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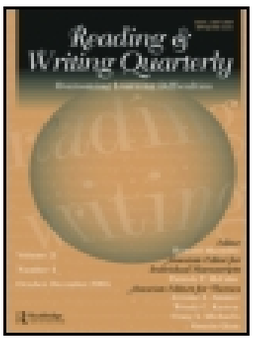

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Teachers' Instruction of Reading Strategies and Primary School Students' Reading Literacy: An Approach of Multilevel Structural Equation Modelling

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ABSTRACT

Reading strategy instruction is positively related to students' reading literacy. However, little is known about how reading instruction that emphasizes different types of reading strategies affects reading literacy. This study examined how Singapore primary school teachers' reading strategy instruction affected Grade Four students' reading literacy, and how reading strategy instruction was affected by teacher collaboration and other teacher characteristics. To control for possible effects of student characteristics on their reading literacy, we also included at the student level the students' gender and their socioeconomic status as represented by their parents' educational level. We used a multilevel structural equation modeling approach to analyze the Progress in International Reading Literacy Study 2016 (PIRLS 2016) data provided by 6,327 Singapore students nested within 356 teachers. At the teacher level, (1) teachers' instruction on reading strategies can be categorized into micro-level reading strategy instruction and macro-level reading strategy instruction; (2) only instruction on the macro-level of comprehension significantly affected students' reading literacy; and (3) teachers' reading strategy instruction was positively impacted by their collaboration with other teachers. At the student level, reading literacy was positively affected by the parents' educational level, the language the students used before starting school, and the students' gender (in favor of girls). The findings suggest that the relationship between reading strategy instruction and reading literacy is complex. To develop learners' reading literacy, teachers should emphasize both micro-level reading strategies and macro-level reading strategies in their reading instruction.

Introduction

Reading literacy refers to learners' ability to construct meaning from a wide range of reading materials (Mullis et al., 2016). This process involves multilevel cognitive processing. The well-regarded situation model (Kintsch & Rawson, 2005; Kintsch & Van Dijk, 1978) posits a distinction between micro-level comprehension (word, clause, sentence level) and macro-level comprehension (text structure level) in the construction of textbase. Accordingly, reading strategy instruction can differ in focuses. Intervention studies provided evidence for positive effects of instruction on training reading strategies for micro-level comprehensions, such as identifying important information (Van Der Schoot et al., 2008), resolving lexical and anaphoric reference

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(Gallini & Spires, 1995; Wilawan, 2011), and making inferences (Bos et al., 2016; Elbro & Buch-Iversen, 2013; Wassenburg et al., 2015). Research has also demonstrated the positive effects of reading strategy instruction on macro-level comprehensions, such as using text structure (Akhondi et al., 2011; Meyer & Poon, 2001; Meyer & Ray, 2011) and organizational structure (Yuill & Joscelyne, 1988). Gallini and Spires (1995) argued that micro-level comprehension provided a foundation for constructing macro-level comprehension and macro-level comprehension induced micro-level comprehension. However, studies (Dewitz et al., 1987; Gallini & Spires, 1995) generated contradictory results for effects of micro-level strategy instruction and macro-level strategy instruction on students' reading performance. More studies are needed to understand how these two types of instruction affect reading literacy, respectively.

There is growing interest in examining how teacher collaboration improves reading teachers' practice. Findings from qualitative studies showed that collaboration provided opportunities for teachers to share experience, reflect on practice, articulate implicit teaching beliefs, and analyze teaching practice from the perspective of learning, all of which enhanced reading instruction (Burbank & Kauchak, 2003; Rosaen et al., 2013). Nevertheless, research has rarely sought to examine how teacher collaboration affects reading strategy instruction quantitatively, considering teacher gender, teaching experience, and educational qualifications concurrently.

Moreover, a series of student characteristics, such as gender (Lietz, 2006; Martin et al., 2003; Mullis et al., 2012; Solheim & Lundetrae, 2018) and the language they used before they started school (De Naeghel & Van Keer, 2013; Scheele et al., 2010), was reported to predict reading literacy. That is to say, the effect of reading strategy instruction may vary across different students. To gain a comprehensive understanding of the relationships between these various teacher variables and student variables and students' reading literacy, we need to differentiate the effects of different levels (i.e., the teacher level and the student level).

The study aimed to apply the two-level structural equation modeling to examine the relationships between the teacher-level variables, the student-level variables, and students' reading literacy. The model is appropriate for approaching our goals for at least two reasons. The model's incorporation of latent variables allowed us to explore whether a large number of discrete reading strategies emphasized by teachers could be reduced to a small number of factors. The two-level structure of the model allowed us to distinguish between the effects of the teacher and those from the student.

Effects of reading strategy instruction on reading literacy

Reading comprehension is a complex process. Based on the situation model (Kintsch & Van Dijk, 1978; Kintsch & Rawson, 2005), the construction of textbase consisted of micro-level comprehension and macro-level comprehension. Micro-level comprehension refers to processing meanings of words, clauses, and sentences and building a microstructure of interrelated propositions (Kintsch & Rawson, 2005, p. 210). This process involves reading strategies such as identifying important information (Van Der Schoot et al., 2008), analyzing lexical cohesion (Gallini & Spires, 1995; Wilawan, 2011), resolving anaphoric cohesion (i.e., relating a current expression to what is mentioned earlier in a text) (Van Der Schoot et al., 2008), and making inferences for filling in conceptual gaps and connecting meanings across clauses and sentences (Cain & Oakhill, 1999; Cain et al., 2001; Phillips, 1988). Studies (Cain & Oakhill, 1999; Van der Schoot et al., 2012; Yuill & Joscelyne, 1988) that compared good comprehenders and poor comprehenders yielded more frequent and successful employment of these micro-level comprehension reading strategies in good comprehenders.

Furthermore, instruction that focused on training reading strategies for micro-level comprehension was found to positively affect reading comprehension (Bos et al., 2016; Cain et al., 2001; Elbro & Buch-Iversen, 2013; Phillips, 1988). Wassenburg et al. (2015) trained primary students

from four urban schools in the Netherlands on how to use inferential strategies for monitoring reading comprehension in the first language (L1). There were 64 students from Grade Three and Grade Four in an experimental group and 51 from both grades in a control group. By adopting the Dutch standardized reading comprehension test, they found that both Grade Three and Four participants benefited from the strategy training and made larger gains in reading comprehension texts than the control groups, though the employment of the trained reading strategies was not as evident in Grade Three as that in Grade Four, as shown in an inconsistency detection test. In a similar vein, Elbro and Buch-Iversen (2013) did a study on 236 sixth-grade students from six schools in Norway. They divided the participants into an experimental group with a number of 151 and a control group with a number of 85. The results revealed that the experimental group who received training on inference-making strategies outperformed the control group in a test of filling in inferencing gaps, with an effect size of 0.92, indicating that the intervention effectively enabled the experimental group to use the strategy. Besides, larger improvements in reading comprehension tests of fiction and nonfiction texts were observed in the experimental group, with effect sizes from medium to large. A delayed post-test on a smaller sample of 53 students showed that the training effects were maintained after five weeks of the intervention.

Macro-level comprehension refers to identifying a hierarchy of information and interpreting topics and themes to construct a macrostructure. Readers may have difficulty in selecting the important information from a text due to differences in prior knowledge and beliefs, and thus, fail to understand the author's top-level structure (Kintsch & Van Dijk, 1978; Kintsch & Rawson, 2005). Therefore, building a macrostructure entails the interpretation from the author's perspective. Research has demonstrated the effects of reading strategy instruction on macro-level comprehension (Akhondi et al., 2011; Meyer & Poon, 2001; Meyer & Ray, 2011) on reading comprehension. For example, Meyer and Poon (2001) conducted an intervention study on 56 younger and 65 older adults from a university in the US. In a strategy group on text structure, learners received training on how to apply the author's top-level structure to organize text information. This process enabled the learners to select important information that was central to interpret themes and topics. Interest-group learners were trained to evaluate their reading interests for the purpose of increasing reading motivation. The results of the recall tests showed that the structure strategy group memorized more important information in a more organized way than their counterparts did. This finding demonstrated that text structure strategy training facilitated information storage and retrieval. However, their study did not employ standardized reading tests and thus, we are unable to know how text structure instruction contributes to general reading comprehension.

A meta-analysis summarized 45 intervention studies of text structure instruction on L1 reading comprehension targeting Grade 2–12 students from urban to rural areas (Hebert et al., 2016). The findings indicated an overall positive effect of the intervention on proximal measures of reading comprehension (comprehending specific information), with an over medium Cohen's effect size ($d = 0.57$). Besides, analysis on measures of transferring taught structures to untaught structures generated an above medium Cohen's effect size ($d = 0.62$). However, the effect size for measures on standardized reading comprehension was only 0.15, though it was significant. Another recent meta-analysis of 44 quasi-experimental studies with grades 4–6 students of multiple L1s by Bogaerds-Hazenberg et al. (2020) found that text structure strategy training had positive effects on both standardized and nonstandardized tests in the students' L1. The effect sizes of Hedges' g on recall tests ($g = 0.38$), summarization ($g = 0.58$), and knowledge about the text structure ($g = 0.34$) were higher than those of the comprehension questions ($g = 0.25$) consisting of literal comprehension, referential comprehension, and interpretation questions.

Prior studies revealed positive effects of text structure instruction on macro-level comprehension in students' L1 while its effects on general reading comprehension were not conclusive. The differences between micro-level comprehension and macro-level comprehension lead to varying

focuses on reading strategy instruction, which may lead to different effects on learners' general reading comprehension. However, there is a dearth of evidence on the relative contributions of micro-level reading strategy instruction (Mic-RSI) and macro-level reading strategy instruction (Mac-RSI) to reading comprehension. An early study by Gallini and Spires (1995) compared the effects of macro strategy, micro strategy, and combined strategy training on text learning of 71 undergraduate students who were studying at a state university. In the micro strategy group, the participants' attention was guided to anaphora, connectives, and transitions, all of which led to building a microstructure. The macro strategy group was presented with the author's schematic map to facilitate macro processing. The combined strategy group received both types of training. The results of a free recall test (summary) revealed an overall advantage of the macro strategy group over the other groups. In addition, the macro strategy group was found to gain larger improvements in a test assessing basic knowledge of the text. The combined group did not show salient advantages on the basic knowledge test than the other two groups. Dewitz et al. (1987) reported different results. They assigned 101 fifth-grade students from a suburban primary school to four groups (three experimental groups and one control group) based on reading abilities. The three experimental groups received training on generating inferences (the inference group), organizing text structure (the text structure group), and both (the combined group), respectively. They found that the combined group and the inference group outperformed the text structure group and the control group in terms of literal questions and inferential questions. Indicated by the delayed tests, the combined group's advantage was maintained in terms of literal questions, and the inference group's advantage was observed in terms of inferential questions.

The contradictory results may be explained by the employment of different age groups of learners. Micro-level reading strategies training may be more appropriate for primary students than for undergraduate students because primary students are more likely to have difficulties in processing sentence-level and inter-sentence level information. The complex relationship between reading strategy instruction and reading comprehension is caused by the multifaceted nature of the individual construct. Therefore, more empirical evidence is needed for us to yield a comprehensive picture of how reading strategy instruction on multilevel cognitive processes contributes to reading comprehension, which will also provide insights into instructional practice.

Teacher collaboration and teacher characteristics on reading strategy instruction

Teacher collaboration was reported to impact reading instruction (Burbank & Kauchak, 2003; Rosaen et al., 2013). Many studies examined teacher collaboration in different forms, for example, the professional learning community (Stahl, 2015), action research (Burbank & Kauchak, 2003), or in a specific manner, such as observing other teachers' lessons (Rosaen et al., 2013). Rosaen et al. (2013) reported a study on 18 reading teachers' collaborating behavior that emerged from watching and analyzing videos of other teachers' reading lessons. They found that teachers made connections between their own teaching and the practice in the videos and then reflected on how they could improve or avoid in their own teaching practice. The teachers in discussion groups stated the benefits of sharing with colleagues the advantages and disadvantages of teaching practice.

By employing collaborative action research, Burbank and Kauchak (2003) recruited 20 preservice and in-service secondary teachers who were involved in the teacher professional program at the University of Utah. The preservice teachers were post-baccalaureate students and in-service teachers were from secondary schools. The qualitative analysis showed an increase in some teachers' awareness of students learning and implicit teaching assumptions. Many of the teachers reported that collaboration provided opportunities to explore and improve teaching practice, though some teachers did not report this impact. The survey revealed that the in-service teachers had more positive attitudes toward the collaborating model than the preservice teachers.

The qualitative evidence demonstrated that teachers' collaboration provided opportunities for teachers to share experience, reflect on practice, articulate implicit teaching beliefs, and analyze teaching practice from the perspective of learning, all of which led to an improvement in reading instruction. However, quantitative evidence from a large sample size is needed for further investigating how teacher collaboration affects reading strategy instruction.

Previous studies also revealed that reading instruction could be affected by teachers' characteristics, such as years of teaching (Buddin & Zamarro, 2009; Croninger et al., 2007; Goe, 2007; Harris & Sass, 2011; Rice, 2003), gender (Lam et al., 2010; Muralidharan & Sheth, 2016; Rubie-Davies et al., 2012) and educational qualifications (Croninger et al., 2007; Goe, 2007; Rice, 2003; Troyer, 2017). For example, Troyer (2017) followed 17 teachers' implementation of a reading program on adolescent learners and three literacy coaches in the United States. By analyzing teacher characteristics and classroom teaching practice, she found that teachers' educational qualification, as measured by holding a reading certificate, was a significant predictor of the degree to which the teachers implemented the coached reading practice. However, the number of years of teaching experience was not found to be predictive. Lam et al. (2010) examined the effects of primary teachers' gender on their reading instructions in Hong Kong. The results revealed that male teachers employed a teacher-centered approach, whereas female teachers encouraged students' collaboration in teaching reading. Therefore, the teacher variables, years of teaching experience, gender, and educational qualifications were included in this study.

Effects of student gender, home language, and parents' educational level

Student characteristics, such as gender, language spoken in the home, and parents' educational level, have also been found to affect students' reading literacy. In terms of gender effect, the advantage of girls in reading compared to boys has been well documented in the literature (Lietz, 2006; Martin et al., 2003; Mullis et al., 2012; Solheim & Lundetrae, 2018). Research has also shown that students who spoke the language of the assessment at home outperformed those who did not speak that language at home (De Naeghel & Van Keer, 2013; Scheele et al., 2010). Students whose parents had a high level of education performed better than those with less-educated parents (Giambona & Porcu, 2015). The current study analyzed the impacts of student characteristics on reading literacy so as to purify any effects from the teacher level.

Reading strategy instruction has been reported to be effective in improving students' reading literacy. However, several issues remain to be solved. First, a wide range of reading strategies has been examined, but little is known about the relative importance of Mic-RSI and Mac-RSI to reading literacy. Second, the question of how teacher characteristics influence reading strategy instruction needs further exploration. Reading comprehension is a complex process that can be affected by multiple-level factors. This study contributes to the literature by employing the approach of multilevel structural equation modeling to (1) explore the relative contributions of Mic-RSI and Mac-RSI to reading literacy, and (2) examine the relationships between teacher collaboration and characteristics and reading strategy instruction, and (3) the relationships between student characteristics and reading literacy. The Progress in International Reading Literacy Study 2016 (PIRLS 2016; Mullis et al., 2016) a standardized measurement of reading literacy in a global context, provides an opportunity for examining relationships among these influential variables and reading literacy. To achieve the research objectives, this study addressed four research questions:

1. Can instruction on reading strategies be categorized into micro-level reading strategy instruction and macro-level reading strategy instruction?

2. To what extent do different types of reading strategy instruction affect students' reading achievement?
3. To what extent do teacher collaboration and teacher characteristics (i.e., teacher gender, years of teaching, and educational level) predict teachers' choices of reading strategy instruction?
4. To what extent do student variables (i.e., student gender, language used before entering school, and parents' educational level) affect reading achievement?

Methods

Sample and demographic measures

Our study was a secondary analysis of the International Association for the Evaluation of Educational Achievement (IEA) data on the PIRLS 2016. The PIRLS is an international assessment that measures fourth graders' reading literacy worldwide. This study analyzed the PIRLS data from Singapore, which included a total of 6,327 students nested within 351 teachers (see Table 1 for details). Singapore ranked quite high (as Top 2) in the PIRLS 2016 data from the participating countries and regions.

The mean age of the students was 10.37 years (SD = 0.35). Boys and girls each occupied nearly 50% of the total sample. An overwhelming portion (85%) of the students spoke English before they entered primary school, in contrast to the small portion (15%) that spoke other languages in the home prior to starting school. For parents' education, 48% of the parents had received education at the university level or higher, 45% had a secondary or post-secondary education, and 7% had just a lower secondary education or no school experience at all.

Among the 351 teachers, 74% were females, and 26% were males. A major portion of the teachers (69%) were aged between 30 and 49 years old, followed by those under 29 years (18%), and those above 50 years (13%). For the teachers' background in terms of years of teaching, 28% reported having a total teaching experience of fewer than 5 years, 28% had taught for 6–10 years, 27% had taught for 11–20 years, and 17% had teaching experience for more than 21 years. For teacher education, 71% of the teachers had obtained a bachelor's degree or an equivalent level of education (Level 6), 18% had received an upper secondary education (level 2) to short-cycle tertiary education (level 5), and 10% had a master's degree (Level 7) or a doctor's degree (Level 8).

Measures of teacher strategy instruction, collaboration, and reading literacy

Table 2 shows descriptive statistics and reliability for two teacher activity measures: instruction on reading strategies and teacher collaboration.

Reading strategy instruction was measured using a four-point scale (from 1 = every day or almost every day to 4 = never or almost never) as shown in Table 2. As all items were originally asked reversely, we reversed the raw values produced by the respondents before computing mean values and later data analysis. The scale had nine items falling into two dimensions: micro-level reading strategy instruction (Mic-RSI) and macro-level reading strategy instruction (Mac-RSI). Micro-level reading strategy instruction consisted of six items (e.g., ATBR12A: "locate information"). The internal consistency of the scale was Cronbach's alpha = 0.92. Macro-level reading strategy instruction consisted of three items (e.g., ATBR12H: "describe the text structure"). The internal consistency of the scale was Cronbach's alpha = 0.82.

Teacher collaboration was measured using five items (from ATBG09A, referring to sharing teaching experiences, to ATBG09E, referring to comparing reading from multiple sources) rated on a four-point scale (1 = very often, 2 = often, 3 = sometimes, 4 = never or almost never). To smoothen the reading values, the mean values were computed after reversing the raw responses. The mean values ranged from M = 1.67 (SD = 0.75) for ATBG09D (working with teachers from

Table 1. Teacher and student (parent) demographic information.

Teacher demographic information

	Gender		Age			Years of teaching				Degree		
	Female	Male	<29	30–49	>50	<5	6–10	11–20	>21	2–5	6	7–8
Percentage	74%	26%	18%	69%	13%	28%	28%	27%	17%	18%	71%	11%
Count	259	91	62	243	46	98	98	95	60	63	249	39

Student demographic information

	Gender		Language before school		Parent education		
	Girls	Boys	English	Non-English	University or higher	Secondary or postsecondary (not university)	Lower secondary or no school
Percentage	50%	50%	85%	15%	48%	45%	7%
Count	3,176	3,151	5,241	904	2,896	2,752	412

Table 2. Descriptive statistics and reliability for teacher activity variables.

		Mean[a]	SD	Skewness	Kurtosis
	Micro-level reading strategies				
ATBR12A	Locate information	3.32	0.61	−0.39	−0.26
ATBR12B	Identify the main ideas	3.27	0.67	−0.48	−0.29
ATBR12C	Explain or support their understanding	3.32	0.63	−0.37	−0.68
ATBR12D	Compare reading with experiences	3.12	0.73	−0.37	−0.53
ATBR12F	Make predictions on what will happen	3.25	0.67	−0.51	−0.01
ATBR12G	Generalize and draw inferences	3.17	0.64	−0.24	−0.40
			Cronbach's alpha = 0.92		
	Macro-level reading strategies				
ATBR12E	Compare reading of multiple sources	3.01	0.75	−0.46	−0.04
ATBR12H	Describe the text structure	2.77	0.78	−0.22	−0.33
ATBR12I	Determine the author's perspective	2.72	0.84	−0.14	−0.61
			Cronbach's alpha = 0.82		
	Teacher Collaboration				
ATBG09A	Share teaching experiences	2.86	0.74	0.05	−0.81
ATBG09B	Observe another classroom	2.18	0.69	0.44	0.40
ATBG09C	Work together	2.77	0.78	−0.06	−0.55
ATBG09D	Work with teachers from other schools	1.67	0.75	0.95	0.42
ATBG09E	Work with teachers to ensure continuity in learning	2.18	0.83	0.33	−0.42
			Cronbach's alpha = 0.81		

[a]To facilitate reading, the mean values were computed after reversing the raw responses.

other schools) to M = 2.86 (SD = 0.74) for ATBG09A (sharing teaching experiences). All skewness and kurtosis values were within the range of ±1 and suggested a normal distribution. The Cronbach's alpha was 0.81, thus suggesting high consistency of the items in measuring teacher collaboration.

Reading literacy in PIRLS 2016 was defined as "the ability to understand and use those written language forms required by society and/or valued by the individual." (Mullis et al., 2016, p. 12). The PIRLS 2016 test focused on four processes of reading comprehension: retrieving stated information, making inferences, interpreting and integrating, and evaluating and critiquing (Mullis et al., 2016). The PIRLS 2016 test contained a series of texts (literary text and informative text) followed by multiple-choice or constructed-response items. The quality of the original test in English was ensured by the PIRLS 2016 test development task force (Mullis & Prendergast, 2017) and the validity of the translated test was verified by an IEA-affiliated translation agency (Ebbs & Wry, 2017). The mean of Singapore students PIRLS 2016 was 576 within the scale range between 300 to 700. The Cronbach's Alpha of PIRLS 2016 for Singapore was 0.91.

Data analysis

Missing values were inspected before data analysis. For the variables representing teacher activities, only two items had missing values: ATBG09A (share teaching experiences) and ATBR12E (compare reading of multiple sources), each with a portion of missing data. For student and teacher demographic variables, the missing values ranged from 0.3% (teachers' educational level) to 4% (parents' educational level). Given the small portions, we followed Enders (2010) and replaced the missing values with multiple imputations (Schafer, 1997) using *Mplus* 7.4 (Muthén & Muthén, 1998).

To examine the relationships among teacher's instruction on reading strategies, teacher collaboration activities, and the relationship between students' demographic variables and their reading achievement, we conducted a series of multilevel structural equation modeling (ML-SEM) (Muthén, 1994). An ML-SEM model bears an essential assumption that an outcome variable (e.g., students' reading achievement) is explained by predictors at more than one level (e.g., student demographic variables at the lower level, and teachers' instruction on reading strategies, teacher

collaborations, and other teacher demographic variables at the higher level) (Finch & Bolin, 2017; Heck & Thomas, 2015; Muthén, 1994).

We first examined the necessity of using ML-SEM by checking the magnitude of intra-class correlation (ICC) (Barcikowski, 1981), or the variation of students' reading literacy across teachers. According to Barcikowski, even small ICCs (e.g., significantly larger than zero) can have an impact upon significance tests. The ICC of reading for our sample was 0.474, thereby suggesting the need for multilevel modeling (Heck & Thomas, 2015).

Our primary data analysis involved two stages. The first stage was the assessment of measurement quality for two teacher activity variables: one for instruction on reading strategies (Model 1a as original model and Model 1b as the modified model) and the other for teacher collaboration (Models 2a as original model and Model 2b as the modified model). The second stage tested a full two-level structural model (Model 3): At the teacher level, reading literacy was regressed on instruction on reading strategies and teacher collaboration, and on the teacher demographic variables (i.e., gender, educational level, and years of teaching). At the student level, reading literacy was regressed on three student demographic variables (student gender, parents' educational level, and country of birth).

All of these models were tested using *Mplus* 7.4 (Muthén & Muthén, 1998) with the estimator of Maximum Likelihood Robust (MLR) (Satorra & Bentler, 1994). Evaluation of the ML-SEM model (Model 1) was based on the following criteria recommended by Mueller and Hancock (2010): the root mean square error of approximation (RMSEA) (Steiger, 1990) and the standardized root mean square residual (SRMR) (Bentler, 1995) not being larger than 0.05, and the Comparative Fit Index (CFI) (Bentler, 1990) and the Tucker–Lewis index (TLI) (Tucker & Lewis, 1973) not being smaller than 0.95.

Results

Correlations

Table 3 shows the zero-order correlations between teacher variables, student demographic variables, and reading achievement. The correlations between reading literacy and teacher variables were all significant and positive, except for the significant but negative correlation with teacher gender in favor of female teachers (1= female and 2 = male). The largest magnitude was with teacher gender ($r = -0.14$, $p < 0.01$), and the smallest magnitudes were with reading literacy and teacher collaboration and reading literacy and years of teaching (for both variables, $r = 0.03$, $p < 0.05$). Regarding the correlations between reading literacy and student variables, the largest correlation was with parents' educational level ($r = 0.40$, $p < 0.01$), followed by the language used before entering school ($r = -0.17$, $p < 0.01$), in favor of English speakers, and student gender ($r = -0.11$, $p < 0.01$), in favor of girls.

Of the correlations among the various teacher variables, instruction on reading strategies as a whole was positively correlated with teacher collaboration ($r = 0.25$, $p < 0.01$) and teacher gender ($r = 0.06$, $p < 0.01$) in favor of males, but instruction on reading strategies was negatively correlated with teacher educational level ($r = -0.06$, $p > 0.05$). Teacher collaboration was positively correlated with years of teaching ($r = 0.16$, $p < 0.01$), but negatively correlated with teacher educational level and with gender (for both, $r = -0.08$, $p < 0.01$).

Can instruction on reading strategies be categorized into micro-level reading strategy instruction and macro-level reading strategy instruction?

The model fit results are shown in Table 4. The scale for instruction on reading strategies was constructed to capture two factors: micro-level reading strategy instruction and macro-level reading strategy instruction, as represented by Model 1a. Micro-level reading strategy instruction

Table 3. Correlations among key variables.

Teacher level variables	V1	V2	V3	V4	V5	V6	V7
V1. Reading		0.095**	0.201**	0.040**	0.050**	0.033**	−0.193**
V2. Micro-level reading strategy			0.681**	0.228**	−0.050**	−0.008	0.029*
V3. Macro-level reading strategy				0.244**	−0.066**	0.019	0.088**
V4. Teacher collaboration					−0.083**	0.162**	−0.084**
V5. Teacher education						−0.334**	0.055**
V6. Years of teaching							−0.194**
V7. Teacher sex							
Student level variable	V1	V2	V3	V4			
V1. Reading	–	−0.111**	0.401**	−0.169**			
V4. Parent education			−0.023	0.023			
V5. Student sex				−0.161**			
V6. Language before schooling							

*$p < .05$, **$p < .01$.

consisted of six items (ATBR12A, ATBR12B, ATBR12C, ATBR12D, ATBR12F ATBR12G). Macro-level reading strategy instruction consisted of three items (ATBR12E, ATBR12H, ATBR12I). This model fit the data adequately: RMSEA = 0.03, SRMR (between) = 0.08, CFI = 0.88, and TLI = 0.84. After meaningful model modification based on *Mplus* output––that is, freeing the residual covariances between two items involving comparing: ATBR12D (compare reading with experiences) and ATBR12E (compare reading of multiple sources), and between ATBR12H (describing the text structure or style) and ATBR12I (determining the author's perspective or intention), two items more cognitively challenging (Anderson et al., 2001), the model (Model 1 b) fit the data excellently: RMSEA = 0.02, SRMR (between) = 0.04, CFI = 0.97, and TLI = 0.95.

To what extent do different types of reading strategy instruction affect students' reading achievement?

The diagram of the final structural model is shown in Figure 1. At the teacher level, aggregated reading literacy was predicted significantly by instruction on macro-level reading strategies ($\beta = 0.34$, $p < 0.01$) but not by instruction on micro-level reading strategies ($\beta = -0.18$, $p = 0.21$).

To what extent do teacher collaboration and teacher characteristics (i.e., teacher gender, years of teaching, and educational level) predict teachers' choices of reading strategy instruction?

The original one-factor teacher collaboration scale (Model 2a) had an adequate fit: RMSEA = 0.04, SRMR (between) = 0.06, CFI = 0.90, and TLI = 0.80 (Table 4). Following the recommendation by *Mplus* output, we identified two pairs of residual covariances and freed these two constraints. One related to ATBG09A (sharing teaching experiences,) and ATBG09C, (working together), both items asking about the same content but using different wording; the other pair deals with ATBG09B (observing another classroom) and ATBG09E (working with teachers to ensure continuity in learning), two items whose content possibly compensate each other (i.e., observe another teacher's classroom to ensure learning continuity). The model fit the data perfectly: RMSEA = 0.01, SRMR (between) = 0.02, CFI = 1.00, and TLI = 0.99. Drawing from the two established measurement models, the full structural model (Model 3) produced an excellent fit with the data: RMSEA = 0.01, SRMR (between) = 0.05, CFI = 0.96, and TLI = 0.94.

Teacher collaboration was a significantly strong predictor of both types of instruction: $\beta = 0.21$, $p < 0.01$ for micro-level reading strategy instruction, and $\beta = 0.23$, $p < 0.01$ for macro-level reading strategy instruction. None of the teacher demographic variables was found to be a significant predictor of the two types of instruction.

Table 4. ML-CFA & SEM fit results.

Model	χ^2	*df*	χ^2/df	*p*-Value	RMSEA	SRMR		CFI	TLI
						Between	Within		
Model 1a ML-CFA with Instruction on reading strategies	142.54	26	5.48	<0.019	0.03	0.08	–	0.88	0.84
Model 1b ML-CFA with Instruction on reading strategies (Covariances: ATBR12D with ATBR12E, ATBR12H with ATBR12I)	58.38	24	2.43	<0.119	0.02	0.04	–	0.97	0.95
Model 2a ML-CFA with teacher collaboration	52.80	5	10.56	<0.001	0.04	0.06	–	0.90	0.80
Model 2b ML-CFA with teacher collaboration (Covariances: 1 with 3, 2 with 5)	5.15	3	1.72	<0.190	0.01	0.02	–	1.00	0.99
Model 3 ML-SEM	218.778	114	1.919	<0.166	0.01	0.05	0.00	0.96	0.94

Note. RMSEA: root mean square error of approximation; SRMR: standardized root mean square residual; TLI: Tucker–Lewis index; CFI: comparative fit index.

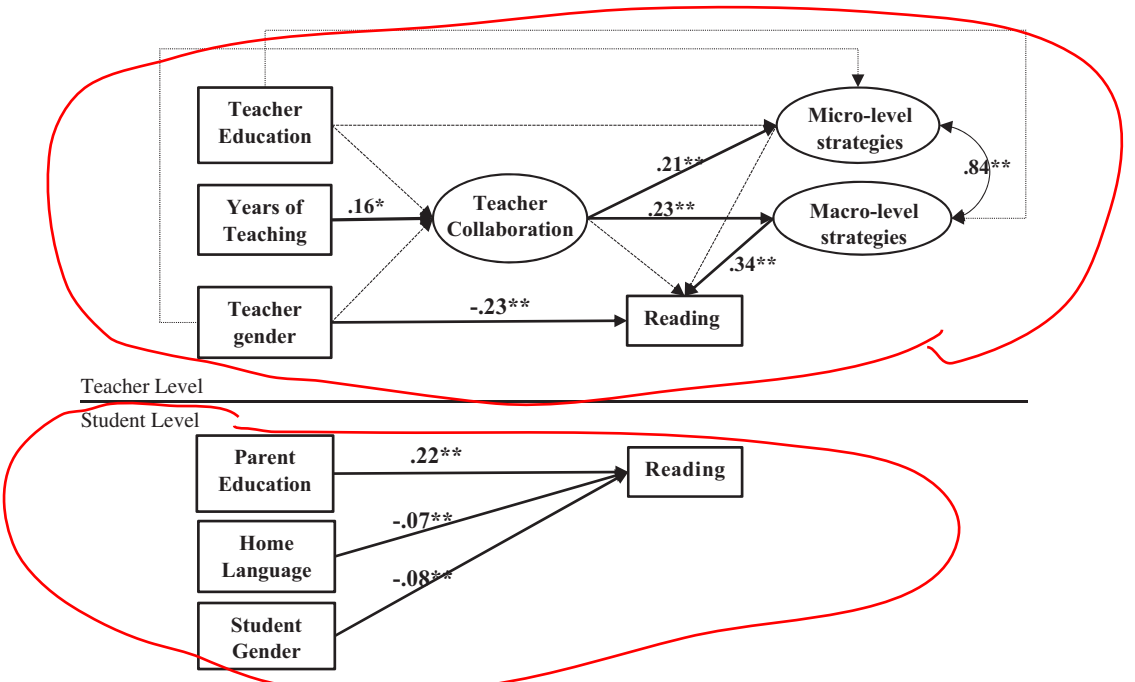

Figure 1. Two-level SEM for the relationship between teaching strategies and reading literacy. $^{**}p < 0.01$; $^{*}p < 0.05$. Dashed lines represent paths with nonsignificant estimates.

Regarding the predictors of teacher collaboration, only the number of years of teaching experience was a significant predictor of teacher collaboration: $\beta = 0.23$, $p < 0.01$.

To what extent do student variables (i.e., student gender, language used before entering school, and parents' educational level) affect reading achievement?

At the student level, reading literacy was predicted significantly by all of the student demographic variables: $\beta = -0.08$, $p < 0.01$, in favor of girls; $\beta = 0.22$, $p < 0.01$ for parents' educational level; and $\beta = -0.07$, $p < 0.01$ in favor of students who spoke English (the test language) before they entered school.

Discussion

This paper used data for Singapore from the PIRLS 2016 to assess relationships between teacher--level variables, student-level variables, and students' reading literacy. Results of multilevel modeling showed that (1) at the teacher level, teachers' instruction on reading strategies can be categorized into Mic-RSI, or micro-level reading strategy instruction, and by Mac-RSI, or macro-level reading strategy instruction; (2) Mac-RSI significantly affected students' reading achievement; (3) teachers' reading strategy instruction was positively affected by teacher collaboration; and (4) at the student level, reading literacy was positively affected by their parents' educational level, the language they used before entering school, and by their gender, in favor of girls.

Micro-level and macro-level reading strategy instruction

On the basis of the situation model (Kintsch & Van Dijk, 1978; Kintsch & Rawson, 2005), the construction of a text base involves both micro-level comprehension and macro-level comprehension. These two levels require different language knowledge, discourse knowledge, and cognitive

skills, and can hardly be covered by a single reading strategy instruction. Our study extends the previous research by demonstrating that reading strategy instruction differed in its focus and could be categorized into Mic-RSI and Mac-RSI. Micro-level reading strategy instruction guides learners to locate main ideas, explain what they read, and make predictions and generalizations. Macro-level reading strategy instruction guides learners to determine the author's perspective and to identify the structure of the text.

Effects of different types of reading strategy instruction on students' reading achievement

In correspondence to the previous intervention studies in which reading strategies were found to enhance students' reading performance (Bos et al., 2016; Dewitz et al., 1987; Meyer & Ray, 2011), this study demonstrated the positive association between reading strategy instruction and reading achievements. Contributing to the issue of how these two types of instruction affect reading literacy, we found that, in the Singapore context, Mac-RSI contributed significantly to reading literacy, even in children as young as 10 years old, whereas Mic-RSI did not contribute to reading literacy directly, supporting Gallini and Spires' (1995) research. One reason may be that Mic-RSI does not necessarily lead to macro-level comprehension. Meyer and her colleagues (Meyer & Poon, 2001; Meyer & Ray, 2011) argue that readers do not automatically organize the information into a superordinate structure. On the other hand, Mac-RSI may induce both micro-level and macro-level comprehension as a macrostructure is built on interpretation, summarization, and selection of the interrelated propositions (Gallini & Spires, 1995). Besides, macro-level reading strategies help readers establish a coherent mental representation of the text for deep processing (Meyer & Poon, 2001). This mechanism should have made Mac-RSI a stronger predictive factor than Mic-RSI on reading literacy.

Another explanation could be that the importance of Mac-RSI may have been neglected by young children who also have difficulties in constructing a text structure as adult readers do. As young children's difficulties have been located at linguistic-level comprehension and micro-level comprehension, such as processing unknown vocabulary or filling in comprehension gaps (Catts et al., 2006; McCardle et al., 2001), teachers may have focused on teaching vocabulary and sentence structures while neglected teaching text structures or analyzing author's perspectives. This omission may have led to the explanatory power that Mac-RSI had on students' reading achievement, to the exclusion of Mic-RSI. Therefore, macro-level comprehension should be stressed in reading instruction in young children, as well.

Teacher collaboration, teacher characteristics, and reading strategy instruction

With regard to teacher collaboration, this study provided quantitative evidence showing that teacher collaboration significantly predicted reading strategy instruction, thereby corroborating the findings of the qualitative research in the literature (Burbank & Kauchak, 2003; Rosaen et al., 2013; Stahl, 2015). The finding suggests that a variety of teacher collaborating activities, such as sharing their experiences, working with other teachers, and observing other teachers' classrooms, can be employed to enable teachers to emphasize both micro-level reading strategies and macro-level reading strategies in reading instruction.

Contrary to the positive associations found in the literature between teacher demographic variables and teacher instruction (Lam et al., 2010; Rice, 2003; Rubie-Davies et al., 2012; Troyer, 2017), in this study none of the teacher demographic variables was found to be a significant predictor of the reading strategy instruction. One reason for the difference in findings could be that the measurements of teacher variables and teaching behavior have varied from study to study. For example, Lam et al. (2010) examined teaching behavior in terms of students' engagement in classes, whereas this study focused on the reading strategies that were emphasized in instruction.

We suggest that the definitions and measurements of these variables should be clarified and be applied consistently in the future, in order to generate patterns in the associations between teacher demographic variables and characteristics of instruction. Furthermore, only years of teaching significantly predicted teacher collaboration, indicating that experienced teachers may be more willing to collaborate with other teachers in Singapore.

Effects of student variables on reading achievement

Our results were consistent with the literature in finding that, in addition to the above variables, the student variables were predictive of their reading literacy. First, this study found that girls performed better than boys, confirming the gender effect discovered in the prior research (Lietz, 2006; Martin et al., 2003; Mullis et al., 2012; Solheim & Lundetrae, 2018). Second, this study also found that students whose parents had high levels of education performed better than did those with parents who had low educational levels, thus corroborating that parental education affected students' reading literacy (Duncan & Magnuson, 2005; Giambona & Porcu, 2015; Lauer, 2003). Third, students who spoke the language of the assessment (English) before starting school performed better than did those who did not. This result corroborates the argument in the literature that the language spoken in the home plays an important role in developing students' reading literacy (De Naeghel & Van Keer, 2013; Scheele et al., 2010). Furthermore, the findings showed that parents' educational level had a larger predictive power ($\beta = 0.22$, $p < 0.01$) than the other two variables ($\beta = -0.07$, $p < 0.01$ for home language and $\beta = -0.08$, $p < 0.01$ for gender), which suggests that parents' educational level has more impact on students' reading literacy than students' gender and home language. Giambona and Porcu (2015) explain that well-educated parents tend to motivate their children to read and they are able to provide support, such as reading with their children, which plays an essential role in fostering reading literacy.

Conclusions

Reading literacy is influenced by both teacher-level variables and student-level variables. In its contribution to the literature, the current study found that among those variables, teachers' reading strategy instruction had substantial effects on students' reading literacy, and the teaching behavior played the crucial role in improving learners' reading literacy. Furthermore, this study found that reading strategy instruction with different focuses had varying contributions to students' reading literacy. More importantly, macro-level reading strategy instruction contributed significantly to reading literacy, even in young children.

The current study was based on a secondary analysis of PIRLS 2016 data. Several limitations should be taken into consideration when interpreting the results. First, reading strategy instruction and teachers' collaboration activities were reported by the teachers, which may not correspond to actual teaching practice. Classroom observations may be employed to investigate teaching behavior in reading instruction from a different perspective. Second, our analysis was conducted on cross-sectional data. Longitudinal designs in the future could shed light on how reading strategy instruction contributes to learners' development of reading literacy over a period of time. Besides, future research may consider intervention studies that compare the impact of Mac-RSI and Mic-RSI on students' reading literacy.

In practice, macro-level reading strategies may have been neglected for young learners. The professional development of reading teachers should equip them with knowledge of a variety of reading strategies, from strategies for micro-level comprehension to those for macro-level comprehension, and the specific functions of those strategies in developing learners' reading literacy. Furthermore, teachers' collaboration with each other should be encouraged, regardless of the individual teacher's gender, teaching experience, and educational qualifications, in order to enhance

the quality of reading strategy instruction. Future research can explore the relationships between the characteristics of teacher collaboration and reading strategy instruction specifically, in an effort to provide insights into models for reading teachers' professional development.

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