reading comprehension

Regarding the relationship between teacher beliefs and students' reading comprehension achievement, whether or not mediated by teachers' instructional practices, the present study found no significant associations. The existing literature regarding these relationships is rather ambiguous. To gain more insight into this relationship, subject-specific measures of both TSE and TA have been called for in prior studies. The present study took this into account by investigating the relationship between subject-specific TSE and TA regarding both ERSI and DRI on the one hand and students' reading achievement on the other hand (*Hypotheses 4a, 6a, 8a, and 10a*), potentially mediated by the implementation of both instructional practices (*Hypotheses 4b, 6b, 8b, and 10b*). A plausible explanation for the lack of significant associations with reading comprehension found in the present study can be attributed to the complex process of reading comprehension and reading comprehension instruction. It is important to note that reading comprehension instruction cannot be reduced to only ERSI and DRI, although they constitute essential components of it (Slavin et al., 2009). Furthermore, although TSE and TA are contextual and thus subject-specific beliefs in nature, some researchers caution against overspecifying these concepts: "there is a danger of developing measures that are so specific they lose their predictive power for anything beyond the specific skills and contexts being measured" (Tschannen-Moran & Johnson, 2011, p. 754). The present study used the PIRLS 2021 reading assessment as a measure for students' overall reading comprehension abilities. This assessment did not target the measurement of students' reading strategy use. In contrast, TSE and TA were measured with a specific focus on ERSI and

DRI. Therefore, there might have been a misalignment between the specificity of the measured concepts at the teacher and the student level.

Psychological behavioural theories, such as the Theory of Planned Behaviour, as well as previous empirical research state that teachers' instructional behaviour is impacted by their beliefs, such as TSE and TA. In the present study, teachers reported quite high levels of TSE and TA regarding ERSI and DRI. In line with behavioural theories, the present study confirmed that higher levels of TSE and TA regarding ERSI indeed relate to a more frequent ERSI implementation (resp. *Hypothesis 5* and *Hypothesis 9*). Accounting for both the subject-specificity of TSE, TA and DRI, the present study furthermore established that higher levels of TSE and TA relate to a more frequent DRI implementation (resp. *Hypothesis 7* and *Hypothesis 11*). In sum, the present study reveals that primary school teachers who feel more competent to implement evidence-based instructional practices such as ERSI and DRI on the one hand and on the other hand value these practices more, also report to implement them more frequently. Furthermore, bringing both TSE and TA together, a relationship was found between TSE and TA regarding DRI (*Hypothesis 12*) and ERSI (*Hypothesis 13*). While this relationship was expected for DRI, based on research in the field of inclusive education (Emmers et al., 2020), it was investigated exploratively for ERSI, due to a lack of prior research on this matter. The established links indicate that subject-specific TSE and TA might mutually reinforce each other.

These findings point to a powerful interdependency between teacher beliefs and their classroom practice that should not be ignored. As both TSE and TA have been demonstrated to be related to teachers' instructional practices, both in the present study and in prior research, teacher training programs and in-service professionalization trajectories should not only focus on didactics and instructional practices, but also on the teachers' self-efficacy and attitudes regarding these practices. In order for teachers to implement evidence-based practices, like ERSI and DRI, teachers need to intrinsically value these practices and feel capable of implementing them. While the importance of teachers' self-efficacy and attitudes for teachers' instructional practices has been established in other fields like STEM (e.g., Thibaut et al., 2018) and self-regulated learning (e.g., Dignath-van Ewijk, 2016), the present study extends these insights by affirmatively establishing their positive association with teachers' reading instruction practices. Particularly, after the PIRLS 2021 release, recording a downward five-year-trend in reading comprehension achievement in two-thirds of the participating countries¹ (Mullis et al., 2023), it is of crucial importance to nurture teacher beliefs worldwide to counteract despondency.

Limitations and future research

The lack of significant relationships between on the one hand teachers' instructional practices and students' reading comprehension, and on the other hand teacher beliefs and students' reading comprehension, should be understood with careful consideration of the cross-sectional nature of the research design. Most of the effectiveness research in reading instruction is intervention-based (e.g. Okkinga et al., 2018), examining the

¹ The COVID-19 pandemic could have impacted trends between PIRLS 2016 and PIRLS 2021.

causal effect of instructional practices via pretest and posttest, while keeping other variables stable. The aim of the present study was to explore associations between ERSI, DRI, teacher beliefs, and students' reading comprehension achievement using large-scale assessment data in order to obtain more generalizable insights. This study did not involve manipulating instructional practices or measuring changes over time. Therefore, a cause-and-effect relationship could not be established. While valuable insights into associations are provided, readers should exercise caution in inferring causation due to the inherent characteristics of the present research design. Furthermore, all different variables were measured at the same moment in the school year. At this point, students' reading comprehension achievement was the result of four years of formal schooling, often taught by four different teachers. However, the instructional practices and beliefs of only one of these teachers—the grade 4 teacher—were taken into account in the present study. To account for this problem, PIRLS 2026 offers a promising longitudinal option to assess the same students both in grade 4 and grade 5 (IEA, 2023). Through this design, the difference in beliefs and instructional practices between two teachers and the corresponding differences in students' reading comprehension achievement can be identified.

In addition to the research design, the results of the present study should be understood with consideration of the instruments used. Data on teachers' implementation practices were collected through self-report data. Brevik (2014) suggested that teachers might not be explicitly aware of their reading comprehension strategy instruction, making both interview and self-report questionnaire data ambiguous to interpret. To overcome the problem of self-report by teachers, observational data in primary classrooms could be an asset to this study. Another possibility to overcome the problems associated with teachers' self-report questionnaires, and yet work with a large and generalizable sample, would be to map students' perceptions of their teachers' instructional practices. Since students do not necessarily perceive their teachers' instructional practices as they were intended (Harmon et al., 2016), it is of great value to also give voice to students when trying to unravel the relationship between teachers' practices and students' achievement.

Also related to the instruments, the present study investigated the role of implementation practices on students' reading comprehension in terms of implementation quantity, instead of implementation quality. The Dynamic Model of Educational Effectiveness of Kyriakides and Creemers (2008) states that quantity is only one dimension of teacher behaviour and is often less predictive of student outcomes compared to the teaching quality. Therefore, follow-up research should investigate whether, in addition to the quantity of the implementation of ERSI and DRI, the quality of these instructional practices does relate to reading comprehension performance. This could be mapped using observational data.

Finally, some limitations concerning the validity of the instruments applied in this study should be acknowledged. It is important to note that the questionnaire instruments employed consist of a limited number of items, especially for the scales of TA, TSE and implementation regarding DRI, containing only 2 items per scale. The incorporation of more diverse items would have increased the likelihood of accurately capturing the intended constructs. However, in large-scale surveys, time

constraints often limit the number of items that can be included in a questionnaire and not uncommonly items need to be removed from an already limited pool (Eisinga et al., 2013). Consequently, these measures might not comprehensively represent the entire scope of the underlying constructs of interest. Furthermore, regarding DRI, items in the questionnaire focused on the students' background characteristics, rather than on specific differentiation practices, such as adapting reading material. Therefore, the present study could not examine the full construct of differentiation within reading comprehension instruction. Considering the complex construct of differentiated instruction (Gheysens et al., 2020), future research should investigate primary school teachers' subject-specific TSE and TA including all features of DRI. In this respect, the DI-Quest model (Gheysens et al., 2020), which acknowledges the complex, flexible and dynamic nature of differentiated instruction, and considers both teachers' philosophy and differentiation-related practices, can serve as a frame of reference.

Alongside these considerations related to the research design and instruments, this study uncovers some substantive themes that may fuel follow-up research. First, little research has explored TA regarding instructional practices in reading comprehension instruction. The present study indicates however an important link between these beliefs and teachers' instructional practices. More research is needed to further unravel the role of attitudes on teachers' various evidence-based practices in reading comprehension instruction.

Second, this study found evidence for the link between teachers' subject-specific TSE and TA regarding ERSI and DRI. Although generally, grade 4 teachers in the present study reported fairly positive levels of TSE and TA regarding both instructional practices, significant differences between teachers, relative to their years of experience and gender were observed. To explore these differences further, qualitative research methods, such as interviewing teachers, can be used in future research to gain a better understanding of the range of factors involved in establishing these beliefs. By understanding these factors better, teacher educators and policymakers could nurture teacher beliefs in a targeted way.

Third, this study indicates that teachers' implementation practices of ERSI and DRI are related. In other words, teachers implementing more ERSI are also implementing more DRI. Additionally, also teachers' subject-specific TSE and TA regarding TSE and DRI are linked, indicating that teachers reporting higher TSE regarding one of the two instructional practices, also report higher TA regarding that specific instructional practice. These findings might indicate the existence of teacher profiles in terms of their beliefs and instructional practices regarding ERSI and DRI, but possibly also regarding other evidence-based instructional practices. To provide targeted support to teachers in their implementation of evidence-based practices, and to ensure the educational opportunities of every student, follow-up research should explore the possible existence of these teacher profiles through latent profile analyses.

Finally, as the results of the present study indicate, IEA PIRLS data allow to unravel insights into diverse educational domains on a large scale.

Conclusion

Whereas TSE and TA are highly contextual and subject-specific beliefs, much uncertainty remains about their role in reading comprehension instruction, and more specifically regarding ERSI and DRI, two highly recommended and evidence-based instructional practices. The present study used large-scale data to provide insight into Flemish grade 4 teachers' subject-specific TSE and TA regarding ERSI and DRI, both in relation to their self-reported implementation of ERSI and DRI and in relation to students' reading comprehension achievement. Results reveal that teachers' subject-specific TSE and TA are related to their instructional practices. Teachers who report lower levels of TSE and TA regarding ERSI and DRI report that they implement these practices less frequently. Furthermore, teachers' implementation practices of ERSI and DRI are mutually related, indicating that the occurrence of both instructional practices generally goes hand in hand. Finally, TSE and TA seem to reinforce one another. These findings point to the need to support teachers, nurturing TSE and TA in reading comprehension instruction. Follow-up research is needed to further explore potential teacher profiles and/or other tendencies in teacher beliefs and instructional practices. Only then can appropriate support initiatives, targeted at the promotion of TSE and TA and eventually the actual and effective implementation of ERSI and DRI, be developed. In conclusion, this study contributes to insights about the beliefs associated with teachers' implementation practices in reading comprehension instruction, which could be interesting for teacher education and support purposes.

Appendix

Estimates of the three combination models with reading comprehension as the outcome variable

See Table 4.

Table 4 Standardized coefficients for Model 1, Model 2, and Model 3 with reading comprehension as the outcome variable

	Model 1		Model 2		Model 3	
	β	SE	β	SE	β	SE
Dependent variable: reading comprehension						
Fixed part						
Intercept	21.000	1.519	27.175	2.430	26.468	2.866
Gender (ref.: girl)			− 0.132***	0.033	− 0.151***	0.040
SES (ref.: high)			0.162***	0.018	0.156***	0.020
Home language: (ref.: language of instruction)			− 0.149***	0.019	− 0.144***	0.023
Number of books at home (ref.: many)			0.213***	0.016	0.226***	0.017
Teacher gender (ref.: female)			0.140	0.196	0.173	0.216
Teacher experience			− 0.002	0.079	0.013	0.089
Composition disabilities			− 0.118	0.078	− 0.102	0.088
Composition home language			0.002	0.098	− 0.041	0.100
Composition SES			− 0.311**	0.105	− 0.357***	0.106
TSE ERSI					0.069	0.147
TA ERSI					0.063	0.106
Implementation ERSI					− 0.039	0.129
TSE DRI					− 0.175	0.142
TA DRI					− 0.092	0.102
Implementation DRI					0.205	0.160
Random part						
R ² teacher level			0.114	0.057	0.174	0.072
R ² student level			0.141	0.012	0.139	0.014
ICC	0.134		0.077		0.078	
Model fit						
CFI	0.000		1.000		0.984	
TLI	1.000		1.008		0.931	
RMSEA	0.000		0.000		0.017	
SRMR within	0.000		0.003		0.010	
SRMR between	0.000		0.034		0.050	

This table presents the standardized coefficients with ** $p < 0.01$, *** $p < 0.001$ of the three combination models, with reading comprehension as the outcome variable

Abbreviations

DRI	Differentiated reading instruction
ERSI	Explicit reading strategy instruction
PIRLS	Progress in International Reading Literacy Study
TA	Teacher attitudes
TSE	Teacher self-efficacy

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Author contributions

NB was in charge of conceptualization, data collection, formal analysis, methodology, visualization and writing of the original draft. KD was in charge of funding acquisition, conceptualization, data collection, supervision, and reviewing and editing. HVK was in charge of funding acquisition, conceptualization, supervision, and reviewing and editing. KA was in charge of funding acquisition, conceptualization, data collection, methodology, supervision, and reviewing and editing.

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Availability of data and materials

The data used in this study come from two datasets. The first dataset is available in the PIRLS repository, PIRLS | IEA.nl. The second dataset contains data from national adaptations to the teacher questionnaire and is available from the corresponding author on reasonable request.

Declarations**Ethics approval and consent to participate**

The PIRLS 2021 procedure in Flanders was approved by the Ethical Committee of KU Leuven (file number: G-2020-1688-R2(MIN)).

Consent for publication

All co-authors have agreed to the byline order and to submission of the manuscript in its current form. I have taken on the responsibility of keeping my co-authors updated on our progress throughout the editorial review process.

Competing interests

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