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The interplay between students' home literacy environment, reading attitudes and comprehension: a serial mediation analysis using PIRLS 2021-data

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Abstract

Background: Providing a rich home literacy environment (HLE) is considered to contribute to the development of students' reading comprehension. However, less research attention has been given to the underlying mechanisms that influence this relationship, including potential mediating characteristics. The present study aims to assess whether students' reading enjoyment, reading motivation and reading frequency mediate different aspects of the active and passive HLE and reading comprehension of Grade 4 students in Flanders (Belgium).

Methods: This study uses the Flemish data of the Progress in International Reading Literacy Study (PIRLS) 2021. Participants were 5114 students from 141 schools and their parents. The hypotheses were tested using a serial mediation model implemented through structural equation modelling.

Results: We observed different associations between specific aspects of the HLE and fourth graders' reading comprehension. Both an active reading climate and the amount of books at home were found to be positively associated with students' reading comprehension. We found no contributions of parents' reading enjoyment and their own reading frequency to their child's reading comprehension. We found significant indirect effects of both the active reading climate and parents' reading enjoyment on students' reading comprehension, mediated through students' reading enjoyment, motivation and reading frequency. Additionally, we found evidence for an indirect pathway from the amount of books at home to students' reading comprehension, mediated by their reading frequency.

Conclusions: Our findings highlight the importance of conceptualizing HLE as a broad construct consisting of multiple components (e.g., activities, beliefs, availability of literacy-related resources at home), as these aspects are related to students' reading comprehension development in different ways.

Keywords: Reading comprehension, Home literacy environment, Reading enjoyment and motivation, Reading frequency, Primary education

Introduction

The ability to understand written texts is of crucial importance in modern-day society. Well-developed reading comprehension abilities are not only the foundation of learning and academic success, but are also required in people's social life, participation in society and economic development (Wieschollek et al., 2018). According to Snow and the RAND Reading Study Group (2002), reading comprehension is the process of actively constructing meaning based on the interaction between the reader and the text, within a larger sociocultural context. The development of reading comprehension can be considered a complex process affected by cognitive characteristics (such as letter knowledge, knowledge of the world and working memory), non-cognitive characteristics (such as reading motivation, self-concept and anxiety) and environmental characteristics (such as home or school literacy environment; Duke & Carlisle, 2010; Katzir et al., 2018; Segal et al., 2018; Sénéchal, 2006; van Bergen et al., 2017).

Given the critical importance of reading, extensive research has already been conducted to identify student characteristics to predict students' reading comprehension abilities (Hjetland et al., 2017). Although studies initially tended to focus on cognitive and non-cognitive student characteristics, Sénéchal's home literacy model (2006) lead to increased attention for the influence of the home literacy environment (HLE) on students' reading comprehension abilities. The HLE can be understood as a multi-componential construct describing the amount and variability of literacy-related stimulation a child receives within the home environment, such as shared reading, library visits and the amount of available books at home (Burgess et al., 2002; Zhang et al., 2020). During the past two decades, extensive research has been conducted on HLE and reading comprehension, reporting in general a positive association (Dong et al., 2020; van Bergen et al., 2017). However, since almost all of these studies solely assumed a direct association, potential mediating relationships remain unclear (Wieschollek et al., 2018). The investigation of such mediating relations is nevertheless of crucial importance to gain a deeper understanding of the specific pathways through which HLE is related to students' reading comprehension abilities.

In the present study, we therefore propose a model that includes both direct paths between students' HLE and their reading comprehension abilities and multiple paths that run via the mediating role of students' reading enjoyment and reading motivation as well as via their reading frequency. These variables are likely to mediate the relationship between HLE and reading comprehension, as previous research has shown that students' reading enjoyment, motivation and frequency are, on the one hand, affected by the HLE (Altun, 2022; Arzubiaga et al., 2002; Baker et al., 1997; Roni & Merga, 2019) and, on the other hand, contribute to the reading comprehension ability of students (Becker et al., 2010; Soemer & Schiefele, 2018; Stutz et al., 2016; Wieschollek et al., 2018; Yang et al., 2018). By incorporating both direct and indirect paths in our model, we gain a deeper understanding of the HLE's direct role in students' reading comprehension, as well as the indirect pathways that involve intermediate student characteristics. This approach effectively captures the complexity of how the HLE shapes reading comprehension.

Following Burgess and colleagues (2002), we distinguish within the HLE an *active* as well as a *passive* component. The active component of the HLE refers to children's direct involvement in literacy-related interactions with their parents, such as playing

word games or shared storybook reading. The passive component of the HLE refers to the context in which children are exposed to a literacy-stimulating environment without active participation. For instance, seeing a parent read a book for enjoyment communicates to the child that this is a desirable activity (Myrtil et al., 2019; Wiescholek et al., 2018). Specific aspects of both the active and passive HLE are separately included in the hypothesized model in the present study, which allows us to examine their individual contribution to students' reading comprehension.

Home literacy environment

Inspired by Bronfenbrenner's (1979) ecological systems theory, which emphasizes the importance of environmental influences in students' learning and development, researchers are increasingly investigating the contribution of a rich HLE in explaining individual differences in students' reading comprehension abilities (Hemmerechts et al., 2017; Manolitsis et al., 2011; Niklas & Schneider, 2013). The increased research attention for the importance of HLE in students' reading comprehension has raised questions about its conceptualization. Much of the early studies on HLE tended to focus exclusively on the frequency of literacy-related activities parents do with their child (e.g., Evans et al., 2008). However, many authors argue that these activities only partially cover the complex construct of HLE, as parents' own beliefs, attitudes, expectations and demographic characteristics may also be an important part of the HLE children are exposed to (Eccles & Harold, 1993). As such, HLE is rather perceived as a complex, comprehensive construct reflecting various components in students' home environment that might contribute to their language and literacy development. This richer and more complete conceptualization of HLE often includes the availability of literacy-related resources at home (e.g., number of books at home), literacy-related activities parents do with their child (e.g., shared book reading, singing songs, playing word games), parents' personal literacy-related attitudes (e.g., considering reading as important, considering themselves good at reading) and parents' literacy-related expectations for their children (e.g., being able to write a story without spelling mistakes; Fish & Pinkerman, 2003; Relyea et al., 2020; Roberts et al., 2005; Silinskas et al., 2020a). The different components are considered to be interrelated rather than being mutually exclusive (Weigel et al., 2006). Moreover, some researchers have argued that these components tend to focus on two main categories: (a) what parents do with their child to support their literacy abilities, referring to the *active HLE*, and (b) in which way parents serve as role models, including their attitudes, beliefs and expectations with regard to language and literacy, known as the *passive HLE* (Gottfried et al., 2015; Pfost et al., 2016; van Tonder et al., 2019; Wiescholk et al., 2018; Yang et al., 2018; Yeo et al., 2014).

The combined results of studies that simultaneously examined the influence of the active and passive HLE in students' reading comprehension abilities are inconclusive. Some studies showed that the active HLE can be considered as a better predictor of students' reading abilities compared to the passive HLE (Bracken & Fischel, 2008; Burgess et al., 2002). However, other studies reported the opposite, indicating that the passive HLE is the stronger predictor (e.g., Rashid et al., 2005). Other authors found no association between the active or passive HLE and students' reading comprehension (e.g., Wiescholek et al., 2018).

Active home literacy environment

According to the information-transfer theory, frequent and regular shared learning experiences between children and their parents are an essential prerequisite in children's reading development (Hindman et al., 2010; McCoach et al., 2006). Through these activities, parents are able to transfer their reading skills and literacy knowledge to their child, allowing them to achieve a higher level that they were unable to reach on their own. The active HLE consists of a wide array of activities that parents do with their children to encourage their literacy development, such as shared storybook reading, playing word games, talking about things they have read, singing songs and telling stories (Lau & Richards, 2021). Despite differences in conceptualizations of the active HLE, most studies indicated a positive association between an active HLE and children's reading comprehension (Baker et al., 1997; Caro, 2018; Sénéchal & LeFevre, 2002; Yang et al., 2018; Yeo et al., 2014) as well as between and active HLE and children's enjoyment and motivation (Baker et al., 1997; Netten, 2010; Wiescholek et al., 2018).

From all activities that are considered part of the active HLE, most research attention went to shared storybook reading, which has been repeatedly linked to students' reading comprehension (Sénéchal, 2006; Yeo et al., 2014), reading motivation (Baker et al., 1997) and reading frequency (Garces-Bacsal & Yeo, 2017; Sénéchal, 2006). Often studied in combination with shared reading is the frequency at which parents and children are talking about what they have read (Georgiou et al., 2021; Hampden-Thompson et al., 2013; Huttenlocher et al., 2010). Snow and colleagues (1998) argued that a dialogue about the book being read may facilitate children's story understanding and can also contribute to their phonological and graphemic skills necessary for reading. In addition, a considerable amount of research has emphasized the importance of storytelling as an aspect of the active HLE (e.g., Jiang et al., 2023; Lewis et al., 2016; Van Steensel, 2006).

Especially in children's early years, literacy-related activities appear to have a positive and significant impact on children's reading development (Hemmerechts et al., 2017). In fact, the longitudinal study of Sénéchal and LeFevre (2002) showed that these early activities in literacy are significantly and positively related to students' later reading achievement as well as to their reading motivation. Gottfried and colleagues (2015) additionally found that these activities appear to be good predictors of students' higher educational attainment. Therefore, it can be assumed that children reap long-term benefits from engaging in literacy-related activities with their parents during early childhood.

Passive home literacy environment

The passive dimension of HLE, as a part of socialization, highlights the importance of a stimulating literacy environment in students' reading development (Bourdieu, 1983). The passive HLE, encompassing all non-actively intended stimulation related to literacy within the home environment, has been investigated sufficiently during the past few years (Wiescholek et al., 2018). Drawing from existing research, three main characteristics of the passive HLE can be identified as predictors of students' reading comprehension abilities: (a) the amount of books at home, (b) parents' reading enjoyment and (c) parents' reading frequency.

The amount of books at home, which can be considered as a core element of the HLE, has been found to play a major role in explaining individual differences in students' reading comprehension, frequency and enjoyment (Bracken & Fischel, 2008; Sénéchal & LeFevre, 2002; van Bergen et al., 2017; Zhang et al., 2020). In contrast to other aspects of the HLE that are mainly focused on the importance of social interactions in students' reading development, the number of books at home emphasizes the critical role of independent literacy activities and resources that contribute to students' development as independent literacy agents (Silinskas et al., 2020b). Students that have more access to books at home are more likely to read and further develop their reading abilities (Bracken & Fischel, 2008). However, in educational literature, the amount of books has been found to strongly correlate with students' socioeconomic status (SES), with numerous studies employing the amount of books as an indicator of students' SES (Heppt et al., 2022). Since prior studies already showed that students' SES could be considered as an important predictor in their reading performance (Evans et al., 2010), it is of crucial importance to study both the amount of books and students' SES simultaneously for a more comprehensive and accurate understanding of these relationships.

During the past decade, the contribution of parents' reading enjoyment in students' reading experiences has received increasing interest from researchers. Especially the role of parents' reading enjoyment in students' reading enjoyment and motivation has been well examined, indicating, in general, a positive association (Ozturk et al. 2016; Pfost et al., 2016; Yeo et al., 2014). This is not surprising, given that parents act as important role models for their children (Bandura, 1977; Wildová & Kropáčková, 2015). Less evidence has been found for the role of parents' reading enjoyment in their children's reading comprehension abilities, as only a few studies have addressed this positive correlation (e.g., Abu-Rabia & Yaari, 2012). Nevertheless, it is likely that parents' reading enjoyment may have an effect on the development of their children's reading comprehension abilities, given their stimulating role in children's reading development (Bingham, 2007).

Parents' reading frequency reflects the amount to which parents are engaged in reading activities, such as reading books, newspapers or magazines. According to the social learning theory (Bandura, 1977), individuals, especially children, observe, model and imitate behaviours of other persons in their environment. Children who observe their parents reading are therefore more likely to also want to read books (Burgess et al., 2002). Research findings of Chen (2008) reported a strong, positive relationship between ninth graders' reading frequency and their parents' reading frequency. Additionally, Garces-Bacsal and Yeo (2017) demonstrated that this relationship also seems to depend on parents' reading objective, as they have found that parents of less avid readers were more likely to read newspapers or work-related materials rather than recreational texts. In contrast, parents of highly avid readers were found to read significantly more frequently for their own enjoyment. Furthermore, studies examining the role of parents' reading behaviour in students' reading comprehension abilities remain relatively limited (Yang et al., 2018). However, since children's reading frequency can be considered as a strong predictor in explaining differences in reading performance, parents' reading frequency might also relate, eventually indirectly, to students' reading performance.

Students' reading attitudes

In the past few years, a growing number of researchers have argued that solely assuming a direct association between the HLE and students' reading comprehension abilities is an oversimplification of this much more complex relation, which is likely to be influenced by other characteristics (Carroll et al., 2019; Wiescholek et al., 2018). In previous studies, students are often treated as passive consumers of information, neglecting the active role of their individual characteristics, such as their own reading attitudes.

Several studies have confirmed a positive association between students' reading attitudes and their reading comprehension abilities (Cheema, 2018; Malanchini et al., 2017). According to Smith (1990), reading attitudes can be defined as a state of mind, accompanied by feelings and emotions, that makes reading more or less probable. Regardless of some minor differences in approach, reading attitudes are mostly conceptualized as a three-dimensional construct, consisting of an affective, a cognitive and a conative component (Breckler, 1984; Eagly & Chaiken, 1993). The *affective* component contains the prevalent feelings and emotions an individual has towards reading (e.g., the enjoyment we experience during reading; McKenna et al., 1995). The *cognitive* component refers to the opinions, beliefs or evaluations an individual attaches to reading (e.g., the motivation we have to read; McGuire, 1969; Park et al., 2008). The *conative* component refers to behavioural intentions or actions an individual undertakes in relation to reading (e.g., the frequency at which we read; Eagly & Chaiken, 1993).

As a part of the affective component of reading attitudes, students' reading enjoyment has been identified as a predictor of reading comprehension achievement (Chiu & Chow, 2015; Malanchini et al., 2017; Rogiers et al., 2020; Tse & Xiao, 2014). Reading enjoyment refers to the feelings of amusement and pleasure a person experiences while reading (Wigfield, 1997). Theorists argue that students who enjoy reading are often more deeply engaged in what they read, which in turn leads to higher reading abilities (Park, 2011). Nevertheless, empirical findings of studies examining the association between students' reading enjoyment and their reading comprehension abilities are mixed (Goux et al., 2017). Cheema (2018) argued that these mixed findings are partly due to inconsistencies across survey items, setting and participation. Therefore, additional research into the association between students' reading enjoyment and reading comprehension is required (McKenna et al., 2012).

In educational literature, the concepts of reading motivation and reading enjoyment are closely related, as these are often used interchangeably and some authors argue that students' reading enjoyment can be considered as a component of their intrinsic reading motivation (Rogiers et al., 2020). Students' *intrinsic* reading motivation can be considered a result of their interest and enjoyment in reading (Deci & Ryan, 2000). In contrast, *extrinsic* reading motivation originates from external sources, which are not part of the reading activity itself, such as rewards or recognition from their teachers or parents (Schiefele et al., 2016). Studies that directly compared the contribution of both intrinsic and extrinsic reading motivation in students' reading comprehension abilities have found that students' intrinsic reading motivation was positively associated with their reading comprehension competencies whereas students' extrinsic reading motivation was negatively related with their reading comprehension abilities (Becker et al., 2010; Schafner & Schiefele, 2016).

Earlier studies identified students' reading frequency, as part of the conative component of reading attitudes, as an important predictor of students' reading comprehension (Garces-Bacsal & Yeo, 2017; Harlaar et al., 2011; Mol & Bus, 2011). Frequent exposure to written texts enables children's knowledge of words, complex sentence structures as well as context information that enhances their capacity to deduce meaning of unfamiliar words which, in turn, enables children to become more proficient in reading comprehension (Mol & Bus, 2011). In contrast, several other studies have not identified a significant correlation between children's reading frequency and reading comprehension (De Naeghel et al., 2012; Wang & Guthrie, 2004). These results suggest that regular reading habits may not consistently contribute to the development of students' reading comprehension. Some students, for example, may lack essential abilities and strategies necessary for effective reading comprehension (Hartman, 2001).

A prevailing hypothesis in educational research posits that the affective and cognitive components of students' reading attitudes are significant predictors of their conative component. In other words, students who derive enjoyment from reading (affective) and appreciate its value and benefits (cognitive) are more likely to engage in reading activities on a regular basis (conative). This hypothesis is supported by multiple empirical studies. For example, Twist and colleagues (2007) found that students who enjoy reading and perceive themselves as competent readers tend to read more frequently. Similarly, De Naegel and colleagues (2012) observed that higher reading motivation correlates with more frequent and positive reading behaviors. Prior research suggests that reading attitudes are strongly influenced by a range of intrinsic and extrinsic characteristics, among which the HLE may play a pivotal role (Wieschollek et al., 2018). However, the literature remains less clear on how different aspects of the HLE interact with the various components of reading attitudes and their impact on students' reading comprehension skills.

Educational context of the present study

The present study was undertaken in Flanders, the northern and Dutch-speaking part of Belgium. Primary education in Flanders is compulsory and comprises six consecutive years of study, starting at the age of six. Before entering primary education, almost all students are enrolled in a pre-primary education program for three to four years. Except for a very small number of exceptions, all schools in Flanders follow a curriculum that aims for their students to reach a set of minimum objectives that were developed by the Flemish government (Denies et al., 2022).

Over the past decade, primary school pupils' achievement in reading in Flanders has been in decline. The PIRLS 2016 results revealed that Flanders had the largest decline in Grade 4 students' average reading achievement between 2006 and 2016 out of all participating countries (Mullis et al., 2017). The results of PIRLS 2021 only confirm this negative trend (Denies et al., 2023). While teachers and schools are often seen as responsible for declining results, we argue that other characteristics—including the HLE and students' reading motivation and behaviour—can play a role as well. Indeed, the background questionnaires of PIRLS 2021 reveal that Flemish parents do not invest as profoundly in preschool literacy activities as parents from other countries. Flanders also does not score well on parents' enthusiasm for reading. Additionally, Flemish Grade 4 students have one of the lowest average scores for reading enjoyment and motivation

(Mullis et al., 2023). Against this background, the examination of various aspects of HLE together with students' reading enjoyment, reading motivation and reading frequency is critical in order to fight the declining literacy achievement trend in Flanders.

The current study

Despite extensive research on the association between the HLE and students' reading comprehension, the underlying mechanisms, including potential mediating relationships, remain ambiguous (Wiescholek et al., 2018). The current study aimed to extend previous research by examining the effects of two potential mediating variables—namely students' reading enjoyment and motivation as well as their reading frequency—within the relationship of HLE and fourth graders' reading comprehension abilities. In line with Burgess and colleagues (2002), we consider HLE as a multi-componential construct that can be distinguished as either active or passive. Since we include specific aspects of both the active HLE as well as the passive HLE in our model, we are able to examine the individual contribution of each of these elements to students' reading comprehension abilities. Based on our literature review, we propose the theoretical model depicted in Fig. 1, which contains the following hypotheses:

H1: Active reading climate (H1a), amount of books at home (H1b), parents' reading enjoyment (H1c) and parents' reading frequency (H1d) directly and positively affect students' reading comprehension.

H2: Students' reading enjoyment and motivation (H2a) and reading frequency (H2b) positively affect their reading comprehension.

H3: Active reading climate (H3a), amount of books at home (H3b), parents' reading enjoyment (H3c) and parents' reading frequency (H3d) positively affect students' enjoyment and motivation.

H4: Active reading climate (H4a), amount of books at home (H4b), parents' reading enjoyment (H4c) and parents' reading frequency (H4d) positively affect students' reading frequency.

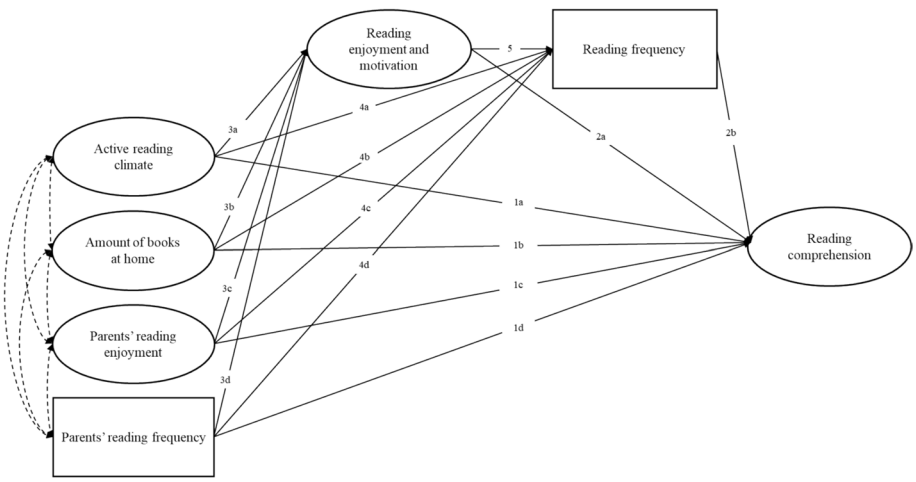

Fig. 1 Hypothesized theoretical model of HLE and its association with students' reading comprehension mediated by their (1) reading enjoyment and motivation and (2) reading frequency

H5: Students' reading enjoyment and motivation positively affect students' reading frequency.

In addition to the aforementioned hypotheses, the present study aimed to test the following hypotheses that suggest indirect relationships:

H6: Active reading climate (H6a), amount of books at home (H6b), parents' reading enjoyment (H6c) and parents' reading frequency (H6d) affect students' reading comprehension through students' reading enjoyment and motivation.

H7: Active reading climate (H7a), amount of books at home (H7b), parents' reading enjoyment (H7c) and parents' reading frequency (H7d) affect students' reading comprehension through students' reading frequency.

H8: Active reading climate (H8a), amount of books at home (H8b), parents' reading enjoyment (H8c) and parents' reading frequency (H8d) positively affect students' reading comprehension through students' students' reading enjoyment, motivation and reading frequency.

Method

Sample

The current study reports on Flemish data from the fifth international cycle of PIRLS (2021), an international large scale assessment program measuring students' reading achievement in Grade 4. Schools were recruited by means of a national implicitly (according to school size and region) and explicitly (according to source of funding: private/official; and school composition: low, medium, or high average score on an indicator of students' at-risk status) stratified clustering strategy. Primary schools with four or fewer students in Grade 4, schools with French as the language of instruction and schools that only offer special education to students with a visual impairment were excluded from the sampling frame. Within the selected schools, all fourth-grade students were eligible to participate, except those who (1) had a physical impairment or (2) severe learning disability that prevented them from participating or (3) had only received education in Dutch (the language of instruction) for one year or less and were not sufficiently proficient in Dutch to understand and complete the assessments. In addition, parents had the option to refuse their child's participation through an opt-out procedure. The Flemish sample met the PIRLS 2021 standards for sampling participation and is considered representative. The final sample consisted of 5114 students (50.75% boys; 49.25% girls, $M_{age} = 10.00$ years, $SD_{age} = 0.51$) from 141 schools in Flanders.

Procedure

Data were collected during the spring of 2021. Fourth-grade students were given two sessions of 40 min to complete a standardized reading comprehension assessment. The present study reports on data of students participating in digitalPIRLS, meaning that they completed the assessment via a digital platform. The assessments took place in their own school during class hours, under the supervision of an independent test administrator. Afterwards, the students received a questionnaire that included questions about their background characteristics, reading motivation, and behaviour. The students' parents also filled out a questionnaire, tapping into various aspects of the active and passive HLE.

Measures

All assessments and questionnaires were administered in Dutch. Items in the questionnaires that were phrased negatively (e.g., "reading is boring" as an indicator for student's reading enjoyment and motivation) were reverse-coded before they were added to the model (for a complete list of the reverse-coded items, see Appendix A).

Reading comprehension

The students' level of reading comprehension was assessed using standardized reading assessments of PIRLS 2021. Similar to other large-scale assessments such as the Programme for International Student Assessment, PIRLS generates five plausible proficiency values to account for measurement uncertainty and variability in students' ability estimates. These values are derived using item response theory and multiple imputation methods (Maehler & Rammstedt, 2020). Both responses to the assessment items and background characteristics are included in the estimation of plausible values (von Davier et al., 2023). To analyze the relationships between predictors and reading comprehension, we conducted statistical analyses independently for each plausible value in the PIRLS database. Subsequently, the parameter estimates from these analyses are aggregated to produce final estimates. Based on item response theory and multiple imputation, a total of five plausible values per student were generated in order to minimize measurement error in students' ability estimates (Maehler & Rammstedt, 2020). Both the responses to the included assessment items as well as background characteristics were taken into account in the estimation of the plausible values (von Davier et al., 2023). The average of the measurement scale of PIRLS was set at 500 with a standard deviation of 100 across the participating countries during the first PIRLS cycle in 2001 (Mullis et al., 2023).

Home literacy environment

Active home literacy environment

Students' active home literacy environment was measured using an adapted version of the *Early Literacy Activities Before Beginning Primary School (ELA)* scale (Mullis & Martin, 2019) included in the parent questionnaire of PIRLS. Specifically, the number of items was reduced from 9 to 3 items, as these items (i.e., shared book reading, storytelling and talking about what they read) were considered as main indicators of an active home literacy environment (Hargrave & Sénéchal, 2000; Wasik & Bond, 2001), more so than, for instance, reading aloud signs and labels. Parents were asked to report the frequency of these activities based on the following 3-point scale: (1) often, (2) sometimes or (3) never or almost never.

Passive home literacy environment

For the passive home literacy environment, three components included in the PIRLS parent questionnaire were used: (1) the amount of books at home, (2) parents' reading enjoyment and (3) parents' reading frequency.

Amount of books at home was measured using a scale that consists of two indicators: the total number of books in the household and the number of children's books

present. Considering the amount of books at home as a latent construct composed of these two indicators provides a more nuanced understanding of the amount of books at home, capturing both general and child-specific reading materials.

Parents estimated the total number of books in the household on a 5-point scale (0–10; 11–25; 26–100; 101–200; more than 200) and the number of children's books on a 5-point scale (0–10; 11–25; 26–50; 51–100; more than 100).

Parents' reading enjoyment was assessed using the *Parents Like Reading* (PLR) scale (Mullis & Martin, 2019). Parents rated their reading enjoyment through 7 items using a 4-point Likert-type scale: (1) agree a lot, (2) agree a little, (3) disagree a little or (4) disagree a lot. These items included for instance "I read only if I have to" and "I like talking about what I read with other people" (for all statements, see Mullis & Martin, 2019).

Parents' reading frequency was measured based on the frequency at which parents read for their own enjoyment at home using a single item on a 4-point Likert-type scale: (1) every day or almost every day, (2) once or twice a week, (3) once or twice a month and (4) never or almost never.

Reading attitudes

Reading enjoyment and motivation

Students' reading enjoyment and motivation was measured by all 8 items of the question "What do you think about reading?" included in the student questionnaire of PIRLS (Mullis & Martin, 2019). Students were asked to rate items including "I like talking about what I read with other people" and "I would be happy if someone gave me a book as a present" on a 4-point Likert-type scale: (1) agree a lot, (2) agree a little, (3) disagree a little, (4) disagree a lot (for all statements, see Mullis & Martin, 2019).

Reading frequency

In order to measure the reading frequency of students, the student questionnaire asked about the amount of time they spend reading outside of school on a normal school day using a 4-point scale: (1) less than 30 min, (2) 30 min up to 1 h, (3) from 1 h up to 2 h and (4) 2 h or more.

SES

Students' SES was included in our model as a control variable, as prior research repeatedly showed that SES correlates significantly with students' reading comprehension abilities (Evans et al., 2010). We categorized students' SES into three levels (0 = low SES; 1 = medium SES; 2 = high SES) based on data that we received from the Flemish Government. Specifically, we computed the sum of two binary indicators: (1) whether the students' household receives an education allowance and (2) whether the student's mother had completed secondary education.

Analyses

To assess relationships between the variables, a serial mediation model (as visualized in Fig. 1) was tested using structural equation modelling (SEM). Both students' reading enjoyment and motivation as well as their reading frequency were included as mediating variables between HLE and reading comprehension.

All SEM analyses were conducted with Mplus version 8 (Muthén & Muthén, 2017). All parameters were estimated using maximum likelihood estimation. All variables were standardized (mean: 0, standard deviation: 1) using the STDYX option in Mplus. We accounted for the clustering strategy by including the house sampling weights provided by the IEA (for more information, see Mullis & Martin 2019). In order to estimate the standard errors, we applied the jack-knife replication procedure (Raghunath, 2017). Since model fit indices are not provided when applying replication methods, we employed a two-step approach to obtain these indices (Little et al., 2007). In the first step, we ran the model without replicate weights to generate the necessary model fit indices. In the second step, we re-ran the model incorporating the replicate weights and used the resampling technique to obtain accurate standard errors.

Model fit was evaluated using five widely applied fit indices (Kline, 2016), including the χ^2 goodness-of-fit statistic, the root mean square error of approximation (RMSEA), the standardized root mean square residual (SRMR), the comparative fit index (CFI) and the Tucker-Lewis coefficient (TLI). As suggested by Hu and Bentler (1999), the following criteria indicated a relatively good model-data fit: RSMEA < 0.06, SRMR < 0.08, CFI > 0.95, TLI > 0.95.

Alongside evaluating the indirect effects in the mediation model using regression coefficients and standard errors, we employed the proportion of the mediated effect (PM; Fairchild & McDaniel, 2017) as an additional measure to enhance our understanding of the findings. The proportion mediated effect size quantifies the extent to which the total effect is mediated, calculated as the ratio of the mediated effect to the total effect.

Results

Descriptive results

Descriptive statistics and zero-order Pearson correlation coefficients of all variables included in this study are presented in Table 1. These composite measures are based on summative scores that are only used for these descriptive analyses and are not integrated in the structural equation models. As can be seen in Table 1, all examined correlations are statistically significant ($p < 0.001$). The strongest correlations can be found between parents' reading enjoyment and parents' reading frequency ($r = 0.409$, $p < 0.001$) as well as between the amount of books at home and parents' reading enjoyment ($r = 0.485$,

Table 1 Descriptive statistics and zero-order Pearson correlation coefficients of all independent variables. *** $p < 0.001$

	Mean	SD	α	1	2	3	4	5	6
Continuous variables									
1. Active reading climate	2.320	0.478	0.558	–					
2. Amount of books at home	2.865	1.126	0.780	0.390***	–				
3. Parents' reading enjoyment	2.932	0.742	0.897	0.409***	0.485***	–			
4. Students' reading enjoyment and motivation	2.868	0.780	0.870	0.145***	0.161***	0.196***	–		
Categorical variables									
5. Parents' reading frequency	2.870	1.097	–	0.318***	0.359***	0.639***	0.134***	–	
6. Students' reading frequency	1.650	0.885	–	0.098***	0.158***	0.138***	0.304***	0.126***	–

SD = standard deviation, α = Cronbach's alpha

$p < 0.001$). Means, standard deviations and sample sizes of all scales are included in Appendix A. A series of preliminary analyses—including an examination of potential outliers, deviations from normality and multicollinearity (Kline, 2016)—indicated that the data meet the required statistical assumptions for SEM.

Structural equation model

The hypothesized model was tested using structural equation modelling. The statistics revealed that the initial model had a reasonable fit, $\chi^2(234) = 3718.606$, $p < 0.001$, RMSEA = 0.054, SRMR = 0.057, CFI = 0.890 and TLI = 0.871. A correlation between the error terms of two items regarding reading enjoyment and motivation ("I think reading is boring" and "I enjoy reading") and again two items of parents' reading enjoyment ("I enjoy reading" and "I would like to have more time for reading") was allowed, taking into account the similarities between these pairs of items. These changes resulted in a modified model with a good fit $\chi^2(232) = 2977.238$, $p < 0.001$, RMSEA = 0.049, SRMR = 0.057, CFI = 0.914, TLI = 0.897. In addition, the model accounts for 15.7% of the variance in students' reading comprehension, 5.3% of the variance in students' reading enjoyment and motivation and 11.6% of the variance in students' reading frequency.

Standardized beta coefficients of the final structural equation model, measuring associations between various components of the HLE, students' reading comprehension and motivation, their reading frequency and reading comprehension abilities are summarized in Fig. 2. The amount of books at home ($\beta = 0.186$, $p < 0.001$), active reading climate ($\beta = 0.179$, $p < 0.001$) and students' reading frequency ($\beta = 0.070$, $p < 0.01$) positively affected fourth graders' reading comprehension abilities. However, parents' reading enjoyment ($\beta = 0.001$, $p > 0.05$), parents' reading frequency ($\beta = -0.027$, $p > 0.05$) and students' reading enjoyment and motivation ($\beta = 0.010$, $p > 0.05$) were not significantly

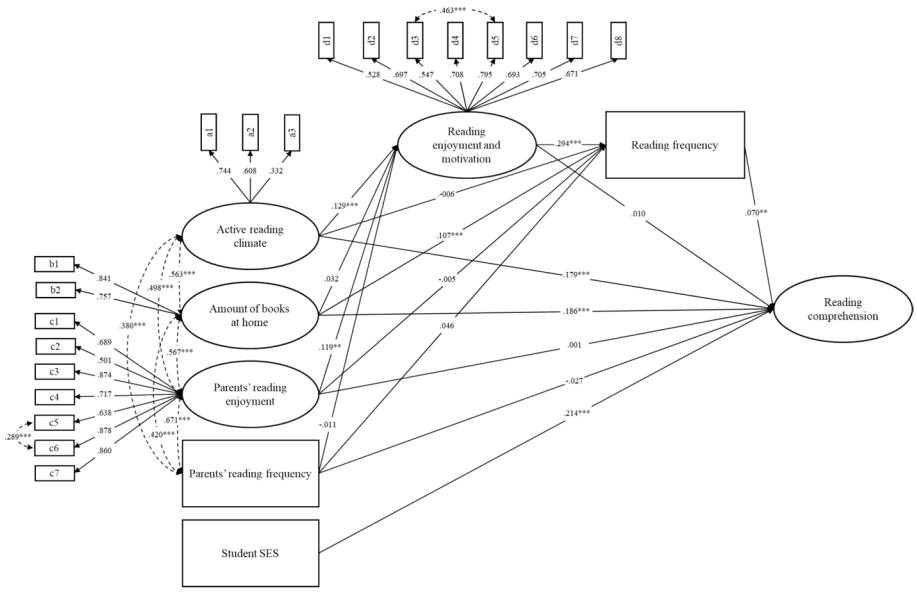

Fig. 2 HLE and its association with students' reading comprehension mediated by their (1) reading enjoyment and motivation and (2) reading frequency. Standardized beta coefficients with * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

related to fourth graders' reading comprehension abilities. Furthermore, active reading climate ($\beta = 0.129$, $p < 0.001$) and parents' reading enjoyment had a positive impact on students' reading enjoyment and motivation ($\beta = 0.119$, $p < 0.001$). Additionally, the amount of books at home ($\beta = 0.107$, $p < 0.001$) and students' reading enjoyment and motivation ($\beta = 0.294$, $p < 0.001$) positively affected students' reading frequency ($\beta = 0.107$, $p < 0.001$).

Regarding the mediation of the relationship between various aspects of the HLE and reading comprehension through students' reading enjoyment and motivation or via their reading frequency (Table 2), only one significant indirect path was established, being the mediating relationship of students' reading frequency in the association between amount of books at home and reading comprehension ($\beta = 0.008$, $p < 0.05$). More specifically, we found that the number of books at home is positively related to students' reading frequency and this contributes, in turn, to students' reading comprehension performance. Furthermore, a small but significant indirect effect was found when reading enjoyment and motivation led to reading frequency, which in turn influenced reading comprehension ($\beta = 0.003$, $p < 0.05$). This suggests that an active reading environment in the home may influence children's reading comprehension, primarily through increased reading enjoyment and frequency. Parents' reading enjoyment exhibited a significant

Table 2 Indirect effects, total indirect effects and total effects of the final structural equation model

	B	*SE*	*PM*
Indirect effects			
Active reading climate → reading enjoyment and motivation → RC	0.001	0.003	0.005
Active reading climate → reading frequency → RC	0.000	0.002	0.000
Active reading climate → reading enjoyment and motivation → reading frequency → RC	0.003*	0.001	0.016
Amount of books at home → reading enjoyment and motivation → RC	0.000	0.001	0.000
Amount of books at home → reading frequency → RC	0.008*	0.003	0.041
Amount of books at home → reading enjoyment and motivation → reading frequency → RC	0.001	0.001	0.005
Parents' reading enjoyment → reading enjoyment and motivation → RC	0.001	0.003	0.250
Parents' reading enjoyment → reading frequency → RC	0.000	0.002	0.000
Parents' reading enjoyment → reading enjoyment and motivation → reading frequency → RC	0.002*	0.001	0.500
Parents' reading frequency → reading enjoyment and motivation → RC	0.000	0.001	0.000
Parents' reading frequency → reading frequency → RC	0.003	0.002	0.125
Parents' reading frequency → reading enjoyment and motivation → reading frequency → RC	0.000	0.001	0.000
Total indirect effects			
Active reading climate → RC	0.003	0.003	0.016
Amount of books at home → RC	0.009*	0.003	0.046
Parents' reading enjoyment → RC	0.003	0.003	0.750
Parents' reading frequency → RC	0.003	0.002	0.125
Total effects			
Active reading climate → RC	0.182***	0.035	–
Amount of books at home → RC	0.195***	0.038	–
Parents' reading enjoyment → RC	0.004	0.030	–
Parents' reading frequency → RC	−0.024	0.028	–

RC = reading comprehension

Standardized beta coefficients with * $p < 0.05$, *** $p < 0.001$

indirect pathway to reading comprehension, mediated by both reading enjoyment and motivation, followed by reading frequency ($\beta = 0.002$, $p < 0.05$). This finding suggests that when parents enjoy reading, it may indirectly foster their children's motivation to read, resulting in more frequent reading and, ultimately, enhanced reading comprehension. Notably, the PM is relatively high at 0.500, indicating that this indirect pathway plays a crucial role in understanding how parents' reading enjoyment influences students' reading comprehension. The investigation of the total indirect effects (Table 2) confirmed the findings that only the amount of books at home significantly contributes to students' reading comprehension abilities ($\beta = 0.009$, $p < 0.05$). Finally, only the total effects of active reading climate ($\beta = 0.182$, $p < 0.001$) and the amount of books at home ($\beta = 0.195$, $p < 0.001$) were significantly related to fourth graders' reading comprehension.

Discussion

Following Bronfenbrenner's (1979) ecological systems theory, a large amount of research has already confirmed the positive association between students' reading comprehension abilities and their HLE (Dong et al., 2020). However, studies examining potential mediating relationships remain scarce (Wiescholek et al., 2018). We extended the existing body of literature on students' reading comprehension by investigating possible associations between specific aspects of the HLE and Grade 4 students' reading comprehension abilities through their reading enjoyment and motivation as well as reading frequency. We distinguished the HLE as either *active*—where parents and their children actively participate in literacy activities—or *passive*—in which the child may be stimulated without being involved in any activities (Burgess et al., 2002; Wiescholek et al., 2018). The contribution of each of the aspects of both the active and passive HLE in students' reading performance was examined using a serial mediation structural equation model.

We first hypothesized that each aspect of both the active and passive HLE would positively affect students' reading comprehension performance (Hypothesis 1). This hypothesis was only partially confirmed because not all aspects of a rich HLE effectively contributed to students' reading comprehension abilities. In line with previous research on the role of an active reading climate in students' reading development (Baker et al., 1997; Sénéchal & LeFevre, 2002), the present study found a positive association between the frequency of early literacy activities—namely shared book reading, telling stories and talking about what they have read—and students' reading comprehension performance in Grade 4 (H1a). An even stronger association has been found between the amount of books at home and students' reading comprehension (H1b). These findings were consistent with earlier research of Netten et al. (2010) and van Bergen et al. (2017). Students who have access to a larger amount of books at home may be more likely to read and further develop themselves as independent readers (Bracken & Fischel, 2008; Silinskas et al., 2020b).

Conversely to H1a and H1b, we did not find support for the hypothesized relation between parents' reading enjoyment and their children's reading comprehension (H1c). This finding was not surprising, given that there were only a limited number of earlier studies that reported a positive association between parents' reading enjoyment and their children's reading comprehension (e.g., Abu-Rabia & Yaari, 2012). Similarly, no evidence has been found that parents' reading frequency relates to students' reading

comprehension (H1d). Although the literature concerning this relationship was rather scare, our findings countered the conclusion of Yang and colleagues (2018), who did find a positive association between parents' reading frequency and their children's reading performance. A possible explanation for our results might be that parents' reading frequency only has an impact when students are actually observing their parents reading, i.e., the link is probably weaker if parents only read for pleasure when their children are not around (Mullan, 2010). This finding may therefore be in line with Bandura's social learning theory (1977), which states that learning occurs through observation, imitation and modelling.

In addition, we hypothesized that students' reading attitudes were positively related to students' reading comprehension (Hypothesis 2). Again this hypothesis was only partially confirmed, as we did not find any evidence to support the assumption that students' reading enjoyment and motivation was positively related to students' reading comprehension (H2a). This finding was not in line with other studies that established the mutual relationship between students' reading enjoyment and motivation and their reading comprehension (Malanchini et al., 2017; Rogiers et al., 2020). A potential explanation for these conflictual findings might be the differences in conceptualizations of reading enjoyment and motivation across studies. According to Baker and Wigfield (1999), reading motivation is a multi-dimensional construct, consisting of eleven dimensions (i.e., reading efficacy, challenge, work avoidance, curiosity, involvement, importance, recognition, grades, competition, social and compliance). Since most studies only partially covered the complex construct of reading motivation, measuring different dimensions of reading motivation, research findings remained scattered (Malanchini et al., 2017; Schiefele et al., 2016). Additionally, there is a possibility that our quite broad and general operationalization of the concept 'reading enjoyment and motivation' may have failed to adequately encapsulate the subtleties inherent in these constructs.

Furthermore, we did find evidence for a significant, positive relationship between students' reading frequency and reading comprehension (H2b). This is in line with the findings of Garces-Bacsal and Yeo (2017), who already argued that students who read more tend to develop better reading comprehension abilities. However, prior research has shown that there is no point in forcing students to read for pleasure more frequently, as they will only read more often outside of school when they have materials that match their level, interest and needs (Garces-Bacsal & Yeo, 2017). Specifically, Merga (2017) identified five themes that would encourage students to read more frequently: finding engaging books, series adherence, challenge seeking, skill deficit and time availability. For this reason, parents and teachers should support students in choosing the right book regarding interest and reading level as well as make time for them to read during leisure-time.

Additionally, consistent with the findings of Twist et al. (2007) and De Naegel et al. (2012), our model demonstrated a significant positive contribution of students' reading enjoyment and motivation to their reading frequency (Hypothesis 5). This finding underscores the importance of fostering a positive attitude toward reading, as students who find enjoyment in reading and feel motivated are more likely to engage in reading activities regularly.

Furthermore, we examined whether aspects of the active and passive HLE were associated with students' reading enjoyment and motivation (Hypothesis 3). The present study confirmed that the active reading climate (H3a) and parents' reading enjoyment (H3c) made independent contributions to students' reading enjoyment and motivation. This result confirmed the findings of previous studies showing that these aspects of the HLE were related to students' reading enjoyment and motivation (Garces-Bacsal & Yeo, 2017; van Bergen et al., 2017; Zhang et al., 2020). The strongest association was found between an active reading climate at home and students' reading enjoyment and motivation, indicating the crucial role of home literacy activities between parents and their young children. Contrarily, we did not find evidence for the impact of the amount of books at home (H3b) and parents' reading frequency on their children's reading enjoyment and motivation (H3d). Regarding this last hypothesis, the absence of an effect might be explained by the possibility that parents' reading frequency only has an impact on students' enjoyment and motivation when students are actually observing their parents reading or when parents discuss their enthusiasm about what they are reading with their children. The latter would be part of the active HLE for which our analyses revealed that it does play an active part on shaping students' reading enjoyment and motivation.

Regarding the relation between aspects of the HLE and students' reading frequency (Hypothesis 4), this study only revealed a positive association between the amount of books at home and fourth graders' reading frequency (H4b). With this finding, we confirmed our prior assumption that students who are exposed to many books at home read more frequently compared to students with a smaller amount of books at home (Mol & Bus, 2011; Schiefele et al., 2012). Besides this positive association, no evidence was found for effects of the active reading climate (H4a), parents' reading enjoyment (H4c) and their reading frequency (H4d) on students' reading frequency. These findings were surprising, as previous studies widely acknowledged the contribution of these aspects on students' reading frequency (Garces-Bacsal & Yeo, 2017; Harlaar et al., 2011; Mol & Bus, 2011).

Finally, the present study extends previous research by examining the potential indirect effects of students' reading enjoyment and motivation, as well as their reading frequency, within the context of various aspects of the HLE and students' reading comprehension performance (Hypotheses 6, 7 and 8). The findings indicate significant indirect effects of both an active reading climate and parents' reading enjoyment on students' reading comprehension, mediated by students' reading enjoyment, motivation and reading frequency. Additionally, we identified an indirect pathway from the amount of books at home to students' reading comprehension, mediated by their reading frequency. Although the effect sizes were relatively small (ranging from $\beta = 0.002$ to $\beta = 0.008$), they nonetheless highlight meaningful relationships between these variables. Importantly, these indirect effects account for a substantial proportion of the total effects; for example, the indirect effect of parents' reading enjoyment on students' reading comprehension—mediated through students' reading enjoyment, motivation, and reading frequency—constitutes 50 percent of the total effect of parents' reading enjoyment on students' reading comprehension, underscoring the significance of these indirect pathways.

Limitations and suggestions for future research

The generalizability of these results is subject to certain limitations. First, since the present study relied on cross-sectional data, the relationships between HLE, students' reading attitudes and their reading comprehension abilities should be interpreted with careful consideration of the study's design (Wang & Cheng, 2020). Examining all variables at the same point in the school year precludes the detection of causal effects. However, our model specification adhered to structural effect expectations consistent with the literature on reading comprehension. Thus, despite using cross-sectional data, our findings significantly contribute to understanding the role of HLE and students' reading attitudes in reading comprehension. Nevertheless, using longitudinal data in future studies (e.g., PIRLS 2026) is recommended to gain a clearer understanding of the precise direction of these relationships.

Second, aspects of HLE and students' reading attitudes were assessed on the basis of self-report measures by fourth-grade students as well as their parents, which are susceptible to social desirability and response bias (Krumpal, 2013). Additionally, the number of items which were used to measure our latent concepts were relatively small (e.g., 3 items were used to measure the concept of an active HLE). Despite the fact that we cannot guarantee the absence of bias in our measures of HLE and students' reading attitudes, it seems unlikely given the high variability in the distribution of responses. Although these self-report measures are commonly used to assess HLE, future studies might also consider the use of observational measures to enrich and verify the present findings.

Third, the measure for the amount of books at home has become more complex over the years, as digital reading materials and e-readers have become more frequently used, with the consequence of the perceived unnecessity of paper books at home. Since literature on the contribution of e-books at home in students' reading comprehension abilities remains relatively scarce (Heppt et al., 2022), further research might contribute by examining the digitalization of the reading climate at home and, in turn, its role in the development of students reading comprehension abilities.

Theoretical and practical implications

The present study has some important theoretical and practical implications. From a theoretical perspective, we nuanced the widely accepted assumption that creating a rich HLE contributes to students' reading development. We showed that various aspects of the HLE were differently related to fourth graders' reading comprehension, as we only found positive contributions of an active reading climate and the amount of books at home. Regarding the investigation of indirect effects of students' reading attitudes within the relation between HLE and reading comprehension, we only found evidence for a positive contribution of the amount of books at home to students' reading frequency, which, in turn, led to higher reading comprehension abilities.

From a practical perspective, this study has three main implications. First, we stipulated the inevitable role of parents in children's reading comprehension development, not so much by being quiet readers themselves but particularly when they engage in or enable active home literacy activities. For this reason, in addition to the optimisation of

reading education at schools, we must also focus on strengthening the reading climate at home in Flanders. For instance, even after the transition to the first grade, shared storybook reading between parents and their children should be stimulated. Reading days and other initiatives can help to raise awareness concerning the importance of shared reading and to ensure sustained efforts. Second, we recommend to invest in the availability of books and other reading materials. The availability of a diverse, up-to-date range of books is a crucial building block of a high-quality reading environment. Additionally to all types of voluntary initiatives, creating partnerships between schools and local libraries can be a step in the right direction in creating a rich reading environment for all students. Third, we advise to further invest in early literacy activities at home. Currently, Flemish parents tend to engage in such activities to a limited extent, while there is an evident correlation with later reading performance. We advise to foster partnerships among schools, municipalities and other supporting organizations, which can take on a more active role in promoting and educating parents, in order to encourage and facilitate early literacy activities at home.

Conclusion

The present study examined relationships between students' reading enjoyment, motivation, frequency, different aspects of the active and passive HLE and reading comprehension of Grade 4 students. Using a serial mediation model with Flemish data from PIRLS 2021, we found positive associations between students' active reading climate, the amount of books at home and their reading comprehension. No relationships were found between parents' reading enjoyment, their reading frequency and students' reading comprehension. We found significant indirect effects of both the active reading climate and parents' reading enjoyment on students' reading comprehension, mediated through students' reading enjoyment, motivation, and reading frequency. Furthermore, we identified an indirect pathway from the amount of books at home to students' reading comprehension, mediated by their reading frequency. Our findings highlight the importance of conceptualizing HLE as a broad construct consisting of multiple components (e.g., activities, beliefs, availability of literacy-related resources at home), as these aspects are related to students' reading comprehension development in different ways.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40536-024-00233-8.

Additional file 1.

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Author contributions
RC was in charge of conceptualization, formal analysis, methodology, visualization and writing of the original draft. JL was in charge of conceptualization, formal analysis, methodology, reviewing and editing. KD was in charge of funding acquisition, conceptualization, data collection, supervision, and reviewing and editing. NB was in charge of conceptualization, data collection, reviewing and editing. JD was in charge of conceptualization, methodology, 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 is available in the PIRLS repository, PIRLS | IEA.nl.

Declarations

Competing interests
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